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Functional category production in English agrammatism

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Background: Individuals with agrammatism show selective deficits in functional categories. The tree-pruning hypothesis (TPH; Friedmann & Grodzinsky, 1997) suggests that this results from inability to project certain nodes in the syntactic tree. On this account, higher nodes in the tree are more vulnerable than lower ones. Other theories, however, suggest that functional category impairments can be explained in the context of a morphological deficit (e.g., Arabatzi & Edwards, 2002; Penke, 2003; Thompson, Fix, & Gitelman, 2002).
Aims: This study examined production of complementisers, tense, and agreement morphology in four English-speaking agrammatic participants to test the hierarchical nature of functional category deficits. The consistency of verb inflection errors was also tested under conditions examining a minimal set versus a full array of English inflected forms.
Materials & Procedures: In Experiment 1 participants were asked to produce sentences by using a complementiser (i.e., *whether*, *that*, and *if*), a tense (-*ed*), or agreement marker (-*s*), in structured sentence elicitation tasks. In Experiment 2 the participants' production of both finite and non-finite verb inflection forms was examined.
Outcome & Results: All participants produced complex sentences successfully using a complementiser, indicating intact projection to the Complementiser Phrase (CP). As for tense and agreement—structures within the Inflection Phrase (IP)—the agrammatic speakers were impaired in both categories and they showed higher scores in non-finite vs finite verb conditions. Further, their errors were dominated by substitutions, rather than omissions, with various non-target morphemes.
Conclusions: Our agrammatic participants' deficits are morphological, rather than syntactic. The participants were able to project to the uppermost structure, CP. They showed the ability to project verb inflection and to implement inflectional rules in their grammar. However, instantiation of grammatical markers sometimes failed to operate, resulting in incorrect inflectional forms. These findings suggest that within the domain of functional categories, IP- and CP-level deficits may result from disruption of differing underlying mechanisms and, therefore, they may require separate treatment strategies.

Keywords: Functional categories; Agrammatism; Selective impairment; Tree-pruning hypothesis.

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One of the hallmarks of agrammatic aphasia is impaired production of functional categories; that is, grammatical morphology. However, not all functional categories are equally impaired. For instance, dissociations between free and bound morphemes have been reported (e.g., Thompson et al., 2002), as have dissociations between tense and agreement morphemes (e.g., Friedmann & Grodzinsky, 1997). Understanding the nature and source of functional category deficits is important for guiding treatment, in that linguistically related, but not linguistically unrelated, structures often recover together when treatment is provided (Thompson, 2007).

Several theories have been advanced to account for the selective functional category deficits seen in agrammatism. One theory, the tree-pruning hypothesis (TPH), attributes these patterns to an inability to project to higher nodes in the syntactic tree (Friedmann, 2002; Friedmann & Grodzinsky, 1997). Following Pollock's (1989) split inflection hypothesis, each functional element heads its own category at a separate node in the syntactic tree and the hierarchical position of these nodes predicts agrammatic errors. Thus, within the Inflectional Phrase (IP), if the Agreement Phrase (AgrP) is impaired so too will be the Tense Phrase (TP), because TP is projected above AgrP. Further, if IP is impaired, the Complementiser Phrase (CP), the uppermost node in the tree, will also be impaired. Friedmann and Grodzinsky (1997) reported that, in repetition and sentence completion tasks, a Hebrew-speaking agrammatic patient showed preserved agreement but impaired use of tense. Similar data derived from other languages, including Spanish, Catalan, and English (Benedet, Christiansen, & Goodglass, 1998; Ferreiro, 2003) and Dutch (Kolk, 2000), support this dissociation. In addition, based on analysis of spontaneous speech data from Japanese, French, and Italian agrammatic speakers, Hagiwara (1995) found that structures in the CP were more impaired than those in the IP. Friedmann (2002) reported a similar pattern in 13 Hebrew and 2 Palestinian Arabic participants as well as one English-speaking agrammatic patient, all of whom presented with difficulty producing wh-question and yes/no question forms that are projected from the highest node in the syntactic tree (i.e., CP).

Other studies, however, have reported a different constellation of deficits in agrammatic speakers. Studies derived from Korean (Lee, 2003), Dutch (Bastiaanse & Thompson, 2003), German (Burchert, Swoboda-Moll, & De Bleser, 2005; Penke, 2001, 2003; Wenzlaff & Clahsen, 2005), English (Arabatzi & Edwards, 2002; Thompson et al., 2002), Greek (Nanousi, Masterson, Druks, & Atkinson, 2006), and other languages (Menn & Obler, 1990) have shown that error patterns do not appear to follow a hierarchy based on the syntactic tree. Arabatzi and Edwards (2002) described eight English agrammatic speakers who made more errors within the IP than the CP. The speakers omitted only 1.3% of wh-words, which are located in the specifier position of the CP, in the face of frequent omissions and substitutions of verb inflections in their production attempts. Similar data sets showing, e.g., preserved CP but impaired IP, were reported by Lee (2003), Thompson et al., (2002), Penke (2001, 2003), and Wenzlaff and Clashen (2005). Some studies also reported dissociations between TP and AgrP, which are not consistent with a syntactic, tree-pruning, account (Burchert et al., 2005; Nanousi et al., 2006).

Rather than a syntactic deficit, the aforementioned studies posited morphological accounts whereby either morphological features are underspecified or feature-checking mechanisms are impaired (Arabatzi & Edwards, 2002; Burchert et al., 2005; Wenzlaff & Clahsen, 2005), or post-syntactic morphological rule application is faulty (Thompson et al., 2002). The former is based on a lexicalist view (Chomsky, 1993), in which the verb is inserted into the structure fully inflected and its features are checked against Inflection (Infl.) to ensure compatibility during the derivation of S-structure. The other view, i.e., Distributed Morphology (DM; Halle & Marantz, 1993), includes another level of derivation, Morphological Structure (MS) that interfaces between S-structure and the phonological level. In this approach, the terminal elements of the tree consist of bundles of concatenated syntactic or inflectional features, instead of morphemes. After syntactic derivation is complete, MS computes these feature bundles, replacing them with actual morphemes. Thus, the morphological component operates separately from the syntax, but it takes the results of syntactic computations (hierarchical phrase structures and feature bundles) as input for its computations.

Regardless of which of these accounts is correct, it appears that some deficit patterns seen in agrammatism cannot be attributed to a syntactic-tree-based account. The uppermost node in the syntactic tree (i.e., CP) can be relatively unimpaired, while lower nodes (i.e., IP) are impaired in the participants' speech. One problem with research in this area is that different elicitation conditions have been utilised across studies and, in addition, not all inflected forms, relevant to a particular language, have been tested. Several researchers used spontaneous speech samples, whereas others used various elicitation tasks or both. For example, in Hagiwara (1995)'s findings were based on analysis of spontaneous speech data, whereas other researchers have used tasks ranging from repetition of words and sentences to sentence completion or picture description (e.g., Benedet et al., 1998; Ferreiro, 2003; Friedman & Grodzinsky, 1997; Kolk, 2000; Nanousi et al., 2006). Some studies have also used different methodologies to test various forms. For example, Friedmann (2001) used a sentence completion task to examine verb inflections and a sentence elicitation task to test CP structures (subordination clauses and wh-questions), although a repetition task was used for both verb inflections and CP structures. Further, Kolk (2000) examined only present and past tense inflections in Dutch without testing other finite and non-finite forms. Indeed, different elicitation conditions can lead to different performance patterns, and testing some, but not all, inflected forms in a particular language can lead to spurious results.

The purpose of this study was to examine agrammatic speakers' production of complementisers, as well as tense, and agreement markers, in sentence contexts. First we queried whether CP grammatical morphology is more impaired than IP-level morphemes, and whether or not, within the IP, there is a clear dissociation between tense and agreement as well as a hierarchical deficit pattern, with tense more impaired than agreement. Second, we examined whether tense and agreement deficits manifest similarly when tested using a minimal set of tense and agreement inflections versus when using a full array of English inflected forms. Two experiments were conducted. In the first experiment, production of complementisers (i.e., *if*, *whether*, and *that*) and verb inflections (i.e., -*s* and -*ed*) were examined. The second experiment elicited production of seven verb forms in order to better examine the participants' tense and agreement inflections.

PARTICIPANTS

Four individuals with mild-to-moderate agrammatic Broca's aphasia (all male, age range 35–64) participated in this study: FG, LC, KB, and SL. Except for FG, a Spanish–English bilingual speaker, all were monolingual speakers of English.

Although FG's first language was Spanish, he began using English as his primary language at the age of 4 and maintained greater competency in English post stroke. All suffered a left hemisphere stroke and had normal hearing and vision, without a history of language disorders or neurological disorders prior to their stroke.

The diagnosis of agrammatic Broca's aphasia was made based on the Western Aphasia Battery (Kertesz, 1982), the Northwestern Assessment of Verbs and Sentences (NAVS, Thompson, unpublished), and narrative speech samples derived by participants telling the Cinderella story. WAB aphasia quotients (AQs) ranged from 64.5 to 82.4. The NAVS results showed preserved verb comprehension, while verb production was compromised. At the sentence level, both comprehension and production were affected. Narrative samples, analysed following the coding procedure developed by Thompson and colleagues (1995), showed a reduced proportion of grammatical sentences, verb inflection errors, and other speech patterns consistent with agrammatism. Notably, three participants' verb inflection scores were relatively high (72–87% correct), due to overuse of non-finite and present progressive (*-ing*) forms, which are acceptable in the storytelling task utilised. The participants' demographic and language testing data are provided in Table 1.

EXPERIMENT 1

Stimuli

To examine production of complementisers, and tense and agreement markers, two sets of stimuli were developed. For complementiser production, four complement verbs (i.e., *care*, *ask*, *see*, and *wonder*) were selected for the matrix (main) clause and 10 regular transitive verbs (e.g., *call* and *pull*) were selected for use in the embedded clause (see Appendix for a list of selected transitive verbs). All were one- or two-syllable high-frequency verbs (CELEX; Baayen, Pieenbrock, van Rij, 1993). Only animate nouns were used, making all sentences semantically reversible (e.g., *The boy is pulling the girl.*). Picture stimuli depicting the action of each verb were developed for both the matrix clause and the embedded clause, and the target verbs were written on each. Each embedded action card was used twice, resulting in 20 items in total.

For the tense and agreement production task, the same 10 transitive verbs and pictures were used. Temporal adverbs, i.e., *yesterday* and *nowadays*, were used to elicit tense (i.e., V + *-ed*) and agreement (i.e., V + *-s*) inflection, respectively. Each verb was elicited twice for tense and agreement, resulting in 20 items for each inflected form. A group of healthy university students reliably produced target responses for all stimuli. Sample stimuli are presented in Figure 1.

Procedure

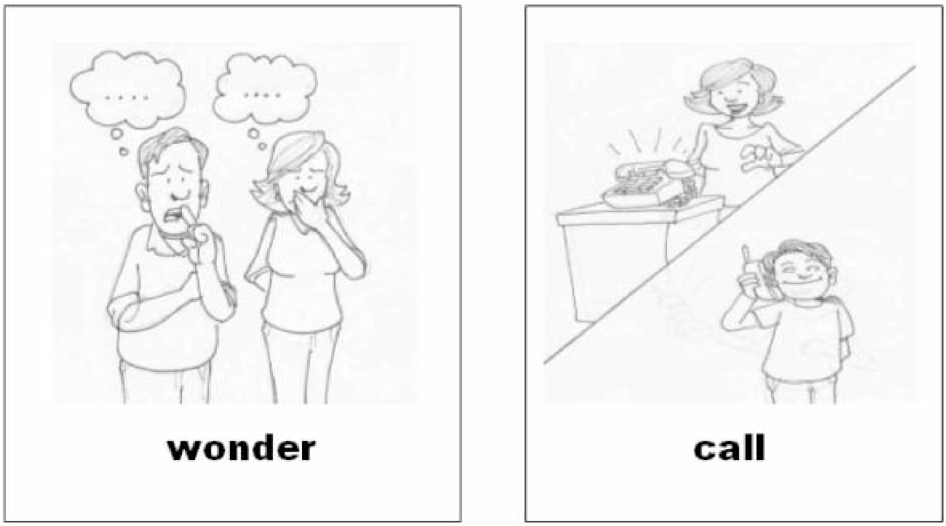
Prior to the experimental tasks the participants were familiarised with all verbs and adverbs to ensure that they could produce all bare stems of the verbs and understand the meaning of "nowadays" and "yesterday". A trained examiner presented each verb for the patient to name. Incorrect responses were corrected using phonological cues and modelling. Responses were considered correct if 75% of phonemes of a verb were produced correctly. For the temporal adverbs, using a calendar, the patient was asked to point to "today", "yesterday", and "nowadays". All participants attained 100% accuracy prior to the experiment.

TABLE 1
Patients' demographic and language testing data

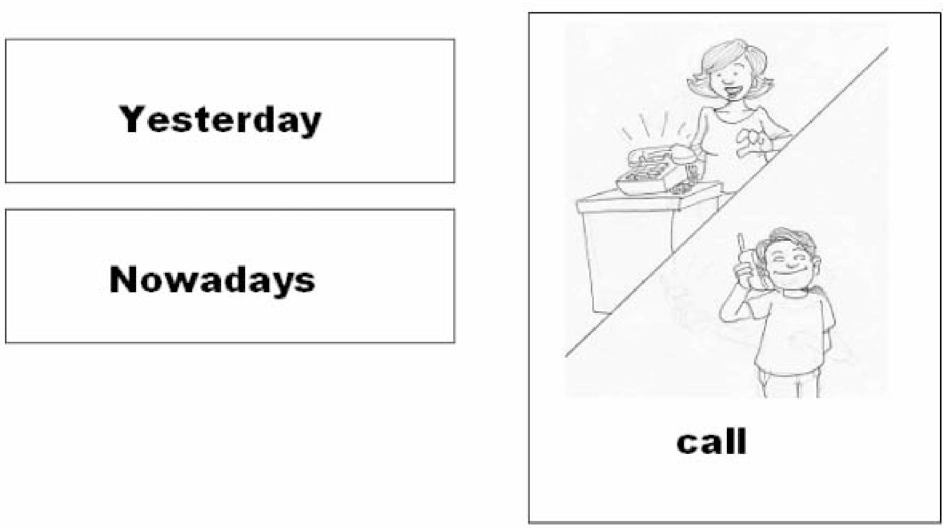
Patients	*FG*	*LC*	*KB*	*SL*	*Healthy Speakers* (Mean(SD))*
Demographic variables					
Age	48	56	64	35	71 (7.40)
Gender	M	M	M	M	2 F, 2M
Language(s)	Spanish, English	English	English	English	English
Education (years)	18	16	18	16	16.6 (1.15)
Handedness	Right	Right	Right	Left	Right
Etiology	CVA	CVA	CVA	CVA	N/A
Post-onset (years)	4.2	4	12.7	2.7	N/A
Diagnosis (aphasia type)	Broca's	Broca's	Broca's	Broca's	N/A
Other disorders	None	None	None	None	None
Hearing/Vision	Normal	Normal	Normal	Normal	Normal
Language variables					
Western Aphasia Battery					
Fluency	5	4	4	4	N/A
Comprehension	9.8	8.1	8.8	8.5	N/A
Repetition	10	9.3	8	5.6	N/A
Naming	9.3	7.5	8.7	7.1	N/A
Aphasia Quotient (AQ)	82.4	69.8	70.3	64.5	N/A
Northwestern Assessment of Verbs and Sentences					
Verb Naming	44	47	49	51	N/A
Verb Comprehension	100	100	100	100	N/A
Argument Structure Production	72	74	75	75	N/A
Sentence Production Priming	76	78	80	82	N/A
Sentence Comprehension	73	75	76	77	N/A
Narrative Speech Data					
MLU	9.56	5.11	4.19	4.67	14.95 (6.78)
% Grammatical sentences	75	50	84	33.33	96.22 (0.04)
Noun: verb ratio	1.2	1.25	2.21	1.63	1.02 (0.12)
% Verb with correct morphology	86.67	87.5	52.63	72.3	99.25 (1.50)

* Healthy control narrative data are based on four age-matched speakers from the database of the Aphasia and Neurolinguistics Research Laboratory.

Notably, the complementiser task and tense and agreement task were quite similar to one another, although some differences were required in order to obligate production of the target morphemes. The same transitive verbs and picture stimuli were used for the two tasks, but they necessarily coincided with different clauses across tasks. In the complementiser task the transitive stimuli were used to obligate production of an embedded clause, while in the tense and agreement task they were used for elicitation of a matrix clause. In both tasks, participants were required to concatenate two stimuli (see below). Two practice items were presented before the test stimuli for each task. One repetition was allowed for each item and a 10-second



Target: They wonder *if (whether)* the man is calling the woman.



Target: Yesterday the man *called* the woman (tense).

Nowadays the man *calls* the woman (agreement).

Figure 1. Sample stimuli used for complementiser (top) and tense and agreement production task (bottom) in Experiment 1.

response time was imposed with only general response feedback provided (e.g., "You are doing fine"). The order of presentation of all items was randomised and all sessions were audio recorded and transcribed on-line for later verification.

Complementiser production. In the complementiser task participants were asked to produce 20 sentences using *if*, *whether*, or *that* when presented with corresponding picture stimuli. First, the matrix verb stimulus picture was presented and the examiner said, "In this picture, they wonder." Then, the embedded clause picture was presented and the examiner said, "This picture has a man and a woman. The action is call." The relevant nouns (e.g., *the man* and *the woman*) were provided by the examiner in order to eliminate any confounding effect of word retrieval problems in sentence production. After presenting the pictures, the examiner instructed the patient to produce a sentence, saying "Make a sentence putting these together." The target sentence, *they wonder if (whether) the man is calling the woman*, was expected. Responses were scored as "correct" if the patient produced a complementiser to introduce the embedded clause. For trials using the complement verbs *wonder* and *care,* production of the complementisers *if* or *whether* were accepted, based on grammatical restrictions in English; whereas for the verbs *see* and *ask,* production of any of the target complementisers, *if*, *whether*, or *that*, was considered correct.

Tense and agreement production. The patient was asked to produce a sentence by describing the action in a picture together with a temporal adverb. The examiner first placed the temporal adverb card on the table in front of the participant, identifying it by saying "This card says 'yesterday/nowadays'." Next the transitive action picture was presented and the examiner identified the actors and action by saying "This picture has a man and a woman. The action is call." Finally, participants were instructed to "Make a sentence by putting these together." The expected responses were, *nowadays/yesterday the man calls/called the woman*. Responses were considered correct if the verb was properly inflected; that is, V + -*s* and V + -*ed* for agreement and tense conditions, respectively. Error types were also analysed.

Results

The percent correct data, as shown in Figure 2, indicated that all participants showed better production of complementisers as compared to tense and agreement inflection. With regard to tense and agreement, FG and LC performed better for agreement; FG produced 15 correct responses (75%) for agreement, while he showed 9 correct responses (45%) for tense. LC showed 13 (65%) and 5 (25%) correct production for agreement and tense, respectively. However this pattern was not observed in KB and SL's data. Neither of them produced any correct tense or agreement markers, resulting in zero percent correct for both categories.

The error analysis for tense and agreement production indicated that all participants produced a greater number of substitution errors as compared to omission (bare stem) errors. FG and LC made 14 out of 17 (82%) and 12 out of 22 (55%) substitution errors, respectively. KB produced all substitution errors (100%) and SL produced 34 substitution errors out of a total of 40 incorrect responses (85%). Both FG and LC substituted -*s* for -*ed* (e.g., *Yesterday a man calls a woman.*) more frequently than -*ed* for -*s* (e.g., *Nowadays the child painted the woman.*). FG incorrectly used the -*s* marker in nine cases where -*ed* was required, as compared to

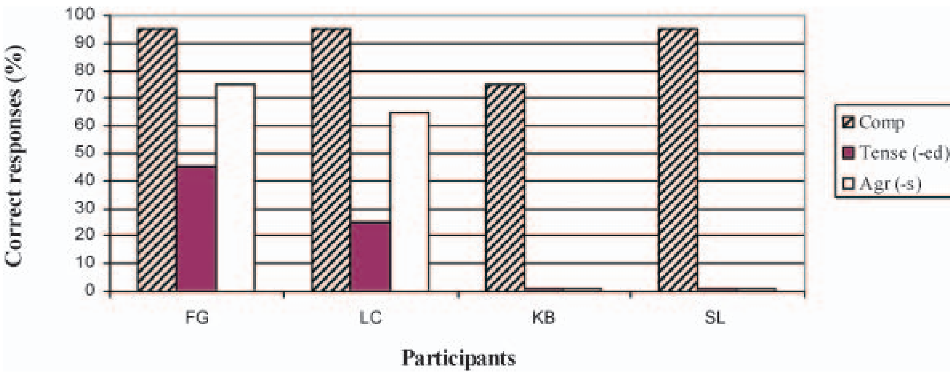


Figure 2. Percent correct responses in complementisers, tense, and agreement production in Experiment 1.

five cases of *-ed* for *-s* substitutions. This pattern also was seen for LC, who produced 11 *-s* substitution errors, and only one *-ed* substitution. Unlike FG and LC, the other two participants, KB and SL, produced *-ing* substitutions for both *-ed* and *-s* (e.g., *Yesterday the dog is chasing the cat*.)

Note that, in Experiment 1, we examined only two verb inflection forms, *-ed* and *-s*. In English, tense (i.e., present) and agreement (i.e., third person singular) are merged into one morpheme *-s*. This language-specific characteristic makes it difficult to tease apart tense and agreement inflection abilities based only on these two forms. In addition, Experiment 1 did not include a non-finite condition where verb inflection was not required. Thus, in Experiment 2 we examined the participants' verb inflection patterns across all possible finite and non-finite conditions in English.

EXPERIMENT 2

Procedure

A verb inflection test, developed by Bastiaanse and Thompson (unpublished), was used to examine seven inflectional forms, which included 10 regular and 5 irregular verbs, for a total of 105 items (see Appendix). Using a sentence completion task and corresponding action pictures, participants were asked to provide correct inflectional forms of the verb. For testing non-finite verb forms (present progressive, modal, and infinitives), an auxiliary verb or modal was provided. Tense was elicited using temporal information (e.g., *last week*, *nowadays*), and agreement was tested by manipulating subject noun number (singular or plural). A list of elicited forms is shown in (1) below. During testing, only general feedback was given and all responses were transcribed on-line and tape-recorded.

(1) Sample sentence completion task stimuli

Non-finite:

The boy is ____ home. (Present progressive: *walking*)

The boy can ____ home. (Modal: *walk*)

The boy likes to ____ home. (Infinitive: *walk*)

Finite:

Nowadays the boy ____ home. (Present singular: *walks*)

Nowadays the boys ____ home. (Present plural: *walk*)
Last week the boy ____ home. (Past tense: *walked*)
By now the boy has ____ home. (Past participle: *walked*)

Responses were scored as correct if a correct form of the verb was provided. Errors were analysed by tallying different error types in terms of omission (bare stem), substitution—i.e., "-*s*", "-*ed*" (regular past tense & past participle)—"-*en*" (regular past participle)", "-*ing*", "*ired*" (irregular past tense, e.g., *bit*), "*iren*" (irregular past participle, e.g., *bitten*), overgeneralisation (e.g., *throwed* for *threw*) and other responses (e.g., "I don't know" and unintelligible responses).

Results

As shown in Table 2, the participants showed better performance in non-finite conditions—mean (SD) = 84 (4.04)—as compared to finite conditions—mean (SD) = 33 (2.08)—(Wilcoxon $z = -2.521$, $p = .012$). For present singular (-*s*) and past tense (-*ed*) forms, we did not find a clear dissociation in their production accuracies (Wilcoxon z = −.378, $p = .705$). While FG and SL performed better on present singular (60% and 20%, respectively) than past tense (53% and 13%), LC and KB performed better on past tense (67% and 7%, respectively) than present singular (40% and 0%, respectively).

Error analysis showed that, as in Experiment 1, all participants except for LC made more substitution errors than omission errors. FG produced 20 substitution errors out of a total of 27 errors (74%). KB and SL produced 97% (65/67) and 81% (52/64) substitution errors, respectively. However, LC's errors were dominated by omissions (70%, 19/27).

In making substitution errors, each patient used different morphemes as their default markers. FG overused -*s* and -*ed* across various categories. Out of a total of 20 substitution errors, -*s* and -*ed* inflection markers occurred in nine (45%) cases each. With regard to KB and SL's error patterns, both overused -*ing* across categories. Out of 65 total substitutions, 64 (98%) were -*ing* for KB and 42 out of 50 substitutions (81%) consisted of misuse of the -*ing* marker for SL. Although few, overgeneralisation errors, using a regular inflection form for an irregular form (e.g., *throwed* for *threw*), were also observed across participants.

TABLE 2
Percent correct responses by verb inflection category in Experiment 2

	Nonfinite				Finite					
Patients	*Infinitive*	*Modal*	*Present Progressive*	*Mean (SD)*	*Present Singular*	*Present Plural*	*Total Agreement**	*Past Tense*	*Past Participle*	*Mean (SD)*
FG	93	100	100	98 (4.04)	60	40	50	53	60	53 (8.16)
LC	100	100	80	93 (11.55)	40	80	60	67	53	60 (17.3)
KB	73	53	100	78 (23.59)	0	0	0	7	20	3 (4.04)
SL	86	67	60	71 (13.45)	20	13	16	13	13	15 (3.5)
Mean (SD)				**84 (4.04)**						**33 (2.08)**

* "Total Agreement" indicates the mean percent correct of "Present Singular (e.g. *The boy walks*.)" and "Present Plural (e.g. *The boys walk*.)".

DISCUSSION

Findings from this study indicated better performance on structures associated with CP as compared to IP. Specifically, in Experiment 1 verb inflection was impaired for all participants, even though they showed ability to produce complementisers in embedded sentences. In fact, three of the participants showed near ceiling performance (95%) on complementisers, indicating very well-preserved ability to project to the CP layer of the syntactic tree. These data are in line with previous cross-linguistic findings, supporting the presence of CP in some agrammatic aphasic participants in the face of IP deficits (e.g., Arabatzi & Edwards, 2002; Thompson et al., 2002, for English; Penke, 2001; Wenzlaff & Clashen, 2005, for German; also see Dickey, Milman, & Thompson, in press, for preserved comprehension of complementisers vs impaired comprehension of tense and agreement inflections).

It is of interest to note that we found this pattern using tasks developed to be as similar to one another as possible, even though it could be argued that the complementiser condition was more difficult than the verb inflection condition. The complementiser condition involved two propositions (two verbs) and sentential embedding, linguistic properties known to increase difficulty in aphasic participants (Caplan & Waters, 1997, and others). However, our participants performed better on this task as compared to the verb inflection task, which involved only one proposition (verb) and no embedding. We therefore are confident that the derived results reflected participants' ability to generate grammatical morphology, not their ability to perform the task.

With regard to production of tense and agreement, no clear dissociations were found in our data. KB and SL showed near complete inability to produce both structures in both Experiments 1 and 2, using the progressive marker -*ing* as a default in most cases. Further, the data from Experiment 2 revealed disruptions in FG and LC's production ability for both tense and agreement, even though in Experiment 1 tense was more impaired than agreement for both participants. This latter finding highlights the importance of testing a full array of inflected forms when evaluating agrammatic participants. Indeed, the better performance on agreement in Experiment 1 reflected overuse of -s. Only when both third person singular and plural agreement were tested in Experiment 2 was an agreement deficit apparent. In fact, in Experiment 2 both participants showed slightly better production of tense as compared to agreement forms. FG correctly produced 53% and 50% of tense and agreement targets, respectively, erring on both singular (60%) and plural agreement forms (40%). His substitution errors were equally dominated by -*s* and -*ed* (45% each), suggesting an inability to distinguish between the two. LC's production of tense markers (-*ed*) was 67% correct, compared to 60% accuracy for agreement and he made more omission errors (70%) than substitutions (7.4%).

Consideration of the participants' data in the context of extant theories of functional category deficits indicates that they are not consistent with predictions of the TPH (Friedmann & Grodzinsky, 1997). All participants produced CP-level structures with little difficulty, but they showed deficits in production of TP- and ArgP-level structures, which are lower in the syntactic tree than CP structures. In addition, it is noteworthy that all participants produced aspectual (-*ing*) forms, which project from a node below tense and agreement (e.g., Ouhalla, 1990). A tree-based account would thus show a syntactic tree "pruned" in the middle, with the highest and lowest nodes intact and those in between impaired. Indeed, this impairment pattern does not fit within a TPH framework.

The TPH also predicts TP to be more impaired than ArgP because ArgP is below TP on the tree. Our participants' data did not conform to this prediction. However, not all linguists agree on the levels of projection or their placement on the tree. Based on the minimalist program (Chomsky, 2000), tense and agreement are not considered structurally separate functional nodes; rather they are thought to project from a single Tense (or Inflection) node. Our participants' data coincide with such a claim in so far as there was no clear difference in their ability to produce tense and agreement markers. In contrast, other theories propose that IP is split into nodes for tense and agreement (Pollock, 1989) and some suggest that the structure of IP is language specific (Bobaljik & Thráinsson, 1998), based on the language's morphological properties. Bobaljik and Thráinsson (1998) espouse that languages that allow distinct markers of tense and agreement to co-occur on finite verbs (e.g., Spanish) have a split IP, whereas languages with an unsplit IP are restricted to having maximally one inflectional morpheme attached to the inflected verb (e.g., English, German). This may account, to some extent, for differences in tense and agreement deficit patterns across languages.

The findings from this study fit best with a morphological explanation, rather than a syntactic one. That is, the data suggest an impairment related to implementation of morphological rules, in particular pertaining to verb inflection. Production of non-finite verb forms was more preserved than finite forms. Substitutions were the dominant error type, occurring when participants failed to provide correct forms in finite conditions. Further, a variety of forms, including -*s*, -*ed*, and -*ing* as well as overgeneralisation of regularised forms (e.g., *throwed* and *swimmed* for *threw* and *swum*, respectively) were used as substitutions. These patterns indicate that: (a) the ability to distinguish contexts where verb inflection is required from where it is not is preserved, thus, the affixation process per se appears to be intact; and (b) the presence of inflectional rules was preserved in their grammar. These findings suggest that our agrammatic participants' deficits may lie in instantiation of grammatical markers, rather than impaired syntactic projection.

In conclusion, deficits in functional categories do not always affect both CP- and IP-level grammatical morphemes. Further, a deficit at the IP level does not always coincide with a CP-level deficit. The present data, as well as those derived from previous research in agrammatic aphasia, attest to this: IP structures can be impaired when CP structures are not, and therefore deficits at the IP level do not accurately predict deficits at the CP level (Arabatzi & Edwards, 2002; Penke; 2001, 2003; Thompson et al., 2002; Wenzlaff & Clashen, 2005). Similarly, tense and agreement deficits do not neatly fit into syntactic hierarchies, at least for English. Thus, a unified account of agrammatic aphasic patients' morphological and syntactic impairments, such as the TPH, does not adequately account for the available data. Rather, our data suggest that verb inflection deficits may be better explained on morphological, rather than syntactic, grounds. However, the precise morphological deficit that underlies verb inflection impairments is presently unknown. Is feature checking impaired (Arabatzi & Edwards, 2002)? Are morphological features underspecified (Wenzlaff & Clashen, 2004, 2005; Nanousi et al., 2006)? Do participants have difficulty accessing inflectional morphemes (Penke, 2003)? Or is it the computation of morphological features that is faulty (Thompson et al., 2002)? Answers to these questions await further research. However, we end by pointing out that our findings (and those of others) suggest that within the domain of functional categories, IP- and CP-level morphological impairments may result from disruption of different underlying mechanisms and that the more we learn about these mechanisms, the better prepared we will be to develop appropriate strategies to remediate such deficits.

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REFERENCES

Arabatzi, M., & Edwards, S. (2002). Tense and syntactic processes in agrammatic speech. *Brain and Language*, *80*, 314–327.

Baayen, R. H., Pieenbrock, R., & van. Rij, H. (1993). *The CELEX Lexical Database (Release1)*. Philadelphia: Linguistic Data Consortium, University of Pennsylvania.

Bastiaanse, R., & Thompson, C. K. (2003). Verb and auxiliary movement in agrammatic Broca's aphasia. *Brain and Language*, *84*, 286–305.

Bastiaanse, R., & Thompson, C. K. (unpublished). *Verb Inflection Test*.

Benedet, M. J., Christiansen, J. A., & Goodglass, H. (1998). A cross-linguistic study of grammatical morphology in Spanish- and English-speaking agrammatic participants. *Cortex*, *34*, 309–336.

Bobaljik, J. D., & Thráinsson, H. (1998). Two heads aren't always better than one. *Syntax*, *1*(1), 37–71.

Burchert, F., Swoboda-Moll, M., & De Bleser, R. (2005). Tense and agreement dissociations in German agrammatic speakers: Underspecification vs. hierarchy. *Brain and Language*, *94*, 188–199.

Caplan, D., & Waters, G. S. (1997). Determinants of sentence comprehension in aphasic participants in sentence–picture matching tasks. *Journal of Speech, Language, & Hearing Research*, *40*, 542–555.

Chomsky, N. (1993). A minimalist program for linguistic theory. In K. Hale & S. J. Keyser (Eds.), *The view from Building 20: Essays in honor of Sylvain Bromberger* (pp. 1–52). Cambridge, MA: MIT Press.

Chomsky, N. (2000). Minimalist inquiries: The framework. In R. Martin, D. Michaelis, & J. Uriagereka (Eds.), *Step by step* (pp. 89–155). Cambridge, MA: MIT Press.

Dickey, M. W., Milman, L. H., & Thompson, C. K. (in press). Judgment of functional morphology in agrammatic aphasia. *Journal of Neurolinguistics*, *21*, 35–65.

Ferrerio, S. M. (2003). *Verbal inflectional morphology in Broca's aphasia.* MA thesis, Universitat Autonoma de Barcelona, Spain.

Friedmann, N. (2001). Agrammatism and the psychological reality of the syntactic tree. *Journal of Psycholinguistic Research*, *30*, 71–88.

Friedmann, N. (2002). Question production in agrammatism: The tree-pruning hypothesis. *Brain and Language*, *80*, 160–187.

Friedmann, N., & Grodzinsky, Y. (1997). Tense and agreement in agrammatic production: Pruning the syntactic tree. *Brain and Language*, *56*, 397–425.

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

Halle, M., & Marantz, A. (1993). Distributed morphology and the pieces of inflection. In K. Hale & S. J. Keyser (Eds.), *The view from Building 20: Essays in honor of Sylvian Bromberger* (pp. 111–176). Cambridge, MA: MIT Press.

Kertesz, A. (1982). *Western Aphasia Battery*. New York: Grune & Stratton.

Kolk, H. (2000). Canonicity and inflection in agrammatic sentence production. *Brain and Language*, *74*, 558–560.

Lee, M. (2003). Dissociations among functional categories in Korean agrammatism. *Brain and Language*, *84*, 170–188.

Menn, L., & Obler, L. K. (1990). Cross-language data and theories of agrammatism. In L. Menn & L. K. Obler (Eds.), *Agrammatic aphasia. A cross-language narrative sourcebook* (Vol. 2, pp.1369–1389). Amsterdam: John Benjamins.

Nanousi, V., Masterson, J., Druks, J., & Atkinson, M. (2006). Interpretable vs. uninterpretable features: Evidence from six Greek-speaking agrammatic participants. *Journal of Neurolinguistics*, *19*, 209–238.

Ouhalla, J. (1990). Sentential negation, relativised minimality and the aspectual status of auxiliaries. *The Linguistic Review*, *7*, 183–231.

Penke, M. (2001). Controversies about CP: A comparison of language acquisition and language impairments in Broca's aphasia. *Brain and Language*, *77*, 352–363.

Penke, M. (2003). On the morphological basis of syntactic deficits. *Brain and Language*, *87*, 50–51.

Pollock, J-Y. (1989). Verb movement, universal grammar, and the structure of IP. *Linguistic Inquiry*, *20*, 365–424.

Thompson, C. K. (2007). Complexity in language learning and treatment. *American Journal of Speech and Language Pathology*, *16*, 3–5.

Thompson, C. K. (unpublished). *Northwestern Assessment of Verbs and Sentences (NAVS)*.

Thompson, C. K., Fix, S., & Gitelman, D. (2002). Selective impairment of morphosyntactic production in a neurological patient. *Journal of neurolinguistics*, *15*, 189–207.

Thompson, C. K., Shapiro, L. P., Tait, M. E., Jacobs, B., Schneider, S., & Ballard, K. (1995). A system for the linguistic analysis of agrammatic language production. *Brain and Language*, *51*, 124–127.

Wenzlaff, M., & Clashen, H. (2004). Tense and agreement in German agrammatism. *Brain and Language*, *89*, 57–68.

Wenzlaff, M., & Clashen, H. (2005). Finiteness and verb-second in German agrammatism. *Brain and Language*, *92*, 33–44.

APPENDIX

List of verbs for Experiment 1 (used in both complementiser and tense and agreement tasks) and Experiment 2

Experiment 1 (n = *10*)	*Experiment 2* (n = *15*)	
call	Regular (*n* = 10)	climb
cover		cook
crown		kiss
follow		iron
paint		smoke
pull		polish
save		push
shave		row
tickle		walk
weigh		wash
	Irregular (*n* = 5)	bite
		ride
		dive
		throw
		swim