



Canonicity effects as grammatical phenomena

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Abstract

The existence of a split in agrammatic Broca's aphasics' comprehension of semantically reversible sentences with canonical vs. non-canonical word order have been explored in deep in the last decades. In this paper we present and discuss a new approach to *canonicity effects* that derives the asymmetry in a principled way from the Relativized Minimality approach to locality in syntax. The approach takes both processing and representational considerations into account thus avoiding problems, such as *variation* and *complexity*, encountered in non-integrated accounts. New data from a series of tests on both comprehension and production with an agrammatic Broca's aphasic patient are presented and discussed in light of the new proposal. Reduction of these asymmetries to a special case of the more general theory of locality allows generalizations to be made, which might be extended over different populations.

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1. Introduction

In this paper we present and discuss a novel approach to *canonicity effects* in agrammatic Broca's aphasia developed originally in Grillo (2003, 2005). In addition to testing the hypothesis against existing data in the literature, we present and discuss evidence from a series of experiments on both comprehension and production of semantically reversible sentences by an Italian agrammatic aphasic patient. The approach adopted here captures the selectivity of the effect by reducing the phenomenon to a special

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case of Relativized Minimality (RM) (in the sense of Rizzi, 1990, 2004a; Starke, 2001). RM is a general principle of economy of syntactic representation which states that a syntactic relation is restricted to the closest possible element capable of bearing that relation. The novel approach avoids many problems posed by previous approaches (most notably those related to variation) and gives a principled account of complexity effects with respect to movement.

Grillo (2003, 2005) proposes that a loss of (syntactic) processing abilities can compromise the representation of the full array of morphosyntactic features normally associated with syntactic elements, thus giving rise to Minimality Effects in precisely definable syntactic configurations. In (1) a schematized representation of an *object-cleft* (*it is the boy who the girl kissed*) sentence in normal adult speakers is given.¹ RM authorizes the formation of the relevant chains between the moved NPs and their traces by virtue of the difference between the feature set associated with the subject NP and that associated with the object NP.

$(N, \theta_2, \phi_S, \text{acc}, \text{wh})_{\text{ClassQ}} (D, N, \theta_1, \phi_S, \text{nom})_{\text{ClassA}} (N, \theta_2, \phi_S, \text{acc}, \text{wh})_{\text{ClassQ}}$
 (1) It is the boy_i [who_i [the girl]_j [<the girl>_j kissed < who >_i]].

The presence of the *wh*-feature, in fact defines the object (who) as a member of a class (Q, the Operator's class) distinct from the one to which the subject (the girl) belongs to. The former belongs to the Operator class while the latter belongs to the Argumental class.

In (2) the proposed representation of the same structure by an agrammatical aphasic is schematized.

$(N, \theta_2, \phi_S, \dots)_{\text{ClassA}} (D, N, \theta_2, \phi_S, \dots)_{\text{ClassA}} (D, N, \theta_2, \phi_S, \dots)_{\text{ClassA}}$
 (2) It is the boy_i [who_i [the girl]_j [< ... >_? kissed < ... >_?]].

The impoverishment of the set of features, more specifically the absence of the *wh*-feature leads to RM blocking chain formation: as a consequence it is impossible to assign the correct thematic role to each argument, which in turn generates poor comprehension.

This analysis predicts that different pattern will arise with subject relatives, which are, in fact, correctly interpreted by agrammatical patients. In these structures no other NP intervenes between the moved constituent and its trace, hence no RM effects are expected:

(3) It is the boy_i [who_i [<the boy>_i loved the girl]].

1.1. Agrammatical Broca's aphasia and the canonicity problem

Since the seminal paper by Zurif and Caramazza (1976), a great amount of work has been dedicated to reach a better understanding of agrammatical Broca's aphasics' difficulties with semantically reversible sentences with a *non-canonical* linear order of the argument NPs. Different approaches have been proposed to deal with this phenomenon and, more generally, with the correct characterization of agrammatism (see Avrutin, 2001 for a review).

Simplifying to a high degree, and leaving aside the many differences between individual approaches, it is possible to divide the whole spectrum of analyses into two major

¹The example in (1) is intended merely to give a flavor of the account developed here. A more detailed discussion follows a proper introduction to the issues raised and the theoretical framework adopted in this paper. Non-crucial details are omitted, indexes are used for explanatory purposes only.

'families': those regarding the deficit as a loss of (part of the) knowledge of grammar (see Friedmann, 1998, 2002; Friedmann & Grodzinsky, 1997; Grodzinsky, 1990, 1995a,b, 2000 among others), and those considering it as the result of a processing deficit compromising the possibility of utilizing such knowledge (see Avrutin, 2006; Caplan and Hildebrandt, 1988; Caplan and Waters, 1999; Carpenter et al., 1994; Haarmann and Kolk, 1991; Hagiwara, 1995; Kolk, 1987, 1998; Piñango, 1999, among others).

While it is beyond the scope of the present paper to discuss these various approaches in detail, it is, nonetheless, important to mention them and to show how they relate to ours. The reader is referred to the cited literature for more in-depth discussion.

One of the most debated approaches to the canonicity problem in agrammatic aphasia is Trace Deletion Hypothesis (henceforth TDH) formulated by Grodzinsky (1986a,b, 1990, 1995a,b, 2000) which states that traces of referential NPs (the phonologically empty categories at the tail of a movement chain in the syntactic representation) are deleted from the S-structure representation in agrammatism. Deletion of the trace of a moved argument NP makes it impossible to assign the NP its thematic (θ) role using the standard grammatical mechanism (chain interpretation); interpretation is instead assigned through a non-grammatical strategy which assigns the *agent* θ -role to the first NP encountered. This strategy leads to correct (*above chance*) performance where the first NP encountered does indeed carry the *agent* role, as is the case in (*unscrambled*) *actives*, *subject relatives*, and *subject clefts*. The same strategy, however, does not necessarily lead to the correct interpretation (and thus to *chance* performance) when the second NP is also assigned the *agent* role structurally. This should be the case with *passives*, *object relatives*, *object clefts*.

The TDH has been criticized on both conceptual and empirical grounds. Discussion has focused on two principal issues. The first one, often called the *variability debate* (on which see Burchert et al., 2003; Caplan, 2001; Caramazza et al., 2001; Drai et al., 2001) is connected to the existence (or not) of a uniform pattern among different subjects. The extent to which variation is actually observed when the data are subject to sophisticated statistical analysis is at the center of an ongoing debate (see Drai & Grodzinsky, 2006a,b and related work for discussion of this central point). The second issue (on which see Avrutin, 2006) is of a more general nature and relates, in fact, to any representational approach and not only to the TDH. The question is how to relate the TDH, or any other theory of aphasia as a loss of part of the knowledge of grammar, with everything else we know about agrammatism.² In other words what connection, if any, could there be between deletion of traces and, e.g. telegraphic speech, omission of Tense morphology, omission of Determiners, selective problems with Binding of pronouns?

Both these issues are often taken to constitute strong arguments in favor of a *processing based* account: differences in the severity of the deficit can be easily translated into differences in the availability of processing resources. Moreover, the furthers natural assumption that more complex structures require additional processing resources, and may thus be out of reach of an impaired system, makes it possible (at least on principled

²Note however that as Grodzinsky himself pointed out (Grodzinsky, 1986a, p. 179) the TDH is not a *theory* of agrammatism, rather a *descriptive generalization* based on the "striking correlation between the distribution of a formal construct called *trace* and the performance types that agrammatic patients exhibit. A statement is then proposed that modifies the linguistic model to account for agrammatism. This statement is claimed to serve as the proper descriptive generalization concerning the data observed."

grounds) to attribute different patterns of comprehension and production to the same source.³

Processing approaches, however, are not exempt from problems. A central issue in processing based accounts is the correct definition of *complexity*. We know on independent grounds (for an application to agrammatism see, e.g. Carpenter et al., 1994) that some structures are more complex than other to process. This observation may well allow us to draw up a scale of complexity that we can use to check our hypothesis and reach a proper *description* of the facts. It will not, however, necessarily lead us very far in understanding the deeper mechanisms that are disrupted in agrammatic aphasia, nor the linguistic (*cognitive*) mechanisms that make a sentence more complex than another one. In other words, if our goal is to understand *why* certain structures are more complex than others, than the issue requires going back to linguistic representation and, which is far from trivial, reaching a proper understanding of the linguistic, representational, *syntactic* properties of those structures. Without addressing this question, our quest for proper understanding of agrammatism will lead us to little more than an interesting collection of curious accidental phenomena albeit elegantly connected. To this ends much work has been done in the study of agrammatism with respect to binding theory, in a framework which combines a (syntactic) processing deficit approach with *Primitives of Binding* framework of Reuland (2001) (see Piñango and Burkhardt, 2001; Burkhardt, 2004; Avrutin, 2006; Vasić, 2006; Vasić et al., 2006 among others; for a different approach see Grodzinsky and Reinhart, 1993).

Regarding *movement* (the fundamental property distinguishing canonical vs. non-canonical word order) it is so far however unclear how to derive the relevant patterns on the basis of a processing account. In the present paper we use locality in syntax and RM in particular as the key to address this issue.

The paper is organized as follows in the remainder of this section: we present the theoretical framework and set out our hypothesis of underspecification of morphosyntactic feature sets. In Sections 2–5 we present the experimental methodology, material, procedures, and results. Section 6 is devoted to analyzing and discussing the experimental data in light of the proposals put forward in Section 1.3. The paper ends with some more general remarks and indications for future work.

1.2. Theoretical framework

Locality is a pervasive property of natural languages. Relativized Minimality (RM) (Rizzi, 1990, 2000, 2004a; Starke, 2001) captures this property in a very simple and elegant way: syntactic relations have to be satisfied in the smallest possible environment in which they can be satisfied. A formal definition of RM is given (from Rizzi, 2004a, (4)).

(4) MINIMAL CONFIGURATION: ... X... Z... Y...

Y is in a minimal configuration (MC) with X iff there is no Z such that

³Another argument often taken to support processing based accounts comes from the observation that performance levels of non-impaired adult speakers in *stressful situations* tend to pattern with those of agrammatic aphasic patients (Dick et al. (2001)). This similarity falls out from the assumption that stress decreases the processing capacities of the human mind/brain.

- (i) Z is of the same structural type as X, and
- (ii) Z intervenes between X and Y.

The principle is illustrated below:

- (5) (a) How did you solve the problem { how }?
- (b) I wonder who solved the problem in this way.
- (c) * How do you wonder who solved the problem { how }?

In (5(a)) the manner interrogative element *how* has ‘moved’ from its first merge position where it has left a copy (indicated here in angled brackets). In (5(c)) however the attempt to construct a *wh*-question from the sentences (5(b)) with the manner adjunct *in this way* using the same relation instantiated in (5(a)) is blocked by the presence of another interrogative element (*who*) intervening between the moved element and its trace.

Intervention in (4) (ii), is defined in terms of c-command.⁴ The exact characterization of ‘sameness’ in (4) (i) has been the object of debate and modification in the course of the last two decades; however, the fundamental nature of locality as an anti-identity principle has not been touched by such modifications.⁵ The approach we adopt here is the one developed in Rizzi (2004a) and which makes use of the recent developments known as the Cartographic Approach (the attempt to draw maps as detailed as possible of syntactic structures; see Belletti, 2004; Cinque, 1999, 2002, 2006; Rizzi, 1997, 2004b among others). Rizzi shows that the right definition of ‘sameness’ can be reached taking into account a series of positions offered by the cartographic studies. Each of these positions, in fact, can be defined by its particular set of morphosyntactic features, and such features can be cataloged in virtue of the ‘class’ they belong to:

- (6) (a) Argumental: person, gender, number, case
- (b) Quantificational: *wh*-, Neg, measure, focus . . .
- (c) Modifiers: evaluative, epistemic, Neg, frequentative, celerative, measure, manner
- . . .
- (d) Topic.

By virtue of this classification, we can define ‘same structural type’ as

- (7) ‘Same structural type’ = Specifier licensed by features of the same class in (6).

Given the above formulation, we expect RM effects to be generated by intervening elements whose set of features belong to the same class, but not by features sets that belong to a different class.⁶

⁴Note that intervention for minimality can and does exceed strict c-command and is commonly found in simple linear order: see the case of ellipsis from Rizzi (2004a, ex. (9)): *John sells books; Mary buys records and Bill V newspapers*; where the elided V can only be *to buy*.

⁵For an extensive formulation of RM as an anti-identity principle, meaning a principle that forbids any identical element to intervene in a syntactic relation, see Starke (2001). More extensive discussion of Starke’s work in relation to the present hypothesis can be found in Grillo (to appear).

⁶Note that the definition in (7) allows to avoid the excess of restriction on movement generated by the simple A/Ā distinction (of the system developed in Rizzi, 1990) on the one hand, and the excessive freedom generated by the

1.3. A processing derived structural deficit account

Grillo (2003, 2005) hypothesizes that a (temporal or permanent) reduction in processing capacity can lead to an underspecification of the morphosyntactic feature sets normally associated with the elements in the syntactic tree. Selective minimality effects can be expected to arise as a natural consequence of this underspecification.

The idea that a reduction in processing capacity can generate underspecified syntactic structures is closely related to the idea, widely accepted in the psycholinguistic field, that even in normal situations, the human mind/brain is ‘lazy’ and this ‘laziness’ leads to postulation of the minimal possible structures compatible with a given syntactic environment (see De Vincenzi, 1991; Frazier and Rayner, 1988; for a recent formulation in terms of *minimal everything* see Fodor, 1998; Inoue and Fodor, 1995). Here the consequences of underspecification/minimization at the featural level are explored.

A slower than normal activation of the syntactic information present in lexical items (Zurif et al., 1993 among others), a slowed-down building up of this information into well formed syntactic constituents, or a faster than normal decay of syntactic representations (see Haarmann and Kolk, 1991; Kolk, 1995, 1998; Piñango, 1999) can be at the base of this impoverishment. Grillo claims furthermore that features of a certain class, i.e. Operator class, scope–discourse related, and more generally those related to the periphery of the clause and of the *vP*, are more likely to be compromised in cases of processing deficit. This assumption is based on different considerations. Firstly we posit that underspecification follows a particular order: the representation of features that are accessed later in the derivation is more likely to be compromised as a consequence of a slower than normal activation/faster than normal decay of syntactic representation.⁷ Secondly there is substantial evidence from the work of Friedmann (1998), Friedmann and Grodzinsky (1997), Friedmann (2002) indicating that material (features) associated with the left periphery of the clause is more problematic for agrammatical aphasics to access than that lower down in the syntactic tree, e.g. Agreement information.⁸ A third argument is related to Sergey Avrutin’s *Weak Syntax* approach to agrammatical aphasia. Avrutin builds up on the *Primitives of Binding* approach developed by Reuland (2001) in which the representation of purely syntactic dependencies is shown to be less costly than that of dependencies that require the interface of narrow syntax and extra-syntactic information, in particular these belonging to the (linguistic) discourse level. Avrutin’s claim is that agrammatical aphasia is characterized by a *weakened* syntax, a specific reduction of syntactic processing capacities which changes the hierarchy of PoB making the use of means other than the syntactic ones more economical for agrammatical patients to make us of. Support for these claims comes from different studies of production (omission of Tense, Determiners) and comprehension patterns in agrammatism (*wh*-movement, binding of

(footnote continued)

Minimal Link Condition (see Chomsky, 1995) on the other. See Rizzi (2004a) for extensive discussion of this point.

⁷Independent evidence for the order of activation of syntactic features comes from the fixed hierarchical order of both position in the syntactic tree, as it emerges from cartographic studies (see reference in the discussion in 1.2 above) and movement operations as indicated by improper movement, i.e. the possibility of an element undergoing A movement first followed by \bar{A} movement and the ungrammaticality of the opposite order.

⁸See Neuhaus and Penke (2003), Penke (2000, 2001) for a contrasting perspective based on data from German agrammatism.

pronouns) in agrammatic patients (see Avrutin, 1999, 2000a,b; Hickok & Avrutin, 1995; Ruigendijk, Vasić, & Avrutin, 2006; Vasić, 2006; Vasić et al., 2006). We interpret these results as additional evidence for a problem with syntactic representation of discourse related material, more specifically as a disruption of the syntax/discourse interface related to a slowed-down access of scope–discourse related features.

To sum up, we assume that the activation of features involved in the CP layer representation will not be reached (or their activation will decay faster than normal) *if* this cost overwhelms the system's processing capacities. The main result of this idea is that agrammatic aphasics's comprehension asymmetries with canonical vs. non-canonical sentences may be reduced to a special case of RM violation, due to the correct application of this constraint to impoverished syntactic structures.^{9,10}

The hypothesis we present correctly predicts the structures that require establishment of a movement dependency over an intervening NP will be more complex to process and thus more likely to be compromised in agrammatic aphasia comprehension. An example of the functioning of the model with cleft constructions was presented in (1). Agrammatics' performance levels with subject and object relative clauses can be derived in much the same way: only in *object* but not in *subject* relatives does an NP intervene between the moved element and its trace. The same account can be extended to cover other comprehension patterns in agrammatism such as the asymmetry between canonical SVO actives and actives in which the object has been Topicalized; as well as that between *actives* and *passives*; between *unaccusatives* and passives and *adjectival* passives on the one hand and *verbal* passives on the other.¹¹ Table 1 sums up the relevant data. Structures whose correct interpretation requires movement over an intervening NP lead to chance performance, while structures involving the same kind of movement, but which crucially does NOT involve crossing an intervening NP, are interpreted correctly by agrammatic speakers. Note that performance levels are to be taken to indicate general tendencies for a given structure. Given the *processing based* perspective assumed here it is possible to deal with the attested *variation*.

In order to provide additional evidence for the present hypothesis we run a series of experiment with an Italian agrammatic Broca's aphasic. The experiments, presented and discussed in the following sections, allow a tentative extension of the present hypothesis, originally formulated for comprehension, to cover production data. As noted above

⁹Petra Burkhardt (personal communication) pointed out that late reactivation of the antecedent, instead of total absence of it, could be taken as evidence against the present account (for an overview on late priming in agrammatism see Zurif, 2003). Notice however that late reactivation must be separated from proper chain construction, otherwise agrammatics would not have problems with non-canonical word order (on this point see also Friedmann and Gvion, 2003). What these facts seem to suggest is that chain interpretation does not simply require to reactivate a moved element, but it requires to reactivate it on time and with its complete featural make-up. Moreover non-delayed reactivation of the antecedent in turn requires normal activation of the full morphosyntactic feature set associated with it and absence of any intervening element of the same *type*, which is what we claim goes wrong in the first place. The interaction between timing and grammatical principles is an extremely important issue that we plan to investigate further in the future.

¹⁰It is important to emphasize that the intuition of the existence of some long distance principle at work in agrammatic aphasia is not new. We can find some speculation in this direction in Hickok et al., 1993, p. 387 who claim that some sort of long distance principle could be responsible for canonicity effects: "it seems that when two elements that need to be 'associated' are separated by lexical material, comprehension is poor." Much the same intuition is expressed in Friedmann and Shapiro (2003, fn.4 p.295). For a somewhat similar account for normal processing see also Gibson (1998).

¹¹For a specific application of the approach to the active/passive asymmetry see Gehrke and Grillo (2007); for a comprehensive discussion of the relevant structures see Grillo (2005, to appear).

Table 1

(See Beretta et al., 2001; Burchert and de Bleser, 2004; Drai and Grodzinsky, 2006a; Friedmann and Shapiro, 2003; Grodzinsky et al., 1991; Grodzinsky, 2000; Hagiwara, 1995; Luzzatti et al., 2001; Piñango, 1999; among others.)

Construction	Language	Type	Performance
Active	(It/Eng/Heb/Sp/Jap/Kor/Du/Ger)	¬ crossing	Above Chance
Unaccusatives	(Eng)	¬ crossing	Above Chance
'Short' passives	(Eng)	+ crossing	Chance
'Long' passives	(Eng/Heb/Sp/It)	+ crossing	Chance
OSV scrambling	(Jap/Kor)	+ crossing	Chance
OVS scrambling	(Ger)	+ crossing	Chance
OVS Topic mov.	(Heb)	+ crossing	Chance
OSV Topic mov.	(Heb)	+ crossing	Chance

agrammatics have been claimed to have problems with the Left Periphery of the clause, the CP layer (see Friedmann, 2002; Friedmann and Grodzinsky, 1997; Hagiwara, 1995), we concentrated on two structures that involve this part of the syntactic structure: relative clauses and question formation. We decided to test agrammatic performance with *wh*-questions looking for possible effects of a mismatch in animacy between the moved object and the intervening subject, the idea behind this move being that a such a mismatch could help the system in distinguishing between the two NP. As we will see the results support the idea that fine grained, grammatically encoded, distinctions can contribute to improve agrammatic comprehension by allowing the system to distinguish between a moved NP from an intervening one.

2. Methods

2.1. Participants

M.R. is a 42 year old, right handed, Italian woman. She has aphasia caused by a focal lesion in the left hemisphere in frontal and parietal areas caused by a stroke in the zone of the middle cerebral artery (MCA). The unilateral damage was ascertained by CT scan. After the lesion event the patient showed global aphasia and right hemiparesis. Her linguistic competence subsequently improved, until she reached a stage of non-fluent elliptical speech. This study was conducted two years post-onset by which time M.R.'s condition had stabilized.

M.R.'s language screening was carried out with the standard battery for Italian speakers (B.A.D.A.) Miceli et al. (1994). The screening revealed: difficulties with object and action naming (43.3% of objects are correct, 57.1% of actions), non-fluent speech with omission of grammatical elements, an impairment in the comprehension of reversible sentences with inversion of thematic roles (Active: $\frac{16}{18}$ correct items; Passive: $\frac{5}{17}$), failure in grammaticality judgments of object relative clauses ($\frac{3}{3}$) and of pronoun reference, low scores in working memory tasks measured at word list level.

We collected a corpus of spontaneous production during the experimental sessions. As can be seen from the transcription below her speech production is characterized by a non-fluent speech, impoverished functional lexicon with several omissions and substitution of functional material.

(8) Recipe: the cream puffs

... I bigné. Allora un uovo un un. Un? Burro. La ... acqua
The cream-puffs. Then an egg a a. A? Butter. The ...water
 ...Allora la la il tegamino. e mescola la
and ...Then the the_[sing,fem] the pan_[sing,masc.]. and mix the
 ...piano piano così fin quando fin quando una pasta così così
...softly softly like-that till when till when a dough thus thus
 così. bella. Poi poi mi mi ... la tortiere. Un pezzettino a
thus. beautiful. Then then me me ... the cake-tins. A piece to
 un bigné un bigné un bigné al forno. Allora e
a cream-puff a cream-puff a cream-puff in oven. Then and
 cresce cresce ...il gas. Il gas no. Allora allora. forno forno. Poi
grows grows ... the gas. The gas no. Then then. oven oven. Then
 questa qua pronta. Poi la ricotta. Io zucchero e il latte, il
this one ready. Then the ricotta. I sugar and the milk, the
 latte. E cuoce, no. E poi piano piano ... avvolgi avvolgi
milk. And bake, no. And then softly softly ... roll roll
 avvolgi e e mescola mescola mescola fin quando tutto.
roll and and mix mix mix till when all.

Reading and writing abilities were also highly damaged, but they were not dealt with in this study.

3. Materials

3.1. Comprehension of relatives and clefts

An initial investigation involved the well attested pattern of canonicity effects in comprehension. This is generally tested with a double choice sentence-picture matching task. Using an auditory picture selection task with all pictures presented portraying humans as a homogeneous interpretative factor we investigated M.R.'s ability to interpret canonical and non-canonical relative clauses and cleft sentences. The test sentences used are all semantically reversible; and filler items consist of non-reversible sentences; two pictures were presented for each sentence, one with the target interpretation and one portraying the reversal thematic assignment. Test items were as follows:

- (i) 20 subject relatives, *The boy who kissed the girl is happy*;
- (ii) 20 object relatives, *The boy who the girl kissed is happy*;
- (iii) 20 subject clefts, *It is the boy who kissed the girl*; and
- (iv) 20 object clefts, *It is the boy who the girl kissed*.

3.2. Production

We investigated M.R.'s competence in producing interrogative sentences. Experimental material consisted of 48 target sentences, divided between the following categories:

→ 48 items:

- (i) 24 argumental *who* questions: 12 subject, 12 object and
- (ii) 24 argumental *what* questions: 12 subject, 12 object.

Standard Italian displays a flexible word order in several constructions and a sentence like *chi ha visto Maria?* (lit. who has seen Maria?) is potentially ambiguous between a subject or an object question reading. To avoid this ambiguity the experiment was designed to force the overt presence of the second person object clitic *ti* (*chi ti ha baciato?*, lit. who you has kissed? *who kissed you*) involving the patient directly in an interview situation with the investigator. This was necessary to give the experimenter the certainty that the patient had activated the correct representation-interpretation. The clitic in fact is an important cue in disambiguating a subject from an object interpretation.

The items were balanced for animacy. In Italian, as in English, animacy is grammaticalized in the interrogative elements. The difference between the two *wh*-elements WHO and WHAT is the presence or absence of the feature animacy (in relation to their quantification on an argumental element). Basically, WHO is a grammatically marked with a [+animate] feature and WHAT [-animate]. We tested subject *wh*-questions with animate subjects as in (9(a)) and with inanimate subjects, as in (9(b)). The same animacy alternation was tested with object questions as (10(a)) and (10(b)).

- (9) (a) Chi ti ha accompagnata al cinema?
Who you_{cl} has accompanied to-the cinema?
Who has accompanied you to the cinema?
- (b) Cosa ti ha impedito di uscire ieri sera
What you_{cl} has prevented to go-out yesterday evening?
What prevented you from going out yesterday evening
- (10) (a) Chi hai invitato per il tuo compleanno?
Who have-you invited for the your birthday?
Who did you invite for your birthday?
- (b) Cosa hai eliminato dal tuo armadio?
What have-you removed from-the your closet?
What did you remove from your closet?

Yes/No questions were used as fillers. The items were organized in eight different lists of 12 items each. Different sentence types were alternated. Every list contained all types of items in a randomized order.

4. Procedures

4.1. Comprehension

M.R. took part in an auditory picture selection task. All pictures presented portrayed humans. The task was easily understood and the experimental session was not problematic. Each experimental session was carried on in a quiet room and the patient could interrupt and ask for item to be repeated.

4.2. Production

To investigate M.R.'s production abilities we opted for an elicited production technique in consideration of her difficulties in spontaneous production. The participant had to produce a target sentence after the presentation of the specific context. To test her ability to manage *wh*-dependencies we used a context originally elaborated in L1 acquisition studies (Thornton, 1995). This context requires the use of a particular syntactic structure called *sluicing* (see Ross, 1969). Sluicing involves a deletion process at the level of phonological form, resulting in a type of ellipsis as

(11) Maria visited somebody but she did not say who *<she visited>*.

In the experiment elaborated for children (Thornton, 1995) the investigator tells the child a story; this is the context for elicitation. At the end of the story the investigator invites the child to ask a puppet a missing detail of the story:

- (12) (a) Investigator: 'In that story, there was **something** the spaceman did not like. Ask the snail **what**'
 (b) Target: *What did not the spaceman like?*

In the task created for the patient we used sluicing contexts, similar to those used by Thornton in the acquisition domain. Contexts and target answers are presented in (13):

- (13) WHAT-OBJECT
 Investigator: Ho mangiato qualcosa di speciale. Tu vuoi sapere **cosa**.
 Quindi mi chiedi ...
 I ate something special. You want to know **what**. So you ask me ...
 Target: Cosa hai mangiato?
What did you eat?
- (14) WHO-OBJECT
 Investigator: Ho incontrato qualcuno dopo il cinema. Tu vuoi sapere **chi**. Quindi mi chiedi ...
*I met someone after the cinema. You want to know **who**. So you ask me ...*
 Target: Chi hai incontrato?
Who did you meet?
- (15) WHAT-SUBJECT
 Investigator: Qualcosa mi ha sporcata. Tu vuoi sapere **cosa**. Quindi mi chiedi ...
*Something soiled me (my clothes). You want to know **what**. So you ask me ...*
 Target: Che cosa ti ha sporcata?
What has soiled you?

Table 2
M.R.'s scores on comprehension of relatives and clefted sentences

Sentence type	Correct	%
Subject Relatives	$\frac{17}{20}$	85
Object Relatives	$\frac{8}{20}$	40
Subject Clefts	$\frac{18}{20}$	90
Object Clefts	$\frac{8}{20}$	40
Total	$\frac{51}{80}$	63.7

(16) WHO-SUBJECT

Investigator: Qualcuno mi ha salutato per la strada. Tu vuoi sapere

chi. Quindi mi chiedi

*Someone greeted me in the street. You want to know **who.** So you ask me ...*

Target: Chi ti ha salutato per la strada?

Who has greeted you in the street?

The subject had to create the interrogative sentence substituting the indefinite in the first sentence with the relevant *wh*-element and moving the latter to the interrogative position in the CP layer.¹² The same tests were carried out with one control subject, paired with the participant in age, education and mother tongue (standard Italian). The control subject did not show any deviation from the target items.

The investigator read the contexts. Every session was preceded by a training session. The procedure was the same for all item types.

5. Results

5.1. Comprehension of relatives and clefts

In the battery of relatives and cleft sentences, M.R. shows a selective deficit in comprehension of reversible sentences with inversion of thematic roles. Results are summarized in Table 2.

Object relatives and clefts are at chance level, while subject relatives and subject clefts are significantly above chance.

5.2. Production

A series of clear asymmetries are registered in M.R.'s performance related to the nature of the grammatical arguments. Table 3 summarizes the main results.

¹²See Garraffa (2004) for a detailed comparison of this experimental context with other elicitation techniques.

Table 3
M.R.'s performance in *wh*-question production

Sentence type	Correct	%
<i>who</i> -subject	$\frac{9}{12}$	75
<i>who</i> -object	$\frac{0}{12}$	0
<i>what</i> -subject	$\frac{10}{12}$	83.3
<i>what</i> -object	$\frac{9}{12}$	75
Total	$\frac{28}{48}$	58.3

The participant showed close to normal performance with subject *wh*- element (75/83% correct). The performance degrades reaching 0% correct production with *who*-object questions. M.R.'s performance varies considerably between *who*-object questions (0% correct) and the same construction with *what* (75% correct). Performance levels with object *who* and object *what* questions differ significantly ($\chi^2(1) = 11.3778, p < 0.05$).

(17) ERROR TYPOLOGY

(i) WHO SUBJECT: clitic omission: *Chi (ti) ha accompagnato a casa?*

(Who you_{clit} has taken to home?), *Chi (ti) ha salutato?* (Who you_{clit} has greeted?);
1 fragment: *Chi?* (Who is?).

(ii) WHO OBJECT With *who*-object questions the patient has a score of $\frac{0}{12}$ target responses ($\chi^2(1) = 10.08, p > 0.05$).

The main error type is agreement substitution (with or without clitic insertions) that generates a grammatical subject question. This is an index of a clear preference for *who*-subject interpretation.

(iii) WHAT SUBJECT: 1 clitic omission: *Cosa ha macchiato?* instead of *Cosa ti ha macchiato?*;

1 fragment: *Cosa?* (What?).

(iv) what object: 1 agreement substitution: *Che cosa hai_{3rd sing} macchiato?* Instead of *Che cosa hai_{2nd sing} macchiato?*;

1 fragment: *Che cosa?* (what (thing)?) instead of *che cosa studi?* (what do you study?);

1 substitution with a Yes/No question: *hai mangiato?* (have you eaten) instead of *Che cosa hai mangiato?* (what have you eaten?).

6. Discussion

In this section we discuss the data collected in the light of the proposal illustrated in section two. In Section 6.1 we discuss the data from the comprehension task on relative clauses, clefts, and relatives with number mismatch between the subject and the object DPs. In Section 6.2 we attempt to extend to agrammatic production the *minimality approach* originally formulated for comprehension. The most natural expectation being

patient in building the relative chain and overcome the minimality effect observed in comprehension.

The correct representation of an interrogative sentence requires activation of the relevant *wh*-feature in both the element to be moved (*goal*) and in its dedicated position in the left periphery (*probe*). In the present model, the attested existence of a split between lower (more accessible) projections in the tree and these left peripheral (less/inaccessible) positions in the syntactic representation of agrammatic speakers Hagiwara (1995), Friedmann (1998, 2002), Friedmann and Grodzinsky (1997) is associated with non-standard activation and representation of operator features. In this sense, the expectation that effects similar to those found in comprehension will also show up in production is a natural one, even taking into account the distinctions between the two modalities.

The results presented here offer preliminary support to this claim: a substantial asymmetry arises between subject and object *wh*-question production: the latter being more compromised than the former. Again, only when chain construction requires the crossing of an NP, thus a potential intervener, the patient's performance decreases significantly.

In subject *who* questions, as the one in (20) (*who kissed you*) a problem with the representation of the operator feature should not lead to a production problem: even if an impoverishment of this sort changes the class to which the moved element belongs, the absence of potential intervener (NP) between it and its extraction position cannot give rise to any minimality effects.

(20) Chi <chi> ti ha baciato?

The situation clearly changes when the patient is asked to produce an object question ((21) *who did you kiss*). In this case a slowed-down activation, or a faster than normal decay, of the operator feature changes the class of the set of features associated with the syntactic element to be moved (from Operator to Argumental), making the intervention of the subject NP critical for minimality.

Crucially for our discussion, the possibility of a breakdown is revealed dramatically in the asymmetry between subject and object questions: with 0% correct production of *who*-object questions.

(21) Chi_[+animate] *pro*_[+animate] hai baciato <chi>?
×

As shown in 17(ii), when asked to produce an object *who* question, the participant most frequent error was an agreement substitution that generates a grammatical subject question instead. 'Collapse for subject interpretation' in *who*-object question is a strategy to avoid the construction of a long chain in favor of a less costly structure. In processing terms, this is a kind of reanalysis which takes place when the system is not able to see the crucial distinction between the elements or as a way to solve potential ambiguities (see De Vincenzi, 1991 for a similar preference in the processing of *wh*-questions in adults).¹⁴

Interestingly, the pattern with *what* questions shows that where access to higher order (scope–discourse related) grammatical features is compromised, lower level grammatical

¹⁴See Garraffa (2007) for extensive discussion of this point and for a more specific approach to grammatical processing in aphasia.

distinctions could play a crucial role in helping the patient building up the correct representation. While at first sight the *above chance* performance (75%) with *what* object question production seems to contradict the present account, there is, however, a fundamental difference between *who* and *what* questions. We propose that the availability of a mismatch in the grammaticalized [\pm animate] feature can provide the system with the distinction needed to avoid a minimality effect arising between the moved object and the intervening subject in the case of *what* questions. In the case of *what*-object questions, in fact, the moved object [$-$ animate] differs in animacy from the intervening subject [$+$ animate]. This mismatch could very well be irrelevant in unimpaired grammar where normal activation of the *wh*-feature allows the system to disregard these lower level distinctions (though it could help to reduce the processing load), the same distinction, however, seems to be crucial in helping an impaired system to construct the correct syntactic representation.

- (22) Che cosa_[-animate] pro_[+animate] hai mangiato <che cosa>?

List (22) (what have you eaten) shows that a mismatch in animacy between the moved object and the intervening subject seems to be responsible of a significant increment in correct responses. For the present analysis it is important to underline that M.R. does not show a deficit in checking agreement in *what* question, ($\frac{1}{12}$ substitution in contrast to $\frac{9}{12}$ substitution errors in *who*-object questions). This is important as it strengthens the idea that subject position does not count as an intervener in *what* questions.

Interestingly a very similar result has been obtained by Mak et al., 2002, 2006 with a series of studies on normal processing of relative clauses with mismatch in animacy between the moving object and the intervening subject.¹⁵ Mak and colleagues show that though a preference for subject relative clauses is generally found cross-linguistically, this preference disappears in case of a mismatch in animacy as the one analyzed here is present. Crucially moreover in relative clauses with an inanimate antecedent and an inanimate relative-clause-internal noun phrase, the usual preference for subject relative clauses is found.

These results can be interpreted as indication of the way in which a grammatical principle can be adapted to an exceptional situation.¹⁶

7. Conclusions

The main assumption of the present work, forming the background to our discussion, is that minimality is a general principle of language and possibly of cognition.¹⁷ Taking this

¹⁵Thanks to Esther Ruigendijk and Iris Mulders for pointing our attention to these works.

¹⁶Two anonymous reviewers have pointed out an alternative analysis of the patterns presented here. Regarding comprehension of semantically *non-reversible* sentences, they suggest that better performance with *what* questions can be attributed to independent factors, external to syntactic representation, such as world knowledge. In our view, however, a crucial difference with comprehension is that here the patient knows the correct thematic assignment beforehand, and more importantly this knowledge extends to both *who* and *what* conditions. We conclude from this that better performance with *what* questions cannot be derived on independent grounds. We feel that the data presented here support the generally accepted claim that agrammatic patients interpretation of non-reversible sentences is in fact guided by grammatical principles.

¹⁷The study of human errors (see Reason, 1992 among others) reveals the existence of mechanism analogous to RM (errors induced by similarity effects, often described as intervention effects arising along the path taken in the search for a target) in the most disparate human activities. See Grillo, to appear for a detailed discussion of this point.

principle as a starting point, hypothesis that a specific processing deficit can lead either to a problem in activation, or to a fast decay of part of the morphosyntactic feature arrays associated with syntactic structures in grammatical representations. Reinterpreting much work of the past decade on the topic (Avrutin, 2006; Friedmann, 2002, a.o.; Friedmann and Grodzinsky, 1997; Hagiwara, 1995) we claim furthermore that scope/discourse related features are more likely to be affected by such impoverishment. We claim that the combination of these two factors should affect syntactic comprehension in a selective way.

The data analyzed here, and more importantly the general difficulty with so-called non-canonical structures revealed cross-linguistically in agrammatic aphasia's studies seems to provide consistent support for this hypothesis. Agrammatics' problems with non-canonical structures arise from the fact that in these structures an element similar to the moved antecedent intervenes between the latter and its trace impeding formation of the relevant chain, the syntactic object that is the very essence of movement. It is important to stress that this mechanism applies in the exact same way as it applies in 'normal' grammars. In fact, this is one of the major points made in this paper: in a non-trivial sense there is no difference between aphasic and normal grammar; at the relevant level of analysis it makes no sense to speak about agrammatism at all.

The present approach derives the canonicity effects from a *capacity limitation* of processing resources, which has many advantages (avoidance of stipulating any independent mechanism differentiating the knowledge of agrammatic subjects, unification of islandhood phenomena and canonicity effects) but in particular it allows to deal with *variability* in agrammatic performance (which, as far as we know, has never been shown to display an opposite pattern to the one predicted here, e.g. where canonical structures are more problematic than non-canonical ones).¹⁸

Our proposal elaborates further the idea that the module responsible for syntactic structure building is weakened/slowed down in agrammatism, as proposed by Haarmann and Kolk (1991), Piñango (1999), Avrutin (2006), among many others, and we investigate the interaction of this slowed-down component with economy principles regulating locality and principles of minimal structure. In this sense we built a non-trivial connection between the underlying intuition behind the TDH (that *selective* disruption of chain construction is one of the fundamental characteristics of agrammatic Broca's aphasia) and the *processing* based approaches developed in the last decades.

The fundamental *processing based* nature of the account proposed here means it could also be extended to explain similar patterns displayed by different populations such as children (see especially Avrutin, 2000a,b) and unimpaired adult speaker tested under

¹⁸Druks and Marshall (1995) report on a patient who displays better comprehension patterns on passives than on actives. These results clearly contradict the claim made here. However, as the authors themselves point out, it far from clear that the patient in question should be classified as agrammatic aphasic (see also Zurif, 1996 on this point). The authors observe that the patient response to standard tests batteries for aphasia diagnostics in fact is far better than that of the other patient they report on. In fact they make use of these data to support their claim that the use of traditional categories for the classification of aphasic syndromes should be abandoned in the first place. They claim that different effects on performance could be predicted if a perspective is taken in which different submodules of grammar can be selectively disrupted in different patients. They even develop an analysis of these facts, along with a more classical case of a patient displaying typical canonicity effects, in terms of selective disruption of the case module. Though these facts require an explanation which is not provided here they, and the analysis provided by Druks and Marshall (1995), are not necessarily incompatible with the claim made here. For reasons of space limitations, a proper discussion of these facts lays beyond the scope of the present paper. We refer to Grillo (to appear) for a detailed discussion of the issue.

constrained processing conditions and in stressful situations (see above fn. 3). The possible extension of this approach cover certain typical comprehension and production deficits found in different populations is still at a very premature stage, but it is the authors' view that there seem to be no principled reasons for not following this path. It is clear that the analysis presented here and many issues that were left open for further investigation (and in particular the role of *animacy* features in avoiding minimality effects) require longer and careful reflection and statistically analyzable test result. Though many of the result presented here replicate cross-linguistic, well attested patterns, others should be treated with the usual caution accorded to a single case study.

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References

- Avrutin, S. (1999). *Development of the syntax discourse interface*. Dordrecht: Kluwer Academic Publisher.
- Avrutin, S. (2000a). Comprehension of *wh*-questions by children and Broca's aphasic patients. In Y. Grodzinsky, L. P. Shapiro, & D. A. Swinney (Eds.), *Language and the brain: Representation and processing* (pp. 295–312). San Diego: Academic Press.
- Avrutin, S. (2000b). The syntax-discourse interface and Root Infinitives. In H. Bennis, & M. Everaert (Eds.), *Interface strategies*. Dordrecht: Kluwer.
- Avrutin, S. (2001). Linguistic and agrammatism. *GLOT International*, 5(3).
- Avrutin, S. (2006). Weak Syntax. In K. Amunts, & Y. Grodzinsky (Eds.), *Broca's region*. New York: Oxford University Press.
- Belletti, A. (2004). *Structures and beyond. The cartography of syntactic structures*, Vol. 3. New York: Oxford University Press.
- Beretta, A., Schmitt, C., Halliwell, J., Munn, A., Cuetos, F., & Kim, S. (2001). The effects of Scrambling on Spanish and Korean agrammatic interpretation: Why linear models fail and structural models survive. *Brain and Language*, 79, 407–425.
- Bhatt, R. (2002). The raising analysis of relative clauses: Evidence from adjectival modification. *Natural Language Semantics*, 10, 43–90.
- Bianchi, V. (1999). *Consequences of antisymmetry: Headed relative clauses*. Berlin: Mouton de Gruyter.
- Burchert, F., & de Bleser, R. (2004). Passives in agrammatic sentence comprehension. A German study. *Aphasiology*, 18, 29–45.
- Burchert, F., de Bleser, R., & Sonntag, K. (2003). Does morphology make the difference? Agrammatic sentence comprehension in German. *Brain and Language*, 87, 323–342.
- Burkhardt, P. (2004). *Representation and interpretation at the syntax-discourse interface*. Ph.D. thesis, Yale University.
- Caplan, D. (2001). The measurement of chance performance in aphasia, with specific reference to the comprehension of semantically reversible passive sentences: A note on the issues raised by Caramazza, Capitani, Rey and Berndt (2001) and Draí, Grodzinsky and Zurif (2001). *Brain and Language*, 76(2), 193–201.
- Caplan, D., & Hildebrandt, N. (1988). *Disorders of syntactic comprehension*. Cambridge, MA: MIT Press.
- Caplan, D., & Waters, G. S. (1999). Verbal working memory and sentence comprehension. *Behavioral and Brain Sciences*, 22, 77–94.

- Caramazza, A., Capitani, E., Rey, E., & Berndt, R. (2001). Agrammatic Broca's aphasia is not associated with a single pattern of comprehension performance. *Brain and Language*, 76(2), 158–184.
- Carpenter, P. A., Miyake, A., & Just, M. A. (1994). Working memory constraints in comprehension—evidence from individual difference, aphasia and aging. In M. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 1075–1122). New York: Academic Press.
- Chomsky, N. (1995). *The minimalist program*. Cambridge, MA: MIT Press.
- Cinque, G. (1999). *Adverbs and functional heads*. New York: Oxford University Press.
- Cinque, G. (2002). *Functional structure in DP and IP. The cartography of syntactic structures*, Vol. 1. New York: Oxford University Press.
- Cinque, G. (2006). *Restructuring and functional structure*. New York: Oxford University Press.
- De Vincenzi, M. (1991). *Syntactic parsing strategies in Italian*. Dordrecht: Kluwer.
- Dick, F., Bates, E., Wulfeck, B., Utman, J., Dronkers, N., & Gernsbacher, M. A. (2001). Language deficits, localization and grammar: evidence for a distributive model of language breakdown in aphasics and normals. *Psychological Review*, 108(4), 755–788.
- Drai, D., & Grodzinsky, Y. (2006a). A new empirical angle on the variability debate: Quantitative neurosyntactic analyses of a large data set from Broca's Aphasia. *Brain and Language*, 76, 117–128.
- Drai, D., & Grodzinsky, Y. (2006b). The variability debate: More statistics, more linguistics. *Brain and Language*, 76, 157–170.
- Drai, D., Grodzinsky, Y., & Zurif, E. (2001). Agrammatic Broca's aphasia is associated with a single pattern of comprehension performance: A reply. *Brain and Language*, 76(2), 185–192.
- Druks, J., & Marshall, J. C. (1995). When passives are easier than actives: Two case studies of aphasic comprehension. *Cognition*, 55, 311–331.
- Fodor, J. D. (1998). Learning to Parse? *Journal of Psycholinguistic Research*, 27, 285–319.
- Frazier, L., & Rayner, K. (1988). Parameterizing the language system: Left- vs. right branching within and across languages. In J. Hawkins (Ed.), *Exploring language universals*. Oxford, UK: Basil Blackwell.
- Friedmann, N. (1998). *Functional categories in agrammatism: A cross linguistic study*. Ph.D. thesis, Tel Aviv University.
- Friedmann, N. (2002). Question production in agrammatism: The Tree Pruning Hypothesis. *Brain and Language*, 80, 160–187.
- Friedmann, N., & Grodzinsky, Y. (1997). Tense and Agreement in agrammatic production: Pruning the syntactic tree. *Brain and Language*, 56, 397–425.
- Friedmann, N., & Gvion, A. (2003). Sentence comprehension and working memory limitation in aphasia: A dissociation between semantic-syntactic and phonological reactivation. *Brain and Language*, 86, 23–39.
- Friedmann, N., & Shapiro, L. P. (2003). Agrammatic comprehension of simple active sentences with moved constituents: Hebrew OSV and OVS structures. *Journal of Speech Language and Hearing Research*, 46, 441–463.
- Garraffa, M. (2004). Task dependent effects: What are you asking for? A good context for elicitation of *wh*-questions, Poster presented at the *Science of Aphasia V Conference*, Potsdam, September 2004.
- Garraffa, M. (2007). *Impoverishment of grammatical features in a non-fluent aphasic speaker: The grammatical nature of minimal structures*. Ph.D. thesis, Università di Siena.
- Gehrke, B., Grillo, N. (2007). Aspects on passives. In S. Blaho, L. Vicente, & E. Schoorlemmer (Eds.). *Proceedings of ConSOLE XIV* (pp. 121–141), {<http://www.sole.leidenuniv.nl/>}.
- Gibson, E. (1998). Linguistic complexity: locality of syntactic dependencies. *Cognition*, 68, 1–76.
- Grillo, N. (2003). *Comprensione agrammatica tra processing e rappresentazione: effetti di minimalità*. Master's thesis, Università di Siena.
- Grillo, N. (2005). Minimality effects in agrammatic comprehension. In S. Blaho, E. Schoorlemmer, L. Vicente, L. (Eds.), *Proceedings of ConSOLE XIII* (pp. 106–120), (<http://www.sole.leidenuniv.nl/>).
- Grillo, N. (to appear). *Generalized minimality*. Ph.D. thesis, Utrecht Institute of Linguistics OTS.
- Grodzinsky, Y. (1986a). Cognitive deficits, their proper description, and its theoretical relevance. *Brain and Language*, 27, 178–191.
- Grodzinsky, Y. (1986b). Language deficits and the theory of syntax. *Brain and Language*, 27, 135–159.
- Grodzinsky, Y. (1990). *Theoretical perspectives on language deficit*. Cambridge, MA: MIT Press.
- Grodzinsky, Y. (1995a). A restrictive theory of agrammatic comprehension. *Brain and Language*, 50, 27–51.
- Grodzinsky, Y. (1995b). Trace deletion θ -roles and cognitive strategies. *Brain and Language*, 51, 469–497.
- Grodzinsky, Y. (2000). The neurology of syntax: Language use without Broca's area. *Behavioral and Brain Sciences*, 23, 1–71.

- Grodzinsky, Y., Pierce, A., & Marakovitz, S. (1991). Neuropsychological reasons for a transformational derivation of syntactic passives. *Natural Language & Linguistic Theory*, 9, 431–453.
- Grodzinsky, Y., & Reinhart, T. (1993). The innateness of binding and coreference. *Linguistic Inquiry*, 24(1), 69–101.
- Haarmann, H. J., & Kolk, H. H. (1991). A computer model of the temporal course of agrammatic sentence understanding: The effects of variation in severity and sentence complexity. *Cognitive Science*, 15, 49–87.
- Hagiwara, H. (1995). The breakdown of functional categories and the economy of derivation. *Brain and Language*, 50, 92–116.
- Hickok, G., & Avrutin, S. (1995). Representation, referentiality, and processing in agrammatic comprehension: Two case studies. *Brain and Language*, 50, 10–26.
- Hickok, G., Zurif, E. B., & Canseco-Gonzalez, E. (1993). Structural description of agrammatic comprehension. *Brain and Language*, 45, 371–395.
- Hulsey, S., & Sauerland, U. (2006). Sorting out relative clauses. *Natural Language Semantics*, 14, 111–137.
- Inoue, A., & Fodor, J. D. (1995). Information paced parsing of Japanese. In R. Mazuka, & N. Nagai (Eds.), *Japanese sentence processing*. Hillsdale, NJ: Erlbaum.
- Kolk, H. H. J. (1987). A theory of grammatical impairment in aphasia. In G. Kempen (Ed.), *Natural language generation*. Dordrecht: Martinus Nijhoff.
- Kolk, H. H. J. (1995). A time-based approach to agrammatic production. *The Linguistics Review*, 2(1), 139–160.
- Kolk, H. H. J. (1998). Disorders of syntax in aphasia: linguistic-descriptive and processing approaches. In B. Stemmer, & H. Whitaker (Eds.), *Handbook of neurolinguistics*. San Diego: Academic Press.
- Luzzatti, C., Toraldo, A., Guasti, M. T., Ghirardi, G., Lorenzi, L., & Guarnaschelli, C. (2001). Comprehension of reversible active and passive sentences in agrammatism. *Aphasiology*, 15(5), 419–441.
- Mak, W. M., Vonk, W., & Schriefets, H. (2002). The influence of animacy on relative clause processing. *Memory and Language*, 47, 50–68.
- Mak, W. M., Vonk, W., & Schriefets, H. (2006). Animacy in processing relative clause: The hikers that rocks crush. *Memory and Language*, 54, 466–490.
- Miceli, G., Burani, C., Capasso, R., Laudanna, A. (1994). *Batteria per l'analisi dei deficit afasici-B.A.D.A.* (2nd ed.). CEPSAG.
- Neuhaus, E., & Penke, M. (2003). Wh-question production in German Broca's aphasia. *Brain and Language*, 87, 50–60.
- Penke, M. (2000). Unpruned trees in German Broca's aphasia. *Behavioral and Brain Sciences*, 23(1), 46–47.
- Penke, M. (2001). Scontroveries about CP: A comparison of language acquisition and language impairments in Broca's aphasia. *Brain and Language*, 77, 351–363.
- Piñango, M. M. (1999). Syntactic displacement in Broca's aphasia comprehension. In Y. Grodzinsky, & R. Bastiaanse (Eds.), *Grammatical disorders in aphasia: A neurolinguistic perspective* (pp. 75–87). London: Whurr.
- Piñango, M. M., & Burkhardt, P. (2001). Pronominals in Broca's aphasia comprehension: The consequences of syntactic delay. *Brain and Language*, 79(1), 167–168.
- Reason, J. (1992). *Human error*. Cambridge, UK: Cambridge University Press.
- Reuland, E. (2001). Primitives of binding. *Linguistic Inquiry*, 32, 439–492.
- Rizzi, L. (1990). *Relativized Minimality*. Cambridge, MA: MIT Press.
- Rizzi, L. (1997). The fine structure of the Left Periphery. In L. Haegeman (Ed.), *Elements of grammar* (pp. 281–337). Dordrecht: Kluwer.
- Rizzi, L. (2000). Reconstruction weak island sensitivity and agreement, ms. CISCL Università di Siena {<http://www.ciscl.unisi.it/publicazioni.htm>}.
- Rizzi, L. (2004a). Locality and the left periphery. In A. Belletti (Ed.), *Structure and Beyond* (pp. 223–251). New York: Oxford University Press.
- Rizzi, L. (2004b). *The structure of CP and IP-The cartography of syntactic structures*, Vol. 2. New York: Oxford University Press.
- Ross, J. R. (1969). Guess who? In *Papers from the fifth regional meeting of the Chicago Linguistic Society* (pp. 252–286).
- Ruigendijk, E., Kouwenberg, M., & Friedmann, N. (2004). Question production in Dutch agrammatism. *Brain and Language*, 91, 116–117.
- Ruigendijk, E., Vasić, N., & Avrutin, S. (2006). Reference assignment: Using language breakdown to choose between theoretical approaches. *Brain and Language*, 96, 302–317.
- Sauerland, U. (1998). *The meaning of chains*. Ph.D. thesis, Massachusetts Institute of Technology.
- Starke, M. (2001). *Move dissolves into Merge: A theory of Locality*. Ph.D. thesis, University of Geneva.

- Thompson, C. K., & Shapiro, L. P. (1994). A linguistic-specific approach to treatment of sentence production deficits in aphasia. *Clinical Aphasiology*, 22, 307–323.
- Thompson, C. K., Shapiro, L. P., Tait, M. E., Jacobs, B. J., & Schneider, S. L. (1996). Training *wh*-question production in agrammatic aphasia: Analysis of argument and adjunct movement. *Brain and Language*, 52, 175–228.
- Thornton, R. (1995). Referentiality and *wh*-movement in Child English Juvenile D-Linkuency. *Language Acquisition*, 4, 139–175.
- van der Meulen, I. (2004). *Syntactic movement and comprehension deficit in Broca's aphasia*. Ph.D. thesis, University of Leiden.
- Vasić, N. (2006). *Pronoun comprehension in agrammatic aphasia*. Ph.D. thesis, Utrecht Institute of Linguistics OTS.
- Vasić, N., Avrutin, S., & Ruigendijk, E. (2006). Interpretation of pronouns in vpellipsis constructions in Dutch Broca's and Wernike's aphasia. *Brain and Language*, 96, 191–206.
- Zurif, E., Swinney, D., Prather, P., Solomon, J., & Bushell, C. (1993). An on-line analysis of syntactic processing in Broca's and Wernike's aphasia. *Brain and Language*, 45, 48–464.
- Zurif, E. B. (1996). Grammatical theory and the study of sentence comprehension in aphasia: Comments on Druks and Marshall (1995). *Cognition*, 58, 271–279.
- Zurif, E. B. (2003). The neuroanatomical organization of some features of sentence comprehension: Studies on real-time syntactic and semantic composition. *Psychologica*, 32, 13–24.
- Zurif, E. B., & Caramazza, A. (1976). Linguistic structures in aphasia: Studies in syntax and semantics. In H. Whitaker, & H. Whitaker (Eds.), *Studies in neurolinguistics*, Vol. 2. New York: Academic Press.