The goal of this article is to familiarize the reader who has background in theoretical linguistics with some of the recent research in aphasiology. Needless to say, it is far beyond the space limitation, and my capacity, to present all work carried out in the field of language impairment, even during the last decade. My goal is more modest: I will attempt to demonstrate how the interaction of theoretical linguistics and aphasiology can inform both disciplines; what impact the development of linguistics as a field has had on our understanding of language breakdown, and how studies of aphasia can be beneficial for our understanding of the human unimpaired linguistic capacity. In this article, therefore, I will focus, primarily, on the psycholinguistic research that approached investigation of aphasia from a linguistic, theory-based perspective. It is my hope that the results presented below will further encourage linguists to view aphasiology as an important source for our understanding of the human linguistic capacity, and that aphasiologists will be further inspired to view theoretical linguistics as an important, if not necessary, tool for obtaining a better picture of language impairment.

1. Aphasia: a brief overview
Agrammatism is a case of a more general linguistic impairment known as Broca’s aphasia. It is manifested by the presence of ungrammatical utterances in the speech of patients with a particular brain damage as well as in abnormal (‘ungrammatical’) comprehension of certain constructions (see below for details). This disorder usually results from a brain damage such as trauma or stroke. As language is an extraordinary complex system, it is natural that there are various types of impairment related to this system – that is various types of aphasia.

Very informally, Broca’s aphasia can be characterized as a language disorder resulting in effortful, ‘telegraphic’ speech. The utterances are typically reduced in length and it takes patients significantly longer to express their thoughts, or to describe pictures. Broca’s aphasics typically have severe problems with word findings, which can at least partially account for their elliptical utterances and poor naming. Agrammatic aphasia, furthermore, is characterized by frequent omission of functional categories, such as determiners, tense, complementizers. Patients’ comprehension appears to be normal, at least the intuitive feeling is that they understand what they hear, and struggle to reply appropriately. As discussed below, however, recent psycholinguistic research has shown that comprehension in agrammatism is also impaired.

Broca’s aphasia is usually contrasted with another language impairment known as Wernicke’s aphasia (an overview of other types of aphasia can be found, for example, in Benson 1985). The comprehension pattern of Wernicke’s aphasics is usually characterized as poor. However, they appear to have undisturbed computational capacity in speech production: their speech is effortless, functional categories are, for the most part, present and used correctly and the intonation pattern seems to be normal. Yet, the semantic content of their speech is often empty and sentences may contain some jargon thus making it hardly comprehensible. The speech of Wernicke’s aphasics may sometimes contain nonwords, most often semantic substitution (verbal paraphasia).

The following examples represent a typical pattern of speech of Broca and Wernicke’s patients, respectively, produced as a description of a test picture. In this picture, known as ‘Cookie Theft Picture’, a woman is drying dishes not noticing what is going around her: the water flows out of the sink, a boy and a girl are taking cookies out of a jar, and the boy, standing on a kitchen stool, is about to fall down.

**BROCA’S APHASIC PATIENT B.L.**

**B.L.:** Wife is dry dishes. Water down! Oh boy! okay. Awright. Okay . . . Cookie is down . . . fall, and girl, okay, girl . . . boy . . . um . . .

**Examiner:** What is the boy doing?

**B.L.:** Cookie is . . . um . . . catch

**Examiner:** Who is getting the cookies?

**B.L.:** Girl, girl!

**Examiner:** Who is about to fall down?

**B.L.:** Boy . . . fall down!
First of all, this is falling down, just about, and is gonna fall down and they're both getting something to eat . . . but the trouble is this is gonna let go and they're both gonna fall down . . . but already then . . . I can't see well enough but I believe that either she or will have some food that’s not good for you and she's to get some for her, too . . . and that you get it and you shouldn't get it there because they shouldn't go up there and get it unless you tell them that they could have it. And so this is falling down and for sure there's one they are going to have for food and, and didn't come out right, the uh, the stuff that's uh, good for, it's not good for you but it, but you love it, um mum mum (smacks lips) . . . and that so they've . . . see that, I can't see whether it's in there or not.

Examiner: Yes, that's not real clear. What do you think she's doing?
H.W.: But, oh, I know. She's waiting for this!
Examiner: No, I meant right here with her hand, right where you can't figure out what she's doing with that hand.
H.W.: Oh, I think she's saying I want two or three, I want one, I think, I think so, and so, so she's gonna get this one for sure it's gonna fall down there or whatever, she's gonna get that one and, and there, he's gonna get one himself or more, it all depends with this when they fall down . . . and when it falls down there's no problem, all they got to do is fix it and go right back up and get some more.

This superficial distinction between the two kinds of impairment led some researchers in the past to propose a somewhat simplified model of what a brain – language relation might look like. What is now known as Broca's area was taken to host human 'production' capacity, and Wernicke's areas was labeled a 'comprehension center'. Such a view, of course, ignores the incredibly complex nature of our linguistic knowledge and its internal structure. There is a long way from a thought to an acoustic wave transmitted from one speaker to another, and to say that 'speech production is impaired' is to say nothing. To properly understand the nature of aphasia, it is crucial to understand the structure of language, its internal rules and principles. Only then will it be possible to state what part of the language capacity is disrupted as a result of a particular brain damage.

At the same time, research in language impairment can be very important for linguistic research as well. One of the reasons why aphasia has attracted linguists' attention is its relevance for the modularity of language thesis. Aphasics, for the most part, preserve normal cognitive abilities; their impairment is related specifically to language. Thus, the very presence of such disorder supports the claim that language is an independent system that is governed by its own rules and principles. Linguistic analysis of the aphasic speech, thus, can provide a theory-based view on the localization of a particular linguistic function: If it can be shown that some language property X is impaired in a population with a damage to area A, it is plausible (although not necessarily true) to claim that this area is related to X. As discussed below, whether A is the locus of human knowledge of X, or it is crucial for the implementation of this knowledge, constitutes an important topic for current debate.

Moreover, findings in aphasia research can be used to distinguish between alternative linguistic theories. Suppose we observe that a certain brain damage results in selective impairment of a certain construction S, while leaving another construction, C, intact. Suppose further that there are two competing theories, X and Y, one of which (X) analyses S and C as related, and the other (Y) claiming the opposite. The results obtained from aphasia, in this case, will argue against theory X because, prima facie, two linguistically related constructions should be equally impaired as a result of a specific brain damage.

In this article I will focus mostly on agrammatic aphasia – a disorder that results in apparently 'agrammatic' pattern of speech production and, in some instances, abnormal comprehension. The reason for this choice is that it is agrammatism that attracted most of the recent linguistic research in aphasia, precisely because application of theoretical linguistics as a tool for investigation proved to be very fruitful. Whether agrammatism is really an impairment of the human knowledge of grammar (the lack-of-knowledge hypothesis), or it is a reflection of the inability to implement this knowledge due to the lack of processing resources (the lack-of-resources hypothesis) is still an open question (see, for example, Lukatela et al., 1995; for their discussion of the Structural Deficit Hypothesis vs. Processing Limitation Hypothesis).

One of the most important results of the application of linguistic theory to the study of language impairment, I believe, is that the nature of the deficit exhibited by Broca's and Wernicke's aphasics had to be redefined. It is no longer feasible now to characterize Broca's aphasia simply as a 'production' disorder, and Wernicke's as disorder of comprehension. As will be shown in the next section, we can get a better insight on the nature of impairment if we address the deficit from the perspective of linguistic theory.

2. Comprehension in aphasia
As Broca's aphasia is best known for the non-fluent, effortful, 'telegraphic' pattern of speech, the comprehension problems associated with this syndrome are less noticeable and harder to detect. Indeed, until the 1970's, when theory based, controlled experiments began to be carried out, the deficit in this modality had been largely ignored or not noticed at all. In their pioneering work, however, Caramazza & Zurif (1976) showed that Broca's aphasics exhibit different pattern of comprehension of 'semantically reversible' and 'semantically irreversible' sentences, such as (1) and (2).
(1) The ball that the boy is kicking is red.
(2) The cat that the dog is chasing is black.

Patients were successful in comprehending (1), which provided semantic cues for the correct interpretation, while they failed on (2), where the correct interpretation relied on syntactic structure only. These findings initiated further research on the syntactic capacity of Broca’s aphasics, which led to the formulation of the Trace Deletion Hypothesis (henceforth TDH, Grodzinsky, 1984) – one of the most influential and controversial claims in neurolinguistics.

2.1. Overt movement and TDH

Many researchers have shown that Broca’s aphasics have problems with understanding passive sentences, as in (3a). Comprehension of corresponding active sentences (3b) is intact (for a detailed overview of a large number of studies, see Grodzinsky et al., 1999).

(3) a. The boy was pushed by the girl.
   b. The girl pushed the boy.

Grodzinsky’s proposal is that Broca’s aphasics are unable to represent traces (hence the name of the theory). As the NP trace in the object position in (3a) is necessary for transmitting theta-role to the moved constituent, patients fail to correctly interpret the boy as the patient of the pushing event. They therefore may opt for some other, non-syntactic way of interpreting the sentence, for example through a default strategy that assigns the first NP in English the agentive interpretation. As a result, aphasics may end up with a representation where two agents are present: the girl (as it appears in the by-phrase), and the boy (by default). Faced with the ‘double-Agents’ uncertainty, patients guess, which results in their chance performance in comprehending passive constructions.

Interestingly, analogous results were obtained with Japanese aphasics, but in a more diverse set of constructions. Hagiwara (1993) presented agrammatic patients with active and passive sentences; however some active sentences, too, involved transformations (scrambling), while some passives did not. The experimental paradigm is given in (4) and (5).

(4) a. Taro-ga Hanako-o nagutta
   ‘Taro hit Hanako’ (Active, non-scrambled)
   b. Hanako-o Taro-ga ti nagutta
   ‘Hanako hit Taro’ (Active, scrambled)

(5) a. Taro-ga Hanako-ni ti nagu-rare-ta
   ‘Taro was hit by Hanako’ (Passive, derived)
   b. Okaasan-ga musuko-ni kaze-o
   ‘Mother’s son caught a cold’

Only structures in (4b) and (5a) involve movement operation (and traces), and it was precisely in these two cases that Japanese agrammatics showed a chance performance.

Further experiments appear to support TDH. Broca’s aphasics show a significantly better performance on comprehension of subject relative clauses, subject clefts and adjectival passives. A summary of experimental results (from Grodzinsky, 1999) is given below.

<table>
<thead>
<tr>
<th>Construction Type</th>
<th>Performance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>(6) a. The girl pushed the boy</td>
<td>above chance</td>
</tr>
<tr>
<td>b. The girl who pushed the boy was tall</td>
<td>above chance</td>
</tr>
<tr>
<td>c. Show me the girl who pushed the boy</td>
<td>above chance</td>
</tr>
<tr>
<td>d. It is the girl who pushed the boy</td>
<td>above chance</td>
</tr>
<tr>
<td>e. The boy was interested in the girl</td>
<td>above chance</td>
</tr>
<tr>
<td>f. The woman was uninspired by the man</td>
<td>above chance</td>
</tr>
<tr>
<td>(7) a. The boy was pushed by the girl</td>
<td>chance</td>
</tr>
<tr>
<td>b. The boy who the girl pushed was tall</td>
<td>chance</td>
</tr>
<tr>
<td>c. Show me the boy who the girl pushed</td>
<td>chance</td>
</tr>
<tr>
<td>d. It is the boy who the girl pushed</td>
<td>chance</td>
</tr>
<tr>
<td>e. The woman who was uninspired by the man</td>
<td>chance</td>
</tr>
</tbody>
</table>

The relevant for the present discussion difference between constructions in (6) and (7) is that the former either do not involve phrasal movement (e.g. adjectival passives), or movement does not result in a structure where two NPs are assigned the same agentive interpretation (e.g. the boy in (a–d) is Patient while the girl is Agent, although, for Broca’s aphasics, such interpretation in some cases may be obtained by default, not through structure).

In fact, even those constructions that yield above-chance performance in Broca’s patients, such as subject relative clauses, are processed by these patients in an abnormal manner. Zurif et al. (1993) showed that these subjects do not access the antecedent (the professor in (8)) in the same manner as normal speakers.

(8) The gymnast loved the professor from the northwestern city who complained about the bad coffee.

Normal speakers showed priming for a word semantically related to the antecedent (e.g. ‘teacher’) when it was presented immediately after ‘who’. Broca’s aphasics, however, failed to show priming. Zurif and his colleagues argue that presence of priming (that is faster recognition of a word) points to a fast, automatic connection between the gap and its antecedent that normal speakers establish in the course of sentence
processing. Broca’s aphasics, according to these authors, fail to establish such connection. Thus, even though these patients appear to understand sentences of type (6), they do it in an abnormal manner.

Not all comprehension results are easily accounted for by TDH and the default strategy proposed by Grodzinsky. Beretta & Munn (1998), for example, demonstrate, in a nicely controlled experiment, that agrammatic representation does not involve double Agents. Specifically, they presented patients with pictures one of which contained two individuals that could be interpreted as agents (e.g. both a woman and a giraffe kicking a dog). When agrammatics were asked to interpret a passive sentence (e.g. ‘the giraffe was kicked by the woman’) they almost never chose the picture depicting both characters as agents (e.g. both kicking a dog). These results contradict Grodzinsky’s proposal that both NPs are interpreted by agrammatics as agents, and, as the authors argue, refute the proposed default strategy as the source of the chance performance. Pinango (1999) demonstrated that agrammatic patients exhibit normal-like performance in comprehension of unaccusative sentences, which suggests that these patients can represent subject NP traces. In her experiment, Broca’s aphasics showed no difference in interpreting unergative (9), alternating (10) and non-alternating (11) unaccusatives:

(9) The girl clapped because of the boy.
(10) The girl spun because of the boy.
(11) The girl fell because of the boy.

As the same patients exhibited chance performance in comprehension of passive constructions, Pinango argues that the impaired comprehension can only be observed when syntactic movement brings about reversal of thematic roles (see Pinango, 1999 for her formulation of the Argument Linking Hypothesis).

Other authors suggested that problems with passive constructions in agrammatism are not related to the structural deficit but to a processing limitation. Hartsuiker & Kolk (1998), for example, showed that agrammatics who never produced passives in their spontaneous speech were able to do so after ‘syntactic priming’: having repeated a sentence like ‘the speaker is interrupted by the noise’ they tended to use passives in describing a picture of a tank killing a soldier (see also Baum, 1988; Friederici & Kilborn, 1989 for other syntactic priming studies). While these studies involved production experiments, and the original formulation of the TDH was based on the comprehension deficit, the results are highly important. Indeed, if agrammatism involves deletion of traces from the syntactic representation of a sentence, it is natural that they should be missing both in the course of comprehension and production. Thus, patients’ ability to produce passives, although after priming, contradicts the claim that traces are absent altogether.

Hickok & Avrutin (1995) and Tait et al. (1995) observed that aphasics’ comprehension of another construction involving overt transformations, wh-movement, may depend on the type of the moved constituent. It appears that these patients have more problems interpreting D-linked wh-phrases (12a) than non-D-linked ones (12b).

(12) a. Which tiger did the lion chase?
  b. Who did the tiger chase?

Patients demonstrated above chance performance on (12b) and a chance performance on (12a) (no difference was found for the corresponding wh-subject questions, both being above-chance). These findings suggest that a proper characterization of the impairment may be more subtle than trace deletion, although whether it is a structural deficit (as argued by the authors), or related to the syntax–discourse interface (Avrutin, 2000), is an open question.

Another challenge to the purely structural deficit approach comes from the grammaticality judgment studies. Sensitivity to violations of the inflectional morphology has been demonstrated in Italian, German, and Serbo-Croatian agrammatics (Kolk & van Grunsven, 1985; Bates et al., 1987; Friederici et al., 1992; Lukatela et al., 1995). Retained ability to detect syntactic violations has been demonstrated even in patients with severe forms of agrammatism (e.g. Linebarger et al., 1983; Shankweiler et al., 1989, see, however, Grodzinsky & Finkel, 1998 for an attempt to argue otherwise). These authors argue that the ability to detect a linguistic anomaly demonstrates aphasics’ intact knowledge of relevant rules; the nature of the deficit then lies in the limitation of processing capacity needed for the implementation of the available knowledge in real time.

2.2. Comprehension difficulties in structures without overt movement

Comprehension deficit in agrammatism is not restricted to structures with overt phrasal movement. Avrutin et al. (1999) show that these patients have difficulties with establishing reference for a pronoun in the presence of two possible antecedents:

(13) First John hit Bill, and then Mary hit him.

Normal speakers interpret pronoun him as referring to Bill, and they switch reference if the pronoun is stressed (‘... and then Mary hit HIM’). Aphasics, however, were at chance in both conditions choosing randomly between John and Bill as the antecedent. Nevertheless, they did show sensitivity to the stress: they chose the matrix subject more often in the stressed than in the unstressed condition.

Interestingly, the same patients showed a better performance in the control condition (also involving stress) where assignment of pronominal reference (a discourse-related operation) was not at stake. Thus, when asked to point to a hotdog, they had less problems distinguishing between a picture...
corresponding to a compound noun (‘a HOT dog’) and an adjectival phrase (‘a hot DOG’).

Errors with pronoun interpretation were observed in a study by Grodzinsky et al. (1993) (see also Pinango, 2000). In this study, subjects were at chance on sentences (14) while above chance on (15) and (16).

(14) Is Mama Bear touching her?

(15) Is Mama Bear touching herself?

(16) Is every bear touching her?

In about 50% of the time, Broca’s aphasics allowed her to refer to Mama Bear. Significantly fewer errors were observed with the reflexive in (15), or with a pronoun with a quantified antecedent (16). Following Reinhart’s (1983) analyses of pronouns as bound variables and referring expressions, and subsequent work by Grodzinsky & Reinhart (1993, Rule I), the authors argue that Broca’s aphasics observe syntactic constraints on the interpretation of pronouns, while they have difficulties in implementing Rule I because it requires accessing discourse level of representation and comparing the derived meanings. Such a comparison overloads aphasics’ capacity, which results in their guessing performance. When a pronoun is a bound variable (16), or in sentences with reflexives (15), no such comparison is required (the interpretation relies exclusively on syntactic structure and corresponding principles, such as c-command, Principle A). In this case, aphasics show a significantly better performance.

Regarding quantifiers, however, it is not the case that aphasics are completely like normals. Philip & Avrutin (1998) demonstrated that these patients have an abnormal way of interpreting constructions in (17) (see also Saddy, 1990).

(17) Every boy is driving a car.

When presented with a picture where each of the three boys is driving a car, and there is another car that is not driven by anyone, Broca’s aphasics, unlike normal adult speakers, reject sentence in (17) as a true description of the picture, pointing to the fourth, empty car. Following Philip’s (1995) proposal, the authors suggest that aphasic patients interpret constructions in (17) as quantification over events, rather than individuals, which may represent a more economical option for a population with limited processing resources.

Thus, it appears that problems that Broca’s aphasics have go beyond sentences with overt phrasal movement. The data suggest that the difficulties may be related to the lack of processing resources necessary for implementing particular linguistic knowledge, which, by itself, is intact. Similar proposals have been made with respect to aphasics’ abnormal production pattern, to which I turn shortly. Before discussing production studies, however, I would like to emphasize once again the importance of theoretical linguistics for psycholinguistic research. Even the design of experiments presented above became possible due to the existence of some theoretical analyses that allowed researchers to formulate questions, make predictions and analyse the obtained data. For example, whether correct or not, the formulation of the trace deletion hypothesis was possible due to the availability of movement-based analyses of passive constructions. The difference between various types of wh-questions was formulated in Pesetsky (1987) on the basis of independent syntactic phenomena, and it was his theory that directed psycholinguistic researchers towards a possible source of deficit in agrammatic aphasia. The formulation of principles A and B of the Binding Theory gave researchers a theoretical mechanism for designing experiments on comprehension of pronouns in agrammatism, as well as allowing for theory-based analyses of the results. Moreover, the different pattern of comprehension of referring and bound variable pronouns can be taken as evidence for a particular linguistic theory (e.g. Reinhart’s, 1983 theory that distinguishes these two interpretations as belonging to two different domains, one being discourse. Reinhart’s view, supported by the psycholinguistic results, is different in this sense from that expressed in Chomsky, 1981 who does not differentiate between referring and bound variable pronouns, both being subject to the same principle B). These are, of course, just few examples illustrating the relevance of linguistic theory for aphasiology. The same holds for the analyses of agrammatic speech, which is discussed in the next section.

3. Production

As mentioned above, a characteristic feature of agrammatic speech is frequent omission of functional categories, such as determiners, Tense, and comple mentizers. This omission is typical for agrammatic speech and is often taken as the diagnosis of agrammatism (e.g. Marshall, 1986; Goodglass, 1993; among others). It is worth noting, however, that agrammatic errors are not ‘random’: they seem to follow certain patterns depending on the ambient language. As Grodzinsky (1990, 1999) argues, patients’ performance can be characterized either as omission or substitution: In languages like English or Japanese, where bare stems can function as independent lexical items, agrammatists tend to omit bound morphemes. In languages like Hebrew, Russian or Italian, where bare stems are not allowed, subjects do not produce bare stems, but may use an incorrect one (for example, making agreement errors, as in (18)). Some examples (from Grodzinsky, 1999) are given below:

(18) a. Uh, oh, I guess six months … my mother pass away.

b. inorimasu (correct: inorimasushita) (Japanese)

I-pray (I-prayed)

c. stol stoyat (Russian)

table (SNG) stands (PL)

d. Cappuccetto rossa andava (Italian)

Little Ridinghood-MASC Red –FEM went
The sensitivity to the properties of the surrounding language points once again to the importance of linguistic theory in a proper characterization of agrammatism. As shown below, such approach turned out to be very fruitful in providing a more restrictive theory of impairment.

3.1. Non-finite forms

A typical feature of agrammatic speech is their frequent use of non-finite utterances in the context where a tensed verb is required:

(19) a. televisie kopen (Dutch, from De Roo, 1999) TV buy
target: ‘The TV is buying’

b. ich morgen aufstehen (German, from Penke, 1996) I morning get-up-INF
target: ‘I am getting up tomorrow’

c. sen jag ringa till Maud syster (then I call-INF to Maud sister) Swedish, from Platzzack, in press)

It is not the case, however, that agrammatics lack tense altogether; rather they appear to optionally use non-finite constructions alongside with finite clauses.

The use of infinitives in agrammatism, nevertheless, seems to be constrained by various syntactic and semantic factors. Bastiaanse & van Zonneveld (1998), for example, show that the use of non-finite forms in aphasia is restricted to the main clause (the authors’ claim being that agrammatics have problems with verb movement which takes place in Dutch only in the main clause; see however, Lonzi & Luzzatti, 1993). When asked to complete a sentence with a missing verb, agrammatics produced finite form in (20) only 49% of the time. In (21), however, the performance increased to 86%:

(20) de boer . . . de koe
target: ‘The farmer . . . the cow’

(21) Ik zie dat de man het koor . . .
I see that the man the choir . . .
target: ‘I see that the man directs the choir’

Avrutin (1999) suggests that these findings demonstrate agrammatics’ sensitivity to what Gueron & Hoekstra (1995) label ‘the tense chain’, that is the requirement on the coindexation of Comp and T. Agrammatics, thus, preserve subtle syntactic knowledge that in the presence of overt Comp, only finite T can participate in the tense chain. Further support for this view comes from the observation that agrammatics always produce tensed auxiliary verbs and modals (even in the main clause), that is the elements that head TP and therefore occur in the tense chain (e.g. Bastiaanse & Jonkers, 1998; Kolk, 1998; de Roo, 1999).

Further restrictions on the use of non-finite forms in agrammatism are reflected in their sensitivity to the semantic content and structural position of the verb. Kolk (in press) observed that most non-finite verbs in the speech of Dutch agrammatics are activity predicates, while stative predicates usually show up tensed. Avrutin & Manzoni (2000) obtained similar results for Italian aphasics (these findings are reminiscent of Wijnen’s, 1997 observations of the speech of Dutch children, see Section 7).

Agrammatics also demonstrate subtle syntactic knowledge of the relationship between verb movement and finiteness. Kolk & Heeschen (1992) show that if a non-finite verb is produced by a Dutch or German (V2 languages) aphasic speaker, this verb, in the vast majority of cases, is in the clause final position; the finite verb is always correctly placed in the second position. Lonzi & Luzzatti (1993) report similar results for Italian agrammatic aphasics. The authors observe that when the verb is in a nonfinite form, it either precedes or follows the adverb (both positions are correct in Italian), but when the verb is finite, the adverb always follows it.

The above findings suggest that agrammatic aphasics preserve at least some syntactic knowledge as evidenced by their sensitivity to the relevant constraints in the ambient language. Crucially, these observations became possible only as a result of the application of linguistic theory to what appeared to be ungrammatical utterances. Minimally, for example, one needs to have a theory of clause structure in Dutch or German in order to properly formulate a hypothesis about the correlation between finiteness and structural position, which otherwise remains a mystery, as much as the asymmetry in the omission of NPs in the subject and object position (see below). In the absence of a theoretical apparatus, such observations can only be characterized as ‘general problems with morphological retrieval’, or ‘limitations of working memory’, which does not provide too much insight on the nature of agrammatism.

3.2. Null subjects and omission of determiners

Omission of subject NPs in the speech of Broca’s aphasics is well documented (e.g. Kean, 1977; Kolk et al., 1990; Tesak & Dietmann, 1991; Caplan, 1996; among others). Some examples of null subjects in the speech of Broca’s aphasics are given below (from Goodglass & Geschwind, 1976; de Roo, 1999).

(22) a. belt de nummer op
‘dials the number’ (meaning: ‘he dials the number up’)

b. write a letter (meaning: ‘I am writing a letter’)

The speech of Broca’s aphasics also contains instances of determiner omission in languages where these elements are normally required (e.g. Goodglass et al., 1967; Miceli et al., 1983; Tesak & Dietmann, 1991; Lesser & Milroy, 1993; de Roo, 1999; among others).

While it is in principle possible to relate omission of subject NPs to the general problem of lexical access in this population, recent research (e.g. de Roo, 1999; Ruigendijk, in preparation) has indicated that this is not the case. De Roo shows that two Dutch Broca’s aphasics in her study omit significantly more
subjects than objects. Thus, these patients appear to be sensitive to the structural position of a NP.

De Roo (1999) further observes that there is a correlation between finiteness and omission of subjects. In most cases, null subjects show up in non-finite utterances. Avrutin & Manzoni (2000) report the same pattern in the speech of Italian agrammatics. They also show that the rate of determiner omission is also higher in non-finite clauses than in finite and that agrammatics omit more subjects than objects (which is, naturally, consistent with the pro-drop character of Italian).

Such findings, thus, argue against an account that relies on the difficulties with lexical access. Several authors therefore propose that agrammatic patients ‘overuse’ some grammatical registers (e.g. Avrutin, 1999; de Roo, 1999; Kolk, in press). Indeed, both null and determinerless subjects are possible both in English and Dutch in specific, contextually constrained registers. Subject drop is possible in English in the so-called ‘diary style’ (see Haegeman, 1990 for discussion):

(23) ‘Got up at 7. Took shower. Had to go to work. Left.’

De Roo (1999) shows that the distribution of determinerless NPs in Dutch is similar to the pattern of omission exhibited by Dutch agrammatics. Specifically, omission of determiners seems to be restricted to the first position:

(24) Wie is dat meisje?
‘who is that girl?’
(een) meisje van school is dat.
(a) girl from school
dat is *(een) meisje van school
she is *(a) girl from school’ (from de Roo, 1999)

In other words, neither null subjects, nor determinerless NPs represent, strictly speaking, instances of ungrammatical utterances. (In fact, the same claim can be made about the non-finite utterances which are possible in certain registers in a variety of normal speech, see Blom, 2001 for Dutch, Lasser, 1997 for German, Schutze, 1997 for English and Avrutin, 1999 for Russian.) An important question for psycholinguistic research, then, is how to correctly characterize the differences in the use of such elliptical constructions between normal speakers and agrammatic aphasics (see Kolk, in press; Avrutin, 1999 for a possible line of analyses).

3.3. A partial tree?
Overall, at least in a number of languages, agrammatic patients make more errors related to the tense system than to the agreement system (Saffran et al., 1980; Nespolous et al., 1988; Miceli & Mazzucchi, 1990; Friedeman, 1998). This observation led Friedeman to argue for a highly selective nature of agrammatic deficit, the so-called Tree Pruning Hypothesis. According to this author, Broca’s aphasics produce trees that are intact up to the Tense node and are ‘pruned’ from this node and up. Thus, assuming that structural hierarchy in (25), patients will have problems with CP and TP but not NegP or AgrP. Crucially, Friedeman’s account predicts that there can be no deficit such that leaves CP intact but has TP impaired.

(25) [CP [TP [NegP [ AgrP [VP ...]

A similar account, but along processing lines, has been proposed by Hagiwara (1995). According to this author, the source of impairment in agrammatism is not grammatical deficit per se, but rather deficiency of resources necessary to construct a full syntactic tree. Taking Chomsky’s (1995) Minimalist Program as the theoretical basis, Hagiwara suggests that each application of the Merge operation requires a certain amount of resources; thus the higher element ends up in the syntactic representation, the more resources such tree demands. Agrammatic patients, thus, may end up with a partial syntactic representation due to the inability to apply Merge the required number of times.

Other investigations of functional categories in agrammatic speech include Mc Entee (1993), Ouhalla (1993), Cahana-Amity (1997), de Roo (1999), among others. Mc Entee, for example, shows that the number of unrealized functional projections depends on the severity of the impairment. She proposes the Markedness Hierarchy according to which DP can be reduced to NP, and CP or IP to VP. Ouhalla (1993) and Grodzinsky (1990) suggest that functional categories may be missing from agrammatic representations altogether. Platzack’s (in press) argues that the problem in agrammatism is related exclusively to what he calls ‘vulnerable c-domain’, that is the CP level (but see Penke, in press, for an alternative view based on data from German agrammatic patients).

However, as Miceli et al. (1983) and de Roo (1999) correctly point out, the rate of omission of functional categories is usually less than 100%; in other words agrammatic patients often demonstrate certain optionality in their speech pattern. The source of this optionality, and a potential similarity with chance performance in some comprehension experiments, is still an open question. It suggests, however, that a complete lack of functional categories in agrammatism is, perhaps, too strong a statement.

4. Lexical access
Not only functional categories present problems for agrammatic speakers. As several authors show (e.g. Prins, 1987; Bastiaanse, 1991; Thomson et al., 1995; Edwards & Bastiaanse, 1998; Bastiaanse & Jonkers, 1998; among others) agrammatics have more difficulties with verb production than with nominals. Verbs are omitted more often and verbal morphology seems to be impaired more.

At the same time, Broca’s aphasics do not differ from normal speakers in their sensitivity to a verb’s
representational complexity. Thus, as Shapiro et al. (1987) demonstrate, it takes longer for normal speakers to process verbs that have more possible argument structures (e.g. alternating datives such as ‘send’ takes more resources than a transitive verb such as ‘fix’). Following up on this study, Shapiro & Levine (1990) showed that Broca’s aphasics exhibit a similar pattern of performance: while their reaction, overall, is significantly slower than normal, the same distinction between verbs with regard to the argument structure complexity can be detected in these patients. Ruijgendaal (in preparation) demonstrates that German agrammatics are sensitive to the verb’s case assigning properties: the rate of case errors in these patients correlates with the rate of verb omission.

Swinney et al. (1989) argue that lexical access of nouns in agrammatics is also abnormal in the sense that it is significantly slower. In their study of ambiguous words (e.g. ‘bat’, or ‘scale’) these authors found that Broca’s aphasics, like normal controls, initially activate the most frequent meaning of an ambiguous word. However, for normal speakers, activation of the secondary meaning takes place almost immediately after the primary meaning. For Broca’s aphasics, on the other hand, this operation takes significantly longer. In addition to various psycholinguistic findings from priming studies in normal and aphasic speakers (see, for example, Caplan, 1996) these results suggest that agrammatics’ deficit may not be restricted to structural deficit only. This seems to be the case for both production and comprehension.

5. Beyond syntax
At least for some studies cited above, the relevance of extra-syntactic, discourse-related operations appear to be relevant. Consider, for example, the distinction between who- and which-questions. The difference is related to D-linking (Pesetsky, 1987) that is to the discourse presupposition of a particular set of individuals (which-questions), and the lack of such presupposition in the case of who-questions. Agrammatics have more troubles with the former, which may point to extra-syntactic nature of impairment.

Similarly, comprehension of referring pronouns, as opposed to reflexives and pronouns as bound variables, also involves the ability to properly take discourse into account (Reinhart’s Rule I). As Grodzinsky and his colleagues demonstrated, such operation may be problematic for aphasics as well. Further evidence for the relevance of discourse includes patients’ inappropriate use of definite expressions (e.g. pronouns and definite determiners in the contexts where no reference has been specified, see Lesser & Milroy, 1993). In fact, frequent omission of subjects and determinerless NPs are possible even in typically non-pro-drop registers (see Haegeman, 1990 for her analyses of the Diary style, de Roo, 1999 for the relevant data in Dutch, and Avrutin, 1999 for similar claims about Tense system).

It is possible, therefore, that apparently ‘ungrammatical’ utterances do not represent grammatical impairment, but that they manifest underlying deficit in the domain of the syntax-discourse interface, which, in turn, may be related to the lack of resources necessary for establishing connection between two systems: ‘narrow syntax’, and ‘discourse’. In any case, it is informative that certain constructions that are typical taken to be ‘ungrammatical’ do exist in special registers in normal, unimpaired speech. This observation suggests that the term ‘agrammatism’ may turn out to be purely descriptive in the sense that the actual disorder does not involve disruption of grammatical abilities. Agrammatism then would be nothing but ‘appearance’ of ungrammatical utterances, as much as, say, Diary register, may be labeled ‘agrammatic’ by prescriptive grammarians. Further research, of course, is necessary for making rather strong claims of this sort.

6. Wernicke’s aphasia
The focus of this article is agrammatic aphasia. Nevertheless, it may be instructive to compare the results obtained with one population with another group of brain damaged patients, specifically if the goal of the research is determining cortical localization of some linguistic functions. As mentioned in the introduction, agrammatism, and Broca’s aphasia in general, is one of various language-specific disorders. Typically, Broca’s aphasia is contrasted with Wernicke’s aphasia because the two syndromes provide an apparently clear contrast. The speech of Wernicke’s aphasics appears to be effortless; their sentences contain many functional categories.

Some of the studies cited above were conducted with both agrammatics and Wernicke’s aphasics. For example, Wernicke’s patients showed normal-like priming pattern for ambiguous words (Swinney et al., 1989). They also seemed to be able to establish trace-antecedent connection in real time: In Swinney et al.’s study they differed from Broca’s aphasics (and patterned with normal controls) in showing priming effect at the trace position. At the same time, unlike Broca’s aphasics and normal speakers, Wernicke’s failed to show sensitivity to a verb’s representational complexity (Shapiro & Levine, 1990). Their performance on the sentences with pronouns (Grodzinsky et al., 1993) was at chance in all conditions.

Overall, experimental studies with Wernicke’s aphasics are conducted in order to get a better picture of brain localization of a particular linguistic function. Contrasting impairments to the Broca’s and Wernicke’s areas of the brain (whatever the exact topology of these areas may be) provides the neurological source of comparison, while linguistic analyses of the
observed deficit (or intact abilities) serves as a theoretical tool for a precise characterization of the function related to a particular area.

7. Language acquisition and language impairment

Some of the experimental studies described above have been conducted with another population whose linguistic performance differs from that of adult speakers, that is with normally developing children. Children’s difficulties with interpreting pronouns, for example, are well known (for review see Koster, 1993; Baauw, 2000; among others). Avrutin (2000) showed that children exhibit a similar pattern of comprehension problems with D-linked wh-questions. Children’s erroneous interpretation of sentences with universal quantifiers (e.g. ‘Every boy is riding a car’) is also well documented (e.g. Philip, 1995). Presence of non-finite verbs is a conspicuous feature of child speech in a variety of languages (see Wexler, 1994 for a cross-linguistic review and his formulation of the Optional Infinitive Stage in language development). Wijnen (1997) observed that most root infinitives in the speech of normally developing Dutch children occur with activity predicates, in the same way as reported by Kolk (in press) for Dutch agrammatic aphasics. Other similarities and differences between the two populations have been a topic of discussion at a recent workshop on language acquisition and language breakdown (papers to appear in Brain and Language, 2001).

Needless to say, the similarities (at least superficial) between the linguistic performances of the two populations have been a topic of various speculations for some time now (for more discussion see Caramazza & Zurif, 1978 and references cited there). The observations of similar speech patterns have given rise to several influential psycholinguistic theories, such as Ribot’s Law. According to this view (expressed as early as 1883, see Ribot, 1883/1977), the order of language development is reversely mirrored by the order of language loss. A somewhat similar, but more linguistically based approach is due to Roman Jakobson (e.g. Jakobson, 1941), which is known as the Regression Hypothesis. A more recent approach based on the influential Subset Principle (e.g. Berwick, 1985; Wexler & Manzini, 1987), is offered in Grodzinsky (1990).

What is characteristic of the views presented above is that the apparent similarities between the two populations are relegated to the domain of linguistic knowledge. Children’s knowledge is claimed to be incomplete, and aphasics knowledge is claimed to be lost. However, the lack of knowledge in both populations is an empirical question. It is quite plausible that what both children and agrammatics have in common is a lack of processing resources. In fact, Kolk (in press) argues for precisely such account. His explanation is based on the influential Adaptation Theory (e.g. Kolk, 1995) according to which speakers with limited resources may try to adapt their language to what is available, which often results in ‘elliptical’ utterances. The impairment itself is a reduced capacity to keep sentence elements in computational simultaneity. This may result in a disintegrated sentence representation before the sentence is completely produced or understood (see also Pinango, 2000 for a similar view). Thus, the adaptation theory, or some specific versions of it, may provide a linguistically relevant common ground for approaching the observed similarities between children and agrammatics.

8. Conclusions

An important breakthrough in our understanding of agrammatism, and aphasia in general, is related to Chomsky’s revolution in the study of language. The availability of a theoretical apparatus provided neurologists with a scientific tool necessary for the study of language as a natural phenomenon. It has allowed researchers to conduct investigation of language impairment in the way commonly accepted in cognitive science: to compare obtained data to a model. Linguistic theory, as a model of human knowledge of language, provides the basis for analyses of aphasics speech. Rather than describing language impairment in terms of ‘production’ or ‘comprehension’ disorder, it has now become possible to obtain a more fine-grained picture of the disruption of the linguistic system, and, consequently, gain a better insight on the brain-language relation.

Acknowledgments

I thank the Glot International editors and an anonymous reviewer for their comments, and Roelien Bastiaanse and Herman Kolk for valuable discussions. The preparation of this article was supported by NWO PIONEER grant ‘Comparative Psycholinguistics’ which is hereby gratefully acknowledged.

A Linguistics and Agrammatism Bibliography


