

Wp 2

THEORETICAL LINGUISTICS PROGRAMME, BUDAPEST UNIVERSITY (ELTE)

SENTENCE PARSING IN APHASIA

ZOLTÁN BÁNRÉTI

RESEARCH INSTITUTE FOR LINGUISTICS, HUNGARIAN ACADEMY SCIENCES

WORKING PAPERS IN THE THEORY OF GRAMMAR, VOL. 2, No. 7

RECEIVED: DECEMBER 1995

MTA Nyelvtudományi Intézet Könyvtára



0000331

SENTENCE PARSING IN APHASIA

ZOLTÁN BÁNRÉTI

THEORETICAL LINGUISTICS PROGRAMME, BUDAPEST UNIVERSITY (ELTE)
RESEARCH INSTITUTE FOR LINGUISTICS, HAS, ROOM 120
BUDAPEST I., P.O. Box 19. H-1250 HUNGARY
E-MAIL: banreti@nytud.hu

WORKING PAPERS IN THE THEORY OF GRAMMAR, VOL. 2, No. 7
SUPPORTED BY THE HUNGARIAN NATIONAL RESEARCH FUND (OTKA)

THEORETICAL LINGUISTICS PROGRAMME, BUDAPEST UNIVERSITY (ELTE)
RESEARCH INSTITUTE FOR LINGUISTICS, HUNGARIAN ACADEMY OF SCIENCES

BUDAPEST I., P.O. Box 19. H-1250 HUNGARY
TELEPHONE: (36-1) 175 8285; FAX: (36-1) 212 2050



Wp 2

Nyelvtudományi Könyvtár

Lezárt száma:

26 964/96

1. INTRODUCTION

1.1. The linguistic symptoms of Broca's aphasia can be explained as disturbances and asynchronies in the interactions of processing modules. Some methodological principles need to be assumed, however. According to Linebarger (1990), the basis of the method relying on the selective preservation/loss of linguistic capabilities is the observation that the simultaneous loss of skill X and the selective retainment of skill Y indicate that independent underlying mechanisms can be hypothesized for skills X and Y, especially if we have the reverse situation with other patients, who have retained skill X and lost skill Y. This double dissociation is the standard argument for the independence of X and Y (Marin, Saffran & Schwartz 1976, Linebarger, Shwartz & Saffran 1983, Grodzinsky, Swinney & Zurif 1985, Grodzinsky 1990, Linebarger 1990, Frazier, Flores d'Arcais & Coolen 1993).

1.2. It is an additional assumption of such an analysis relying on selective retainment/loss of linguistic skills that skills X and Y are intuitively of the same complexity and require their inputs to be maintained in memory to a similar degree (Saffran 1985, 1990).

In preparing this paper I benefited from helpful discussions with Jens Allwood, Wolfgang U. Dressler, Susan Edwards, Michael Garman, László Kálmán, Csaba Pléh and Zita Réger.

2. THE RELEVANT FEATURES OF HUNGARIAN

2.1. Hungarian is a more or less "free word-order", agglutinating language (É.Kiss - Kiefer 1994). Unlike in true free word-order languages, in Hungarian the order of words **within** phrases is quite fixed, so it would be more proper to call it **free phrase-order** language. The order of major constituents is independent of their syntactic functions and is subject to great variation in Hungarian sentences.

2.2. Syntactic functions and/or thematic roles, rather than being encoded in terms of linear order, are expressed by morphological devices, primarily by attaching **case suffixes to NPs**. According to Kálmán (1985), the possible subcategorization by verbs involves at least 17 cases expressed by 38 morpho-phonological variants of surface case ending forms in the nominal paradigm.

The plural *-k* and the singular zero indicate the number of nouns.

There are twelve possessive suffixes indicating the person and number of the possessor as well as the number of the possessed element (Kornai, 1992).

Suffixes of a **finite verb** express the number and person of the subject and, with some dependence on context, make it possible to determine the person of direct object as well. Another set of suffixes of finite verbs indicates tense and mood.

The suffixes of finite verbs must be in agreement with suffixes of subject NPs and object NPs in person, number and definiteness, according to agreement rules between the verbal and nominal paradigms.

2.3. Kornai (1992) in connection with statistical machine translation, states that -- because of free phrase-order of Hungarian -- "a simple transitive sentence has at least 6, and a simple ditransitive at least 24 grammatically valid permutations which will all be translated with the same English sentence, a conservative estimate would be that we need at least 10 times as many English/Hungarian pairs for a representative sample as we would for English/French." (255).

2.4. Hungarian has two major types of stress patterns associated to sentence patterns. There are distinct stress patterns for neutral and focused sentences. In neutral sentences each major syntactic constituent bears an identical stress. Sentences of this kind exhibit slight SVO features within the free phrase-order frame (Bánréti 1994).

As for focused sentences, the syntactic position of an XP constituent is determined by an interplay of its discourse function (given, new, contrasted, etc.) describable with terms like Topic and Focus, and its logical scope (quantifier, operator, predicate) (É.Kiss 1994). The rightmost heavy stress-bearing constituent in focused sentences is either the Verb or the XP immediately preceding it (in which case the XP is interpreted as being focused).

The focused sentence type is used only in special, non-zero contexts to convey information whose acceptance is supposed to contradict some expectation of the listener. Neutral sentences do not imply such corrections (Kálmán, 1985).

3. SYNTACTIC PROCESSING IN A REPETITION TEST

3.1. Broca's aphasia shows several, selectively retained syntactic skills. The impairment of access to grammatical morphology (if injuries are less severe) is mainly manifested in fragmented speech; however, the function of syntactic self-correction is present. The patient therefore has maintained his/her intuitions concerning grammaticality in some way.

3.2. For instance, the spontaneous speech of one of our patients showed fragmentation, agrammaticality and syntactic self-monitoring. The patient was 37 years of age, right handed, a car mechanic, suffering from a stroke which resulted in extended fronto-parietal hypodensity of the left hemisphere.

3.3. In the course of a **sentence repetition test** the patient gave answers that were suggestive of initial structure building operations of the syntactic parser. The main

argument for this is the fact that, for our patient, the **performance** of the parser can be **assessed** and **predicted**. We will demonstrate this below.

3.4. With respect to stress patterns, each target sentence was neutral in the test. Hungarian is an inflectional language where, the verb assigns case to noun phrases by means of case endings that mark theta roles in surface structure.

We can outline the **performance of our patient's parser** as follows. In comparison with the target sentence, it is possible for the parser:

- a/ to approximate the class of the target predicate; its case frame is retrievable;
- b/ if a different predicate is retrieved, then the suffixes are those appropriate to the case frame of the "original" predicate;
- c/ if the predicate is missing, the parser stops; for instance, it cannot list only the NP's from the target sentence;
- d/ filling one slot from the argument frame of the predicate with selectional restrictions that are the same as (or very much like) the original;
- e/ knowledge about missing, lexically or phonologically null arguments is manifest in further search attempts that either mention case endings without a content word, or link them to pronouns or neologisms, in repetition of case endings, or in compensatory speech.

Some samples from a sentence repetition test follow: (E stands for the examiner who utters the sentence to be repeated. P stands for the patient's replies. The test was in Hungarian, the glosses below contain the relevant details only):

(1) E: Péter beszélgetett Marival.
 Peter-nom talk-3sg/past Mary-with
 'Peter talked to Mary'.

P: Péterrel beszél ..inná..... -val
 Peter-with talk-3sg/present. nonsense-word -with

(2) E: *Marival találkozott János.*

Mary-with meet-3sg/past John-nom

'John met Mary'

P: *Marival.....beszélgetett volna vele.*

Mary-with talk -3sg/past would have her-with

Ö beszélgetett vele..Marival.

He talk-3sg/past her-with ..Mary-with.

(3) E: *Mari megcsinálta az ágyat és lefeküdt.*

Mary-nom make-3sg/past/def the bed-acc and (she) go-3sg/past to bed.

P: *Mara..... Mara.....Mara.....mmmmmm*

Mara-nom .Mara-nom Mara-nom ...mmmm

(4) E: *Sándor küldött egy képeslapot Marinak.*

Alex send-3.sg/past a postcard-acc Mary-dat.

'Alex sent Mary a postcard.'

P: *Sándor jött és akkor írta ... és azt*

Alex come-3sg/past and then write-3sg/past/def and that-acc

akkor ment hozta.... a.. mi az a.... mit??

then go-3sg/past bring-3sg/past/def the what is that what-acc?

E: *Képeslap!*

Postcard-nom!

P: *Épetlapot, képeslapot édeslapot.*

Nonsense word-acc nonsense word-acc sweetcard-acc

E: *Mit csinált vele?*

What did he do with it?

P: *Képeslapot adott a kis gyerekeknek adott oda és*

Postcard-acc give-3sg/past the little child-dat give-3sg/past to and

'He gave a postcard to the little child...gave to and'

... és akkor ment haza

... and then go-3sg/past home

... 'and then he went home'.

3.5. Analysis of the repetition test

A detailed analysis of the test results suggests that matters are more complex than what we outlined above in 3.4.

In principle, the task of repeating someone else's words could be accomplished in several ways:

- (i) Purely phonological repetition: no syntactic or semantic processing is performed; the subject simply repeats what he/she hears.

- (ii) Surface syntactic repetition: the input sentence is processed up to the level of surface syntactic form, which is then repeated without any semantic processing. This requires the subject to process the surface syntactic structure, derive a phonological representation, and then produce the phonological form thus derived.
- (iii) Unmonitored semantic repetition: the input sentence is processed to extract the semantic gist; the subject then repeats that gist without endeavoring to use the same syntactic structures or phonological forms.
- (iv) Monitored repetition: the patient processes the sentence both syntactically and semantically, then attempts to produce an utterance which matches the phonological, syntactic, and semantic properties of the original utterance.

3.6 Our patient was pursuing the strategy of monitored repetition (iv). For instance, in the utterances in (4), the patient was attempting to repeat the Hungarian equivalent of *Alex sent Mary a postcard*. He made several false starts: notably, they were semantically related to the intended message. First, he tried the Hungarian equivalent of the verb *came* (semantically a motion verb, like *sent*, but intransitive). Next he tried the Hungarian equivalent of the verb *write-3sg/past/def* (with *3.pers.-* suffix referring to direct object as well), correctly transitive but more closely related semantically to *postcard* than to *sent*). However he was not able to retrieve *postcard* itself. He mentioned the accusative case-ending (*-t*) of *postcard* **without** the content word (*postcard*), and linked the accusative case ending to pronouns. (*az-t: that-acc*, *mi-t: what-acc.*) Next he tried the Hungarian equivalent of *went* (which is again, incorrectly, intransitive). Next he came up with the Hungarian equivalent of *bring-3sg/past/def* (with *3.pers-* suffix referring to direct object) which is both syntactically and semantically close to *sent*. But by that time he was completely unable to retrieve what the object was supposed to be. Next he heard the original noun marked for nominative with a zero suffix (the Hungarian equivalent of *postcard-nom*) and he returned a nonsense word marked with an *accusative case ending*! Next he heard a Hungarian pronoun marked with *instrumental case ending* (What did he do **with-it**?) and again he returned an *accusative case ending* but by

that time he was able to repeat the original content word (*postcard-acc*) linking accusative case ending to this content word.

3.7. Hungarian has a very rich inflectional system for nouns. It is remarkable that the patient did not make **purely** inflectional errors in the repetition task. If he approximated the class of the target verb, then its surface case frame was retrievable. Utterances in (4) show that the *surface case ending of a noun* was mentioned **earlier** than the noun itself (with that case ending). See in (4) for instance **the temporal relation** between the Hungarian **accusative case ending** and the Hungarian equivalent of *postcard*, and the temporal relation between the Hungarian **dative case ending** and the Hungarian equivalent of *Mary/little child*, nouns in the dative in the patient's responses.

Temporal asynchrony between accessing case endings and content NPs is shown in **example (1)** as well. (*Péter beszélgetett Marival. Peter-nom talk-3sg/past Mary-with 'Peter talked to Mary'.*) The examiner produced an utterance in which the **first** NP was marked for **nominative** with a zero suffix (*Péter*) and the **second** NP was marked with **instrumental case ending** (*Mari+val, Mary-with*) in sentence-final position. The patient produced an utterance in which the **first** NP was marked with **instrumental** case ending (*Péter-rel, Peter-with*) and the final NP was not mentioned at all. That is to say, the patient attached the case ending of the **final** NP to the **first** NP. He retrieved a case ending which was heard **later** and attached it to an NP which was heard **earlier**.

In **example (2)** (*Marival találkozott János. Mary-with meet-3sg/past John-nom 'John met Mary'*), the target sentence contained a sentence-initial NP marked with instrumental case ending (*Mari-val, Mary-with*) and a final NP marked for nominative with a zero suffix (*János, John-nom*). In his first attempt, the patient repeated the sentence-initial NP marked with instrumental case (*Mari-val*). He was unable to retrieve the sentence-final NP marked for nominative case with a zero suffix (*János, John-nom*) rather he produced a grammatical **pronoun** marked with instrumental case, i.e., he attached the instrumental case ending that has been

retrieved to the pronoun (*vel-e*, *with-her*). In his second attempt, the patient was able to retrieve the first **case ending** without the content NP: he produced a grammatical pronoun marked for **nominative** case with a zero suffix (*Ö*, *He-nom*) then produced a grammatical pronoun marked with **instrumental** case ending (*vel-e*, *with-her*) and finally, after a pause, he repeated the content NP marked with instrumental case ending (*Mari-val*, *Mary-with*). To sum up: by the end of the second attempt, the patient produced the **complete** surface case ending frame of the target verb (NP-nominative, NP-instrumental), he tried to attach case endings to NPs, during this process he used grammatical pronouns (marked for nominative and instrumental case as well). He was able to attach a case ending which was heard **earlier** to an NP which was heard **earlier**. He was able to retrieve a case ending which was heard **later** and was unable to attach it to an NP which was heard **later**.

In our on-line repetition test the parsing mechanism could not proceed unless a verb was produced. This is shown in **example (3)**. The target utterance contained two conjoined verbs with their different case frames. The patient was not able to retrieve either of the verbs and was even unable to "list" only the nouns with correct case-endings. He also failed to use any inflections (see example (3)). But he never made both inflectional errors and errors in the choice of the main verb in the **same** sentence. This is compatible with the assumption that the patient has to trade processing of surface form against lexical access. (Inflection is part of the surface parser module but I do not claim that this (sub)module would not be impaired).

3.8. We have seen that the patient's repetitive performance is agrammatical. Thus it may seem strange that such a patient can correctly assess the grammaticality of some sentences. Furthermore, he can assess sentences he cannot produce correctly either in spontaneous speech or in repetitive tests. For instance he can correctly assess grammatical and ungrammatical instances of accusative or dative use, while the use of these cases is impaired in his speech.

4. GRAMMATICALITY JUDGEMENTS

Grammaticality judgement tests provide an important heuristic device for the interpretation of the grammar-parser relation in aphasia. In what follows, I summarise a few of the most interesting approaches.

4.1. The mapping hypothesis

Linebarger's investigations involve aphasics' impairments in using syntactic processes to constrain thematic role assignments. Agrammatic aphasics are capable of retrieving the syntactic structure of heard sentences and are able to judge some of them correctly. The distribution of grammaticality judgements into easy-to-judge and hard-to-judge tasks shows preserved sensitivity to structural features of sentences that are necessary to the recovery of phrase structure and insensitivity to semantic properties, including lexical information about predicate/argument structure, and impairments in the mechanism of thematic role assignment. The pattern of grammaticality judgements suggests that later interpretative processes are affected more seriously than earlier mechanisms. She stated that "The poor performance of these subjects on the difficult conditions, as well as their asyntactic comprehension, reflects, on this view, a failure to exploit an initial structural analysis for further processing" (Linebarger 1990,105). "...the assessment of grammaticality in the difficult conditions requires maintenance of a record of the lexical input to a degree that taxes the impaired capacities of both agrammatic and conduction aphasic subjects. In contrast, assessment of grammaticality in the easy conditions turns on dependencies that are computed during first-pass parse and that are protected from this STM (short-term memory) limitation: Either the first-pass parse occurs early enough that antecedent elements of the dependencies are still available, or the antecedent elements are somehow carried along as alterations of the internal state of the parser" (113).

"The mapping hypothesis takes the agrammatic data as evidence for the modularity of syntactic processing, because of the disparity between subjects' ability to parse certain structures and their impaired interpretation of these same structures" (Linebarger 1995, 53).

Under the mapping hypothesis, "theta assignment even for unmoved arguments is claimed to be a locus of vulnerability in agrammatics, since it involves linking elements in the two structures, the S-structure and theta grid" (82).

4.2. The competition model

"According to the Competition Model, listeners should attend more closely and react more quickly to sentence elements that are high in cue validity, i.e., cues that carry the most reliable information about aspects of sentence meaning" (Wulfeck, Bates & Capasso 1991, 333). This study extended the Competition Model to grammaticality judgement tasks by performing grammaticality judgement tests in an on-line fashion with English speaking and Italian Broca's aphasics. For Italian aphasics easy-to-judge tasks contained agreement errors while for English speaking aphasics easy-to-judge tasks contained ordering errors. They stated that "Subjects retain language-specific profiles of cue utilization.....Broca's aphasics also display language-specific profiles in their on-line judgements of grammaticality." (333). "...language-specific knowledge is largely preserved in Broca's aphasia requiring an account of language breakdown based on deficits in the processes by which this preserved knowledge (i.e., competence) is accessed and deployed (i.e., performance) (335). Wulfeck, Bates & Capasso (1991) mention Hungarian data as well.

McWhinney, Osmán-Sági & Slobin (1991) examined the use of accusative case marking in sentence interpretation by aphasic speakers of Hungarian and Turkish. "For normal subjects the findings replicated the results of McWhinney, Pléh & Bates 1985 "(248). "In accord with the claims of the Competition Model (McWhinney, Bates eds. 1989) cues that are the strongest in the language tend to be

the best preserved" (248). The case marking cue was more damaged with the Hungarian Broca's and Wernicke's group than the word order cue in English subjects. However, "Despite its high reliability and availability, the use of the case cue in Hungarian and Turkish aphasics declined to a level that was close to the level of use for the much less reliable word order cues"(248). When case marking was not retrievable, Hungarian subjects had a clear SVO interpretation for NVN sentences and VOS interpretation (where the first noun was inanimate) for VNN sentences.

4.3. Disruptions of referential dependencies

Maurer, Fromkin and Cornell (1993) assumed that the parser, "within limits of memory and processing resources, is **correct with respect to the grammar**" (358). They suggest that the syntax of referential dependency is disrupted in Broca's aphasics. Agrammatic aphasics are capable of building syntactic chains, but are incapable of coindexing the members of the chain (anaphors and traces that are referentially dependent on their antecedents). The patients lack the Coindexation Condition (if an element is R-dependent on another, then the two must share the same R-index). According to their Double Dependency Hypothesis "1) the deficit underlying asyntactic comprehension affects the processing of syntactic R-dependencies, and 2) when there is only one such dependency the resulting syntactic representation, although abnormal, is not ambiguous, but when there are two such dependencies the resulting representation is semantically ambiguous" (Maurer, Fromkin & Cornell 1993, 357). In this approach the impaired parser cannot follow the principles of grammar correctly. However, Maurer et al. emphasized that it was unclear "whether this was due to a fundamental loss of grammatical competence in the asyntactic comprehender or to a deficit to processing according to which knowledge is still present, but cannot be used in these tasks" (366).

4.4. The referential representation hypothesis

Frazier and McNamara (1995) criticize the R-Dependence Hypothesis. Performing grammaticality judgement tests they found that aphasic deficit affects referential and non-referential ("government") chains as well, and a consistent subject-object asymmetry predicted by R-Dependence Hypothesis failed to emerge in the judgements. They claim that the R-Dependence Hypothesis does not explain subjects' difficulties with computational vocabulary. (The computational vocabulary consists of predicates, case endings, prepositions, operators like *wh*-expressions, variables like traces, conjunctions, etc.) Frazier and McNamara propose what they call the Referential Representation Hypothesis: "agrammatics sacrifice the computational representation when the processing demands of the sentence exceed available processing capacity" (Frazier and McNamara 1995, 237). They claim that "the representation of the referential/descriptive content of a phrase **supplants** its computational description at points where processing demands threaten to exceed processing capacity" (237). As an explanation, they assume that listeners are orientated to the content of sentences not to their form.

Linebarger (1995) contrasts different accounts of agrammatism. She claims that chain disruption hypotheses (Grodzinsky's Trace Deletion Hypothesis, the Double Dependence Hypothesis, and others) and trade-off hypotheses have some empirical and conceptual shortcomings. For instance, chain disruption accounts "attribute to agrammatics an unimpaired ability to infer correct interpretation from impoverished syntactic representations in certain cases (subject gaps, simple actives)...but cannot explain why the same kinds of interpretative inferencing cannot be employed in other cases (passives, S-S relatives)" (75).

Linebarger claims that trade-off hypotheses cannot offer an explanation regarding the dissociation between grammaticality judgements and comprehension or the

pattern of performance within a grammaticality judgement test itself (e.g., differences between easy-to-judge and hard-to-judge tasks).

She argues for the mapping hypothesis, that is, the view that aphasic subjects are able to compute syntactic structure but unable to exploit it in further interpretive processes.

4.5. Impairments on the operational memory

Kolk (1995) claims that grammaticality judgement tasks are easier than comprehension tasks. The latter requires longer availability of the syntactic information in memory than grammaticality judgements. Because of requirements of longer availability in memory, comprehension is more easily disrupted by fast syntactic decay or slow syntactic activation. Kolk states that syntactic "nodes, needed to construct a syntactic tree, take some time to reach their "memory time phase", that is, to become available to interact with other nodes. Furthermore, this memory time is limited; if it is exceeded, elements disappear from memory. A particular syntactic category, say a VP, can be retrieved only if all immediate daughter categories (e.g., V, NP, PP) are available. The activity of one element is required for the activation of another element. For instance, information about the subject of the sentence must be active in order for the right form of the verb to become activated. Between these two types of information, there must therefore be computational simultaneity or synchrony" (Kolk 1995, 284).

Haarmann & Kolk (1994) stated that "Broca's aphasics may show either slow syntactic activation or fast syntactic decay but not both at the same time... normal activation goes at the expense of fast decay and, vice versa, normal decay goes at the expense of slow activation." (513.)

The slowing down of syntactic processes affects not only the computation of structure but also the selection of the proper function words or inflectional endings. A syntactic slow down leads desynchronization in syntactic processes and in integrating categorized syntactic slots with lexical material.

4.6. The role of the on-line modality

Modality of sentence presentation affects subjects' performance in grammaticality judgements. For instance, according to Romani (1994), with grammaticality judgements her patient's performance was poor in **on-line** auditory tests but good in written (off-line) tests. However, if sentences were presented on a computer screen one word at a time, performance deteriorated to the same level as performance in auditory tests.

5. GRAMMATICALITY JUDGEMENTS BY HUNGARIAN APHASICS

5.1. As far as I can tell, wide-ranging grammaticality judgement tests have not been made for Hungarian speaking Broca's aphasics. In our test we intend to cover some relevant features of Hungarian. Judgement tasks involved a lot of syntactic rules, relations between syntax and lexicon and accessibility of lexical information as well. The tests involved the following specific fields:

- attachment of surface case endings to NPs (according to Verb),
- agreement of inflectional suffixes of Verb with subject and object NPs in person, number and definiteness,
- variants of phrase-order compared to the surface position of the Verb,
- contextual relations of focused sentences,
- referential dependencies between moved NP and its trace, referentially free NP and anaphora,
- effects of referential dependencies on agreement of surface case endings and person/number suffixes,
- V-anaphora, VP anaphora, and gapping,
- agreement in lexical features,
- selectional restrictions.

We tested a total of six Hungarian Broca's aphasics (including the patient characterized above in the repetition test). Subjects were asked to judge whether tape-recorded Hungarian sentences were acceptable or unacceptable. Sentences in the test contained grammatical and ungrammatical versions of word order, case endings, NP-movement, anaphoric binding, agreement of syntactic features, pro-Subject, gapping, VP-anaphora, sentential intertwining, and other phenomena. Subjects were capable of making correct grammaticality judgements with some kinds of Hungarian sentences and not with others. The question is the following: What are the factors facilitating or impeding judgement on certain sentences?

5.2. The patients were recruited from the National Institute for Rehabilitation in Budapest and the Neurology and Psychiatry Clinic of the Szent-Györgyi University in Szeged. All subjects had had a cerebral vascular accident (CVA) in the left hemisphere. Patients with different lesions were grouped together as Broca's aphasics because their profile on the clinical battery placed them in the 'agrammatic syndrome' category. They were diagnosed as Broca's aphasics on the basis of performance profiles on the Western Aphasia Battery (WAB) (Kertesz 1982) and in further clinical evaluations by speech-language pathologists and neurologists.

Subjects:

Age: 47, sex: female, lesion site: left fronto-temporal.

Age: 37, sex: male, lesion site: left fronto-parietal.

Age: 59, sex: male, lesion site: left insula and middle temporal gyrus.

Age: 54, sex: male, lesion site: left middle cerebral artery distribution.

Age: 47, sex: male, lesion site: left fronto-temporal.

Age: 52, sex: male, lesion site: left insula with extension into the left parietal region.

All subjects were right-handed.

5.3. We asked the patients to judge whether some sentences were acceptable or unacceptable. For instance, *A gyerek látja őt* (*The child sees him-acc*) is a good sentence, whereas **A gyerek látja én* (**The child sees I-nom*) is not. Acceptable: *A mama berakta a ruhát a szekrénybe* (*Mother put the clothes into the wardrobe*). Unacceptable: **A szín berakta a fázást a lisztbe* (**The colour put cold into the flour*). The first pair of sentences above involves formal rules of syntactic case and number agreement, and the second pair involves selectional restrictions imposed by the verb on its arguments.

The test was presented in the auditory modality, using tape-recorded sentences. The patients were required to give a quick response "as s/he feels", and no explanation was required. The instruction was: "please tell me whether this sentence is correct or incorrect?".

As for stress patterns, each sentence in the test was neutral (in the sense of 2.4.), except for the tasks of **Sentential Intertwining** and **Unfocussable Sentence Adverbial in Focus**. These two types of tasks involved stress patterns of focused sentences.

Each test contained 14 acceptable and 14 unacceptable sentences (28 sentences in all). Acceptable and unacceptable items all figured in **minimal pairs** in the test. Each minimal pair stood for a particular syntactic constructional category. The judgements showed whether the patients were able to sense the opposition between members of minimal pairs. Since a grammaticality judgement on one member of a minimal pair entails judgement of the other member, therefore members of minimal pairs were placed at a distance from each other, separated by members of other minimal pairs. (E.g. the unacceptable counterpart of the first sentence was seventh on the list). Members of a minimal pair were thus separated by intervening items. The average number of items intervening between minimal pairs was 6, the maximum was 8, the minimum was 4. Every patient was given the test five times. Sentence patterns were filled with different (though equally frequent) words in each

test but we did not change the sentence structures themselves. At the end we had $6 \times 5 = 30$ sets of grammaticality judgements made by the patients. Hesitations were disregarded.

5.4. RESULTS

Table 1 and Table 2 show the distribution of judgements according to particular syntactic constructional categories.

TABLE 1.
PATIENTS' RESPONSES for
GRAMMATICAL SENTENCES:

<i>TASK</i>	<i>JUDGEMENT</i>	
	Correct	Wrong
AGREEMENT BETWEEN A RELATIVE PRONOUN AND ITS HEAD	28	2
AGREEMENT OF RECIPROCAL ANAPHORA	30	0
ALL 3 ARGUMENTS PRECEDE THE VERB	30	0
ANAPHORIC AGREEMENT IN PERSON AND NUMBER	30	0
ANAPHORA + CASE HIERARCHY	11	19
ARGUMENT + CASE ENDING	30	0
ASPECT	18	12
GAPPING	11	19
pro-SUBJECT	16	14
SELECTIONAL RESTRICTIONS	23	7
SENTENTIAL INTERTWINING	13	17
UNFOCUSSABLE SENTENCE- ADVERBIAL IN FOCUS	30	0
V-ANAPHORA	30	0
VP-ANAPHORA	20	10

TABLE 2.
PATIENTS' RESPONSES for
UNGRAMMATICAL SENTENCES:

TASK	JUDGEMENT	
	Correct	Wrong
AGREEMENT BETWEEN A RELATIVE PRONOUN AND ITS HEAD	18	12
AGREEMENT OF RECIPROCAL ANAPHORA	3	27
ALL 3 ARGUMENTS PRECEDE THE VERB	2	28
ANAPHORIC AGREEMENT in PERSON and NUMBER	30	0
ANAPHORA + CASE HIERARCHY	14	16
ARGUMENT + CASE ENDING	30	0
ASPECT	14	16
GAPPING	15	15
pro-SUBJECT	17	13
SELECTIONAL RESTRICTIONS	12	18
SENTENTIAL INTERTWINING	9	21
UNFOCUSSABLE SENTENCE- ADVERBIAL IN FOCUS	2	28
V-ANAPHORA	30	0
VP-ANAPHORA	14	16

Table 3 and **Table 4** (in the **Appendix**) show the statistical description of data and an analysis of variance using BMDP statistical software.

Table 3 presents the mean of correct/wrong judgements for the six patients and for each sentence-type and presents the standard deviation of correct/wrong judgements for the six patients and for each sentence-type.

Table 4 presents an analysis of variance for correct judgements. According to this analysis:

- (i) Effect of the sentence-type for correct judgements is significant ($p < 0.05$).
- (ii) Effect of grammaticality for correct judgements is significant ($p < 0.05$).
- (iii) Effect of the interaction of sentence type and grammaticality is significant for correct judgements ($p < 0.05$).

5.5. The results of the five tests have been evaluated in the following way. Those sentences whose acceptable variants were always judged as good and whose unacceptable variants were always judged as bad by the patient were considered as easy tasks from the point of view of grammaticality judgements. Tasks where the patient did not judge correctly (acceptable sentences were termed as bad, and unacceptable sentences were termed as good) were considered as difficult tasks from the point of view of grammaticality judgements. Only those tasks were classified as easy tasks where every patient gave correct judgements in every test. Hesitations were disregarded.

6. DISCUSSION

First analysis

The fact that Broca's aphasics are capable of making correct grammaticality judgements with some Hungarian sentences and not with others is a problem that deserves further study. The question is the following: What are the factors facilitating or impeding judgement on certain sentences? Let us suppose that

grammaticality judgements require some kind of (implicit) analysis of these data. Let us examine what kind of information has to be used with easy tasks and what kind of information should be used with hard tasks.

Empirical division of the test-material into easy and hard tasks: the first analysis of relevant factors of judgements:

6.1. Easy tasks

Easy tasks require the use of the following kinds of information.

6.1.1. The categorizational selections of the verb and the case ending frame of the verb have to be retrievable.

Control of case ending assignment to main syntactic constituents should be possible. The parser has to be capable of checking whether every case ending required by the verb has been assigned, and whether every argument has received a case ending (the tasks of **Argument + case ending**).

Examples from the sentence material (the glosses below contain relevant details only).

ARGUMENT+CASE ENDING

Judgements of case endings assigned by the Verb to NPs, agreement in person, number and definiteness between Verb and NPs

(5) a. *A gyerek ül a széken.*

the child-nom sit- 3sg the chair-on

'The child sits on the chair.'

b. * *A gyerek ül a szék.*

the child-nom sit-3sg the chair-nom.

- (6) a. *Mari szeret úszni.*

Mary-nom like-3sg/present swim-inf.

'Mary likes to swim.'

- b. * *Mari szeret úszik.*

Mary-nom like-3sg/present swim-3sg/present.

- (7) a. *.Erzsi bízik az orvosban.*

Liz-nom trust-3sg/present the doctor-in.

'Liz trusts the doctor.'

- b. * *Erzsi bízunk az orvos.*

Liz-nom trust-1pl/present the doctor-nom.

- (8) a. *Róbert nézi a könyvet.*

Robert-nom look-3.sg/present/def the book -acc

'Robert looks at the book'

- b. * *Róbert nézi téged.*

Robert-nom look-3sg/present/def you-2sg/acc

- (9)a. *A papá-nak kölcsönadott a fiú egy könyv-et*

The father-dat lend-3sg/past the boy-nom a book-acc

'The boy lent a book to the father.'

b. * *A papá-ra kölcsönadott a fiú egy könyv-et .*

The father-on lend-3sg/past the boy-nom a book-acc

6.1.2. The parser has to be capable of sequentially checking grammatical agreement (person and number) of syntactic constituents and that of the suffixes expressing person and number. (Tasks related to **subject and object agreement in person, number and definiteness, antecedent--reciprocal agreement in person and number**). See tasks **Argument+ Case endig** (above) and tasks **Anaphoric agreement in person and number** below:

ANAPHORIC AGREEMENT IN PERSON AND NUMBER

Judgements of agreement in person and number between anaphora (*himself*-type) and its antecedent (content NP):

(10) a. *A gyerek látta magát a tükörben.*
the child-nom see-3sg/past/def him+self-3sg/acc the mirror-in
'The child saw himself in the mirror.'

b. * *A gyerek látta magadat a tükörben.*
the child-nom see-3sg/past/def your+self-2sg/acc the mirror-in

6.1.3. The parser has to be able to take the verb of the sentence as the starting point of dependencies be analysed. (For instance: tasks of one argument **V-anaphora**)

V-ANAPHORA (copying only bare V)

- (11) a.
- János magas volt és Mari is.*

*John tall was and Mary too**'John was tall and Mary too.'*

- b. *
- János magas volt és ezt tette Mari is.*

*John tall was and this-acc did Mary too*** 'John was tall and so did Mary.'***6.2. Hard tasks**

Hard tasks require different kinds of grammatical information for judgements.

6.2.1. The structure of the entire sentence has to be stored in memory, and in the stored structure it is necessary to retrieve and compare lexical material filling two distinct syntactic positions. This is necessary for the following reasons: (i) one has to determine whether it is possible to repeat a constituent that has occurred earlier (**pro-Subject**, **Sentential-intertwining**); (ii) or it is necessary for judging the grammaticality of backward reference to some constituent as antecedent in a coordinating clause (**VP anaphora**); (iii) or for judging with verbs that can be deleted when repeated, whether the syntactic environment of the explicit occurrence of the verb is in contrast with the syntactic environment of the deleted form of the verb (**Gapping**). Thus contrast is impossible if a noun phrase from the first clause is repeated in the second clause, and this NP is adjacent to the position containing the gap (see the sentence with an * with the gapping task).

Examples from the sentence material; glosses below contain relevant details only:

VP ANAPHORA

(Judgements of choice between structures like *so did Liz* and *so was Liz*.)

- (14) a. *Péter festette a kaput és ezt tette Erzsébet is.*

Peter painted the gate-acc and this-acc did Liz too.

'Peter painted the gate and so did Liz.'

- b. * *Péter festette a kaput és ilyen volt Erzsébet is.*

Peter painted the gate-acc and such was Liz too.

GAPPING

- (15) a. *János látott egy kutyát és Péter egy macskát.*

John saw a dog-acc and Peter a cat-acc

'John saw a dog and Peter a cat.'

- b. * *János látott egy kutyát és Péter egy kutyát.*

John saw a dog-acc and Peter a dog-acc

6.2.2. One has to assess the compatibility of lexico-semantic features of two items that occupy distinct syntactic positions. The problem arises with the occurrence of the second lexical unit, and in order to judge compatibility, the lexical material in a preceding syntactic position has to be recalled (features of **Relative pronoun and its head**, compatibility of **Aspect** and **time adverbials**, compatibility of **Selectional restrictions** assigned by the verb and features of NPs in argument position, interpretation of **Unfocussable sentence adverbial in Focus position**). These tasks require the comparison of features like +alive/-alive, concrete/abstract, progressive / perfective, instrument/ /object / agent etc.

Examples from the sentence material (glosses contain relevant details only):

AGREEMENT BETWEEN A RELATIVE PRONOUN AND ITS HEAD

(Judgements of *the pot that* versus * *the pot who*)

(16) a. *Erzsi letette az edényt, amely nehéz volt.*

Liz down put the pot-acc that heavy was.

'Liz put down the pot that was heavy.'

b. * *Erzsi letette az edényt, ki nehéz volt.*

Liz down put the pot-acc who heavy was.

ASPECT

(Judgements of the compatibility of (progressive or perfective) aspect of the verb and the time adverbial)

(17) a. *Két napon át készítette az ebédet.*

for two days (she) was making the dinner-acc.

'She was making dinner for two days.'

b. * *Két napon át elkészítette az ebédet.*

for two days (she) has made (= 'completed making') the dinner-acc

SELECTIONAL RESTRICTIONS

(Judgements of the compatibility of thematic roles, selectional restrictions and lexical features of NPs in argument positions)

(18) a. *A mama elküldte a gyereket a boltba.*

the mother sent the child-acc the shop-in.

'The mother sent the child in the shop.'

- b. * *A mama elküldte az érzést a filozófiába.*
the mother sent the feeling-acc the philosophy-in.

UNFOCUSSABLE SENTENCE ADVERBIAL IN FOCUS

(Presumably-/ perhaps-type of unfocussable adverbials in the position dominated by the 'S' node and in the Focus position -- receiving heavy stress and immediately preceding the Verb. (Capitals and " stand for the Focus position))

- (19) a. *János talán elkésett.*

'John perhaps came late.'

- b. * *János "TALÁN késett el.*

It is PERHAPS that John came late.

6.2.3. One of the conditions of an appropriate grammaticality judgement is the comparison of an internal/final position of sentence structure (stored in memory) with the first position, which has to be accessed again. This requires reanalysis of sentence structure (following lexical insertion), in such a way that a stepwise check of case endings and agreement markers on **adjacent** constituents does not yield correct grammaticality judgements. (For case agreement: **Anaphora and case hierarchy**, for number agreement: **Agreement of reciprocal anaphora**).

Examples from the sentence material; glosses contain relevant details only:

ANAPHORA + CASE HIERARCHY

(Judgements of case assignment to anaphora and antecedent. For instance: *NP + nom* and *himself-acc* is grammatical but the reverse is not.)

- (20) a. *A vezető látta önmagát a tükörben.*
the driver-nom see-3sg/past/def himself-acc the mirror-in
'The driver saw himself in the mirror.'

- b. * *Önmaga látta a vezetőt a tükörben.*
Himself-nom see-3sg/past/def the driver-acc the mirror-in

AGREEMENT OF RECIPROCAL ANAPHORA

(Judgements of the dependency between reciprocal (*each other* type) and antecedent NP with or without coordinating structure. (The NP and the reciprocal are not adjacent.)

- (21) a. *A férfi meg a nő beszélgetett egymással.*
the man-nom and the woman-nom talk-3sg/past each other-with
'The man and the woman talked to each other.'

- b. * *A nő beszélgetett egymással.*
the woman-nom talk-3sg/past each other-with

6.2.4. The correctness of case assignment to NPs has to be assessed without any knowledge of the V that assigns case; or, once the V becomes known the entire chain has to be recalled and case/number/person agreement verified. : **All 3 arguments precede the Verb.**

Examples from the sentence material; glosses contain relevant details only:

ALL 3 ARGUMENTS PRECEDE THE VERB

(Judgements of case endings and agreement of person and number suffixes between NPs and Verb. All 3 NPs precede the Verb)

- (22) a. *A gyereket a boltba a mama elküldte.*
the child-acc the shop-to the mother-nom send-3sg/past
'The mother sent the child to the shop.'

- b. * *A gyerek a boltba a mama elküldte.*
the child-nom the shop-to the mother-nom send-3sg/past

- (23) a. *A papá-nak a fiú egy könyv-et kölcsönadott.*
The father-dat the boy-nom a book-acc lend-3sg/past
'The boy lent a book to the father.'

- b. * *A papá-ra a fiú egy könyv-et kölcsönadott.*
The father-on the boy-nom a book-acc lend-3sg/past

7. ALTERNATIVE POSSIBILITIES FOR THE INTERPRETATION OF DATA

7.1. At first sight it appears that some of the hard tasks can be explained in terms of **length**. The sentences of some hard tasks are longer than the sentences of some easy tasks. However, this is not invariably so. This is because there were some really short hard tasks: **Aspect, Unfocussable sentence adverbial in focus, Anaphora + Case hierarchy, Selectional restrictions, Agreement of reciprocal anaphora.**

7.2. Another explanation that can be ruled out is that hard tasks contain **long distance** referential dependencies between non-adjacent elements in the sentence, whereas easy tasks involve no such interval. In several of the hard tasks, however, the two referentially dependent critical elements are immediately adjacent (**Agreement between a relative pronoun and its head, Aspect**) and some of the easy tasks involve long-range dependencies (**V-anaphora**). We cannot use the Double Dependence Hypothesis (Maurer, Fromkin & Cornell 1993) because there were hard tasks which did not contain two critical referential dependencies (**Aspect, Selectional Restrictions, Unfocussable Sentence Adverbial in Focus, All 3 Arguments Precede the Verb**) and there were easy tasks which involved referential dependency (**V-anaphora**).

7.3. Suppose that we follow the non-modular approach of Bates/MacWhinney and we think in terms of cues. Inflectional endings are one set of cues, used to calculate certain kinds of grammatical relationships (such as complement/verb agreement). The root of a word is another cue, used to retrieve lexical information (which must be employed in more complex syntactic and semantic processes).

Suppose that in normal language functions the word root cue and the case marking cue are used independently and more or less simultaneously. Then consider the following hypothesis: Broca's aphasia involves a reduction in attentional resources, with the result that Broca's aphasics cannot not simultaneously process lexical and inflectional cues, leading either to the neglect of inflection in order to attend to meaning, or to the preservation of inflectional patterns with resultant delays or derailings of lexical access. This is a perfectly plausible theory and one which is compatible with the data of our repetition task. As for grammaticality judgements, I do not think that the Competition Model could be ruled out.

On the basis of grammaticality judgement tests Frazier and McNamara (1995) stated that "the representation of the referential/descriptive content of a phrase **supplants**

its computational description at points where processing demands threaten to exceed processing capacity" (237).

The real nature of "impaired processing capacity", however, remains unclear: whether it is capacity of memory or capacity of attentional resources or general capacity of the language processor.

I assume that the impaired component is one of the language processing modules itself, not processing capacity in general. I suppose the seriality of processing modules as well. There are two main reasons for this approach: (1) the contradiction between patients' performance in repetition tasks and in grammaticality judgements; (2) the distribution of the grammaticality judgements.

7.4. The role of closed class morphemes

7.4.1. The basis of the distinction between open and closed class elements is the following. Natural languages tend to contain two quite different sorts of morphemes, those that are primarily of the world (open class items: nouns, adjectives, adverbs with their own lexical-semantic content) and those that are primarily of the grammar (closed class items). The closed class is generally taken to include case endings, prepositions, determiners, pronouns, conjunctions, auxiliaries, inflectional affixes and a variety of other expressions (Carlson and Tanenhaus 1984, Kean 1977, Lapointe 1983). Linguistic symptoms of Broca's aphasia are sometimes defined as the impairment of access to closed class morphemes. Indeed, the fragmentation or agrammaticality of spontaneous speech, poor sentence repeating skills and good sentence comprehension skills may be correlated with this fact. Closed class morphemes are the elements of a structure-analysing and structure-building complex in on-line speech comprehension and production (Bock 1989). Closed class morphemes can be used as indicators for the speaker since these formatives mark the beginning and the end of noun phrases and other phrases, the units of constituent structure, boundaries of main and subordinate clauses, word

order, etc. They impose structure on strings of words as was suggested by Marcus (1982). These morphemes are members of **computational vocabulary**.

7.4.2. Accessing closed-class morphemes influences access to open-class words (words that refer to entities in the world) as well. Formatives can radically reduce search time in open class vocabulary, if formal information is available as to whether one has to search for a noun, an adverb or an adjective, for example.

Speakers access open class words and closed class morphemes by two distinct access systems. The two access systems have to interact, especially during on-line sentence comprehension. (Saffran 1985, Saffran & Martin 1988, Zurif-Swinney-Garett 1990). This interaction is important for Hungarian speaking aphasics. In case of Hungarian the inflectional endings, especially surface case ending frames subcategorized for by verbs (predicates) provide a highly automatized complex device for processing surface sentence structure.

From the point of view of the **mental lexicon**, there is a level at which theta assigning predicates, like verbs, are members of the **computational vocabulary** (Frazier and McNamara, 1995). Verbs and their subcategorizational frames that include surface case endings constitute complex lexical entries. Surface case endings are parts of subcategorizational frames of verbs and mark theta role assigned by the verb on the complements.

7.5. Asynchrony between syntactic and lexical processes: time-based approaches

7.5.1. Impairments of the surface syntactic parser appear to include **the slowing down of critical functions**. According to Haarman and Kolk (1994), Broca's aphasia affects sentence processing by either slowing down the rate at which new elements are constructed or increasing the rate at which they decay. But not both at the same time. Kolk (1995) argues for computational simultaneity or synchrony. His computational model, SYNCHRON, simulates the temporal course of building up a sentence structure representation. Simultaneity or synchrony is associated with

bottom-up features. Two critical parameters are involved. In the "slow activation" case, it takes longer for the parser to begin processing of an item. The critical activation level is reached too late, thus the item does not become available for further processing tasks. On the other hand, "Fast decay makes elements unavailable when they fall below their critical level too soon to be combined with other elements..." (284).

7.5.2. Cornell (1995) introduced a new computational model, GENCHRON, based on Haarman and Kolk's model. GENCHRON produces semantic representations in accordance with the double dependence hypothesis (Maurer et al. 1993). The grammar used by GENCHRON is a constraint based phrase structure grammar in which rules combine both syntactic and semantic constraints. Cornell's computational model is bottom-up, parallel, and it has the property of simultaneity. The Extended Simultaneity Condition is the following: "Construct a superordinate constituent node, *and solve its associated constraints*, only if there is a point in time at which all of its subordinate constituent nodes are simultaneously available in memory" (306).

In addition to a component of grammar, GENCHRON system has parameter files to control the rate at which nodes become available in memory and with which they decay away.

According to Cornell (1995) **retrieval time models** represent the following deficit: lengthening the time period which it takes to process a new element "increases the likelihood that earlier arriving constituents will have faded from working memory by the time the later arriving constituents are finally constructed" (316).

In processing simulation, however, Cornell used a **memory time model**. This refers to the period during which an element is available in working memory. "Shortening this time period increases the likelihood that earlier arriving constituents will have faded from working memory before later arriving constituents are made available." (Cornell 1995:316)

In processing simulation memory-time parameters were varied according to the open-class/closed class distinction. Cornell made the following parameter settings:

Open-class items persist for: 6 clock cycles;

Closed-class items persist for: 3 clock cycles;

Retrieval time for all items: 1 clock cycle.

(Cornell 1995:317.)

Differences between memory time for open-class and closed class items are important. According to the parameter settings above, closed-class items fade away so fast from memory that the construction of a proper NP (for instance) is doubtful.

7.5.3. Cornell supposes that a processing account of asyntactic comprehension should make predictions for correct/incorrect grammaticality judgements as well. He suggests as a next step that "The version of GENCHRON used in these simulations is subject to the extended simultaneity condition: it waits until all subtrees have been parsed and then attempts to solve all of the constraint at once.

Generalized Simultaneity Condition:

The output of a particular task only becomes available when and if the output of all of its subtasks is available at some point in time. At that point in time the superordinate task begins to make its output available" (323).

7.6. The partial process

Cornell's interesting computational model has a high heuristic value. I believe, however, that grammaticality judgement tasks do not involve this kind of extended simultaneity. These tasks are easier than comprehension tasks in aphasia. Grammaticality judgements require shorter availability of the syntactic representation in memory than comprehension tasks and are therefore less easily disrupted.

Solving judgement tasks does not require that the parser waits "until all subtrees have been parsed and attempts to solve all of the constraint at once". It is not necessary that a syntactic tree for a full sentence should be available. Judgement of

grammaticality is possible as soon as **minimally sufficient structural information** has been made available. Patients' performance in judgements depends on the type of grammatical error hidden in the task, i.e., on the availability of the minimally sufficient structural information which is necessary for correct judgement.

7.7. The initial structure building operations

7.7.1. In what follows I would like to apply the first-pass parse hypothesis. The hypothesis of initial structure building operations has been proposed by a number of psycholinguists (e.g., Frazier, Clifton & Randall 1983, Saffran 1985). In accordance with this hypothesis I assume that in the case of grammaticality judgements an initial structural analysis is computed and is subsequently interpreted. This is followed by later processing operations involving constraints on the indexing of structures. In the sense of Saffran (1985), the first-pass parser protects some of the processed syntactic information during first-pass parse and a working memory deficit restricts further processing operations.

7.7.2. The solution of a grammaticality judgement task is based on a minimally sufficient structural representation. (For aphasic subjects, grammaticality judgement tasks are easier than comprehension tasks). What counts as a minimally sufficient structure, within a given language, will change from task to task. 'Easy-to-judge task' means that minimally sufficient structure is available and 'hard-to-judge task' means that minimally sufficient structure is not available.

As for Hungarian speaking aphasics, I claim that the first-pass parser is based on the verb, its subcategorizational selections for syntactic category of complements and for case endings (that marks theta role on surface structure). This constitutes important syntactic information for the possible syntactic structure, the possible linear order of categorized syntactic slots and the hierarchy of nodes of the structure. According to the Projection Principle, syntactic representation must be projected from the lexicon in that they observe subcategorizational properties of lexical items.

8. Judgements in easy tasks are based on initial structure building operations

8.1. There were three types of easy tasks: **Argument + Case ending , Anaphoric Agreement in Person and Number, V-anaphora**. According to our analysis of grammatical information used in judgements (in 5.6.), with easy tasks correct judgements were based on two kind of processes. The first one is the retrieval of the verb and its subcategorizational frame (including surface case endings) from computational vocabulary. The second one is a set of step-by-step checking movements on surface inflectional endings crosschecking them in person, number and definiteness.

8.2. Processes are effected in stepwise checks. This could be paraphrased as follows: "Take verb X and its case frame as a starting-point. Assign cases from the case frame and make the case of constituent Y agree with that of constituent X; make constituent Y agree with the verb in person, number and definiteness; let constituent Z agree in person and number with constituent W, etc."

8.3. Memory (temporal) deficits do not affect the initial structure building operations

8.3.1. Kolk (1995) presents empirical evidence for syntactic and lexical processes being partially autonomous routines. This becomes apparent in the case of a working memory deficit. "The nodes.....take some time to reach their "memory time phase", that is to become available to interact with other nodes.this memory time is limited; if it is exceeded, elements disappear from memory. ..The type of elements affected by the temporal deficit do make a difference, however. When function word nodes are affected, the required pattern do not emerge. It appears only when phrasal category nodes are impaired" (284).

How can temporal deficit or working memory deficit be reconciled with these easy-to-judge conditions? One can ask why memory time would not be required for number agreement tasks. Of course, judgements of these tasks require some

working memory capacity, but this does not exceed the limitations of the first-pass parser. Although the patient's restricted working memory time may not be sufficient to produce full syntactic representation, it is nevertheless sufficient for the judgement of a verb and a string of inflectional endings (related to that verb).

Judgements in easy tasks are based on information that can be used fast and extracted by processing short phoneme sequences which have high frequency. This operation is carried out by the parser in the form of its changes from one state to another ("what it is seeking to match what"), and is retained while parsing goes on.

8.3.2. Another problem is related to a kind of adjacency relation of inflectional endings. The easy-to-judge "**Anaphoric agreement in number and person**" condition involves retrieving referential dependency and comparing lexical material filling two distinct syntactic positions in order to check agreement. As a matter of fact, minimally required syntactic information for correct judgement is simply based on an agreement of inflectional endings. This is shown in (24):

- (24) a. *A gyerek látta magát a tükörben.*
The child-nom see-3sg/past/def him+self-3sg/acc in the mirror.
'The child saw himself in the mirror'

- b. * *A gyerek látta magadat a tükörben.*
The child-nom see-3sg/past/def your+self-2.sg/acc in the mirror.

Patients do not need the processing of referential dependency to judge these sentences correctly. They simply have to check whether two neighbouring inflectional endings are compatible. The inflectional ending of the verb (*láttA*) is member of the transitive paradigm and marks third person singular. The inflectional ending of the anaphora (*magá-T*) marks accusative case and **third person** singular as well. In the ungrammatical version the anaphora was given an inflectional ending (*magaDAT*) which marks accusative case and **second person** singular, after the same verb

(látt⁴). The contradiction between the inflectional ending attached to verb (definite + 3sg) and the inflectional ending attached to anaphora (accusative + 2sg) was easily detected. The associated referential dependency problem (anaphora) did not make patients misjudge the sentence as this dependency was not part of the minimally sufficient structural information to judge **this type** of tasks. From the point of view of judgement, the "Anaphoric Agreement in Person and Number" task is very similar to the prototypical of easy-to-judge "Argument + Case ending" task.

(25) a. *Róbert nézi a könyvet.*

Robert-nom look-3.sg/present/def the book -acc

'Robert looks at the book'

b. * *Róbert nézi téged.*

Robert-nom look-3.sg/present/def you-2.sg/acc

(Among the hard conditions there are tasks which, in addition to the compatibility of inflectional endings, involve a referential dependency problem as well. Patients produced systematic misjudgements at these tasks: (**Agreement of reciprocal anaphora**)).

It is remarkable that the task "Agreement between relative pronoun and its head" contained two referentially dependent critical constituents that were immediately adjacent. The task was difficult because correct judgement presupposed structural information which involved the processing and comparing of lexical features of open class items filling two distinct syntactic positions.

8.4. How does first-pass parse work?

8.4.1. The approach outlined above involves some problematic details, of course. The first question is whether the working memory deficit immediately affects the accessibility of closed class items from computational vocabulary. In this case there would be a desynchronization between access of closed class items and open class

items. That is, the interaction of the two access system would be disturbed. But how does this desynchronization "work"? (Agrammatic patients produce "agrammatic speech" that contains relatively few erroneously produced morphemes but lacks some of the required "grammatical coherency" and contains a lot of fragments and omission). Do closed class items create syntactic difficulties or do they follow from them?

8.4.2. We have claimed that the first-pass parser is based on the verb and its subcategorizational information involving categorial selection features for complements and case endings attached to these complements. (Case endings mark thematic roles on surface structure in Hungarian sentences).

Suppose that temporal deficit affects the transfer of information between lexicon and syntax. The syntactic component produces an invariant structural frame for all possible Hungarian sentences. That syntactic frame contains categorized slots. The category of Verb, the categories of its subcategorized complements, its case ending frame (and other grammatical function morphemes) would be generated by the syntax in accordance with the Projection Principle. Open class lexical material, like content-words: nouns, adjectives, adverbs, and other descriptive/referential lexical items would be generated by lexical processes and would be inserted into their slots in the syntactic frame.

According to Kolk (1995) open class words have to be inserted into their categorized slots of the syntactic frame. Closed class items have to be integrated with their syntactic slots as well. These two kinds of integration require synchronization.

Impairments on closed class access play an important role. Kean (1981) states that "...a special access systems for clitics (closed class items) would aid in parsing since the rapid retrieval of clitics would make available a rich source of information for making initial hypotheses as to local syntactic structure...Any apparent syntactic deficit would, under this view, be a by-product of the accessing impairment" (195). Berndt et al. (1983) state that "...the special close-class access route...serves a

syntactic function. As input to a parser, the closed class items signal, for example, the introduction of a noun phrase, the distinction between main and subordinate clauses, the difference between active and passive sentences, and so on" (21).

According to Linebarger (1990), **on-line** identification of closed class elements as indicators of structure of heard utterance can help build and indentify structure before the order-preserving lexical representation of the input is deleted from the working memory.

Kolk (1995) states that "a syntactic slow down will lead to desynchronization in integrating syntactic slots with lexical fillers" (292).

Because of the easier nature of the grammaticality judgement task, initial sentence processes could be performed under slowing down of access to closed classes. Our easy-to-judge tasks do not show consequences of syntactic slowing down. I claimed above that initial structure building operations were based on the verb and its subcategorizational selections. With easy tasks this set of information was sufficient to produce correct judgements. Patients were able to use initial structure building operations in checking the basic syntactic frame and its slots for closed classes. I emphasize that it is the initial phase of sentence processsing for which this is valid.

8.4.3. If the judgement of an utterance required synchronization of syntactic and lexical information, patients' performance deteriorated. This is understandable because deficit on closed class retrieval system does not only involve impairments of operational speed. To access a closed class item is to retrieve **the structure building operations that are associated with that closed class item**. The case ending frame assigned by the category of the verb and other inflectional endings **open up a syntactic slot for integration with a content word filler**.

Impairments on access system of closed class items causes **a delay in opening up syntactic slots**. In the sense of Kolk (1995), this means that the point in time at which closed class morphemes deliver a syntactic slot for an open class lexical filler is in synchrony with the **late phase** of lexical selection, **at the end** of activation of a

content word, when "the amount of activation is relatively low, competition from alternative lexical candidates is relatively high" (Kolk 1995, 290.).

9. Hard tasks

9.1. Syntactic and lexical processes should have been integrated

Hard tasks contained different types of grammatical error which would have been detected in a synchronization of syntactic and lexical processes. Synchronization means that syntactic slots are opened up in synchrony with the middle (safe) period of lexical activation of open class items. (cf. Kolk 1995). On the other hand, slowing down of retrievability of closed class items generated by syntax causes desynchronization in the integration of syntactic slots with lexical material. Setting up minimally sufficient structural information for correct judgements exceeds the limitation of an impaired parser in hard tasks. Because of a temporal deficit, the syntactic parser **cannot** build and identify surface syntactic structure **before** the order-preserving **lexical representation** of the heard utterance **faded** fast away from working memory. In this case the lexically processed material would have to be retained in working memory **too long** because of the slowdown of the surface syntactic parser, thus some lexical information will decay. The integration of lexically processed items and surface syntactic positions is deferred. The difference between patients' performance in the easy task **Argument + case ending** and patients' performance in the hard task **All 3 arguments precede the verb** reflected the slowdown of the parser: if Verb was in the final position of the string (preceded by all three arguments), the impaired parser was too late to receive its starting point (Verb + subcategorizational and case ending frame) and patients' performance deteriorated.

9.2. Random judgements versus systematic misjudgements

Easy tasks form one homogeneous set; they almost entirely involve judgements of cooccurrence restrictions among surface inflectional forms. Hard tasks are not

grammatically homogeneous, covering as they do a wide range of **distinct** grammatical patterns; nor are they experimentally homogeneous.

Tables 1 - 2 above and **Tables 3 - 4** in the Appendix show that there are not only two interesting cases (easy and hard tasks) but at least three:

(A) Easy tasks (acceptable sentences were judged 100% as good, unacceptable counterparts were judged 100% as bad);

(B) hard tasks where judgements were essentially **random** and chaotic from a statistical point of view (the patients attempted to make a distinction, but failed to be consistently correct in their judgements), and

(C) hard tasks where acceptable sentences were judged as good with 100%, but **unacceptable counterparts** were judged as good with 100 % or at least close to 100%. Case (C) shows **systematic** misjudgements.

Table 5 in the Appendix presents a **posthoc statistical analysis** on these three categories for means and standard deviation for correct judgements and presents an analysis of variance for correct judgements, for type (A), (B) and (C).

According to this analysis:

- (i) Effect of type A/B/C for correct judgement is significant ($p < 0.05$),
- (ii) Effect of grammaticality for correct judgement is significant ($p < 0.05$),
- (iii) Interaction of type A/B/C and grammaticality is significant ($p < 0.05$).

9.3. Guessing

Case (B) is the random picture resulting whenever the parser is overloaded. Case (B) contains the tasks in which the patients were more or less **guessing**.

These tasks involved complex syntactic relations.

9.3.1. The first subclass of these tasks contained two verbs. Cooccurrence restrictions among surface inflectional endings were affected in connection with the relation between the two verbs. But the tasks were **more complex** because they required the patients to judge two local syntactic dependencies involving two verbs **and** referential dependencies between two arguments (phonologically empty and/or

phonologically/lexically filled arguments) of these two verbs (tasks of **VP-Anaphora, Gapping, Sentential Intertwining, pro-Subject**). Grammatical versions of tasks of **Sentential Intertwining** contained a heavy stress-bearing NP constituent in focus position (which must be interpreted as being focused). Sentences with a focused constituent presuppose special contexts to convey information whose acceptance is supposed to contradict some expectation of the listener. (In our test example: *..it was the BOOK that she said she would buy (and NOTHING ELSE)*). I assume that judgements of these relations overtaxed the working memory.

9.3.2. The second subclass of type (B) tasks required the patients to process **two** local syntactic relations involving a referential dependency and a constraint on the type of case ending attached to syntactic category (tasks **Anaphora + Case hierarchy**). To sum up: in the first and second subclasses of case (B), although surface inflectional forms were affected in connection with syntactic errors, correct judgements should have required radically more complex syntactic and lexical processing in the patient's decisions.

9.3.3. The third subclass of these tasks involved the verification of semantic compatibilities, where the errors involved incompatibility of lexical-semantic features (tasks of **Agreement between a relative pronoun and its head** and **Selectional restrictions**). Alternatively, the tasks required the processing of a relation between the meaning of time adverbial and the point of time specified by the tense-marker suffix and prefix of the verb (the **Aspect** task).

9.4. Systematic misjudgements

Case (C) shows systematic misjudgement where both acceptable sentences and their unacceptable counterparts were judged as good in 100 % or, in the latter case, at least close to 100 %. These are the following categories: **Agreement of Reciprocal Anaphora, Unfocussable Sentence Adverbial in Focus, All 3 Arguments Precede the Verb.**

These tasks are not grammatically homogeneous, they cover a wide range of distinct grammatical patterns. They contain only one verb and involve a non-complex syntactic error which cannot be detected with the help of the surface case frame of the verb, for two reasons. First: the case ending frame is the same in the grammatical and ungrammatical sentences. Second: the syntactic error is connected to the case ending frame itself but the surface syntactic parser is not given its starting point for processing in due time.

9.4.1. In the task **Agreement of Reciprocal Anaphora**, the syntactic error is related to the referential dependency between the reciprocal and the nominative noun phrase with or without a coordinating structure (glosses contains relevant details only):

(26) a. *A férfi meg a nő beszélgetett egymással.*
 the man-nom and the woman-nom talk-3sg/past each other-with
 'The man and the woman talked to each other.'

b. * *A nő beszélgetett egymással.*
 the woman-nom talk-3sg/past each other-with

The surface case frame (case endings) assigned by the verb to NPs are **the same** in the grammatical and ungrammatical sentences. The syntactic error cannot be detected with the help of case endings.

9.4.2. In the task **Unfocussable Sentence Adverbial in Focus** the syntactic error is related to the syntactic position of the sentence adverbial. If it is in the syntactic position of Focus, the sentence will be ungrammatical, otherwise it is grammatical.

T stands for the topic position (dominated by the 'S' node), **F** stands for Focus position, which receives heavy stress, and immediately precedes the V bar dominated by the VP node. **V** stands for the verb. Capitals and " stand for the heavy, main stress in the sentence:

(27) a. *János talán elkésett.*

'John perhaps came late.'

b. **János "TALÁN késett el.*

'It is PERHAPS that John came late.'

Again, the surface case frame of the verb is **the same** in acceptable and unacceptable sentences alike.

Patients accepted the grammatical versions because of the grammatical surface case frame. To judge ungrammatical sentences correctly, patients should have refused sentences with a focused adverbial and should have judged contextual relation (information whose acceptance is supposed to contradict some expectation of the listener) implied by focused sentence:.. *'it is PERHAPS and it is NOT CERTAINLY.'* Patients accepted the ungrammatical versions because of the grammatical surface case frame and neglected the special contextual relation.

(It is worth mentioning that **this kind** of ungrammatical sentence with focused 'modality-adverbial' is not suitable for any correction of modality in Hungarian).

9.4.3. The task All 3 Arguments Precede the Verb involved syntactic errors with the surface case frame itself.

The unacceptable sentence contains two separate Noun Phrases with (two separate) nominative case endings:

(28) a. *A gyereket a boltba a mama elküldte.*

the child-acc the shop-to the mother-nom send-3sg/past

'The mother sent the child to the shop.'

b. **A gyerek a boltba a mama elküldte.*

the child-nom the shop-to the mother-nom send-3sg/past

The unacceptable sentence contains a case ending (*-ra*) that **cannot occur grammatically in the case frame of the verb** (Hungarian equivalent of *lend*):

- (29)a. *A papá-nak a fiú gy könyv-et kölcsönadott.*
The father-dat the boy-nom a book-acc lend-3sg/past
'The boy lent a book to the father.'

- b. * *A papá-ra a fiú- egy könyv-et kölcsönadott.*
The father-on the boy-nom a book-acc lend-3sg/past

In the acceptable sentences the surface case frame was correct. The unacceptable counterpart contained an incorrect instance of case assignment (there were two separate nominative case endings in the sentence), or contained an ordinary Hungarian case ending (like *-ra*) which was ungrammatical within the surface case frame of **the given verb**. As indeed all 3 argument NPs preceded the verb (the verb was the last syntactic constituent in the surface string) the correctness of case assignment to NP's had to be assessed without any knowledge of the verb that assigns case frame; or, once the verb becomes known the entire string has to be recalled and case endings verified.

It is remarkable that the patients' performance was 100 % correct with the Argument + Case ending task (classified as an easy task) in which all three argument NP's **did not precede** the verb, rather, only one argument NP preceded the verb and the other two argument NPs **followed the verb**. The main difference between the easy Argument+Case ending task and the type (C) hard task All 3 Arguments Precede the Verb is **the syntactic position of the verb in the surface string** relative to the positions of its argument NPs. In the task Argument+Case ending the verb is in a non-final position and its argument NPs surround it. In the task All 3 Arguments Precede the Verb the verb is in the final position of the surface string.

The surface position of the verb is **critical** for Hungarian Broca's aphasics. (Hungarian is more or less a "free phrase order" language (Kornai 1992, Kiefer-É. Kiss 1994)). For Hungarian Broca's aphasics involved in our experiments, the judgement of the case ending frame turns out to be easy under the following condition: a verb with three or more argument NPs must occur in non- final position in the surface string. At least one argument NP (from the three) must follow the verb in surface position.

Recall the data of the repetition tasks. The patients' performance in the repetition tasks showed that the verb is the the **starting** point for the surface syntactic analysis. The patients never made both inflectional errors and errors in the choice of the main verb in the **same** sentence. Patients made inflectional errors when they were unable to retrieve any verb (as in example (3)). If the patients approximated the class of the target verb, however, then its surface case frame was retrievable for them. The case frame assigns suffixes to associated nouns; and it does so even if the nouns to which the endings are to be attached cannot be correctly reproduced by the patients.

10. SUMMARY

10.1. Easy tasks required using a verb and its subcategorizational frame (surface case frame) for correct judgements. It was necessary that this minimally sufficient syntactic information would be retrievable for the impaired parser.

10.2. With hard tasks to be judged correctly a synchrony between syntactical and lexical information would have to be available.

10.3. Access to closed class morphemes is impaired therefore syntactic structure building process is slow and the integration and interpretation of some lexically processed input sequence of open class items is deferred. This input sequence would have to be retained too long in the working memory because of the slowing down of the syntactic parser.

10.4. It can be assumed that in the first phase of processing the parser selects surface syntactic information (subcategorizational frame of the verb, surface case frame, word order). Closed class elements provide a syntactic frame into which open class items are inserted in the course of sentence processing. The surface syntactic parser is too slow in processing closed class items, so lexical information in the working memory is already gone when needed. The subjects are unable to integrate the output of the syntactic parser with the segments of the lexical process.

APPENDIX

TABLE 3
DESCRIPTIVE STATISTICS OF DATA

Symbols:

gr = grammatical, **ungr** = ungrammatical

c = correct judgement, **w** = wrong judgement

Abbreviations stand for **sentence-types** as in Table 1 and Table 2. For instance:
Relative.gr./c. = Correct judgements for Grammatical versions of "Agreement
between a relative pronoun and its head" tasks.

VARIABLE NO. NAME	TOTAL FREQ.	MEAN	STANDARD DEV.	ST. ERR. OF MEAN
1 Relative.gr/c.	6	4.6667	.81650	.33333
2 Relative.gr/w.	6	.33333	.81650	.33333
3 Relative.ungr/c.	6	3.0000	.63246	.25820
4 Relative.ungr/w.	6	2.0000	.63246	.25820
5 Recipagr.gr/c.	6	5.0000	0.0000	0.0000
6 Recipagr.gr/w.	6	0.0000	0.0000	0.0000
7 Recipagr.ungr/c.	6	.50000	.54772	.22361
8 Recipagr.ungr/w.	6	4.5000	.54772	.22361
9 3arg.gr/c.	6	5.0000	0.0000	0.0000
10 3arg.gr/w.	6	0.0000	0.0000	0.0000
11 3arg.ungr/c.	6	.33333	.51640	.21082
12 3arg.ungr/w.	6	4.6667	.51640	.21082
13 Anaphagr.gr/c.	6	5.0000	0.0000	0.0000
14 Anaphagr.gr/w.	6	0.0000	0.0000	0.0000
15 Anaphagr.ungr/c.	6	5.0000	0.0000	0.0000
16 Anaphagr.ungr/w.	6	0.0000	0.0000	0.0000
17 Anaphcase.gr/c.	6	1.8333	.75277	.30732
18 Anaphcase.gr/w.	6	3.1667	.75277	.30732
19 Anaphcase.ungr/c.	6	2.3333	.51640	.21082
20 Anaphcase.ungr/w.	6	2.6667	.51640	.21082
21 Argumcase.gr/c.	6	5.0000	0.0000	0.0000
22 Argumcase.gr/w.	6	0.0000	0.0000	0.0000
23 Argumcase.ungr/c.	6	5.0000	0.0000	0.0000
24 Argumcase.ungr/w.	6	0.0000	0.0000	0.0000

VARIABLE NO. NAME	TOTAL FREQ.	MEAN	STANDARD DEV.	ST. ERR. OF MEAN
25 Aspect.gr/c.	6	3.0000	.63246	.25820
26 Aspect.gr/w.	6	2.0000	.63246	.25820
27 Aspect.ungr/c.	6	2.3333	.51640	.21082
28 Aspect.ungr/w.	6	2.6667	.51640	.21082
29 Gapping.gr/c.	6	1.8333	.75277	.30732
30 Gapping.gr/w.	6	3.1667	.75277	.30732
31 Gapping.ungr/c.	6	2.5000	.54772	.22361
32 Gapping.ungr/w.	6	2.5000	.54772	.22361
33 pro-S.gr/c.	6	2.6667	.81650	.33333
34 pro-S.gr/w.	6	2.3333	.81650	.33333
35 pro-S.ungr/c.	6	2.8333	1.1690	.47726
36 pro-S.ungr/w.	6	2.1667	1.1690	.47726
37 Select.gr/c.	6	3.8333	.75277	.30732
38 Select.gr/w.	6	1.1667	.75277	.30732
39 Select.ungr/c.	6	2.0000	.63246	.25820
40 Select.ungr/w.	6	3.0000	.63246	.25820
41 Intertw.gr/c.	6	2.1667	.75277	.30732
42 Intertw.gr/w.	6	2.8333	.75277	.30732
43 Intertw.ungr/c.	6	1.5000	.83666	.34157
44 Intertw.ungr/w.	6	3.5000	.83666	.34157
45 Unfoc.gr/c.	6	5.0000	0.0000	0.0000
46 Unfoc.gr/w.	6	0.0000	0.0000	0.0000
47 Unfoc.ungr/c.	6	.33333	.51640	.21082
48 Unfoc.ungr/w.	6	4.6667	.51640	.21082
49 V-anaph.gr/c.	6	5.0000	0.0000	0.0000
50 V-anaph.gr/w.	6	0.0000	0.0000	0.0000
51 V-anaph.ungr/c.	6	5.0000	0.0000	0.0000
52 V-anaph.ungr/w.	6	0.0000	0.0000	0.0000
53 VP-anaph.gr/c.	6	3.3333	1.0328	.42164
54 VP-anaph.gr/w.	6	1.6667	1.0328	.42164
55 VP-anaph.ungr/c.	6	2.3333	1.0328	.42164
56 VP-anaph.ungr/w.	6	2.6667	1.0328	.42164

TABLE 4

AN ANALYSIS OF VARIANCE for correct judgements (for the 1-st dependent variable)
EFFECT OF SENTENCE-TYPE AND GRAMMATICALITY FOR CORRECT JUDGEMENTS:

Names = Sentence-type, Grammatical
Level = 14, Level = 2.

SOURCE	SUM OF SQUARES	DEGREE OF FREEDOM	MEAN	F-value	PROBAB.
1. Sentence-type	188.97619	13	14.53663	48.93	0.0001
Error	19.30952	65	0.29707		
2. Grammatical	72.02381	1	72.02381	90.57	0.0002
Error	3.97619	5	0.79524		
3. Interaction	145.64286	13	11.20330	47.42	0.0001
Error	15.35714	65	0.23626		

1. Effect of the sentence-type for correct judgements is significant ($p < 0.05$),
2. Effect of the grammaticality for correct judgements is significant ($p < 0.05$),
3. Effect of the interaction of sentence-type and grammaticality is significant for correct judgements ($p < 0.05$).

TABLE 5

A POSTHOC ANALYSIS

A/gr = Anaphagr.gr/c. + Argumcase.gr/c + V-anaph.gr/c. A/gr=A/gr/3

A/ungr = Anaphagr.ungr/c. + Argumcase.ungr/c + V-anaph.ungr/c.
A/ungr=A/ungr/3

B/gr = Relative.gr/c. + Anaphcase.gr/c. + Aspect.gr/c. + Gapping.gr/c. +
pro-S.gr/c. + Select.gr/c. + Intertw.gr/c. + VP-anaph.gr/c.
B/gr=B/gr/8

B/ungr = Relative.ungr/c. + Anaphcase.ungr/c. + Aspect.ungr/c. +
Gapping.ungr/c. + pro-S.ungr/c + Select.ungr/c. + Intertw.ungr/c. +
VP-anaph.ungr/c.
B/ungr=B/ungr/8

C/gr = Recipagr.gr/c. + Unfoc.gr/c. + 3arg.gr/c. C/gr=C/g/3.

C/ungr = Recipagr.ungr/c. + Unfoc.ungr/c. + 3argr.ungr/c. C/ungr=C/ungr/3.

MEANS FOR CORRECT JUDGEMENTS (for the 1-st dependent variable)

Names = type, gr.

Level = 3, 2.

	type	gr	
A/gr	1	1	5.00000
A/ungr.	1	2	5.00000
B/gr	2	1	2.91667
B/ungr.	2	2	2.35417
C/gr.	3	1	5.00000
C/ungr.	3	2	0.38889

Effect of type :

A = 5.00

B = 2.65

C = 2.69

gr = 4.30

ungr = 2.57

STANDARD DEVIATION FOR CORRECT JUDGEMENTS (for 1-st dependent variable)

	type	gr	
A/gr	1	1	0.00000
A/ungr	1	2	0.00000
B/gr	2	1	0.65511
B/ungr	2	2	0.49000
C/gr	3	1	0.00000
C/ungr	3	2	0.38968

ANALYSIS OF VARIANCE FOR CORRECT JUDGEMENTS (for the 1-st dependent variable)

Names = type, gr.

Level = 3, 2.

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F-VALUE	PROBAB.
1. TYPE	43.64130	2	21.82065	165.46	0.0001
Error	1.31877	10	0.13188		
2. GR	26.76625	1	26.76625	355.01	0.0001
Error	0.37698	5	0.07540		
3. Interaction	37.97000	2	18.98500	221.24	0.0001
Error	0.85812	10	0.08581		

As can be seen in analysis of variance

1. effect of type A/B/C for correct judgement is significant ($p < 0.05$),
2. effect of grammaticality for correct judgement is significant ($p < 0.05$),
3. interaction of type A/B/C and grammaticality is significant ($p < 0.05$).

REFERENCES

- Arbib, M., Caplan, D. & Marshall, J. (Eds.) 1982. *Neural models of language processes*. New York, Academic Press.
- Bánrétí, Z. 1994. Coordination, in: *The Syntactic Structure of Hungarian*, Kiefer, F. - É.Kiss, K. (Eds). *Syntax and Semantics Vol. 27*. New York, Academic Press.
- Berndt, R.S., Caramazza, A., & Zurif, E. 1983. Language functions: Syntax and semantics, in: Segalovitz, S., J. (Ed.) *Language functions and brain organisation*, 5-28. New York, Academic Press
- Bock, K. 1989. Closed class immanence in sentence production. *Cognition*, **31** , 163-186.
- Caramazza, A. 1990. (Ed.): *Cognitive Neuropsychology and Neurolinguistics*, Lawrence Erlbaum Associates, Publishers. New Jersey.
- Carlson, G. & Tanenhaus, M.K. 1984. Lexical meanings , structural meanings, and concepts. In: Drago J., Mishra, V. & Testen, D.(Eds.) *Papers from the twentieth regional meeting of the Chicago linguist society*. Chicago, IL: Chicago Linguistics Society.
- Cornell, T. L., 1995. On the Relation between Representational and Processing Models of Asyntactic Comprehension. *Brain and Language*, **50**. 304-324.
- É.Kiss, K. 1994. Sentence Structure and Word Order, in É.Kiss, K. - Kiefer, F. (Eds): *The Syntactic Structure of Hungarian, Syntax and Semantics*, **Vol. 27**. 1-90. New York, Academic Press.
- Frazier, L., Flores d'Arcais, G.B. and Coolen R. 1993. Processing discontinuous words: On the interface between lexical and semantic processing. *Cognition*, **47**. 219-249.
- Frazier, L. - McNamara, P. 1995. Favor Referential Representations. *Brain and Language* **49**, 224-240.
- Grodzinsky, Y. 1990. Theoretical perspectives on language deficits. MIT Press.
- Grodzinsky, Y. - Wexler, K. - Chien, Y. - Marakovitz, S. - Solomon, J. 1993. The Breakdown of Binding Relations. *Brain and Language* **45**. 396-422.
- Grodzinsky, Y., Swinney, D., & Zurif, E. 1985. Agrammatism: Structural deficits and antecedent processing disruptions. In Kean, M. L., (ed): *Agrammatism*, New York, Academic Press, 65-82.

Haarmann, H. J. and Kolk, H. H. J. 1994. On-line Sensitivity to Subject-Verb Agreement Violations in Broca's Aphasics: The Role of Syntactic Complexity and Time. *Brain and Language* **46**. 493 - 516.

Kálmán, L. 1985. Word Order in Neutral Sentences, Word Order in Non-Neutral Sentences, in: Kenesei, I. (Ed.) *Approaches to Hungarian, Data and Descriptions Vol.1*. 13-39. Jate, Szeged

Kean, M.-L. 1977. The linguistic interpretation of aphasic syndromes: Agrammatism in Broca's aphasia, an example. *Cognition*, **5**. 9-46.

Kean, M.L. 1981. Explanation in neurolinguistics, in: Hornstein, N. & Lightfoot D. (Eds.), *Explanation in linguistics*, 174-208. London, Longman.

Kertesz, A. 1982. The Western aphasia battery. New York, Grune & Stratton.

Kiefer, F. - É.Kiss, K. (Eds.) 1994. The Syntactic Structure of Hungarian. Syntax and Semantics **Vol. 27**. New York, Academic Press.

Kolk, H. 1995. A Time-Based Approach to Agrammatic Production. *Brain and Language* **50**. 282-303

Kornai, A. 1992. Frequency in Morphology, in: Kenesei, I. (Ed.) *Approaches to Hungarian, Vol. 4*. 247-268.

Linebarger, M.C. 1990. Neuropsychology of Sentence Parsing, In: *Caramazza (1990) (ed.)*, 55-122.

Linebarger, M. C. 1995. Agrammatism as Evidence about Grammar. *Brain and Language*, **50**. 52-91.

Linebarger M., Schwartz, M. & Saffran, E. 1983. Sensitivity to grammatical structure in so-called agrammatic aphasics. *Cognition*, **13**. 361-392.

Linebarger, M., Schwartz, M & Saffran, E. 1983. Syntactic processing in agrammatism: A reply to Zurif and Grodzinsky. *Cognition* **15**. 207-213.

McWhinney, B., Bates, E. (eds) 1989. The crosslinguistic study of sentence processing. New York: Cambridge University Press.

MacWhinney, B., Pléh, Cs. & Bates, E. 1985. The development of sentence interpretation in Hungarian. *Cognitive Psychology* **17**, 178-209.

MacWhinney, B., Osman-Sagi, J. & Slobin, D. 1991. Sentence comprehension in aphasia in two clear case marking languages. *Brain and Language*, **41**.(2) 234-249.

Marcus, M. P. 1982. Consequences of functional deficits in a parsing model: Implications for Broca's aphasia.

In: *Arbib, M., Caplan, D. & Marshall, J. (Eds.) 1982. 115-133.*

Marin, O.S.M., Saffran, E.M. & Schwartz, M.F. 1976. Dissociations of language in aphasia: Implications for normal functions. In: *Annals of the New York Academy of Sciences*, 280, 868-884.

Maurer, G., Fromkin, V.A., Cornell, T.L. 1993. Comprehension and Acceptability Judgements in Aggramatism: Disruptions in the Syntax of Referential Dependency. *Brain and Language* 45, 340-393.

Romani, C. (1994). The Role of Phonological Short-term Memory in Syntactic Parsing: A Case Study. *Language and Cognitive Processes*, 9. (1) 29-67.

Saffran, E.M. 1985. STM and language comprehension. Paper presented at the meeting on Cognitive Neuropsychology, Venice, Italy.

Saffran, E.,M. & Martin, N. 1988. Short-term memory Impairment and sentence processing : A case study. In: *Vallar & Shallice (Eds.) 1988.*

Saffran, E., M. 1990. Short-Term Memory Impairment and Language Processing. In: *Caramazza (ed.) 1990. 137 -168.*

Vallar,G. & Shallice, T. 1988. (Eds.) Neuropsychological Impairments of Short-Term Memory, Cambridge, University Press.

Wulfeck, B., Bates, E. & Capasso, R. 1991. A crosslinguistic study of grammaticality judgements in Broca's aphasia. *Brain and Language*, 41. (2.) 311-336.

Zurif, E. - Swinney, D. - Garrett, M. 1990. Lexical Processing and Sentence Comprehension in Aphasia. In: *Caramazza (Ed.) 1990. 123 - 136.*

Zurif, E. - Swinney, D. - Prather, P. - Solomon, J. -Bushells, C. 1993. An On-Line Analysis of Syntactic Processing in Broca's and Wernicke's Aphasia. *Brain and Language* 45. 448-464.



PREVIOUS TITLES IN THIS SERIES:

- 1/1: M. BRODY, *Phrase Structure and Dependence*.
- 1/2: K. É. KISS, *Generic and Existential Bare Plurals and the Classification of Predicates*.
- 1/3: L. KÁLMÁN, *Quantification, Conditionals and Bipartite Meanings*.
- 1/4: Z. BÁNRÉTI, *Modularity in Sentence Parsing: Grammaticality Judgments in Broca's Aphasics*.
- 2/1: A. SZABOLCSI, *Strategies for Scope Taking*.
- 2/2: G. RÁDAI and L. KÁLMÁN, *Compositional Interpretation of Computer Command Languages*.
- 2/3: L. KÁLMÁN, *Strong Compositionality*.
- 2/4: M. BRODY, *Towards Perfect Syntax*.
- 2/5: A. ZSÁMBOKI, *Contrastive Co-Ordinations with Focussed Clauses*.
- 2/6: L. KÁLMÁN AND G. RÁDAI, *Dynamic Update Predicate Logic*.

