Agrammatic Comprehension of Empty Categories in English

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Abstract This paper reports an experiment on Broca's aphasics' comprehension of a class of English constructions involving empty categories. Based on Grodzinsky's (1986) account of chance-level performance of agrammatic understanding of movement constructions and their thematic role assignments, I show that Grodzinsky's notion of invisible empty categories can be further extended to include pronomical anaphors (PRO's) in Chomsky's (1981) sense and that the asymmetry in their poor comprehension of subject- and object-control constructions can be explained by the heuristic mechanism of the default thematic role assignment rule, eventually supporting Grodzinsky's claim that empty categories are not visible in agrammatic's syntactic representation.

Keywords agrammatic, Broca's aphasia, empty category, pronominal anaphor, thematic roles

1. BACKGROUND

In most constructions of English, the semantic interpretation regarding the participant roles is determined by an NP's syntactic position in the surface structure.[1] For example, consider the following sentence:

(1) The dog chased the cat.

The first NP is assigned the thematic role of agent while the second NP gets that of a theme as they appear in positions that typically induce an agent and a theme role, respectively. This is the explanation of English speakers' comprehension of those constructions in the tradition of principles and parameters theory of syntax consummated in Chomsky (1981).

The semantic roles of noun phrase participants in so-called movement constructions, on the other hand, are determined in an indirect way, namely by way of the empty categories that are posited in the original position. The passive counterpart of (1) above is analyzed as involving a bit abstract representation as follows:

(2) [$_{NP}$The cat]$_i$ is chased [$_{NP}$ e]$_i$ by the dog.

The first NP in this construction is not assigned an agent role; it has to be assigned a theme role instead. Note, however, that it does not appear in a position that is directly assigned the theme role. This is possible because *the cat* is co-indexed with the empty category [$_{NP}$ *e*]$_i$, a phonetically null

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element, which is assigned the theme role. *The cat* in its present position inherit the role by participating in the chain ⟨the cat_i, e_i⟩ whose tail is assigned the role, according to the principles and parameter theory.

An emerging question in the neurolinguistic circle is whether these empty categories are visible to aphasic patients. That is, will a patient with a lesion in the brain be able to correctly assign the necessary semantic roles to noun phrases that occur in such movement constructions? This is what Grodzinsky (1986) attempted to account for.

Since Caramazza and Zurif (1976) observed that Broca's aphasics tend to show poor comprehension of certain types of English sentences including passives, relative clauses and it-cleft constructions, agrammaticism has been a focus of attention among neurolinguists. Specifically, those patients diagnosed as Broca's aphasic tend to randomly assign semantic roles to noun phrases in such derived constructions.

Grodzinsky (1986, 1989) adopted a highly formal approach to account for the asymmetrical comprehension in those constructions. He argues that agrammatic patients lack empty categories in their syntactic representation and the semantic role assignment is largely determined by a heuristic default principle. The following is Grodzinsky's formulation of rules for normal semantic role assignment:

(3) Thematic Role Assignment

a. NPs in theta-positions have thematic roles assigned to them.
b. An NP in a non-thematic position can inherit the role of a thematic position if and only if it heads a chain that has a theta position as a member.

On the other hand, in agrammatics, the moved NP cannot inherit the thematic role assigned to the trace position as traces are not visible in agrammatics' representation. Instead, they rely on an auxiliary mechanism, namely his Default Principle:

(4) Default Principle

An NP which has not been assigned a thematic role should be assigned a theta role according to a list which universally associates default values to positions.

Grodzinsky argues that in English, the default value for the clause-initial position is the role of agent. Thus the agent role is assigned to the subject of passive sentences. He argues that agrammatics sometimes rely on this default principle or sometimes on the normal syntactic principles, which means that traces are sometimes visible to them or sometimes invisible to them. Thus each instance of chance-level performances among the agrammatic patients can be precisely captured.

For example, the following would be the agrammatic patients' syntactic representation for (2) above, according to Grodzinsky (1986), in which there is no empty trace next to the role assigner:

(5) $[_{NP}$The cat$]_i$ is chased by the dog.

Grodzinsky's explanation goes as follows: Since those patients lack any empty categories properly represented in the derived structure, and thus there is no chain established by proper co-indexing, a prerequisite for correct semantic role inheritance in such derived constructions, the dog is not assigned its theme role. Instead, the patients resort to the default principle which in English assigns the agent role to a sentence-initial (or clause-initial, to be precise) noun phrase. Thus, in (5), *the cat* ends up with an agent role. This agent role clashes with the role assigned to *the dog*, which happens to be another agent by the agentive preposition *by*. Note that the prepositional object is assigned an agent role as the preposition is semantically prominent and is rarely ignored in agrammatics' syntactic representation.[2] This means when the

2) Levelt (1978) observed that *to* in English is less likely to be deleted when used as a preposition than as an infinitive marker. This may be due to the semantic nature of prepositions in general: they tend to

patient is presented with pictures to choose in picture matching tasks, their performance will remain at the chance level because the same role assumed by two noun phrases forces the subject to randomly choose a picture where either *the cat or the dog* is the agent. Their chance level performance is predicted.

Grodzinsky (1989) further extends the range of his data to include other constructions derived by transformational operations, such as relative clauses and it-cleft constructions, which are all derived by applying the rule of movement in Chomsky's (1981) sense. One of the common properties shared by those constructions and the passive sentences above is that they all involve a movement of a phrase leaving an empty category in the original position where the semantic role is assigned. The conjecture is that those constructions will be processed in a similar manner, leaving the agrammatic patients confused with the dual agent role and they randomly choose a picture. Their chance level performance in sentence comprehension tests are in fact extended to all constructions that involve empty categories in normal syntactic representation, regardless of the nature of the empty category in question. NP-traces and wh-traces are treated in the same manner in Grodzinsky's (1989) analysis.[3] They nicely fit into his analysis and the patients' performance was correctly predicted.

2. PRONOMINAL ANAPHORS: PRO

There is yet another type of empty category in the principles and parameter theory of syntax, namely PROs, which are similar to traces left behind after movement of a phrase. They are similar as they are a theoretical artifact, phonetically unrealized. Furthermore, they have to be assigned a thematic role for the completeness of meaning. They are said to occupy the subject position of an infinitival clause. For example, the syntactic representation of (6) below will look like the following:

(6) John promised to leave.
(7) John promised [PRO] to leave.

The rough idea of postulating PRO in this position goes like this: traditionally, a predicate is a device that predicates of an argument. So in (7) above, *John* is understood as the agent of promising act, and at the same time, as the agent of leaving. Note that there is only one word *John* thus there should be an empty filler, dubbed PRO, for that agent role for *leave*. In other words, the person who is understood as the agent doing the act of leaving is the matrix subject, *John*, which happens to be the same as the agent of the matrix predicate: technically, PRO is controlled by *John*. Usually PROs in this type of simple embedded infinitival constructions are controlled by the matrix subject, and are called subject-control constructions.

In the sentences of the following type, however, it is not easy to identify what controls the PRO in the embedded clause:

(8) John promised Mary [PRO] to leave.
(9) John persuaded Mary [PRO] to leave.

It is *John* who is the agent of leaving in (8), making PRO controlled by the matrix subject. It is *Mary*, on the other hand, who leaves in (9). This PRO is controlled by the object of the matrix clause. Verbs like *promise* are called subject control predicates and verbs like *persuade* are called object control verbs.

A question that arises in light of Grodzinsky's

participate in thematic role assignment. Rizzi (1985) argues that agrammatic patients tend to omit from their syntactic representation those elements that do not participate in thematic role assignment. In passive constructions, thus, the noun phrase within the *by*-phrase is assigned its agent role in a lexical manner, ie. without the inheritance process.

3) Notice that NP-traces in Chomsky's (1981) theory are those empty categories that are left behind after applying the NP-movement in passive sentences as in (2) or raising constructions as in $[_{NP}$*The cat*$]_i$ *seemed* $[_{NP}$ *e* $]_i$ *to be happy*. Wh-traces refer to those empty categories postulated in positions from which a wh-phrase has moved out to the clause-initial position, as in *What*$_i$ *did you see* $[_{NP}$ *e* $]_i$*?*

account of agrammatic comprehension of empty categories is whether this new type of empty categories, PROs, will fall into his analysis or not. That is, do agrammatic patients show the same kind of difficulty in comprehending the sentences that involve PROs as in understanding the sentences that involve traces? If they indeed show the same level of poor performance as in the passive or relative constructions, we would be able to extend Grodzinsky's analysis to all empty categories, regardless of the nature of empty category and a wider generalization will be obtained. In the following section, I will outline the differences and/or similarities between traces and PROs in Chomsky's (1981) Government and Binding Theory.

3. TRACE vs. PRO: PREDICTING AGRAMMATIC COMPREHENSION

One of the common properties PROs and traces share is that they are not phonologically realized so that they are classified as empty categories in GB syntax. One of the major differences between them is that PRO is allowed only in a position which is not governed (e.g., the subject position of an infinitival clause or of a gerundive clauses) whereas traces must occur in a governed position (e.g., verbal object positions, prepositional object positions, or subject of a tensed clause in English).[4]

As far as their thematic role assignment is concerned, PROs and traces show some discrepancy. PRO is directly assigned its semantic role by an assigner and is allowed to keep that role throughout the derivation. As it is phonetically null, however, the semantic role assumed by the PRO in question depends on the controlling NP, either the matrix subject or the matrix object. NP-traces, on the other hand, are assigned a semantic role by participating in a chain formation while a chain consists of a head and a tail. The tail is occupied by a phonetically null trace which is assigned its semantic role from an assigner and transmits the role to the head of its chain. Then the head, which is usually a phonetically realized phrase, inherits the role, satisfying the interpretation requirement that demands every noun phrase be assigned a thematic role.

As Grodzinsky (1986, 1989) did not include PRO constructions in his analyses, it might be of interest to see if they fall within the invisible class of such empty categories as NP-traces or wh-traces in their abstract syntactic representation. The previous discussion of different properties of PROs and traces will allow us to make two different predictions about the agrammatics' comprehension of PROs depending on the kind of predicates involved in the test. The first case is object-control constructions where the PRO is controlled by the matrix object. Grodzinsky's theory, however, predicts that object-controlled PROs will be correctly assigned their semantic role due to the default principle, which requires a clause-initial noun phrase, unless otherwise specified, to be assigned an agent role. If an object-controlled PRO is as invisible as traces in agrammatic patients' syntactic representation, the object will be regarded as the agent of the embedded infinitival predicate as the matrix object will be the one that appears right in front of the infinitival predicate. Thus, in the following, the agent role of the embedded clause will be assigned to the matrix object *Mary*:

(10) John persuaded Mary [PRO] to leave.

As the patients will not be able to see the phonetically null PRO, the next available NP placed in front of the predicate will be *Mary*, and the test result is predicted to show as good a comprehension level as normal English speakers.

In the case of subject-control constructions, however, the patients are predicted to have major difficulties in comprehending the agent of the embedded predicate. This is because they will use the default principle and assign an agent role to the nearest NP to the predicate, resulting in the

4) For a precise notion of 'government' in the principles and parameter theory, see Chomsky (1981).

matrix object taken as the embedded agent, contrary to the normal comprehension. So the prediction is that the agrammatic patients will score very low in subject-controlled sentences.

4. EXPERIMENT: PICTURE-MATCHING TASK

Two Broca's patients were chosen as subjects in the sentence comprehension test.[5] One was named Susan, a 41-year-old female diagnosed as Broca's aphasia, secondary to left CVA, who had a left parietal arteriovenous malformation with associated seizure disorder at the time of experiment. The other subject, named Steve, was a 36-year-old male who had sustained a gunshot wound to the mid forehead just above the left temple, with part of the left temporal and left frontal lobes removed. Steve exhibited a severe expressive aphasia with mild comprehension difficulties.

The experiment was a picture-pointing task. For each sentence, the subjects were presented with a set of four pictures, which included the correct answer, a false alarm, and the other two irrelevant pictures. For example, a test sentence *John promised Mary to push the table* came in with a picture depicting a boy pushing a table, the correct answer in this case; another picture with a girl pushing the table, the false alarm; and the other two totally irrelevant pictures. (See Appendix I) The test sentence was written under each set of four pictures. The sentence was also read to the subject, as many times as they wanted for the asking, in order to eliminate any modality-related constraints. In addition, the subjects were allowed to take as much time as they wanted so that their short-term memory limit might not affect their performance. The subjects were asked to indicate a picture that best describes the situation that is going to happen according to the sentence.

To see if our subjects have the same kind of deficit as those discussed in Grodzinsky (1986), I started the experiment with a test of semantically reversible active and passive sentences: five active sentences and five corresponding passive sentences. The sentences used in this part of the experiment are listed below:

(11) a. The dog chases the cat.
b. The dog is chased by the cat.
(12) a. The bird catches the snake.
b. The bird is caught by the snake.
(13) a. The boy pulls the girl.
b. The boy is pulled by the girl.
(14) a. The mother pushes the girl.
b. The mother is pushed by the girl.
(15) a. The boy kisses the girl.
b. The boy is kissed by the girl.

After being presented with these sentences along with a set of pictures, the subjects were asked to point to a correct picture for the sentence. Of course, the pictures and the sentences were randomly presented.

After their comprehension of active and passive constructions were tested, ten simple embedding sentences such as *Mary tried to catch the ball* were given to see if they can correctly assign appropriate semantic roles for the embedded predicates. Sentences used at this stage are given below:

(16) a. Mary tried to catch the ball.
b. John was willing to drive the car.
c. Tom managed to catch the ball.
d. Sue was eager to drive the car.
e. Mary promised to push the table.
f. John wanted to drive the car.
g. John decided to push the table.
h. Mary expects to drive the car.
i. Sue prefers to catch the ball.
j. Mary started to push the table.

Notice that there is no intervening noun phrase between the matrix verb and the infinitive in such

5) The experiment reported in this paper was done in May 1993, at Austin, Texas. I thank Dr. Harvey Sussman for his guidance and help, without which I would not have been able to obtain information about the subjects.

constructions.

Finally, a set of 20 randomized subject-and object-control constructions were presented, consisting of 10 subject-control predicates and 10 object-control predicates, which are given in the following:

Object Control Sentences

(17) a. Sue told Tom to push the table.
b. Tom told Sue to push the table.
(18) a. Tom allowed Sue to drive the car.
b. Sue allowed Tom to drive the car.
(19) a. John wanted Mary to catch the ball.
b. Mary wanted John to catch the ball.
(20) a. John persuaded Sue to push the table.
b. Sue persuaded John to push the table.
(21) a. Mary signalled to Tom to catch the ball.
b. Tom signalled to Mary to catch the ball.

These sentences all include a referring expression between the matrix verb and the infinitival clause which bears the theme role of the matrix verb and the agent role of the infinitive.

Another set of ten sentences are listed below, in which the intervening referring expression cannot be assigned the agent role of the embedded infinitive predicate.

Subject Control Sentences[6]

(22) a. John promised Mary to push the table.
b. Mary promised John to push the table.
(23) a. Sue asked Tom how to drive the car.
b. Tom asked Sue how to drive the car.
(24) a. Mary asked Tom to be allowed to drive the car.
b. Tom asked Mary to be allowed to drive the car.
(25) a. John impresses Sue as being able to push the table.
b. Sue impresses John as being able to push the table.
(26) a. Mary strikes John as being able to catch the ball.
b. John strikes Mary as being able to catch the ball.

These sentences were randomly presented to the subject, who had to pick up one picture from the set of four. Note incidentally that there are relatively few subject-control predicates in English, and consequently, I had to modify the embedded clauses further to force the subject-control reading of the embedded clause.

5. RESULTS

The two subjects' comprehension abilities of semantically reversible active-passive constructions are summarized in the following table:

〈Table 1〉 Susan's Active-Passive Comprehension

	No. of correct choices	No. of incorrect choices
active	5/5	0/5
passive	2/5	3/5

〈Table 2〉 Steve's Active-Passive Comprehension

	No. of correct choices	No. of incorrect choices
active	5/5	0/5
passive	3/5	2/5

These tables show that Susan and Steve are typical agrammatic patients, lacking any proper ability to correctly comprehend passive sentences.

Simple embedding clauses without any intervening noun phrases between the main-clause predicate and the embedded predicate were presented to the subjects. Their comprehension was perfect, as seen in the following:

6) Note that these subject-control sentences are a bit more complicated in structure than the object-control counterparts. It was not easy to construct subject-control sentences in English. That is why the sample sentences ended up with a more complicated structure than object-control sentences. Difference in sentence length or structural complexity, however, does not seem to pose any problem because the subjects were given as much time as they wanted while participating in the experiment.

〈Table 3〉 Simple Embedding Clauses

	No. of correct choices	No. of incorrect choices
Susan	10/10	0/10
Steve	10/10	0/10

Results of the main part of the experiment are summarized below. Both subjects showed poor comprehension in subject control constructions, in which the infinitival predicate's agent refers to the matrix subject noun phrase. Object control constructions were relatively well-comprehended.

〈Table 4〉 Susan's PRO Comprehension

	No. of correct choices	No. of incorrect choices
Object-control	8/10	2/10
Subject-control	3/10	7/10

〈Table 5〉 Steve's PRO Comprehension

	No. of correct choices	No. of incorrect choices
Object-control	10/10	0/10
Subject-control	0/10	10/10

The overall results of the experiment is summed up in the table below:

〈Table 6. Sentence Types and Number of Correct Answers〉

	Active	Passive	Simple Embedding	Object-control	Subject-control
No. of correct answers	10/10	5/10	20/20	18/20	3/20
Percentage	100%	50%	100%	90%	15%

In short, the subjects' comprehension of PRO was considerably lower in subject-control sentences than in object-control constructions.

6. DISCUSSION

Our subjects were typical agrammatic patients as seen in the results of the active and passive tests. Both subjects scored 100% on active sentence comprehension whereas they performed the task at chance level in semantically reversible passives as seen in 〈Table 1〉 and 〈Table 2〉. This means that they fall into the classical category of agrammatism. According to Grodzinsky, this is because their syntactic representation is not rich enough to have the NP-trace at their derived structure, resulting in their failure of proper thematic role assignment via chain formation.

On the simple embedding sentences where the infinitival clause follows the matrix verb without any intervening noun phrase, their performance was pretty good: both scored 100% correct. See 〈Table 3〉. This is what Grodzinksy's account would predict: the default principle assigns an agent role to the sentence-initial noun phrase even though PRO is not present in their structural representation.

Our prediction is further borne out in the object-controlled and subject-controlled sentences: 90% correct in object-controlled PROs compared to the low score of 15% correct in subject-control constructions. As we noted earlier, this follows from two assumptions about agrammatics' comprehension strategy: the invisibility of empty categories and the heuristic employment of the default principle.

Note that this asymmetry in object-controls and subject-controls is in a sense reminiscent of the asymmetry of subject relative and object relative clauses, respectively. It is well-known that the subject relatives (e.g., those relative constructions that contain a gap in the subject position) are much easier for agrammatics than object relatives. For example, (27) is much easier for Broca's aphasic patients to understand, and correctly respond to, than (28):

(27) The cat that is chasing the dog is black.
(28) The cat that the dog is chasing is black.

This discrepancy is accounted for as the agent role from the chasing activity will be assigned to the sentence-initial noun phrase, the cat, by the default principle. On the other hand, in object

relatives as in (28), even though the agent role of the relative predicate is assigned to the embedded subject correctly, the sentence-initial noun phrase *the cat* will also be assigned the agent role by the default principle, resulting in two competing agents for the relative clause.

Similarly, our subject-control and object-control constructions show discrepancy. Consider the following contrast:

(29) Tom persuaded Mary [_ to push the table]
(30) Tom promised Mary [_ to push the table]

As we predicted in the previous section, our subjects' comprehension of the infinitival agent was very poor in subject control constructions as in (30) as attested in their poor performance (15% correct) while they did relatively well with the object control constructions in (29). This is due to the default principle that takes *Mary* as the agent of infinitival predicate. Object control predicates happen to allow for such an interpretation, while subject control verbs do not allow the default rule to make a coincidence in reading.

One point to be noted about the results reported above is that the subjects never chose irrelevant pictures: every choice they made was directed either to the correct answer or the false alarm.[7] Of particular interest is Steve's response to the subject control constructions. As shown in 〈Table 5〉, his responses were all incorrect, which seems to go against the predictions made by Grodzinsky since his theory would demand a chance-level performance on these constructions at best, rather than wrong choices across the board. Note also that Susan's performance was way below the chance level. An emerging question is how we would reconcile the discrepancies. One possible explanation could be found by adopting Chomsky's (1969) analysis of child language acquisition data based on Rosembaum's (1967) Minimal Distance Principle, which states that the subject of an infinitive clause is the nearest NP to its left.[8] Notice however that an aphasic study of the kind as reported in this paper was not what Chomsky had in mind.

To complete our explanation about their chance level comprehension, a further speculation is needed from a reanalysis view concerning the subjects' comprehension strategy. In particular, when we consider the semantic roles assigned to *Mary* in this context, namely the theme of persuade and the agent of push, there are no other accounts available about how such dual roles are reconciled when the agrammatics process the sentence. My speculation is that the first part of the matrix clause, *[Tom persuaded Mary]*, is processed as a constituent first, so that the agent and the theme roles of the matrix predicate are discharged to the subject and the object. Then *Mary* seems to undergo reanalysis forming a new constituent with the following infinitival *[Mary to push the table]*, to which the default principle applies to assign the agent role to *Mary*, regardless of the matrix predicates' control properties. That is why the subjects are more inclined to choose the immediately preceding noun phrase as the agent of the embedded clause.

7. CONCLUDING REMARKS

In this paper, I have shown that agrammatic comprehension is largely degraded in constructions that involve empty categories in their syntactic representation. In a sense, Grodzinsky's account of agrammatic comprehension can be extended to PRO's, which means that those agrammatic patients lack any kind of empty categories represented in their syntactic structure. Note incidentally that the default principle was considered as a heuristic: the subjects largely seem to rely on the surface order of words in assigning semantic roles.

Grodzinsky's (1986) proposal was based on the

7) One of the reviewers pointed out the significance of this observation, to whom I would like to express my sincere thanks.

8) This possibility was also suggested by one of the reviewers.

hypothesis that "a deficit analysis should assume maximal similarity to normal." (p. 140) His analysis was an opening attempt to scrutinize the deficit data in terms of current linguistic theories. This kind of maneuver in linguistic and neurological communities seems promising as it will eventually provide a tool for adequately describing the normal's as well as aphasics' linguistic representation.

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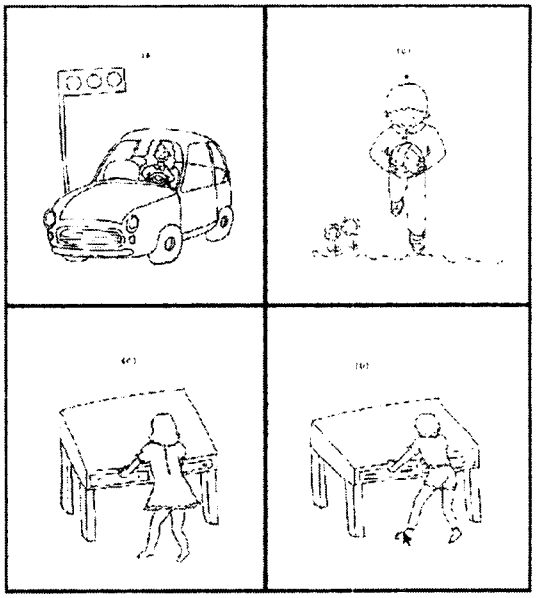
Appendix I. Sample Pictures



John promised Mary to push the table.