SPLIT INFLECTION IN NEUROLINGUISTICS

Na'ama Friedmann and Yosef Grodzinsky

Tel Aviv University

Since Pollock's 1989 paper, much linguistic argumentation has been mounted in favor of the split inflection hypothesis. This paper presents evidence from a neuropsychological angle in support of this hypothesis. Given that agrammatic aphasic patients demonstrate a selective deficit in the syntactic domain, it is tempting to look for impairment patterns that pertain to issues debated in current syntactic theory. Some arguments from agrammatism to linguistics have already been put forth in the past (cf. Grodzinsky, 1990; Grodzinsky, Wexler, Chien, Marakovitz & Solomon, 1993). We will focus on the inflectional domain, and show that the agrammatic selective breakdown pattern follows the exact same line that the theory sketches between subparts of inflection: tense and agreement. Thus, we will present corroborating evidence to the theory, by showing how natural classes within it behave differentially in aphasia. In addition, we will show that the impairment in tense node has implications upon higher nodes in the syntactic tree.

We believe that these claims are relevant to anyone interested in psycholinguistic and neurolinguistic aspects of the theory of syntax. Moreover, they are of special interest to students of language acquisition, where somewhat parallel (yet very different)

Address correspondence to Na'ama Friedmann, department of psychology, Tel-Aviv University, Tel Aviv 69978, Israel. E-mail: naama1@freud.tau.ac.il.

developments have taken place, and in fact, inspired us in our investigation (cf. Rizzi, 1994).

This study is a detailed examination of the speech production abilities in agrammatic aphasic patients. Agrammatism is a language deficit following damage to Broca's area in the left cerebral hemisphere, (cf. Damasio, 1992; Zurif, 1995). It is usually viewed as an impairment to functional elements (or "grammatical morphemes" in common use). However, this description is far too crude, and as will become apparent below, a precise description of the fine patterns of impairment and sparing in this syndrome requires a lot of syntactic machinery. The standard view is that all functional elements are impaired in the production of such brain-damaged patients (cf., for instance, Goodglass, 1976; Grodzinsky, 1984; Kean, 1977, Ouhalla 1993). We show, however, that the pattern of selectivity is more refined than previously thought, and that distinctions provided by the split inflection hypothesis must be part of the proper description of the impairment pattern. We have, in short, documented a dissociation between tense and agreement: While tense is impaired, agreement is intact. Beyond the clinical implications that this finding has, it supports the split inflection hypothesis. This dissociation, we claim, is derived from an impaired phrase marker. Furthermore, the impairment is not restricted to tense inflection. There is a cluster of syntactic disruptions related to the T(ense) node: subject omissions, copula difficulties, and word order problems. By contrast, properties related to Agreement (and to the VP in general) are intact. Thus, a distinction between tense and agreement is neurologically demonstrated. This pattern of impairment is associated, furthermore, with problems in higher nodes of the tree, namely in the CP

2

layer: Wh-questions and embedded clauses are either nonexistent or ill formed in the speech production of patients suffering from this syndrome.

The major part of our data is based upon an extensive experimental study on the speech production abilities of a Hebrew speaking agrammatic aphasic. Special tests were devised to examine the split inflection hypothesis, and at the same time investigate the exact nature of the agrammatic impairment. We then sought, and found, additional empirical evidence supporting our claims in previously published cross-linguistic neuropsychological data, and in 12 more agrammatic patients: 10 Hebrew speakers, and 2 speakers of Palestinian Arabic.
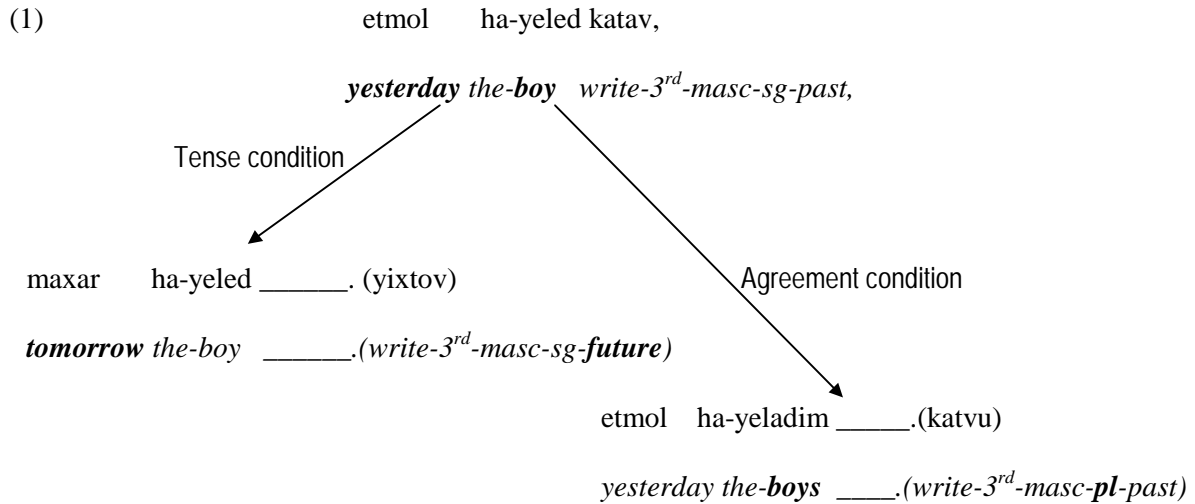
1. First step: deficit to tense but not agreement

In order to assess our patient's abilities, we began with a comparison between tense and agreement in her production of verbal inflection. Since data from spontaneous speech (which are commonly used in aphasia research) are not enough to pursue errors in detail, we used structured tasks[1].

Two tasks were employed: a "sentence repetition" task, in which the patient was asked to repeat the sentences she had heard (after counting to 3), and a "sentence completion" task, in which the patient was required to inflect a verb for either tense or one of the agreement features. The patient first heard a sentence containing an inflected verb, and then a second sentence without the verb, with a change in either the subject or

---

[1] Tense errors which are easily detected in structured tense tasks, may not be evident even in the spontaneous speech of the same patient, since patients can avoid using specific tenses or even avoid verb use. Furthermore, when patients do use tense, it is usually impossible to determine what the target tense was, hence it is impossible to detect tense substitutions.

the time adverb. The subject had to produce the missing verb with the proper inflection

(1).

(1)   etmol   ha-yeled katav,

                          yesterday *the-**boy*** *write-3rd-masc-sg-past,*

                    Tense condition

maxar   ha-yeled _____. (yixtov)

tomorrow *the-boy*   _____.*(write-3rd-masc-sg-**future**)*   Agreement condition

                                                    etmol   ha-yeladim _____.(katvu)

                                          *yesterday the-**boys** _____.(write-3rd-masc-**pl**-past)*

Each test consisted of a large number of token sentences, to allow for quantitative analysis. The tests consisted of simple sentences (3-5 words), which included verbs inflected for one of the 3 tenses and one of 10 agreement forms. In the completion test, sentences were devised to elicit each of the 30 forms. (See table 1 for an example of Hebrew inflectional paradigm). (For more details on the experiments, see Friedmann & Grodzinsky, 1997).

TABLE 1 Hebrew inflectional paradigm (In caps - the root KTV (=write))

		PAST	PRESENT	FUTURE
1st	singular	KaTaVti	KoTeV	EXToV
	Plural	KaTaVnu	KoTVim	NiXToV
2nd masc	singular	KaTaVta	KoTeV	TiXToV
	Plural	KaTaVtem	KoTVim	TiXTeVu
fem	singular	KaTaVt	KoTeVet	TiXTeVi
	Plural	KaTaVten	KoTVot	TiXToVna
3rd masc	singular	KaTaV	KoTeV	YiXToV
	Plural	KaTVu	KoTVim	YiXTeVu
fem	singular	KaTVa	KoTeVet	TiXToV
	Plural	KaTVu	KoTVot	TiXToVna

The results were remarkable: While agreement was normal, tense was severely impaired, even though the patient's perception of time, as well as comprehension of temporal adverbs, proved to be intact through tests[2]. There were mainly tense substitutions (with no preferred "unmarked" form), and some "don't know" responses in tense completion tasks, but almost no agreement errors. Table 2 summarizes the results, followed by typical substitution errors - in repetition (2), and in completion (3).

---

[2] An additional type of completion task was used, which did not include time adverbs ("The girls wanted to swim, so they jumped into the pool and _____." See Friedmann, 1998 for further details about the procedure). The results in this task were identical to the results in the described completion method which included time adverbs.

TABLE 2   Tense vs. Agreement production: patient RS.

	Tense		Agreement	
	% correct	(correct/total)	% correct	(correct/total)
Repetition	77%	(43/56)	100%	(56/56)
Completion	46%	(41/90)	93%	(66/71)
Total	58%	(84/146)	96%	(122/127)

(2) Target: ha-anašim **yixtevu**   mixtav la-bank

*The-people write-**future**-3-m-pl letter   to-the-bank*

Actual repetition: ha-anašim **katvu**   mixtav la-bank

*The-people   write-**past**-3-m-pl letter   to-the-bank*

(3) Target: axšav ata   holex,   etmol   ata   _____(expected: **halaxta**)

*Now   you go-pres-2-m-sg, Yesterday you _____ (go-**past**-2-m-sg)*

Actual completion: axšav ata holex,   etmol   ata **telex**

*Now   you go-pres-2-m-sg, yesterday you go-**future**-2-m-sg.*

A later study of 11 Hebrew speaking agrammatics and 2 Palestinian Arabic speaking agrammatics yielded the same results: impaired tense inflection (29% errors) with intact agreement (only 2% errors) (Table 3). (Friedmann, 1998).

TABLE 3 Tense vs. Agreement production in Hebrew and Arabic. (Friedmann, 1998)

		Tense		Agreement	
		% correct	(correct/total)	% correct	(correct/total)
Hebrew	Repetition	84%	(769/912)	100%	(908/912)
	Completion	58%	(438/760)	96%	(572/596)
Arabic	Completion	31%	(14/45)	91%	(42/46)
Total		71%	(1221/1717)	98%	(1522/1554)

A retrospective literature review indicates that cross-linguistic evidence goes in the same direction: Although very few studies have examined verbal inflection through structured tests, it seems that there is a group of patients (mostly Italian and French aphasics) impaired in tense but not agreement, yet the opposite (i.e., agreement impairment with intact tense) is never found.

For example, the French speaking agrammatic Mr. Clermont, reported in Nespoulous, Dordain, Perron, Jarema, & Chazal (1988, l990), had only tense errors but no verb agreement errors, avoided the use of complex tenses, omitted 50% of the copulas (7/14) and 50% of the auxiliaries (10/20). An example of his tense errors in reading aloud from Little Red Riding Hood is given in (4).

(4)<u>Target</u>: Bonjour, grand-mère, je vous **ai   apporté**   un panier de gâteaux

       Good morning, grandma,   I to-you have bring-pres-perf a bowl   of cake

<u>Read</u>: Bonjour, grand-mère, je **porterai** euh je /pu/ /zɛda/… a-apporté un-un panier de

gâteaux

carry-future

In Romance, the picture is more complicated, first of all, because structured tests of tense and agreement are not available and the only existing data is spontaneous speech[3], and secondly, because tense substitutions in Romance are mainly to the nonfinite forms: participles and infinitives.

In Germanic languages such as Dutch, German, and Icelandic, patients frequently use the infinitive instead of the inflected verb. Crucially, a non-finite form always appears in a sentence-final position, indicating that the verb has not moved up the tree to C, where tensed verbs in matrix clauses of V2 languages should move (Bastiaanse & van Zonneveld, 1998; Kolk & Heeschen, 1992).

These findings immediately suggest a deficit that implicates tense but not agreement features. This, in itself, is new, for agrammatic aphasia has always been thought to implicate all functional elements equally, and the striking difference we observe appears to have been overlooked.

Before making a syntactic claim that T node is impaired and Agr node (or the node where agreement is checked) is intact, other imaginable accounts, such as a lexical account, should be considered. The syntactic and lexical approaches are contrasted clearly: A Split-inflection based approach would claim that the phrase marker is impaired in the T node. A lexical (or morphological) approach, on the other hand, would somehow attribute the problem to the lexical representation of tense features.

---

[3] One structured test of participial agreement is available in Italian. De Bleser & Luzzatti (1994) examined the two agrammatics, and found intact participle agreement completion. Unfortunately, subject agreement was not tested in this study.

Even without fully elaborating upon these alternatives, we can easily see that each has different empirical consequences. What data can be used to decide between the accounts?

A deficit in the T node predicts that all of its other functions will be implicated as well, and does not predict any problem at the single-word level. A lexical account contains the opposite predictions: no impairment in other functions of T node, and a problem with inflections of verbs, whether isolated or embedded in sentences. Furthermore, the observed deficit to higher nodes of the syntactic tree (specifically to CP) can be explained only in a syntactic framework.

Thus, in order to decide between lexical and syntactic accounts, we had to test three levels: single word production, other functions of T, and the CP.

First, we tested production in single word level. The subject repeated verbs and copulas presented outside sentence context: as single items and as quadruplets of items. The results (40/43 correct) indicated the preserved ability at the single-word level.

We were thus led to the next experimental step in which we looked for deficits in other syntactic functions of the T node.

2. Second step: deficits related to the T node

Three functions of T were examined:

1. Copula production

2. The relative ordering of negation and copula

3. Subject pronoun production

2.1. Copular errors

If the Hebrew copula is at T prior to Spell-Out (whether moved, or base-generated there) then impairment to the T node will affect it as well[4]. We thus used the same experimental paradigm, asking our patient to repeat or complete sentences that required her to inflect copulas (for tense and agreement). (5)

(5) Copula completion tasks:

a. Tense completion:

Ha-šana galia hi   xavert-i   ha-tova be-yoter.

The-year Galia cop-pres friend-my the-best .

Gam ba-šana   ha-ba'aa galia _____ xavert-i   ha-tova be-yoter.

Also in-the-year the-next Galia _____ friend-my the-best.

'This year Galia <u>is</u> my best friend. Also **Next year** Galia _____ my best friend.'

b. Agreement completion:

Etmol   hu haya   acuv. Etmol   Gam hi _____ acuva.

Yesterday he cop-past-3rd-sg-mas sad. Yesterday also she _____ sad-fem.

'Yesterday **he** was sad. Yesterday **she** _____ sad too.'[5]

---

[4] Under the previous theoretical framework, copula in Hebrew is held to be located under INFL (Rothstein, 1995; Rapoport, 1987; and Borer, 1995 for "a functional node outside VP"). Based on its semantic function, we suggest that the exact node in INFL in which copula resides is the T node.

[5] In present tense sentences we used only sentences in which present tense copula is obligatory (identity and generic sentences).

In Hebrew, copula inflects like the main verb, for 3 tenses, 10 agreement forms in the past and future, and 4 forms in the present (the participle).

The results show that the ability to inflect copulas for tense was seriously impaired, as predicted by the syntactic account. The patient made many tense substitutions and copula omission errors in repetition and completion tasks, but no agreement error[6]. The results are shown in table 4, and a typical error in (6):

TABLE 4 Copula inflection production in Hebrew.

	Tense		Agreement	
	%correct	(correct/total)	%correct	(correct/total)
Repetition	50%	(30/60)	100%	(60/60)
Completion	20%	(9/46)	100%	(36/36)
Total	37%	(39/106)	100%	(96/96)

(6)   Maxar   dani   haya ba-yam

   Tomorrow Danny was in-the-sea

Again, a review of the literature shows a consistent impairment in copula production in many other languages (Dutch, Swedish, French, Finnish, and Japanese, among others – in the spontaneous speech corpora in Menn & Obler, 1990). In all of these languages,

---

[6] Existing theories for the Hebrew present tense copula describe it as a different entity from the past and future copulas ("pron" in Doron 1983, 1986; Shlonsky 1995). The fact that RS made errors in repetition and completion which were substitution of past and future copula for the present copula and vice versa, might indicate that this claim needs reconsideration.

agrammatics omit the copula 36%-60% of the obligatory contexts, and substitute the copula's tense.

2.2 Copula-Negation order

Aspects of word order in which T plays a role should also be informative for the functioning of T. We therefore looked at the relative placement of negation and copula.

In Hebrew, the relative order of copula and negation depends on tense: past and future tense copulas follow negation (7a), while present tense copulas precede their negation (7b) (unlike in regular verbs where negation always precedes the verb, regardless of tense).

(7) a. David <u>lo</u>   <u>haya/yihye</u> melex   anglia

        David neg was/will-be king-of England

    b. David <u>hu</u> <u>lo</u>   melex   anglia

        David is neg king-of England

The content of T thus plays a critical role in the determination of the relative ordering of negation and copula. If T is impaired in agrammatic aphasia, negation and copula will not be ordered properly. We devised two varieties of "sentence anagram" ordering tasks: The first required the patient to create a sentence from 4 cards: a negation card, a copula card, and two with other sentence parts ((8)a); in a second task the patient was asked to insert a card with a copula into a given sentence containing negation ((8)b), or to insert negation into a sentence containing a copula ((8)c), (for instance: insert "*not*" into "*Dan is happy*").

12

(8) a) David hu lo melex anglia .

b) David lo melex anglia hu

c) David hu melex anglia lo

The patient failed to come up with the correct relative ordering of copula and negation. Instead, she came up with an almost random order of negation and copulas: she performed correctly only on 24% of the sentences (18 out of 76 sentences). Her errors were of three main types: placing negation in front of the whole sentence, using constituent negation instead of sentential negation such as (9), and sometimes just giving up, holding the negation card helplessly in her hand.

(9) *David haya lo melex anglia

David copula-past neg king-of England

A parallel test of verb-negation ordering was carried out, yielding a 4% error rate. Again, this contrast does not mean that NegP is intact: recall that Hebrew systematically shows Neg-Vmain order, irrespective of tense. Negation of main verbs in Hebrew appears in the same position whether or not the verb rises to T. The patients can thus negate the whole VP correctly even without knowing its precise position, and without being aware of the verbal tense.

2.3. Subject omissions

Next, we looked at the subject position, which depends on T for several functions. For instance, if T checks (or assigns) Nominative case (Chomsky 1993), then an impaired T node would have implications upon the subject position: Nominative case cannot be checked, (or assigned), and hence the subject cannot be realized, even in mandatory contexts (Hebrew is only partially null-subject).

In spontaneous speech, subjects were frequently omitted. We therefore conducted a sentence repetition test, and found that subject pronouns were missing in contexts where pro-drop is illicit[7], whereas object pronouns were never omitted[8] (Table 5).

TABLE 5 Pronoun production in repetition.

	%correct	produced/total
Subject – transitive sentence	36%	(5/14)
Subject – intransitive sentence	94%	(14/15)
Object	100%	(6/6)

This evidence is indirect, but it is hard to find direct evidence for lack of Nominative case, since Hebrew does not show Nominative case overtly. The fact that subjects, whenever they appear, do not carry a wrong case, might stem from a similar reason to the one suggested by Friedemann (1993/4) for language acquisition: the agrammatics may use

---

[7] Subjects in the repetition sentences were in third person, where pro-drop is illicit in Hebrew.
[8] An unresolved question remains, as to why the asymmetry is apparent with pronouns, but not with lexical NPs. This problem is similar to that encountered in child language.

subjects as topicalized elements, and assign them a default case, (which in Hebrew is Nominative case).

A relation between verb inflection errors and subject pronoun omission has also been observed for children acquiring language (Pierce, 1989), but the case of agrammatism differs in an important respect: in agrammatism, subject omissions co-occur with tense *substitutions*, not only with use of non-finite forms in matrix clauses.

Summarizing our findings so far, several seemingly separate impairments all follow from a single assumption - a T node deficit.

(10) a. Tense, but not agreement errors in main verbs

b. Tense, but not agreement errors in copular constructions

c. Copula omissions

d. Errors in negation of copular constructions

e. Subject pronoun omissions (in mandatory contexts)

This cluster of phenomena indicates that not only tense inflection, but also other functions of T are impaired. They support a syntactic theory of impaired T node. No other hypothesis we are aware of can account for these findings. Crucially, the theory of split inflection - the distinction between T and Agr, and the assignment of other functions to T (Nominative case, and a landing site for copulas), receives a powerful neurological support.

(11) Generalization: T is impaired in agrammatic production.

The structural generalization in (11) has the desired consequences: errors in tense follow immediately, for both main verbs and copulas; subject omissions follow from lack of Case features, necessary for Nominative case assignment to the subject, or from lack of landing site for the subject in spec TP; finally, problems of negation placement would result from the fact that the tense features of copulas cannot reside in T, and since the relative position of negation and copula crucially depends on these features (cf. (7) above). As for the omission of copulas, we adopted an idea of Guasti (1993). She claims that causatives in Romance do not allow for auxiliaries because they do not contain TP. Since AUX must move to T or otherwise violate Full Interpretation, they are prohibited in structures that do not contain T (see also Rizzi 1994 for a similar point concerning auxiliaries in root infinitives). This account explains why auxiliaries and copulas are omitted or poorly used in the agrammatic sentence: Since agrammatic trees contain a defective TP, or do not contain TP at all, auxiliaries and copulas are impossible to check. This results in either violating FI or avoiding the auxiliary/copula in the first place. In terms of sentence production, the first might look like tense substitution, and the second like auxiliary or copula omission.

Thus, the functional impairment subsequent to anterior lesions in the left cerebral hemisphere, or more precisely, damage to Broca's area and its vicinity, is an impaired T node[9].

---

[9] Cf. Friedmann & Grodzinsky (1997), for further elaboration, and for the definition of degrees of severity within agrammatic Broca's aphasia.

3. Climbing higher in the tree: deficits in the CP

So far, we have been looking at a cluster of syntactic properties that are directly related to the T node, and saw that they are all impaired in agrammatism. We have proposed that T is impaired, and that this deficit is at the heart of the agrammatic impairment in speech production. What would happen to higher parts of the tree, given the crucial role of heads in projecting phrasal nodes? If a fully specified head is critical for phrasal projection, then the construction of nodes higher than T may be hampered, with the result of pruned trees. (Rizzi, 1994 and this volume; Rizzi & Friedemann, this volume). This would have rather radical empirical consequences: it would mean that nodes above TP do not exist in agrammatic representation. Note that we assume here Pollock's original order TP-Agr$_S$P, which was also advocated for Arabic by Ouhalla (1994).

To test this possibility we looked at the corpus of spontaneous speech we have collected from the patient and assessed tests, in search of evidence of higher projections - elements of CP. The results were clear-cut: both complementizers and Wh-questions were severely impaired.

3.1 question production

Out of 440 sentences in the corpus of spontaneous speech of our patient (obtained in the large part from free conversation between the experimenter and the patient), only 3

17

were Wh-questions, of the type: Wh NP (*where the-pin[10]*) (which are grammatical in Hebrew).

In contrast to Wh-questions, the patient produced 11 (matrix) well-formed yes/no questions, some of them instead of properly formed Wh-questions. Since word order in yes/no questions in Hebrew is identical to declarative sentences, and does not require movement of a constituent to CP, this type of question is available to the patient.[11] Moreover, this finding proves that the agrammatic problem in question production is not a general problem with questions, but rather a problem that stems directly from the CP impairment.

An attempt to elicit Wh and yes/no questions led to similar results: out of 20 WH questions <u>no</u> trial was successful. In repetition tasks, the patient repeated only 2/23 Wh questions correctly.

Friedmann (1998) conducted a more extensive study with 8 additional patients: 7 Hebrew speaking and 1 Palestinian Arabic speaking agrammatics. This study also presented a marked dissociation between production of Wh questions and yes/no questions. (Arabic yes/no question do not require the CP as well.)

While the patients succeeded in 90% of the yes/no questions, they only produced 24% of the Wh questions correctly (Table 6).

---

[10] Interestingly, these are questions without a finite T.
[11] The fact that agrammatic patients succeed in producing yes/no questions might indicate that "force" (Rizzi, 1997) does not necessarily reside in C, since although they lack the C node, sentence force is still available to them.

TABLE 6 Question elicitation: Wh- and yes/no questions in Hebrew and Arabic.

	Wh		Yes/No	
	% correct	(correct/total)	% correct	(correct/total)
Hebrew	25%	(45/182)	95%	(100/105)
Arabic	21%	(5/ 24)	65%	(15/ 23)
Total	24%	(50/206)	90%	(115/128)

The main error types in Wh-question production according to frequency of occurrence were:

1. Producing yes/no question instead of a Wh-question, (12)

2. "Don't know" responses,

3. Wrong Wh morpheme selection,

4. Unmoved Wh morpheme in the beginning of the sentence, with filled gap, (13)

5. Wh-in situ.

(12) Experimenter: The sun rose today at a certain hour. You want to know about the hour. So you ask...

Patient: bešeš…ha-šemeš zarxa… ha-šemeš ha-yom… lo yoda'at. Ha-šemeš zarxa ha-yom?

At-six… the-sun rose…   the-sun today… (I) NEG know. The-sun rose today?

(13) a. Patient: **Ma** Dani hidlik **et ha-or**

    What *Danny lit **ACC the-light***

  b. Patient: **Eix** Dani noheg **bi-zhirut**

    How *Danny drives **carefully***

This problem in question production has been found in English as well (Treatment studies in Thompson & Shapiro, 1995; Thompson, Shapiro, Jacobs & Schneider, 1996). Here, again, language specific properties correlate with performance. Thus, unlike in Hebrew, English speaking patients require intact C node for the auxiliary "do" in do support constructions, and therefore need an intact CP for yes/no question production.

The literature on the subject indicates that English speaking agrammatics are indeed unable to produce yes/no questions. The patient reported in Goodglass, Gleason, Bernholz & Hide (1972) produced 0/14 yes/no questions in elicitation tasks.

This corroborates the claim that agrammatics do not have a general question production deficit, but rather a syntactically well-defined deficit, stemming from inaccessibility of CP.

3.2 Embedded sentence production

We proceeded to test another function of the CP layer: embedding. Our first step was to look at spontaneous speech, which can give qualitative, though not quantitative, information about the ability to embed. We found no evidence of such ability. To avoid the need for embedded constructions, the patient either omitted most of the embedded sentence (14), or omitted complementizers (15), or avoided such structures altogether in spontaneous speech.

(14)   dorit ba'aa...etmol...   tilpena la-rofe   **še**......tor.

    *Dorit came...yesterday...called to-the-Doctor **that**...appointment.*

(15)   siparti la.......nir   xayal

    Told-I   her.....Nir (is a) soldier

Since it is difficult to determine the target sentence in spontaneous speech, structured tasks were assessed. Repetition results have shown the same pattern: repetition of sentences with embedding was only 4/23 successful.

A study with 7 additional agrammatics (5 speakers of Hebrew and 2 speakers of Palestinian Arabic), compared elicited production of embedded sentences (subject relatives, (16)) with similar non-embedded sentences (adjectival modification, (17)). This study yielded the same results, summarized in Table 7: Embedding production proved to be severely impaired. (Friedmann, 1998)

(16) zo ha-iša   še-mesaxeket tenis

    This the-woman that-plays   tennis

    'This is the woman who plays tennis'

(17) ze ha-dag ha-kaxol

    This the-fish the-blue

    'This is the blue fish'

TABLE 7 Elicitation of embedded and non embedded sentences.

	Relative clause		Adjectival modification	
	% correct	(correct/total)	% correct	(correct/total)
Hebrew	21%	(44/207)	100%	(76/76)
Arabic	28%	(10/36)	92%	(22/24)
Total	22%	(54/243)	98%	(98/100)

The two most frequent error types in embedding repetition and elicitation were complementizer omission and getting "stuck" after the complementizer without being able to complete the sentence.

Severe impairment in CP embedding production has been documented for other languages as well (cf. de Roo, 1995 for Dutch; Hagiwara, 1995 for Japanese). The pattern of errors is very similar to the ones reported for Hebrew, mainly complementizer omission and omission of most of the embedded sentence.

The following examples demonstrate agrammatic embedding difficulties in repetition in Palestinian Arabic (18), and in spontaneous speech in Finnish (19) and Japanese (20).

(18) <u>Palestinian Arabic- repetition:</u>

Target: rula šaafat il-film   **illi** ṣubḥi xaḍḍaro

    *Rula saw   the-film **that** Subhi made-ACC*

Repeated: rula šaafat il-film … xallas! …   rula šaafat il-film ……ṣubḥi xaḍḍaro

      Rula saw   the-film…enough! … Rula saw the-film ……Subhi made-ACC

                       (Friedmann, 1998)

(19) <u>Finnish</u>

Vahtimestari toteaa-kin   **että**... **että** ...voi veljet kun... vahtimestary huomaa sitten

*Watchman even-remarks   **that**... **that**... oh, brother, how... watchman   notices then*

että... toteaa   **että**... vahtimestari huomaa...voi... tapauksen

***that**... remarks   **that**...watchman notices ... oh...incident:GEN*

               (Niemi, Laine, Hänninen, & Koivuselkä-Sallinen, l990)

(20) Japanese

"Hippat-te kudasai" [**to**]   atasi [ga] ii-mas-u

*"Please pull (me)" [comp] I say   (*Sasanuma, Kamio, & Kubota, l990)

The results show a severe embedding deficit. Can it be only a general deficit in the construction of complex sentences as some aphasiologists claimed, and not a selective deficit to parts of the tree, as claimed here? A type of complex sentence that is preserved and does not involve C may help to decide between these approaches.

When testing different types of embeddings, Friedmann (1998) found that only CP embedding is problematic for the Hebrew speaking agrammatics: untensed clausal complements (infinitival and participial complements) exist in agrammatic spontaneous speech, and were elicited and repeated normally.

Other languages behave in a similar manner with respect to embeddings. The French speaking Mr. Clermont, for example, (Nespoulous et al., 1990) produced only 2 relative clauses and <u>no</u> other CP embeddings compared to 33 and 49 respectively produced by his control subject. On the other hand, his untensed clause embedding proved to be completely normal.

In the untensed embedded constructions patients probably produce a partial tree that does not contain CP, (which is required in these construction according to standard analysis).

These findings indicate that the embedding impairment is not a general deficit in complex sentence production, but rather a problem with accessing CP, that leaves other embedding constructions intact.

23

To conclude, data from spontaneous speech and structured tasks in Hebrew and Arabic, as well as a retrospective review of spontaneous speech data from other languages, show a clear deficit in embedding of clauses headed by C in agrammatic aphasia. This, we suggest, follows from the inaccessibility of the C node in agrammatic production.

Discussion

(21) **Summary of the findings:**

    a) **AgrP level**:   Intact agreement inflection.

    b) **TP level**:   Impaired tense inflection.

                            Copula omissions.

                            Subject pronoun omissions.

                            Ordering errors of copulas and negation.

    c) **CP level**:   No Wh-question production.

                            No CP embedding.

In sum, we have found that nodes higher than TP (namely CP) are also severely impaired in agrammatism. This impairment follows from the principle of an impaired head blocking further construction of higher phrasal nodes. This principle, together with the tense node impairment, constitutes the grammatical deficit in agrammatic Broca's aphasia.

(22) **The Tree Pruning Hypothesis:**

    a) T is impaired in agrammatic production.

    b) An impaired node cannot project any higher.

Having seen that the data fall under a structural generalization, it is now time to examine the generalization in greater detail. In what sense are the T node and its functions impaired? Whatever representational deficit we assume, it must have the consequences in (21). This can be achieved in two possible ways: through a deficit in T node, or through a deficit to checking mechanisms. According to the former, the content of T, namely, the φ-features of the lexical head it dominates, is eliminated; moreover, the T node may not be projected at all. A deficit to checking mechanisms derives the data similarly, yet a question immediately arises: given that mechanisms of checking operate in an identical fashion everywhere, why is the failure in checking restricted to T? The answer, then, must lie in T itself, leading us to conclude that this node is impaired, and that this is the deficit in the syntactic representation of agrammatic speech production.[12]

Another possibility that should be considered is that it is not the T node which is defective, causing deficit in C also, but rather only the C node. The work by Stowell (1982), Enç (1987), and Guéron & Hoekstra (1989) suggests that tense is anchored in C. Is it possible to assume a C impairment only, that hampers tense anchoring and thus tense inflection, and dispense with an impairment in T? The answer is probably <u>no</u>, since

pruning at C will not be able to explain subject omissions, and T deficit will have to be assumed anyway.[13]

Implications for the relative order of functional categories

The intactness of subject-verb agreement in the presence of poor tense bears on one of the central issues in clausal architecture: the relative order of functional categories, and in particular, the relative order of Agr_s and T.

If we adopt the truncation constraint, then no node above the impaired TP can project. (see Grimshaw, 1991, for a similar account at least in the IP, and Rizzi, 1994 and this volume, for the root infinitive stage). Based on this theoretical stand, a poor T node and a well projected Agr above it are out of the question. Taking these together, our claim has the consequence that subject-verb agreement is checked below T, hence it remains intact in agrammatism. For Hebrew and Arabic, at least, this is not an unreasonable assumption.

---

[12] We remain agnostic as to whether the deficit is in representation or in processing. We are not aware of a way to decide empirically between the two (especially in the absence of a well-articulated syntactic theory of on-line sentence production). But one point is crucial: if it is a processing deficit, this deficit <u>must</u> follow very strict syntactic constrains.

[13] Another fact which rules out an account of C pruning for tense errors is the existence of a group of less severe agrammatics who show intact tense and copula inflections with impaired embedding and Wh question formation. This can only be accounted for by describing the tree of this group of mild agrammatics as pruned at C, the tree of the more severe patients as pruned at T. (Friedmann, 1998)

An account of these finding is consistent with two approaches:

1. Agreement and tense are both checked in spec-head relation in designated nodes - tense is checked in T node, and subject-verb agreement in Agr node. Under this assumption, in the normal Hebrew and Arabic phrase markers, the relative order of functional categories is CP>TP>Agr$_s$P.

This is actually the order proposed by Pollock (1989, 1993) for English and French, and by Demirdache (1988) and Ouhalla (1994) for Arabic. It is, nevertheless, the opposite of the relative order suggest by Chomsky (1991, 1993), and Belletti (1990) for Romance.

2. Agreement is checked in a mechanism different from that for tense. It may not have a node of itself, but it checks in one of the other checking points below T, and is thus preserved. So, if the phrase marker is pruned above VP, and agreement is checked in VP spec-head, this is the expected result: VP and subject-verb agreement are intact, but tense inflection is impaired (and so are Wh-structures and subordinations). [14]

Our findings also refute an accepted view in neurolinguistics: Some researchers explain inflectional marker omissions and substitutions by way of a general tendency of ignoring items of low semantic value. This study shows that this can not be the reason for inflectional impairment: It is widely agreed that while agreement does not have semantic content, tense does. If only low-semantic-value items are neglected, we would expect agreement to be impaired, and tense to be preserved. Yet the empirical data point in the opposite direction.

---

[14] This possibility is reminiscent of Chomsky's (1995) proposal, where he dispenses with Agr nodes, but there he suggests that Agr Subj is checked in TP, which does not conform with the data presented here.

To conclude, in aphasia research, very much like in language acquisition (Radford, 1990), researchers have claimed that agrammatics lack all functional categories (Ouhalla, 1993; Caplan, 1985). Like current studies in language acquisition (Hyams, 1992, and Poeppel & Wexler, 1993 for full phrase marker; Clahsen, 1990 for partial phrase marker), we show that agrammatics do have at least some of the functional categories. We claim that the agrammatic phrase marker is pruned in T and above: it contains an Agr node, but does not include the higher nodes: TP and CP.

In verb inflection production, the resemblance between children and agrammatics is only apparent: indeed both children and agrammatics produce main verbs which are not correctly inflected. But while agrammatics substitute tense inflection, children never substitute inflection, they only use the nonfinite forms (Wexler 1994; Borer & Rohrbacher, to appear).

When children use non-finite verbs in matrix clauses, these clauses usually do not contain negation (Friedemann, 1993/4), Wh questions and complementizers (Clahsen, Penke & Parody, 1994; Weissenborn 1992) subject pronouns (Pierce, 1989; Friedemann, 1993/4) or auxiliaries (Guasti, 1993/1994; Poeppel & Wexler, 1993). But the crucial difference between children and agrammatics lies exactly here: Children are able to build these constructions and use these elements (Rizzi, 1994), and agrammatics cannot project any higher than T.

When children do have an additional motivation to build the whole tree up to CP, they do it, and use a finite verb. (Crisma, 1992). These constructions that children consistently use with finite verbs are exactly the ones which are impaired in agrammatic production: Wh questions, auxiliaries and copulas, and pronoun subjects.

While speech production in language acquisition and agrammatism is similar in many respects, the underlying cause is very different: while agrammatics cannot construct the tree up to T and higher, children do not always find it necessary.

References

Bastiaanse, R. and van Zonneveld, R. 1998. On the relation between verb inflection and verb position in Dutch agrammatic aphasics. *Brain and Language,* 64, 165-181.

Belletti, A. 1990. *Generalized Verb movement: aspects of verb syntax.* Rosenberg & Sellier. Torino, Italy.

Borer, H. 1995. The ups and downs of Hebrew verb movement. *Natural language and linguistic theory*, **13,** 527-606**.**

Borer, H. & Rohrbacher, B. To appear. Features and projections: arguments for the full competence hypothesis. Proceedings of the 21st annual Boston University conference on language development.

Caplan, D. 1985. Syntactic and semantic structures in agrammatism. In M.-L Kean, (Ed.), Agrammatism. New York: Academic Press.

Chomsky, N. 1991. Some notes on economy of derivation and representation. In Freidin, R. (Ed.) *principles and parameters in comparative grammar: Current Studies in Linguistics Series, 20,* 417-454. Cambridge: MIT press.

Chomsky, N. 1993. A minimalist program for linguistic theory. In *The view from Building 20*, K. Hale & J. Keyser (Eds.) MIT, Cambridge, Mass. 1-52.

Chomsky, N. 1995. *The Minimalist Program.* The MIT press, Cambridge, Mass.

Clahsen, H. 1990. Constraints on parameter setting: A grammatical analysis of some acquisition stages in German child language. *Language Acquisition*, 1, 361-391.

Clahsen, H., Penke, M., & Parody, P. 1994. Functional categories in early child German. *Language Acquisition*, **3**, 395-429.

Crisma, P. 1992. On the acquisition of Wh-questions in French. *Geneva Generative Papers* 1-2, 115-122.

Damasio, A. R. 1992. Aphasia. *New England Journal Of Medicine,* **326,** 531-539.

De Bleser, R., & Luzzatti, C. 1994. Morphological processing in Italian agrammatic speakers syntactic implementation of inflectional morphology. *Brain and Language,* **46**, 21-40

de Roo, E. 1995. Articles and finite verb inflections in Dutch agrammatism. Poster presented at RuG-SAN-VKL conference on aphasiology, Groningen.

Demirdache, H. 1988. *Nominative NPs in Modern Standard Arabic.* Unpublished ms.

Doron, I. 1983. Verbless predicates in Hebrew. PhD. Dissertation. University of Texas at Austin.

Doron, I. 1986. The pronominal copula as agreement clitic. In *The syntax of pronominal clitics.* H. Borer (ed.) 313-332. Syntax and semantics, 19. New York: Academic press.

Enç, M. 1987. Anchoring conditions for tense. *Linguistic Inquiry*, **18,** 633-657.

Friedemann, M. A. 1993/4. The underlying position of external arguments in French. *Language Acquisition*, **3**, 209-255.

Friedmann, N. 1998. *Functional categories in agrammatic production*. PhD Thesis. Tel-Aviv University.

Friedmann, N., & Grodzinsky, Y. 1997. Tense and Agreement in agrammatic production: pruning the syntactic tree. *Brain and Language,* **56**, 397-425.

Goodglass, H. 1976. Agrammatism. in H. Whitaker & H. A. Whitaker (Eds.) *studies in neurolinguistics (1).* New York: Academic press.

Goodglass, H., Gleason, J. B., Bernholtz, N. A., & Hyde, M. R. 1972. Some linguistic structures in the speech of Broca's aphasic. *Cortex,* **8**, 191-212..

Grimshaw, J. 1991. *Extended Projection.* Ms. Brandeis.

Grodzinsky, Y. 1984. The syntactic characterization of agrammatism. *Cognition,* **16**, 99-120.

Grodzinsky, Y. l990. Theoretical Perspectives on Language Deficits. Cambridge, MIT Press.

Grodzinsky, Y., Wexler, K., Chien, Y. C., Marakovitz, S. & Solomon, J. 1993. The breakdown of binding relations. *Brain and Language*, **45**, 396-422.

Guasti, M.-T. 1993. *Causatives and perception verbs.* Rosenberg and Sellier: Turin.

Guasti, M. T. 1993/1994. Verb syntax in Italian child grammar: finite and nonfinite verbs. *Language Acquisition*, **3**, 1-40.

Guéron, J. & Hoekstra, T. 1989. T-chains and the constituent structure of auxiliaries, in A Cardinaletti, G. Cinque, & G. Giusti (eds.), *Constituent structure*, Foris Dordrecht.

Hagiwara, H. 1995. The breakdown of functional categories and the economy of derivation. *Brain and Language.* **50,** 92-116.

Hyams, N. 1992. The genesis of clausal structure. In J. M. Meisel ed. *The acquisition of verb placement,* 371-400. The Netherlands: Kluwer

Kean, M. L. 1977. The linguistic interpretation of aphasic syndromes. *Cognition***, 5**, 9-46.

Kolk, H., & Heeschen, C. 1992. Agrammatism, paragrammatism and the management of language. *Language and cognitive processes,* **7***,* 89-129.

Menn, L., & Obler, L. (Eds.). 1990. *Agrammatic aphasia: A cross-language narrative sourcebook.* Philadelphia, John Benjamin's Publishing Company.

Nespoulous, J.-L., Dordain, M., Perron, C., Ska, B., Bub, D., Caplan, D., Mehler J. & Lecours, A. R. 1988. Agrammatism in sentence production without comprehension deficits: reduced availability of syntactic structures and/or of grammatical morphemes? A case study. *Brain and Language,* **33,** 273-295.

Nespoulous, J.-L., Dordain, M., Perron, C., Jarema, G. & Chazal, M. 1990. Agrammatism in French: Two case studies. In L. Menn & L. Obler (Eds.), *Agrammatic aphasia: A cross-language narrative sourcebook.* Philadelphia, John Benjamin's Publishing Company.

Niemi, J., Laine, M., Hänninen, R., & Koivuselkä-Sallinen, P. l990. Agrammatism in Finnish: Two case studies. In L. Menn & L. Obler (Eds.), *Agrammatic aphasia: A cross-language narrative sourcebook.* Philadelphia, John Benjamin's Publishing Company.

Ouhalla, J. 1993. Functional categories, agrammatism & language acquisition. *Linguistische Berichte*, **143**, 3-36.

Ouhalla, J. 1994. Verb movement and word order in Arabic. In N. Hornstein and D. Lightfoot (Eds.) *Verb movement.* Cambridge University Press.

Pierce, A. 1989. *On the emergence of syntax: A cross-linguistic study*. Doctoral dissertation. Cambridge: MIT.

Poeppel, D., & Wexler, K. 1993. The full competence hypothesis. *Language*, **69**, 1-33.

Pollock, J. Y. l989. Verb movement, universal grammar and the structure of IP. *Linguistic Inquiry*, **20**, 365-424.

Pollock, J. Y. 1993. *Notes on clause structure*. Amiens: Universite de Picardie: ms.

Radford, A. 1990. *Syntactic theory and the acquisition of English syntax: the nature of early child grammars of English*. Basil Blackwell, Oxford.

Rapoport, T. R. 1987. Copular, Nominal and Small Clauses: A study of Israeli Hebrew. Ph.D. Dissertation. Cambridge: MIT.

Rizzi, L. 1994. Some notes on linguistic theory and language development: The case of Root Infinitives. *Language acquisition*, **3**, 371-393.

Rizzi, L. 1997. The fine structure of the left periphery. In Haegeman, L. (Ed.) *Elements of Grammar: Handbook in Generative Syntax (Kluwer International Handbooks of Linguistics, Vol. 1)*. Dordrecht: Kluwer.

Rothstein, S. 1995. Small Clauses and copular constructions. In Cardinaletti, A. and Guasti, M. T. (Eds.) *Syntax and semantics : Small Clauses, 28*.

Sasanuma, S. Kamio, A. and Kubota, M. l990. Agrammatism in Japanese: Two case studies. In L. Menn & L. Obler (Eds.), *Agrammatic aphasia: A cross-language narrative sourcebook*. Philadelphia, John Benjamin's Publishing Company.

Shlonsky, U. 1995. *Clause structure and word order in Hebrew*. ms. Universite de Geneve.

Stowell, T. 1982. The tense of infinitives. *Linguistic Inquiry*, **19,** 561-570.

Thompson, C. K., & Shapiro, L. P. 1995. Training sentence production in agrammatism: implications for normal and disordered language. *Brain and Language*, **50**, 201-224.

Thompson, C. K., Shapiro, L. P., Jacobs, B. J., & Schneider, S. L. 1996. Training Wh-question production in agrammatic aphasia: analysis of argument and adjunct movement. *Brain and Language*, **52**, 175-228.

Weissenborn, J. 1992. Null subjects in early grammars: implications for parameter setting theory. N J. Weissenborn, H. Goodluck & T. Roeper (eds.), *theoretical issues in Language Acquisition,* Lawrence Erlbaum. Hillsdale, NJ.

Wexler, K. 1994. *Optional infinitives, head movement and the economy of derivations*. In D. Lightfoot and N. Hornstein (eds.) Verb movement. Cambridge University Press.

Zurif, E. B. 1995. Language and the brain. In D. Osherson (ed.,): *Invitation to cognitive science, 2nd edition*. Cambridge, MA: MIT Press.