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Tense and Agreement dissociations in German agrammatic speakers: Underspecification vs. hierarchy

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Abstract

The aim of the present paper was to investigate whether German agrammatic production data are compatible with the Tree-Pruning-Hypothesis (TPH; Friedmann & Grodzinsky, 1997). The theory predicts unidirectional patterns of dissociation in agrammatic production data with respect to Tense and Agreement. However, there was evidence of a double dissociation between Tense and Agreement in our data. The presence of a bidirectional dissociation is incompatible with any theory which assumes a hierarchical order between these categories such as the TPH or other versions thereof (such as Lee's, 2003 top–down hypothesis). It will be argued that the data can better be accounted for by relying on newer linguistic theories such as the Minimalist Program (MP, Chomsky, 2000), which does not assume a hierarchical order between independent syntactic Tense and Agreement nodes but treats them as different features (semantically interpretable vs. uninterpretable) under a single node.

Keywords: Agrammatism; Tree pruning; Tense; Agreement; Functional categories; German; Aphasia

1. Introduction

Recently, many neurolinguistic studies have focused on syntactic trees in agrammatic aphasia with a special focus on functional projections such as the Tense-Phrase (TnsP) and the Agreement-Phrase (AgrP). The results obtained in linguistically informed studies relying on the Government-and-Binding Framework (GB, Chomsky, 1981) have been interpreted as neuropsychological evidence for independent clausal representations of Tense and Agreement (Agr) in line with the Split-Inflection hypothesis (Pollock, 1989). Friedmann and Grodzinsky (1997) found that Tense- and Agr-morphemes are not equally impaired in a Hebrew agrammatic speaker and they proposed the Tree-Pruning-Hypothesis (TPH) to account for this dissociation. For the TPH, the hierarchical order of functional nodes in the syntactic tree plays a crucial role in the sense that higher nodes are more vulnerable than lower ones. Therefore, Tense-morphemes, which are assumed to be located higher in the tree, are more likely to be impaired than Agr-morphemes. A similar though contradictory hypothesis has been put forward by Lee (2003). In agreement with the logic of a syntactic tree constructed in a top–down fashion, she assumes that higher syntactic nodes are more likely to be spared in agrammatism. Such a hypothesis predicts that Agr-morphemes are more prone to impairments than Tense-morphemes. Wenzlaff and Clahsen (2004) presented the Tense Underspecification Hypothesis (TUH) which relies on a newer linguistic theory, the Minimalist Program (MP; Chomsky, 2000). In this theory, Tense and Agr are no longer conceived of as structurally independent functional elements but are subsumed under a single clausal representation which hosts semantically interpretable (Tense) and uninterpretable features (Agr).

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The three accounts mentioned above have in common that they predict that Tense and Agr dissociate in agrammatic patterns of performance and that the breakdown of functional elements is unidirectional, i.e., either Tense- (TPH, TUH) or Agr-morphemes (Lee, 2003) are impaired in agrammatic production.

German provides an interesting case for testing the different accounts on agrammatic production because for this language theoretical linguists have proposed a hierarchical organization of Tense and Agr which is different from English (cf. Belletti, 1990; Grewendorf, 2002) and which results in different predictions.

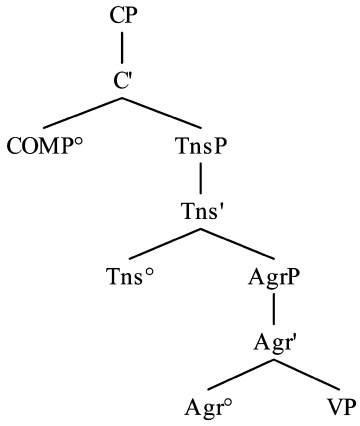
It will be argued in this study that the above mentioned theories are inadequate from a theoretical and an empirical point of view for two reasons. First, patterns of performance in agrammatic production do not follow the hierarchy of functional elements in clausal representations. Second, the breakdown of Tense and Agr in agrammatism can be bidirectional.

2. Tense and Agr in Grammar: A linguistic analysis

Within generative approaches, syntactic structures are conceived of as syntactic trees or phrase markers. According to standard assumptions within the Government-and-Binding Framework (GB, Chomsky, 1981), a clausal representation is built up in a bottom-up fashion and maximally consists of three different kinds of structural layers, each of them constructed in accordance with the requirements of the X-bar scheme.[1] The Verb Phrase (VP) is the hierarchically lowest layer in such a tree and hosts the verb with its arguments. On top of this lexical layer, two functional layers are built up: IP and CP. The Inflectional Phrase (IP) corresponds to morphological features such as Tense and Agr which are expressed either as abstract or concrete specifications, i.e., morphological markings on the verb stem, depending on the language. Furthermore, a finite verb in the head of IP (i.e., Infl°) licenses nominative case of the clausal subject in the Specifier of IP. The Complementizer Phrase (CP), on the other hand, is usually headed by free-standing morphemes. Examples of these are sentence embedding conjunctions like *that* and *if* in English or *dass* and *ob* in German. Furthermore, CP hosts topics and operator-like elements such as focalized elements, *wh-* (i.e., interrogative) and relative pronouns. Alternatives to a bottom-up structure building have been proposed, for example, top–down generation as in Philipps (1996) and also in grammars using phrase-structure rules of the kind S → NP VP [i.e., an S-node (S) expands to an NP-node (the clausal subject) and a VP-node (the verb phrase containing the verb and its arguments)].

The original notion of syntactic representations as a CP–IP–VP system outlined above has been specified and refined in various ways. Not only refinement for VP was proposed (cf. Larson's, 1988 VP-shells) but also the functional layers CP and IP were altered in many respects. Pollock (1989) proposed the notion of Split-Inflection according to which functional morphemes such as Tense and Agr, which were originally hosted in one functional projection—the Inflectional Phrase IP—head their own projection phrases, i.e., TnsP and AgrP, respectively, as in (1).

(1)



The functional independence of Tense and Agr-morphemes can be illustrated by the Finnish example in (2). In a particular linguistic context such as negation, Agr-morphemes, which normally occur on the verb stem on a par with Tense-morphemes (cf. 2a), are separated and attached to the negation morpheme (cf. Mitchell, 1991).

(2) a.	Minä	puhu-isi-n	
	I-NOM	speak-CND-1SG	
	"I would speak"		
b.	Minä	e-n	puhu-isi
	I-NOM	not-1SG	speak-CND
	"I would not speak"		

The splitting of an originally integral functional projection into different morphemes can be observed even within a single category such as Agr. Romance languages provide a case in which a past participle agrees with a clitized object in a preverbal position (cf. Belletti, 2001; Chomsky, 1991; Kayne, 1989).

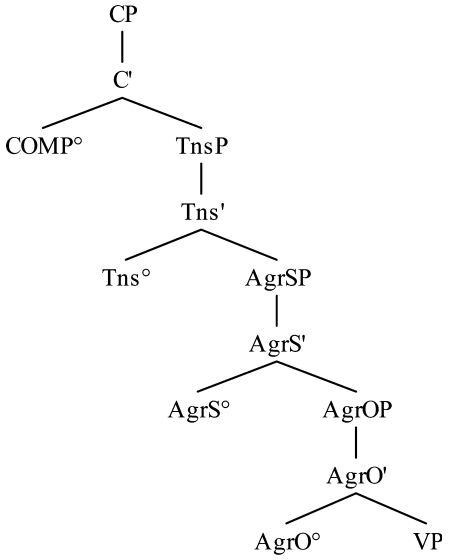
(3) a.	Paul	a	repaint	les tables
	Paul	has	repainted	the tables
b.	Paul	**les**$_i$	a	repaint**es** t_i
	Paul	them	has	repainted

[1] An X-bar scheme contains a lexical head X° which combines with its complements to form intermediate X′-projections which in turn combine with a specifier (e.g., the clausal subject) to form the maximal projection XP: [$_{XP}$Specifier [$_{X'}$X° complements]].

The observation illustrated in (3) gave rise to the establishment of two independent Agr projections, AgrO for object agreement and AgrS for subject agreement (Chomsky, 1995).

The bracketed tree in (4) provides an example of a clausal representation in which the formerly integral functional layer IP has been split up into various independent morphemes, all of them heading their own functional projection, namely, TnsP, AgrSP, and AgrOP, respectively.

(4)



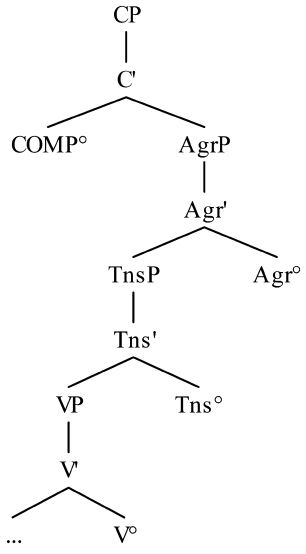
However, there are several controversial issues related to a syntactic tree as depicted in (1) or (4). One of the issues is the hierarchical ordering of TnsP and AgrP under a cross-linguistic perspective. In the original idea of Split-Inflection (Pollock, 1989), Tense was placed above Agr (or in technical terms, there is a c-commanding structural relationship between Tense and Agr). This fixed hierarchy, however, is questionable given the fact that cross-linguistically the serial ordering of Tense and Agr-morphemes is subject to parameterization. Semitic languages like Hebrew do not have stems, suffixes or prefixes as morphological objects but only consonantal roots in which vowels are inserted. German provides an example in which Tense and Agr-morphemes are separately identifiable and are attached to the verbal stem in a systematic way. Table 1 illustrates the conjugational paradigm of a regularly inflected verb such as *hören* (to hear).

In the past tense, there are separate bound morphemes for Tense (i.e., *-te-*) and Agr (e.g., *-st* for 2nd person singular). Furthermore, they appear in a fixed order in that Tense morphemes are attached closer to the verbal stem than Agr-morphemes. If the assumption is correct that morphological processes are mirrored in syntax (Baker's, 1985 Mirror Principle), the ordering of TnsP and AgrP in German must be the reverse (i.e., Agr above Tense) of what has been proposed for English or Hebrew (cf. Belletti, 1990; Grewendorf, 2002; Penke, 2000), cf. (5).[2] The same applies to other languages such as Turkish.

Table 1
Inflectional paradigm for a German regular verb, Tense morphemes are italicized, and agreement morphemes are bold

Infinitive: *hören* (to hear)		Present tense	Past tense
Sg	1	hör-**e**	hör-*te*-ø
	2	hör-**st**	hör-*te*-**st**
	3	hör-**t**	hör-*te*-ø
Pl	1	hör-**en**	hör-*te*-**n**
	2	hör-**t**	hör-*te*-**t**
	3	hör-**en**	hör-*te*-**n**

(5)



Another controversial issue concerns AgrP itself. In recent developments of syntactic theories, i.e., the Minimalist Program (MP; Chomsky, 2000), Agr is fundamentally different from Tense from a syntactic point of view as it is no longer treated as a separate functional element heading its own phrase marker but is located as a feature in the Tense node. This node, therefore, is the host of two different features, namely, the semantically interpretable Tense-features and the uninterpretable Agr-features. In some sense, this minimalist assumption is very similar to the original GB framework in that inflectional morphemes do not require separate functional layers in a clausal representation.

[2] The tree in (5) also illustrates the fact that German is a head-final language (cf. Vikner, 1995).

In the next section, we will discuss in detail various hypotheses about Tense and Agr in agrammatism and empirical evidence in their support.

3. Tense and Agr in agrammatism

One of the predominant symptoms of agrammatic aphasia is non-fluent simplified spontaneous speech production. According to many accounts, this is due to specific problems with grammatical words or functional elements such as inflectional endings that are either omitted or substituted. The pattern of omission or substitution is morphologically driven and depends on whether the verbal stem can be a free-standing morpheme or not (e.g., Grodzinsky, 1984). As a result, agrammatic speech output is often not more than a mere concatenation of content words, with functional elements either being totally absent as in English or overrepresented such as in German uninflected infinitives in contexts which require an inflected form. At the same time, it has been a long-standing observation that different kinds of functional elements are not equally exposed to impairment in agrammatism. For instance, Goodglass and Hunt (1958) showed in an elicitation task that the possessive morpheme—*s* was omitted twice as often as the plural morpheme—*s*, a finding they explained in terms of syntactic complexity of the environment in which these functional morphemes appear.

More recent syntactic theories on agrammatism attribute the sparing and loss of different function words and in particular of Tense and Agr morphemes to their hierarchical position in the syntactic tree. One of these is the Tree-Pruning-Hypothesis (TPH, Friedmann & Grodzinsky, 1997; Grodzinsky, 2000 or Hagiwara, 1995 for a very similar proposal) which states that the higher a functional element is located in the syntactic tree, the more likely it is to be impaired. Given a tree as in (1), where different functional elements all head their own projections, Tense is predicted to be more impaired than Agr as the latter is located in a hierarchically lower position in the tree than Tense. Specifically, TPH assumes that agrammatic phrase markers are incomplete in that they are pruned at a certain node and as a consequence some nodes are absent from the representation. For instance, if the syntactic tree in (1) is pruned above AgrP, all nodes above it (= TnsP and CP) do not project. Hence, impairments are predicted in functional elements which require these functional layers, namely, inflectional endings in TnsP as well as *wh*-morphemes, question formation or sentence embedding, as these all require a CP (Friedmann, 2002).

One of the advantages of the TPH is that it captures the long-standing observation that not all functional elements are equally impaired in agrammatic speech production (e.g., Goodglass, 1968; Howes & Geschwind, 1962; Marshall, 1986). Furthermore, it is grounded in a specific linguistic theory (i.e., the GB framework, cf. previous section) and goes beyond simple empirical description of the findings towards theoretical explanation.

The disadvantages and weaknesses, however, are that its predictions hinge upon a universally fixed order of functional projections (i.e., Tense being higher than Agr) and that its predictions are too strong. The discussion above has illustrated that there is considerable debate upon the question whether Tense is located higher in the syntactic tree than Agr or vice versa. For German, a language in which Agr has been claimed to be located higher than TnsP as opposed to English, the TPH would predict a reverse dissociation between Tense and Agr, i.e., Agr should be more impaired than Tense. However, a recent investigation on inflectional morphemes in German (Wenzlaff & Clahsen, 2004) showed that this prediction is not borne out as Tense was more impaired than Agr in German agrammatics. Furthermore, the strong relationship which the TPH predicts between impairments in Tense and/or Agr and impairments in CP could not be established either (Penke, 2001, 2003; Wenzlaff & Clahsen, 2005). There was no evidence for an association between deficient inflection and the inability to place finite verbs in German matrix clauses correctly in verb-second position which—according to standard analyses—is the head of CP. Finally, though embedded in an explicit linguistic theory, TPH is not compatible with recent theoretical developments. TPH makes use of linguistic theory to explain a pattern of impairment of Tense without impairment of Agr. However, Chomsky's MP no longer assumes a separate Agr projection but rather attributes Subject–verb-agreement to an operation which takes place in TnsP. Under this view, dissociations between Tense and Agr cannot be accounted for by incomplete phrase markers.

A similar though different proposal with respect to the TPH has been put forward by Lee (2003). Her hypothesis also attributes impairments in functional categories to their hierarchical position in the syntactic tree but in another direction. Although not mentioned explicitly, her reasoning follows the logic of a syntactic tree built up in a top–down fashion, where nodes that are created first and located higher in the tree (e.g., CP) are more likely to be spared. An interesting observation made by Lee in her study is that the impairment of functional nodes obviously varies depending on the structural context in which they appear. The Mood Phrase (MP) has been found to be less impaired in matrix sentences, where it is the highest node, than in embedded sentences, which are introduced by a CP as the highest node followed by an MP. Consequently,

Table 2
Summary of predictions for English and German

Linguistics	Neurolinguistics	Dissociability
Hypotheses		
Hierarchical ordering (GB)	TPH	Agr > Tense (for English) Tense > Agr (for German)
Hierarchical ordering (GB)	Lee (2003)	Tense > Agr (for English) Agr > Tense (for German)
No hierarchical ordering (MP)	TUH	Non-discourse Agr-features > discourse Tense-features (for English and German)

the predictions of the TPH and Lee (2003) are also contradictory with respect to Tense and Agr. Given a German tree with a hierarchical order as in (5), the TPH predicts that impairments in the lower node Tense always involve impairments in the higher Agr node whereas Lee (2003) predicts that there may be impairments in the lower Tense node while the higher Agr node remains unimpaired (see Table 2).

In contrast to the TPH, the Tense Underspecification Hypothesis (TUH; Wenzlaff & Clahsen, 2004) tries to capture the patterns of impairment of Tense and Agr within the MP-framework (e.g., Chomsky, 2000). Given the assumption within the MP that the T-node is the host for two kinds of features, namely, the semantically interpretable Tense-features and the uninterpretable Agr-features, TUH claims that T is selectively underspecified in agrammatism for interpretable Tense-features leaving uninterpretable Agr-features unimpaired. Underspecification then gives rise to a dissociated pattern of impaired Tense and preserved Agr as observed in many studies (e.g., Benedet, Christiansen, & Goodglass, 1998; Höhle, 1995).

As for the question why Tense but not Agr is an underspecified feature in agrammatism, the authors speculate that Tense requires the establishment of an anaphoric relationship between the speech act and an event time in the discourse, unlike agreement marking. Such discourse related phenomena have been found to be impaired in agrammatic aphasia, as was shown in the interpretation of non-reflexive pronouns (cf. Grodzinsky, Wexler, Chien, Marakovitz, & Soloman, 1993; Ruigendijk & Avrutin, 2003).

4. The present study

4.1. Aim of the study

The aim of the present study was to investigate Tense and Agr in clausal representations with German speaking agrammatic patients. Since a different hierarchy of Tense and Agr has been proposed for German compared to English as mentioned before, different impairment patterns could be expected depending on the three hypotheses reviewed in the previous section. A first pattern of impairment in German follows from the TPH which links impairments of functional morphemes to their hierarchical position in clausal representations. Therefore, it predicts that Agr should be more impaired than Tense, though this predicted pattern stands in contrast to previous findings in this language (e.g., Höhle, 1995; Wenzlaff & Clahsen, 2004). A second pattern of impairment is predicted by the alternative TUH. It claims that the T-node is underspecified for Tense-features in agrammatism and, therefore, Tense should be more impaired than Agr regardless of the hierarchical position in the tree. A similar prediction is made by a third hypothesis offered by Lee (2003). It follows the logic of a syntactic tree built up in a top–down fashion and claims that in contrast to the TPH higher nodes in the tree are less impaired than lower nodes. In line with the TUH, Agr then should be less impaired than Tense in German. However, only the first impairment pattern would provide empirical evidence for a different ordering of Tense and Agr in German as the second and third pattern would also be compatible with the order originally proposed by Pollock (1989).

Table 2 summarizes the predictions for German and English of the different hypotheses proposed in the literature.

4.2. Subjects

The study was conducted with nine patients. Eight had a left hemisphere damage, one (UW) had a right hemisphere damage but was left handed. Participants were selected according to their clearly agrammatic speech production (i.e., ''telegraphic style''), with a score of 1 or 2 on the syntax rating of the Aachen Aphasia Test (AAT, Huber, Poeck, Weniger, & Willmes, 1983). According to ALLOC, a program for the automatic syndrome classification of patients based on AAT results, there were eight patients who were classified as Broca's aphasics and one as mildly global (RG). There were four female and five male subjects. All of them were native speakers of German. Sample characteristics of the patients are given in Table 3. Furthermore, control data are available from nine age- and education-matched control subjects without language deficits.

4.3. Material and experimental methods

A sentence completion task was administered to the agrammatic subjects to test their abilities to correctly inflect a verb for the morphological features Tense and Agr. Accordingly, there were two experimental conditions, one for Tense and one for Agr. The experimental procedure was identical in both conditions and the test was designed as follows. First, a visually presented

Table 3
Sample characteristics of agrammatic patients

Subjects	Gender/age (years)	Profession	Etiology	Aphasia post-onset (years)	Aphasia classification (severity) (Aachen Aphasia Test: AAT)
MP	F/52	Psychologist	CVA	8	Broca (medium/mild)
WE	M/59	Caretaker	CVA	4	Broca (medium/severe)
JR	F/28	Florist	CVA	2	Broca (mild)
RG	F/49	Sales manager	CVA	10	Global (mild)
WR	M/52	Electrician	CVA	5	Broca (medium)
RK	M/65	Electrician	CVA	14	Broca (medium)
UW	M/64	IT-specialist	CVA right (left-handed)	9	Broca (medium)
JK	M/50	Architect	CVA	2	Broca (mild)
AF	F/31	Stonemason	Trauma	8	Broca (medium/mild)

source clause was read aloud to the patients by the experimenter followed by an auditorily and visually presented second clause—the test sentence. The test sentence contained a gap at the position in which the inflected verb normally appears. It differed from the source clause either in an agreement feature (person or number) or the time of event was different. To complete the gapped test sentence, the patient was asked to make a selection out of a given set of three verbs. The set consisted of the target verb together with two distractors which consisted of a copy of the finite source verb (distractor 1) and another finite or infinite form of the verb (3rd person singular, infinitive or past participle = distractor 2). The agrammatic subjects made a selection either by reading aloud the test sentence with the filled gap or simply by pointing to one of the alternatives. Consequently, possible responses were either correct, a copy of the source verb form or the substitution of another form.

The Tense and Agr condition included $n = 48$ sentence pairs (source clause and test sentence) each. Thus, the entire material consisted of 96 test items. The material was designed as follows. In the Tense condition, the test sentence differed from the source clause only in the event time. Agr-features, i.e., person and number inflection, remained unchanged. In half of the sentence pairs, the time of action which was signaled by a temporal adverb changed from present tense in the source clause to past tense in the test sentence. The opposite change was applied to the other half. An example of a sentence pair and the selection set in the Tense condition is given in (6).

(6) *Tense (Past → Present)*

Source clause:	Gestern	suchte	ich	den Direktor
	yesterday	was looking-for	I	the director
	"Yesterday I was looking for the director"			
Test sentence:	Morgen	(*suche*)	ich	den Direktor
	tomorrow	(*seek*)	I	the director
Selection set:	suche (*seek* = target),			
	suchte (*was looking-for* = copy, distractor 1),			
	gesucht (*sought* = past participle, distractor 2)			

Table 4 summarizes the test material for the Agr condition.

In the Agr condition, two types of inflectional morphology, person or number agreement, were changed from the source clause to the test sentence whereas the event time remained unchanged and was either past tense or present tense in the source clause and the test sentence. There were 24 sentences in which number inflection was changed. In another 24 sentences person agreement varied. For sentences in past tense in which number inflection changed and person agreement was kept constant ($n = 12$), four combinations were chosen out of the possible six, two from singular to plural and two from plural to singular, cf. Table 4. The subject noun phrase in the source clause and the test sentence was invariably either in the 1st or 2nd person. Each combination was represented by three test items. In sentences with present tense ($n = 12$), the number of combinations was restricted due to the fact that the 1st and 3rd person plural are identical with the uninflected infinitive. To avoid these morphologically ambiguous forms, only the 2nd person was chosen for sentences in present tense. There were six test items in which the 2nd person was changed from singular to plural. In another six items, a change occurred from plural to singular. An example for a number inflection manipulation in the Agr condition and the selection set is given in (7).

(7) *Agreement* (*number inflection changed*, *person inflection unchanged*)

Source clause:	Heute	kaufst	du	das Auto
	today	buy	$you_{2PS\ SG}$	the car
	"Today your are buying the car"			
Target clause:	Heute	(*kauft*)	ihr	das Auto
	today	(*buy*)	$you_{2\ PS\ PL}$	the car
Selection set:	kauft (*buy* = target),			
	kaufst ($buy_{2PS\ SG}$ = copy, distractor 1),			
	gekauft (bought = participle, distractor 2)			

In sentences in which person agreement was changed and number inflection was kept constant, three combinations out of the possible six for pairs in the singular were chosen to construct test sentences both in present

Table 4
Sentence completion task, test material for the Agr condition

		Past tense source → test	n =	Present tense source → test	n =
Number inflection ($n = 24$)	Singular	1SG → 1PL	3	2SG → 2PL	6
		2SG → 2PL	3		
	Plural	1PL → 1SG	3	2PL → 2SG	6
		2PL → 2SG	3		
Person agreement ($n = 24$)	Singular	1SG → 2SG	2	1SG → 2SG	2
		2SG → 1SG	2	2SG → 1SG	2
		3SG → 2SG	2	3SG → 2SG	2
	Plural	1PL → 2PL	3	1PL → 2PL	3
		3PL → 2PL	3	3PL → 2PL	3

tense and in past tense, cf. Table 4. The 3rd person singular present was not included in the test sentences because they were part of possible distractor items. Each combination was represented by four pairs, two in past tense and two in present tense. In plural present, the number of pairs was restricted to two, 1PL → 2PL and 3PL → 2PL. In all other possible combinations, either the 1st or 3rd person plural would have appeared in the test sentence. These forms, however, are morphologically ambiguous between an inflected and an uninflected verb. The two combinations were realized by six pairs each, three in past tense and three in present tense. An example for a sentence pair and the selection set in which person agreement was changed (e.g., 2SG → 1SG present) is given in (8).

(8) *Agreement* (*person inflection changed, number inflection unchanged*)

Source clause:	Heute	kaufst	du	das Auto
	today	buy	you	the car
	"Today you are buying the car"			
Test sentence:	Heute	(*kaufe*)	ich	das Auto
	today	(*buy*)	I	the car
Selection set:	kaufe ($buy_{1PS\ SG}$ = target),			
	kaufst ($buy_{2PS\ SG}$ = copy, distractor 1),			
	kauft ($buy_{3PS\ SG}$ = 3rd person singular, distractor 2)			

4.4. Results

The control group performed virtually perfectly on both Tense and Agr with a mean accuracy score of 47.7/48 (99%, $SD = 1.0$, range: 45–48) and 47.9 (100%, range: 47–48), respectively. The aphasic group had problems in choosing the correct verb form both in the Tense (mean 32.6, 68%) and the Agr (mean 30.4, 63%) condition. Statistical between-group comparisons confirmed that the aphasic patients performed significantly worse than the control subjects both on Tense (Mann–Whitney test: $Z = 3.94$, $p = .000$) and Agr (Mann–Whitney test: $Z = 3.58$, $p = .000$). Within-group comparisons revealed that the performance of the agrammatic group on Tense and Agr was not significantly different from each other (Wilcoxon test: $Z = .98$, $p > .05$).

Table 5A presents the agrammatics' individual scores in the sentence completion task. Performance was considered to be partially impaired if it was significantly above chance and below two *SD* from the control mean and to be normal if it was within two *SD* of the control mean. There were basically three individual patterns of performance. A first subgroup of three patients did not show a dissociation in their performance patterns and they were generally above chance (MP, WR, and AF). A second subgroup also had no dissociations but performance was generally at chance (WE, RG, and RK). A third subgroup did show differences in their performance patterns. JR was significantly worse on Agr compared to Tense (χ^2, $p = .03$) although her performance was partially impaired in both conditions. JK, on the other hand, showed the converse pattern as he was at chance on Tense and significantly better on Agr (χ^2, $p = .01$), where his performance was partially impaired. The patterns in these patients thus reveal a strong double dissociation between Tense and Agr, given that the differences were significant but performance on the best preserved task was subnormal, i.e., the dissociation was not a classical one (cf. Coltheart, 2001; Ellis & Young, 1996). A third patient (UW) showed a trend dissociation in favor of Tense, since the difference in his performance did not reach significance. Independent of the presence of dissociating patterns, a majority of the errors made by all patients consisted of copies of the source verb form (mean 19/33, 58%). A detailed error analysis for both conditions is given in Table 5B.

In the Tense condition, the control group performed virtually perfectly on both Past Tense and Present Tense with a mean accuracy score of 23.9/24 (100%, range:23–24) and 23.8/24 (99%, range: 22–24), respectively. Table 6 shows the mean score of the agrammatic group as well as the individual scores on past vs. present in the Tense condition. A statistical within-group comparison revealed that there was no preference for either of the two tenses as the difference between past and present tense did not reach significance (Wilcoxon test:

Table 5A
Agrammatic individual results, Tense vs. Agr, number (%) correct

	Tense ($n = 48$)	Difference from chance level** (χ^2 (df = 1), p =)	Performance level***	Agr ($n = 48$)	Difference from chance level (χ^2 (df = 1), p =)	Performance level	Dissociation
MP	46 (96%)	<.001	Normal	46 (96%)	<.001	Part. imp.	No
WR	40 (83%)	<.001	Part. imp.	41 (85%)	<.001	Part. imp.	No
JR	**44*** (92%)	<.001	Part. imp.	**36** (75%)	<.001	Part. imp.	Yes, strong: T > Agr
AF	44 (92%)	<.001	Part. imp.	44 (92%)	<.001	Part. imp.	No
JK	**24** (50%)	ns	Chance	**36** (75%)	<.001	Part. imp.	Yes, strong: Agr > T
UW	32 (67%)	.001	Part. imp.	24 (50%)	ns	Chance	Yes, trend: T > Agr
WE	25 (52%)	ns	Chance	18 (38%)	ns	Chance	No
RG	22 (46%)	ns	Chance	17 (35%)	ns	Chance	No
RK	17 (35%)	ns	Chance	12 (25%)	ns	Chance	No
Mean	32.7 (68%)	$t(8) = 4.53$, $p = .002$		30.4 (63%)	$t(8) = 3.38$, $p = .01$		
Range	17–46			12–46			

* Significant differences between the two conditions are bold (χ^2, $p < .05$).
** Chance level 16 (33,33%), chance range: 8–25, χ^2 (df = 1), $p > .05$.
*** Part. imp. = partially impaired: above chance and below two *SD* of the control mean.

Table 5B
Error classification in the Tense and Agr condition, number (%) errors

	Tense				Agr			
	Total	Distractor 1	Distractor 2		Total	Distractor 1	Distractor 2	
		Copy	Finite	Non-finite		Copy	Finite	Non-finite
MP	2	1 (50%)	1 (50%)	—	2	—	1 (50%)	1 (50%)
WR	8	8 (100%)	—	—	7	7 (100%)	—	—
JR	4	1 (25%)	—	3 (75%)	12	9 (75%)	1 (8%)	2 (17%)
AF	4	4 (100%)	—	—	4	4 (100%)	—	—
JK	24	24 (100%)	—	—	12	11 (92%)	—	1 (8%)
UW	16	11 (69%)	—	5 (31%)	24	19 (79%)	—	5 (21%)
WE	23	11 (48%)	1 (4%)	11 (48%)	30	12 (40%)	—	18 (60%)
RG	26	14 (54%)	1 (4%)	11 (42%)	31	13 (42%)	2 (6%)	16 (52%)
RK	31	15 (48%)	—	16 (52%)	36	5 (14%)	2 (6%)	29 (81%)
Mean	15.3	9.9 (65%)	0.3 (2%)	5.1 (33%)	17.6	8.9 (51%)	0.7 (4%)	8.0 (45%)

Table 6
Agrammatic individual results, Past vs. Present in the Tense condition, number (%) correct

	Past ($n = 24$)		Present ($n = 24$)	
	Corr	Difference from chance level* (χ^2 (df = 1), p =)	Corr	Difference from chance level (χ^2 (df = 1), p =)
MP	23 (96%)	<.001	23 (96%)	<.001
WR	20 (83%)	<.001	20 (83%)	<.001
JR	22 (92%)	<.001	22 (92%)	<.001
AF	21 (88%)	<.001	23 (96%)	<.001
JK	15 (63%)	.04	9 (38%)	ns
UW	16 (67%)	.02	16 (67%)	.02
WE	14 (58%)	ns	11 (46%)	ns
RG	10 (42%)	ns	12 (50%)	ns
RK	8 (33%)	ns	9 (38%)	ns
Mean	16.6 (69%)	$t(8) = 4.80$, $p = .001$	16.1 (67%)	$t(8) = 4.05$, $p = .004$
Range	8–23		9–23	

* Chance level (33,33%) = 8, chance range: 3–14, χ^2, $p > .05$.

$Z = .40$, $p > .05$). Individually, patients were either generally above chance (MP, WR, AF, JR, and UW) or generally at chance (WE, RG, and RK) with no significant differences between the two conditions. There was one exception, JK, who was above chance on past tense as opposed to chance performance on present tense. However, the difference did not reach significance (χ^2, ns). The control group performed almost perfectly in both conditions (Past: mean correct 23.9 (99.6%), $SD = .33$; Present: mean correct 23.8 (99%), $SD = .67$).

Within the Agr condition, the control group performed virtually perfectly on both Person and Number with a mean accuracy score of 24/24 (100%) and 23.9/24 (100%, range: 23–24), respectively. Table 7 represents the mean scores of the aphasic group as well as the individual results on person and number in the Agr condition. As a group, there was no significant difference between performances in the two conditions (within-group comparison: Wilcoxon test: $Z = 1.77$, $p > .05$). Individually, the agrammatic aphasics either performed generally above chance (MP, WR, JR, AF, and JK) or generally at chance (WE, RG, RK, and UW). The control group performed perfectly (100% correct) both on number and person.

4.5. Summary of results

Table 8 summarizes the results across conditions for the individual agrammatics. The nine agrammatic subjects showed three patterns of performance represented by three patients each. The first subgroup had no dissociations between Tense and Agr and performed overall above chance (MP, WR, and AF). In the second subgroup, Tense and Agr did not dissociate either but performance was not distinguishable from chance (WE, RG, and RK). The third subgroup showed patterns of dissociation (JR, UW, and JK). Performance was better for Tense than for Agr in JR and UW, a difference which reached significance for JR, even though she was above chance on both. The difference between above chance performance on Tense and chance performance on Agr did not reach significance for UW. Neither patient showed significant differences within Tense for past vs. present and within Agr for person vs. number. JK's performance, on the other hand, was significantly better for Agr, which was above chance, than for Tense, which was at chance. He was the only patient who showed a difference within Tense with chance performance on present but not on past tense.

Table 8
Summary of results

	Tense	Agreement	Tense		Agreement	
			Past	Present	Person	Number
MP	>	>	>	>	>	>
WR	>	>	>	>	>	>
AF	>	>	>	>	>	>
WE	=	=	=	=	=	=
RG	=	=	=	=	=	=
RK	=	=	=	=	=	=
JR	>*	>	>	>	>	>
UW	>	=	>	>	=	=
JK	=	>*	>	=	>	>

>, Above chance; =, at chance.
* Significant differences (χ^2, $p < .05$).

5. Discussion

Our general research question was whether the Tense–Agr dissociation which has been found in many studies can be replicated in German, whether the results would provide empirical support for the proposal in linguistic theory that there is a different ordering of functional elements in the syntactic tree in German compared to English, or whether a non-hierarchical representation of Tense and Agr should be preferred.

Given the group results, our findings do not support the assumption of a general Tense–Agr dissociation in agrammatism since there was no significant difference between Tense and Agr for the nine subjects as a group. The agrammatic subjects performed significantly worse than the control group on these functional elements indicating that Tense and Agr are equally impaired. Individually, however, there was no homogeneous pattern of performance. The performance pattern in six of nine patients indicated that Tense and Agr do not necessarily dissociate. The aphasic subjects were either generally above chance (3/9) or generally at chance (3/9). The performance pattern of the three patients who did show

Table 7
Agrammatic individual results, Person vs. Number in the Agr condition, number (%) correct

	Person ($n = 24$)		Number ($n = 24$)	
	Corr	Difference from chance level* (χ^2 (df = 1), p =)	Corr	Difference from chance level (χ^2 (df=1), p =)
MP	23 (96%)	<.001	23 (96%)	<.001
WR	22 (92%)	<.001	19 (79%)	.001
JR	17 (71%)	.009	19 (79%)	.001
AF	24 (100%)	—	19 (79%)	.001
JK	20 (83%)	<.001	16 (67%)	.02
UW	12 (50%)	ns	12 (50%)	ns
WE	11 (46%)	ns	7 (29%)	ns
RG	8 (33%)	ns	9 (38%)	ns
RK	7 (29%)	ns	5 (21%)	ns
Mean	16 (67%)	$t(8) = 3.62$, $p = .007$	14.3 (60%)	$t(8) = 3.01$, $p = .02$
Range	7–24		5–23	

* Chance level (33,33%) = 8, chance range: 3–14, χ^2, $p > .05$.

dissociations in their results did not provide evidence for a one-sided Tense–Agr dissociation in German agrammatics. In fact, for two of the three patients (JK, RK), there was a strong double dissociation between Tense and Agr, which is hard to reconcile with any hierarchical account.

Table 9 summarizes the predictions of hierarchically based hypotheses on the basis of different orderings of Tense and Agr in German and English as well as the findings in this study.

Given these results, our preliminary conclusion is that functional dissociations between Tense and Agr can occasionally be found in German but they are not one-sided and not obligatory. Moreover, given the strong double dissociation between Tense and Agr in the individual results, the impairment of functional elements cannot be straightforwardly related to their hierarchical position in the syntactic tree, in contrast to the proposals made by the TPH and Lee (2003). For the same reason, our results do not provide empirical evidence for a syntactic tree in German in which Agr is placed higher than Tense as opposed to English.

Our findings can better be interpreted within the framework of MP, which does not assume a hierarchical ordering of Tense and Agr nodes but treats Tense and Agr as different features within a single T-node. Furthermore, if the idea of underspecification of object representations is adopted, an explanation of the observed strong double dissociation follows quite naturally. In normal grammar, object underspecification—a term which is widely used in linguistic theory—leaves certain features of the represented object undecided (a value is neither positively nor negatively set), but it does so in a logical and economical way. Whereas originally, modes of underspecification were mainly referred to in semantics, recent developments suggest that underspecification also plays a crucial role in morphology or syntax. In morphology, e.g., underspecification applies in case of inflectional form redundancy or syncretism, i.e., identical forms in declensional or conjugational paradigms that do not contrast two word forms. It was proposed by some researchers (Bierwisch, 1967; Wunderlich & Fabri, 1995) that redundant forms do not have to be listed in an inflectional paradigm but that they are accounted for by assuming that the values of their morphosyntactic features are left unspecified. Psycholinguistic evidence for underspecified inflectional paradigms has been collected in a study by Penke, Janssen, and Eisenbeiss (2004). As for syntactic representations, the study of functional categories, agreement asymmetries, anaphors, and case-matching has provided some evidence that these can be underspecified too.

In the following, the idea will be adopted that underspecification of certain features also occurs in the agrammatic grammar. A similar proposal along these lines has been made by Wenzlaff and Clahsen (2004) in their TUH. According to TUH, Tense-features are especially prone to underspecification in agrammatism since Tense requires the establishment of an anaphoric relationship between the speech act and an event time in the discourse. Discourse related phenomena, on the other hand, have been found to be impaired in agrammatic aphasia, as was shown in the interpretation of non-reflexive pronouns (e.g., Ruigendijk & Avrutin, 2003). However, as already claimed for the hierarchical accounts, TUH is not able to capture the observation of a strong double dissociation between Tense and Agr which was reported before. This finding rather suggests that, in extension to the underspecification of the discourse related Tense-features, the locally interpretable Agr-features may also be selectively impaired in terms of underspecification, thus favoring a Tense–Agr Underspecification Hypothesis (TAUH). Since agrammatic underspecification is not systematic, as claimed before, it is not restrained in any way, e.g., in terms of semantic interpretability or discourse relatedness, in which case only Tense-features would be affected. According to TAUH, selective underspecification of either Tense or Agr leads to impaired Tense or Agr morphology, simultaneous underspecification of both features gives rise to

Table 9
Summary of predictions of different hypotheses and results with respect Tense–Agr dissociations

Linguistics	Neurolinguistic hypotheses					
Hierarchical order (GB)	TPH			Lee (2003)		
	Predictions	Evidenced by	Counterevidenced by	Predictions	Evidenced by	Counterevidenced by
German order: [Agr (Tense…)]	Tense > Agr	JR, UW	JK	Agr > Tense	JK	JR, UW
English order: [Tense (Agr…)]	Agr > Tense	JK	JR, UW	Tense > Agr	JR, UW	JK
Non-hierarchical order (MP)	TUH			TAUH		
	Predictions	Evidenced by	Counterevidenced by	Predictions	Evidenced by	
	Agr > Tense	JK	JR, UW	Agr > Tense	JK	
				Tense > Agr	JR, UW	
				Tense = Agr	MP, WR, AF, WE, RG, and RK	

a performance pattern in which both Tense and Agr are impaired. In some agrammatic subjects both features may generally remain relatively unimpaired, suggesting that underspecification of functional representations is not an obligatory symptom of agrammatism. The fact that features of a syntactic node are subject to underspecification (i.e., do not receive a plus–minus value) does not mean that this node does not project, thus yielding a pruned tree. In cases where there is a difficulty with T and/or Agr, the T/INFL-node does have features although underspecification does not constrain the set of possible specifications.

In sum, we conducted a study on the production of the functional categories Tense and Agr with German speaking agrammatic aphasics. Our results indicate that dissociations between Tense and Agr can be found in production, but not in a one-sided direction, contrary to what has been reported by Friedmann and Grodzinsky (1997) or Lee (2003). Moreover, the strong double dissociation between patients and tasks strongly suggest that impairments in functional elements cannot be linked to their hierarchical positions in the syntactic tree, in contrast to the assumptions made by the hierarchical hypotheses. They can better be accounted for by more recent linguistic frameworks such as MP, in which the difference between the two functional elements does not hinge on hierarchical positions and by adopting the idea of a possibly general or partial underspecification of object representations in agrammatism.

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