Restricted Discrimination between Local Economy and Global Economy in Agrammatic Aphasia

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ABSTRACT

We conducted sentence-picture matching tests with Hungarian speaking Broca's aphasics. The results showed that binding principle *A* was limited (*not Principle B*) in some complex syntactic structures. We will give a characterisation of the limited applicability of the following principles in the aphasic data:

We suggest a characterisation of the limited binding principles in agrammatic aphasia data in terms of global economy and local economy. In the case of local economy, the decision concerning the applicability of an operation depends on what pieces of information are available within the sentence representation at hand, irrespective of other sentence representations (cf. *Principle A*). Global economy constraints require comparison of several sentence representations in order for a decision to be made concerning the applicability of some operation *(Principle B)*.

The discrimination between global economy and local economy in the judgement of pronominal categories was impaired in the performance of the subjects. This distinction is normally strictly made both in structure building and in interpretation but is lacking in the performance of our subjects.

1. INTRODUCTION

In the generative theory of grammar proposed by Chomsky (1997, 1998, 2004, 2005), the principles of Universal Grammar (UG) are revealed in each natural language. The set of economy constraints is a general property of the architecture of UG (i.e. their existence is not language specific). The formal economy principles of the Minimalist Program, namely, *shortest move, fewest steps in operation* and *cyclic application of operations in structure extension*, can be motivated in terms of a non-technical notion of economy, involving the notion of limited resources. According to Collins (2003: 45), the grammar tends to minimize whatever can be ranked along some scale: length of movements, number of operations, sets of features needed, number of syntactic objects in representations, etc. In the understanding of Wilder, Gaertner & Bierwisch (1997:205–226) what the economy principles represent within the architecture of grammar is the fact that a system of unlimited generative capacity is based on a limited set of mental computational resources.

Within the class of universal economy principles, local versus global economy constraints can be distinguished. In the case of local economy, decision concerning the applicability of a given operation depends on what pieces of information are available **within** the sentence representation at hand, irrespective of other possible sentence representations. Global economy constraints require comparison of several sentence representations in order for a decision to be made concerning the applicability of some operation.

The possibility arises that linguistic impairments due to some damage to cortical areas are linked with restricted functioning of principles or constraints of UG.

The economy constraints of the grammar are somehow restricted in the performance of agrammatic aphasic subjects. For instance, Bánréti (2003) showed that an impaired economy constraint prevent an aphasic patient from using of a type of economical ellipsis. Ruigendijk & Avrutin (2005) and Ruigendijk, Vasić & Avrutin (2006) demonstrated that syntactic operations are not the cheapest option for agrammatic speakers. In their study with Dutch agrammatic aphasics, the subjects were examined with a picture selection task that required interpretation of pronouns and reflexives. They investigated the subjects' ability to interpret pronominal

elements in transitive clauses and Exceptional Case Marking constructions. The results were interpreted in the framework of the Primitives of Binding Theory (Reuland, 2001). Among other things, the results showed that the economy hierarchy for reference establishment in the case of agrammatic aphasia differs from that of normal speakers.

In what follows, some results of a test conducted with the participation of Hungarian speaking Broca's aphasic subjects will be shown. The results can be explained as due to some limitation of discrimination between the principles of local vs. global economy.

2. THE BINDING PRINCIPLES

The binding principles are among the universal principles of grammar. Binding depends on the properties of the syntactic structure concerned. The basic claim is this: *α binds β if α and β bear the same (referential) index and α c-commands β.*

Principle A: An anaphor (reflexive pronoun) must be bound in its governing category (clause).

Principle B: A personal pronoun must be locally free (non-bound).

Principle C: An R-expression must be free (that is, its reference must be independent of that of other constituents).

Principle *B* states the condition of impossibility of binding, that is, where binding **cannot** be applied, and not the condition for binding to take place. The latter kind of condition is given by Principle *A* with respect to reflexive/reciprocal pronouns. As we will see, Principle *B* is to be applied **globally** in that it requires comparison of several possible sentence representations to be assessed. Principle *B* is constrained by global economy.

Principle *A*, on the other hand, works as a **local** principle since its applicability can be determined on the basis of the properties of a single sentence representation. Therefore Principle *A* must be based on local economy.

2.1. Is Principle *A* easier?
Grodzinsky *et al.* (1993)'s results suggest that their agrammatic aphasics showed limitations in the tasks concerning the binding of personal

pronouns as opposed to the binding of reflexive pronouns. They explained this by assuming that whenever the two types of binding can be chosen between in the case of ambiguous sentences, following Principle *A* (applied to reflexive pronouns) is simpler in that it does not require consideration of the context.

2.2. Is Principle *B* more difficult?

In Grodzinsky *et al.*'s experiments, the aphasic subjects generally made correct judgements for sentences containing quantified expressions plus personal pronouns where there was no alternative contentful antecedent in another clause. Hence, there was no need to compare alternative structures. But they performed at random when the antecedent of a personal pronoun was to be one of several available contentful referential expressions. Here they had to consider which of the alternative structures would fit the context. The point to consider is as follows. If the listener hears a sentence containing a personal pronoun, he/she has to decide if it is permitted for the personal pronoun to be coreferent with an antecedent **inside** the clause. In other words, he/she has to see if it is possible to replace the pronoun by a locally bound anaphor. For this, he/she has to construct an **alternative** bound representation. If this is **not** possible, the task has come to an end; coreference is permitted, not prohibited.

If there is a possibility of alternative binding, the listener has to construct two representations: one containing a possible binding relation within a local domain and another one that contains the alternative coreference reading with an antecedent from "outside" the local domain. Then he/she has to consider both representations against the context to see if they differ. If they do, coreference is permitted, otherwise it is rejected. Performing such a series of steps constitutes much more of a burden on computational resources than simply enforcing Principle *A* or Principle *C*. In addition, the alternative structural representations have to be assessed with respect to their compatibility with the context. In order to do that, at least two representations have to be accessed, and each of them has to be compared with the context so that the appropriate one can be selected. These operations require a kind of global economy.

3. THE TEST MATERIAL

The subjects were as follows: P., a 25-year-old right-handed man, with left fronto-temporo-parietal lesion of a traumatic origin, linguistic symptoms of agrammatic Broca's aphasia; and B.I., a 49-year-old right-handed man with left temporo-parietal insula of a traumatic origin, Broca's aphasia.

Five syntactic structures of diverse complexity were selected following the logic of binding theory. For each construction, we compiled sentences, each of which had two versions constituting a minimal pair, involving a reflexive pronoun vs. a personal pronoun. For each pair of sentences, two pictures were drawn, suggesting the meanings of the respective sentences. The members of sentence pairs/picture pairs were presented separately, in random order. The test material included 200 sentences and 200 pictures. In *yes/no* decision tasks, each sentence was heard twice once paired up with one of the relevant pictures, and once with the "wrong" picture. With the two aphasic subjects this yielded 400 grammaticality judgements. The subject saw a picture and heard a sentence and was asked to decide if what he heard corresponded to what he saw. Wherever we thought it was necessary, an introductory sentence providing context was also provided (which mainly served for identifying the persons in the picture and disambiguating the things or events that the picture was meant to represent). The total test material was presented in two sessions. The time that elapsed between the sessions was 2 weeks. In each test situation, a given sentence or a given picture only occurred once. Assuming that the distance of a pronoun from its antecedent may affect the assignment of referential relations, in one pair of sentences for each structure (a total of 10 sentences) the topicalised NP in sentence initial position was distanced from the pronoun by inserting *ami azt illeti* 'for that matter'.

We wanted to find out whether there are differences in assigning antecedents to the reflexive vs. personal pronouns and if there are, how much they are affected by the structure of the sentences, by their complexity.

The five types of structures are illustrated by an example each in what follows:

TYPE I
Simple sentence structure. The first sentence is the version with a reflexive pronoun; the second sentence is that with a personal pronoun:

(1) A bohóc fejbevágja **magát.**
      'The clown hits **himself**.'

(2) A bohóc fejbevágja **őt.**
      'The clown hits **him**.'

Pictures:

FIG 1

TYPE II

The reflexive pronoun or the personal/possessive pronoun occurs in a possessive construction in possessor position. With respect to Principle B, the possessive construction may work as a local domain, from outside which binding is not prohibited:

(3) [Mari   befonja [$_{DP}$ a   **maga**   haját]].
     Mary   plaits   the   **herself** hair.poss.acc
     'Mary plaits **her own** hair.'

(4) [Mari   befonja [$_{DP}$ az   **ő**   haját.]].
     Mary   plaits   the   **her** hair.poss.acc
     'Mary plaits **someone else's** hair.' / 'Mary plaits **her own** hair.'

It is to be noted that the possessor position in a DP in Hungarian is one in which both types of pronouns can occur with the same reference. An overt possessive personal pronoun (*ő*) **may** also have a reading with **locally prohibited coreference** such that the hair concerned is not Mary's but somebody else's.

Pictures:

FIG 2

TYPE III

In this structure, the pronoun is not in possessor position but is a modifier of the possessed noun. This restores complementary distribution between reflexive and personal pronouns. A factor that may make processing more difficult is that there are **two possible antecedents** (*lány, fiú*) of which the subject has to select one that suits the type of pronoun involved:

(5) [A   lány   örül   [DP a   fiú   **önmagáról**   készült
        fényképének]].
    the   girl   is glad   the boy   **on himself/herself**   made
    photograph.dat
    'The girl is glad about the boy's photograph of **himself**.'

(6) [A lány   örül   [DP a   fiú   **őróla**   készült
       fényképének]].
    the girl is   glad the   boy   **on   him/her**   made
    photograph.dat
    'The girl is glad about the boy's photograph of **her**.'

Pictures:

FIG 3

TYPE IV
The infinitival construction (S_{inf}) has no lexical subject but does have a covert pronominal subject marked as PRO. The antecedent of the reflexive pronoun is PRO = *Piroska*, whereas the personal pronoun has to find an antecedent **outside** the sentence:

(7) [A   lány   szereti [$_{Sinf}$ PRO nézegetni   **magát**   az
    albumban]].
    The girl   likes   look.at.inf   **herself.acc** the
    album.in
    'The girl likes to look at **herself** in the album.'

(8) [A   lány   szereti [$_{Sinf}$ PRO nézegetni   **őt**   az
             albumban]].
    The girl   likes   look.at.inf   **him/her** the   album.in
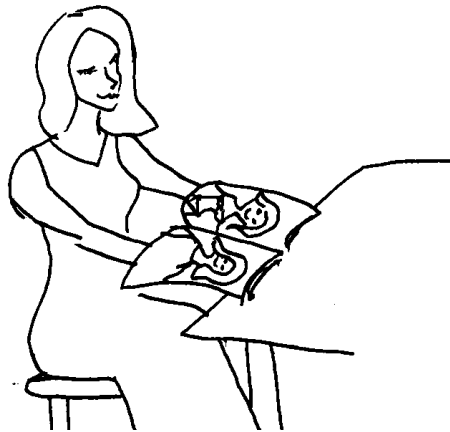   'The girl likes to look at **him/her** in the album.'

Pictures:

FIG 4

TYPE V

The infinitival construction (S_{inf}) has its "own" **lexical** subject that gets its accusative case feature from "outside", from the verb of the matrix clause (*látja*) but that is simultaneously the subject of *mutogatni* in the infinitival construction. Again, a factor making processing the sentences more difficult is that there are two possible antecedents (*asszony, férfi*) in the sentence to choose from in accordance with what the pronoun requires.

(9) Az asszony   lát [valakit   **magára**
     mutogatni].
     the woman   sees someone.acc **himself/herself.at** point.inf
     'The woman sees someone (to) point at **himself/herself**.

(10) [Az asszony lát [valakit   **őrá**
          mutogatni]].
       the woman   sees someone.acc **him/her.at**   point.inf
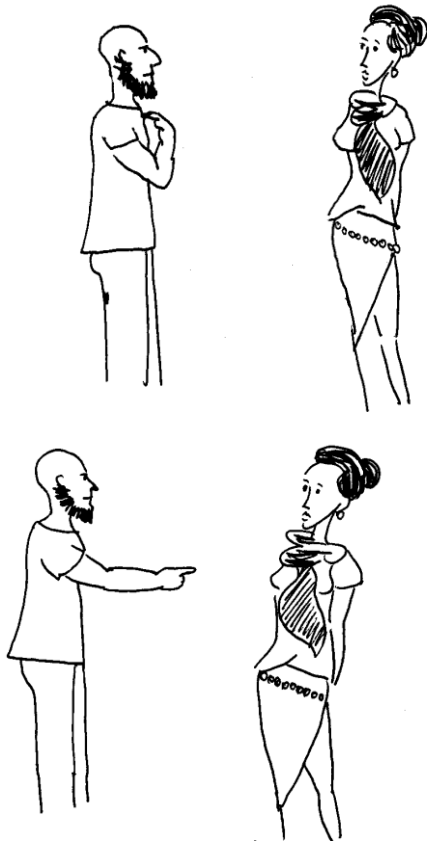   'The woman sees someone (to) point at **her**.'

Pictures:

FIG 5

4. RESULTS

The 400 grammaticality judgements made in the two tests exhibit the following distribution:

STRUCTURES	PICTURE MATCHING	
Judgements:	Grammatical	Ungrammatical
Type I		
Reflexive pronoun	40 (100%)	–
Personal pronoun	32 (80%)	8 (20%)
Type II		
Reflexive pronoun	36 (90%)	4 (10%)
Personal pronoun	36 (90%)	4 (10%)
Type III		
Reflexive pronoun	8 (20%)	32 (80%)
Personal pronoun	28 (70%)	12 (30%)
Type IV		
Reflexive pronoun	32 (80%)	8 (20%)
Personal pronoun	28 (70%)	12 (30%)
Type V		
Reflexive pronoun	12 (30%)	28 (70%)
Personal pronoun	24 (60%)	16 (40%)

5. DISCUSSION

In the case of Type I, the subjects' assessments were faultless in the case of reflexive pronouns, whereas in assigning reference relations to personal pronouns the subject made 8 wrong decisions in the context of the ungrammatical picture.

For Type II, 4 wrong decisions were also made in the context of the ungrammatical picture, for examples containing the inserted material. Similarly, 4 wrong decisions were made with respect to personal pronouns, again in the ungrammatical picture context.

Type III contained two contentful NPs. The pronoun occurred within the possessive construction as a modifier of the possessed noun. The subjects here consistently preferred the sentence-initial NP that was a lot

further away from the pronoun than the other potential nominal antecedent. With respect to reflexive pronouns that require strictly local binding, this resulted in 32 wrong decisions of the 40, a very poor result. The same strategy led to 28 correct decisions in assessing the reference of personal pronouns since these are to be bound by a non-local antecedent.

In the case of Type IV, both for reflexive and for personal pronouns, 8 and 12 wrong decisions were made in the context of the ungrammatical picture. The number of correct decisions was 32 and 28, respectively.

For Type V sentences, we see a similar pattern as for Type III. The sentences to be assessed contain two potential nominal antecedents, one sentence initially, and another one right before the pronoun. In assessing the reference of reflexive pronouns, 28 incorrect decisions were made along with 12 correct ones; the incorrect decisions all turned the sentence initial (non-local) nouns into antecedents although the reflexive pronoun would have to be locally bound by the noun immediately preceding it. The same attitude resulted in 24 correct decisions in the case of personal pronouns since the required non-local antecedent of a personal pronoun may well be the sentence initial NP.

6. CONCLUSIONS

Principle *A*, demanding reflexive pronouns to be locally bound, expressly refers to syntactic structure. Hence, the correctness of decisions concerning reflexive pronoun binding depends on the structural complexity of sentences. The structure of sentences of types I and II was simpler, whereas that of types III–V was more complex.

Principle *B*, referring to the binding of personal pronouns, is based on under what circumstances that binding **would** be impossible. The application of that principle requires the listener to construct alternative syntactic structures/representations, compare them to one another, and relate them to the context, too. Due to the role of context, it is not only the UG principle but also language specific preferences and personal problem solving strategies that may play a role in the listener's decision. In the case of the simplest, type I structures, the subjects made correct discriminations between reflexive and personal pronouns, as they did not resort to guessing for any of them. As the structural complexity of the sentences

grew, the number of correct decisions with respect to personal pronouns decreased somewhat. Two points can be made in that respect. Incorrect decisions were mainly made in the context of the non-matching picture, especially if the personal pronoun was in a relatively complex construction and/or was preceded by inserted material. The deteriorative role of insertion is not surprising: it shows that wherever one of the possible antecedents is distanced from the pronoun, the task becomes more difficult.

An especially interesting result is what we got in the case of types III and V, for reflexive pronouns. The subjects wrongly took the sentence initial NP to be the antecedent of the pronoun in 16 and 14 cases, respectively, as opposed to the actual, local antecedent that immediately preceded the pronoun. The limited range of our data obviously only allows us to draw tentative conclusions. Structures III and V are syntactically complex but not in the same way as sentences involving inserted material. What matters is not the mere distance of the critical items but rather the structural position of the pronoun. The pronoun is either at the "deepest" point of the possessive construction, in the possessed NP (type III) or it is a constituent of an infinitival clause within the sentence. We have to assume that the structural complexity of sentences elicits **alternative structural analyses** and their assessment, similarly to what we said about decisions with respect to the local binding of personal pronouns. And the net result is that the subject wrongly assumed bindings for reflexive pronouns that would have been grammatical local bindings for personal pronouns.

The scheme of the incorrect decisions showed a kind of restricted economy. For Type III the subject incorrectly accepted the sentence in (11) in the context of a picture that showed a photograph of the boy, not of the man. According to the wrong decision, *himself = the man*. The binding relation in the incorrect decision is the following:

(11) *A férfi$_m$ örül a fiú önmagáról$_m$ készített fényképének.
   *'The man$_m$ is glad about the boy's photograph of himself$_m$.'

On the other hand, the grammatical binding relation *(himself = the boy)* would have been the following in a correct decision:

(12) A férfi örül a fiú_m önmagáról_m készített fényképének.
    'The man is glad about the boy's_m photograph of himself_m.'

For Type V the subject incorrectly accepted the sentence in (13) in the context of a picture that showed a man pointing at a little boy, not at himself. According to the wrong decision *himself = the little boy:*

(13) *A kisfiú_w látja a férfit mutogatni önmagára_w.
    *'The little boy_w sees the man point at himself_w.'

The correct decision would have been based on a grammatical binding relation in which *the man* binds *himself*:

(14) A kisfiú látja a férfit_w mutogatni önmagára_w.
    'The little boy sees the man_w point at himself_w.'

The assessment of alternative structural analyses elicited by more complex syntactic structures resulted in better decisions with respect to personal pronouns: for Type III and V the subject made correct decisions in 28, respectively 24, cases out of 40.

As witnessed by the simpler structures (Types I and II), the subjects did possess the ability to distinguish binding relations of reflexive from those of personal pronouns. With more complex structures (Types III and V) they did **not** react to increasing complexity by trying to resort to some structure that was simpler or shorter. On the contrary: in their **incorrect decisions** they used a more costly mechanism, incorrectly. The distinction between local economy and global economy was **not** properly accessible for them. Instead of assessing the operations to be employed in a less

costly manner, restricting their attention to local structural relations and ignoring other, non-local structural representations, they tried to do the opposite: they attempted to make a decision on the applicability of some structural operation by comparing alternative structural relations to one another. But the correct decisions simply needed analysing local structural relations within a local domain. This option was avoided. We suggest that such distribution of performance can be attributed to the subject's limited ability to tell local and global economy from each other.

7. ACKNOWLEDGMENTS

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