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Pronoun Comprehension in Aphasia: A Comparison of Three Languages

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The research reported here investigated the effect of phonological and syntactic factors on the processing of pronouns by aphasics. The comprehension of these "closed-class" elements was studied in three different languages: French, Dutch, and German. The cross-linguistic design made it possible to vary phonological status (clitic/nonclitic) and phrasal category (noun phrase/prepositional phrase) as well as grammatical relation (direct/indirect object) while keeping class membership (closed class) and meaning constant. A sentence–picture matching task was given to 20 German-speaking, 16 Dutch-speaking, and 14 French-speaking aphasics, half of each language group being classified as agrammatic Broca's and half as paragrammatic Wernicke's aphasics. The results suggest that Broca's aphasics' limitations in retrieving pronouns, and therefore other closed-class elements,

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are not a function of either phonological status, phrasal category, or grammatical relation. These subjects' observed high level of performance on pronouns in language comprehension appears due to the kind of semantic and syntactic information they encode. Our findings indicate that a more refined distinction than closed class vs. open class is necessary.

INTRODUCTION

The research reported here focuses on the question of how different types of linguistic information are used in language comprehension. The aim of our study is to test the assumption that different types of linguistic information (e.g., phonetic, phonological, syntactic, semantic, and pragmatic) are processed by different components of the parser. This is done by looking for evidence that lexical elements—here we examine pronouns—which show clear differences with respect to some of these types of information are affected differentially in language breakdown. Selective deficits in pronoun comprehension would be theoretically important, because this can help us to further investigate the proposed division of the lexicon into two types of lexical items: closed class–open class or function words–content words (Garrett, 1975). We believe that neither of these distinctions is fine-grained enough to account for the information that lexical items, in particular pronouns, encode. We hope, in looking at how these elements are treated, to refine the categories for describing aphasic syndromes and thereby allow for a clearer picture of the organization of the mental lexicon and its role in unimpaired language processing.

It has repeatedly been documented that, in aphasia, function words, e.g., determiners, pronouns, prepositions, as well as grammatical bound morphemes, like inflectional affixes, are particularly vulnerable across languages (Bates, Friederici, & Wulfeck, 1987). However, it is still unclear exactly *which* aspects of the information carried by these lexical elements are responsible for these processing difficulties. For example, one possibility is that syntactic differences between elements are what is responsible, i.e., the fact, for example, that certain lexical elements carry mainly syntactic information, like case or agreement, while others carry mainly semantic information.

Kean (1977, 1980, 1981) proposes another distinction between lexical items which she uses to characterize agrammatism. Following Chomsky and Halle (1968), she divides the lexical elements according to their phonological characteristics into two classes: a class of elements to which a word boundary is assigned on both sides (e.g., *#table#*), which includes the major lexical categories of noun, verb, and adjective, and a class of elements to which a word boundary is assigned only on one side, e.g., *##the#*table*##*, and which cannot take primary stress. This latter class mainly consists of elements of the minor lexical categories, such as determiners, conjunctions, etc. Those elements with word boundaries on

both sides Kean calls phonological words, the others she calls phonological nonwords or clitics.[1] It is on the basis of this Phonological Status that Kean (1979) defines agrammatism as a phonological impairment in which those elements which belong to the class of phonological words are retained, whereas those which belong to the class of (phonological) clitics are "omitted," and can, therefore, not be used during language processing. It should be noted that more recently Kean (1981) suggests that semantics may also effect the processing of phonological clitics.

Friederici (1982, 1985) produced evidence of agrammatic behavior contrary to the predictions one would make based either on the computational word class distinction or on the Phonological Status. Her results suggest that the so-called "closed class" should not be considered a homogeneous class: the same prepositional form was treated differently by agrammatics depending on whether it was a preposition with clear locative meaning (1) or a preposition, subcategorized by a verb, with no locative meaning (2).

(1) Peter steht *auf* dem Stuhl.
Peter stands on the chair.

(2) Peter hofft *auf* den Sommer.
Peter hopes for the summer.

Note, that in both (1) and (2), the preposition "auf" belongs to the closed class and functions as the head of its phrase. Moreover, according to Kean's definition the preposition in both instances is a phonological clitic. Thus the obtained results cannot be explained on the basis of the word class distinction (Bradley, 1978) nor within a phonological deficit theory as proposed by Kean (1977, 1981). Friederici (1982, 1985) argued that the agrammatics' performance is best described by a distinction between syntactic versus semantic information. The better performance of agrammatic patients on "semantic" prepositions may be attributable to differences in the amount of syntactic versus semantic information these items carry, that is, to the lexical structure of these elements. This view has recently been supported by a case of an agrammatic aphasic (Tyler and Cobb, 1987) who showed a processing dissociation between bound morphemes which carry primarily semantic information (derivational suffixes) and those which carry primarily syntactic information (inflectional suffixes).

The aim of the present study is to obtain further evidence for agrammatics' sensitivity to two types of linguistic factors, i.e., phonological and

[1] Although this distinction roughly coincides with the open/closed-class distinction, there are some cases where it does not. According to the proposed phonological descriptions, some closed-class elements are phonological words (e.g., two-syllable prepositions in English or tonic pronouns in French), whereas the majority of closed-class elements are phonological clitics (e.g., one-syllable prepositions in English and nontonic pronouns in French).

syntactic, processing a specific type of closed-class elements (personal pronouns). A number of studies have already focussed on semantic and anaphoric aspects of pronoun comprehension in aphasia (e.g., Grober and Kellar, 1981) as well as on semantic, syntactic, and morphological aspects (Blumstein, Goodglass, Statlender, & Biber, 1983), but none of them examined phonological factors. These, however, seem interesting, given current theories of agrammatism. On the basis of a strong version of the Phonological Deficit Hypothesis (Kean, 1977), one would predict performance differences for items of different phonological status, regardless of their class membership and lexical status. Nonclitic pronominal forms, which under Kean's hypothesis are phonological words, should be processed more easily by agrammatics than clitic pronominal forms. By contrast, from a view that takes word class (open vs. closed) as the critical distinction (Bradley, Garrett, & Zurif, 1980) or a view that stresses the lexical structure of the element (Friederici, 1982), pronominal elements should be processed independently of their phonological status.

A cross-linguistic comparison between French, Dutch, and German allows us to test the role of phonological and syntactic factors in the aphasics' comprehension performance. French, in particular, makes it possible to test the influence of the *Phonological Status*. French pronouns can be realized both as phonological clitics, i.e., clitic elements (1), and as phonological words, i.e., nonclitic elements (2).

(1) Il le *lui* montre.
He it to-him shows.

(2) Il le montre *à lui.*
He shows it to him.

The clitic/nonclitic distinction in French, however, is confounded with a number of other factors such as *Phrasal Category* (i.e., their realization within a prepositional phrase ($[_{PP}Prep[_{NP}Pro]]$) or as a bare noun phrase ($[_{NP}Pro]$)) and position (i.e., for the sentences examined here the position of the nonclitic element is sentence-final whereas that of the clitic one precedes the verb). These different factors, however, can be disentangled when French is compared with Dutch and German.

We will turn to the logic of the comparison of the different languages concerning the factors of *Phonological Status* below. Besides the (1) *Phonological Status* (clitic pronoun versus nonclitic pronoun) which has been proposed to influence aphasics' performance (Kean, 1977), there are a number of other factors which are likely to influence comprehension performance in aphasic subjects and which can be varied across the three languages.

These factors are (2) *Grammatical Relation* (indirect object pronoun versus direct object pronoun), with the prediction that direct object pronouns are easier to process than indirect object pronouns as the grammatical relation of the former to the verb is less complex, (3) *Phrasal Category* (pronominalized element realized as a bare noun phrase versus

TABLE 1
SCHEMATIC OVERVIEW OF FEATURES OF THE PRONOMINAL ELEMENTS IN THE THREE LANGUAGES TESTED

Grammatical relation		Languages				
		French		Dutch		German
Indirect object		à lui	lui	aan hem	hem	ihm
	Phonological status: nonclitic	+[+]	−[−]	+[−]	+[0]	+[+]
	Phrasal category: PP	+[+]	−[−]	+[+]	−[0]	−[−]
Direct object			le		hem	ihn
	Phonological status: nonclitic		−[−]		+[+]	+[+]
	Phrasal category: PP		+[+]		+[+]	+[+]

Note. Presence or absence of features is indicated by + or − (0 stands for not realizable); marks outside the brackets stand for pronouns in sentences where one object is pronominalized; marks in brackets stand for sentences where both elements are pronominalized. As examples of pronominal elements the third person singular masculine form is given for each language.

within a prepositional phrase), with the prediction that pronominal elements which are additionally marked by a preposition are easier to process than elements which are not locally marked (e.g., Frazier & Friederici, 1991), and (4) *Number of Pronouns* (one versus two pronominalized elements in the sentence). If aphasic subjects do have problems in processing pronominal elements, in general, then the pronominalization of two object noun phrases should decrease performance compared to one. Table 1 gives a schematic overview of the different factors evaluated in the pronominal system of French, Dutch, and German.

Examples of test items in the three different languages are given in Table 1 for the pronominal forms of third person, singular, masculine. The critical features for each of these elements are indicated in the table. In the following we will discuss the relevant features of the pronominal system of each language individually, starting with French. As already mentioned, French allows the realization of the indirect pronoun as a clitic (lui, leur) and as a nonclitic variant (à lui, à elle, à eux, à elles) (see Table 2).

For masculine singular the word form remains identical both in the clitic (lui) and in the nonclitic variant (à lui). For masculine plural (clitic:

TABLE 2
THE PRONOUN SYSTEM IN FRENCH, DUTCH, AND GERMAN

		Nominative	Dative (indirect object)	Accusative (direct object)
French				
Singular	masculine	il	lui / à lui	le
	feminine	elle	lui / à elle	la
Plural	masculine	ils	leur / à eux	les
	feminine	elles	leur / à elles	les
Dutch				
Singular	masculine	hij	(aan) hem	hem
	feminine	zij	(aan) haar	haar
Plural	masculine	zij	(aan) hen/hun	hen/hun
	feminine	zij	(aan) hen/hun (haar)	hen/hun
German				
Singular	masculine	er	ihm	ihn
	feminine	sie	ihr	sie
Plural	masculine	sie	ihnen	sie
	feminine	sie	ihnen	sie

leur, nonclitic: à eux) and feminine plural (clitic: leur, nonclitic: à elles) as well as for feminine singular (clitic: lui, nonclitic: à elle) the word form of the clitic realization differs from that of the nonclitic realization. As can be seen in Table 1, however, the *Phonological Status* of these pronominal elements is confounded with the factor of *Phrasal Category*. For example, the clitic variant of the indirect object pronoun in sentence (1) is realized as a bare noun phrase, whereas the nonclitic variant is realized within a prepositional phrase (2). Thus the French material alone would not allow to experimentally isolate the factor of the item's phonological status from the other factors.

Comparative analysis of French and Dutch, however, allows us to evaluate the role of these factors for aphasic performance. Dutch provides the possibility to test for the factor of *Phrasal Category* independent of *Phonological Status*. In Dutch, personal pronouns, according to Kean's definition, are phonological words, that is nonclitic elements and object pronouns can occur in prepositional phrases (3) and as noun phrases (4), both in postverbal position. Only the prepositional phrase appears in a sentence-final position.

(3) Hij toont het meisje *aan hem.*
He shows the girl to him.

(4) Hij toont *hem* het meisje.
He shows him the girl.

When both direct and indirect object noun phrases are pronominalized, indirect object pronouns, however, necessarily appear in a prepositional phrase (5) in a sentence-final position.

(5) Hij toont hem *aan hem.*
He shows him to him.

Thus comparison between French and Dutch still does not enable us to completely isolate the factor of *Phonological Status*, as the factor *Phrasal Category* is additionally confounded with the position of the pronoun. In French all pronouns which are realized in prepositional phrases are sentence-final in the type of simple sentences considered here. Thus the indirect nonclitic pronoun appears in a sentence-final position.

In order to evaluate the influence of the position of the pronoun on phrasal category, German was used as the third language for comparison. In German all pronouns are normally phonological words. In our material, indirect object pronouns are realized as sentence-final noun phrases as opposed to sentence-final prepositional phrases in French.[2]

(6) Er zeigt ihn *ihm.*
He shows him to-him.

(7a) Er zeigt *ihn* dem Polizisten.
He shows him to the policeman.

(7b) Er zeigt *ihm* den Polizisten.
He shows to-him the policeman.

The cross-linguistic comparison discussed here provided the possibility to study the factors of Grammatical Relation, Phrasal Category, and the role of an item's phonological and lexical status for agrammatics' comprehension. Although the planned comparison was sufficient to disentangle the critical factors confounded in French, there was one additional factor which could not be controlled experimentally in the three languages—form ambiguity. In all three languages there are pronominal forms which are ambiguous with respect to number, gender, and case (see Table 2). It should be noted that in addition to such ambiguity within the pronoun system, the French pronoun system contains three forms which are plurifunctional in that the forms *le, la,* and *les* can either function as a pronoun (him, her, them) or as a definite article (*le* garçon, *la* fille, *les* enfants: the boy, the girl, the children). The test materials, however, were chosen such that linguistically ambiguous forms were disambiguated

[2] Although in German the order of the two object pronouns is not fixed in principle, the order direct > indirect object is the unmarked order, since the order indirect > direct object can only be used when the direct object pronoun is stressed.

(1) Er zeigt *ihm* ihn.
He shows to-him him.

The study reported here only used sentences of the unmarked type with indirect objects occurring in a sentence-final position as in (6). Sentences with one object pronoun and one full noun phrase require a pronoun > noun order (7a and 7b).

by the picture materials which were presented along with the test sentences.

Ignoring the problem of Form Ambiguity for the present, the predictions are the following: if the Phonological Status alone is relevant for agrammatics' performance on closed-class elements, French-speaking agrammatic aphasics should process nonclitic pronominal elements more easily during sentence comprehension than their clitic variants. In those languages where pronouns are generally realized as phonological words, comprehension performance for these elements should be better than for French where they are realized as clitics.

If other factors—Grammatical Relation or Phrasal Category—interact with the factor of Phonological Status, then the comparison of the different performance patterns in the three languages will be able to shed some light upon this interaction. If processing of closed-class elements in general is problematic for aphasics, then the factor Number of Pronouns should show its effect in all three languages equally.

METHOD

Materials

A sentence–picture matching task was used in all three languages. The language materials will be discussed for each language individually. We start with German which, with respect to the factors tested here, has the least complex pronoun system.

German. The German material consisted of 20 test sentences. In half of these, one object noun phrase was a pronoun; in the other half, two objects were pronouns. In half of the sentences with one pronominal element, this element was the direct object (8); in the other half, it was the indirect object (9). For the complete German material see Appendix I-a.

(8) Der Junge zeigt *ihn* dem Polizisten.
The boy shows him to the policeman.

(9) Der Junge zeigt *ihm* den Polizisten.
The boy shows to-him the policeman.

The processing of the direct and indirect objects was tested by using picture material constructed such that the distractor picture differed from the corresponding sentence with respect to either the direct object or the indirect object in gender and/or number. Appendix I-a lists the critical features of the distractor pictures.

Dutch. Dutch—like English—differs from German in that it allows two different constructions for indirect object pronouns. The indirect object pronoun can either appear in a prepositional phrase (11) or not (12). Direct object pronouns appear as noun phrases (13).

(11) De jongen toont de politieagent *aan hem.*
The boy shows the policeman to him.

(12) De jongen toont *hem* de politieagent.
The boy shows to-him the policeman.

(13) De jongen toont *hem* aan de politieagent.
The boy shows *him* to the policeman.

When both objects are pronominalized as in (14), the indirect object pronoun obligatorily appears in a prepositional phrase.

(14) De jongen toont hem *aan hem.*
The boy shows him to him.

A total of 25 sentences was constructed (see Appendix I-b). In 15 of these, one noun

phrase was pronominalized, 5 of these with direct pronouns and 10 sentences with indirect object pronouns; in 5 of the latter, the pronoun appeared in a prepositional phrase and in the other 5, it did not. In the 10 remaining sentences both object noun phrases were pronominalized (indirect object pronoun always in prepositional phrase).

French. In French, indirect object pronouns can either appear preverbally as clitic elements (15) or postverbally in a prepositional phrase (16).

(15) Le garçon *lui* montre le policier.
The boy *to-him* shows the policeman.

(16) Le garçon montre le policier *à lui.*
The boy shows the policeman to him.

Note that the latter realization is predominantly used in spoken and not in written language unless the pronoun is contrastively marked. Direct object pronouns are always realized as preverbal clitic elements (17).

(17) Le garçon *le* montre au policier.
The boy *him* shows to the policeman.

The French material consisted of a total of 30 sentences (see Appendix I-c), half of which contained one pronoun, and half of which contained two pronouns. In each of these sets of 15 sentences, 5 sentences tested for clitic direct object pronouns, 5 sentences for clitic indirect object pronouns, and 5 sentences for nonclitic indirect object pronouns.

Procedure

The procedure was the same for all the languages. Sentences were read to the patients in their native language. The patient was required to choose from a set of two pictures. One of the pictures represented the sentence correctly and the other differed from it with respect to the number and/or gender marking of the pronominalized element. The critical features of the distractors are marked in Appendix Ia–c. The test was usually performed within half an hour. After the task was explained to the subject, the subject performed on five examples, two of which did not contain pronominalized elements but rather full noun phrases. The test procedure began when the subject performed correctly on three of the five examples. Correct and incorrect responses were recorded.

Subjects

The subjects were 20 German-speaking aphasics (10 agrammatic Broca patients and 10 paragrammatic Wernicke patients), 16 Dutch-speaking aphasics (8 agrammatic Broca patients and 8 paragrammatic Wernicke patients), and 14 French-speaking aphasics (7 agrammatic Broca patients and 7 paragrammatic Wernicke patients). German and Dutch patients were classified according to the German version of the Aachen Aphasia Test (AAT) (Huber, Poeck, Weniger, & Willmes, 1983) and a Dutch version which was constructed in analogy to the German version (Graetz, de Bleser, Willmes, & Heeschen, 1991). In the absence of a French version of this same test we used the Examen Linguistique de l'Aphasie (Nespoulous, Dordain, Perron, Ska, Bub, Caplan, Mehler, & Lecours, 1985) for patient classification. In order to allow comparisons between patients of different language backgrounds, individual comprehension scores as well as scores of the Token Test are listed in Tables 3-a–3-c. Note that the AAT uses the shortened version of the Token Test (Orgass, 1976), whereas French patients were tested with the original version (De Renzi and Vignolo, 1962). Individual patient histories are also listed in Table 3 (a–c).

The German-speaking aphasics were nonhospitalized patients from the Berlin and Aachen area. Patients in Aachen were contacted through the Neurology Department of the TH (Technische Hochschule) Aachen. Dutch-speaking aphasics were taken from a patient pool built up during the aphasia project at the Max-Planck-Institut and the Neurology Department of the University of Nijmegen. French-speaking aphasics were contacted through the Centre Hospitalier Côte-des-Neiges at Montreal. All patients were native speakers of the particular

TABLE 3-a
INDIVIDUAL PATIENT HISTORY (GERMAN)

Subject	Sex	Age	Onset	Etiology	Classification	Token Test (error)	Comprehension score AAT (max. 120)
PR	M	63	80	CVA	Broca	33	86
RE	F	43	76	CVA	Broca	28	48
DI	F	44	76	CVA	Broca	28	60
LA	F	55	82	CVA	Broca	28	90
JU	F	46	79	CVA	Broca	20	87
WI	F	53	82	CVA	Broca	18	85
WA	F	32	77	Trauma	Broca	15	96
BA	F	60	82	CVA	Broca	10	111
KN	M	69	75	CVA	Broca	4	84
TH	M	54	80	CVA	Broca	4	104
OR	F	49	84	CVA	Wernicke	46	74
BR	M	65	81	CVA	Wernicke	43	64
GE	F	52	77	Trauma	Wernicke	36	72
EI	M	64	79	CVA	Wernicke	34	89
DI	M	62	82	CVA	Wernicke	28	81
PE	M	72	82	CVA	Wernicke	24	62
SI	M	51	80	CVA	Wernicke	24	102
HA	F	70	78	CVA	Wernicke	22	85
BÖ	F	44	76	Trauma	Wernicke	17	74
HI	M	74	80	CVA	Wernicke	11	80

language they were tested in. This was also true for the patients contacted at Montreal, most of whom had no or only minimal knowledge of English. The test in Montreal was conducted by a native speaker of the French variant spoken in this area.

RESULTS

French

The mean percentages of correct responses for French-speaking aphasics are displayed in Table 4-a.

Broca's aphasics' overall performance was significantly above chance ($t(6) = 5.61$, $p < .01$) as was the overall performance of Wernicke's aphasics ($t(6) = 9.33$, $p < .001$). The analysis of variance with the factors *Clinical Group* (Broca/Wernicke) × *Number of Pronouns* (one/two) × *Condition* (with three levels, clitic direct object/clitic indirect object/nonclitic indirect object) revealed a significant main effect of *Number of Pronouns*, $F(1, 12) = 6.97$, $p < .05$, with better performance on sentences containing two pronouns. No other main effect of interaction was significant.

Since the factor of *Phonological Status* is partly confounded with the factor of *Grammatical Relation*, a separate analysis was conducted in order

TABLE 3-b
INDIVIDUAL PATIENT HISTORY (DUTCH)

Subject	Sex	Age	Onset	Etiology	Classification	Token Test (error)	Comprehension score AAT (max. 120)
DR	M	50		CVA	Broca	35	82
SO	M	64		CVA	Broca	28	70
WE	M	70		CVA	Broca	25	86
ZO	F	66		CVA	Broca	22	85
HO	F	60		CVA	Broca	19	92
VS	M	67		CVA	Broca	19	101
KA	M	50		CVA	Broca	16	89
SE	M	64		CVA	Broca	6	82
HE	M	64		CVA	Wernicke	39	45
VE	F	73		CVA	Wernicke	35	70
VL	F	70		CVA	Wernicke	32	63
JA	F	66		CVA	Wernicke	30	67
KA	M	69		CVA	Wernicke	26	60
KE	F	73		CVA	Wernicke	22	93
RI	M	64		CVA	Wernicke	22	98
RO	M	65		CVA	Wernicke	8	84

to test for the factor of *Phonological Status*. The analysis involved the factors *Clinical Group* (Broca/Wernicke) × *Number of Pronouns* (one/two) × *Phonological Status* (clitic indirect object/nonclitic indirect object). This analysis revealed a main effect of *Number of Pronoun*, $F(1, 12) = 6.82$, $p < .05$. No other main effect was significant.

Dutch

The mean percentages of correct responses for Dutch-speaking aphasics are displayed in Table 4-b.

Broca's aphasics' overall performance was significantly above chance ($t(7) = 13.0$, $p < .001$), whereas Wernicke's aphasics' overall performance did not exceed chance level $t(7) = 1.73$). The analysis of variance with the factors *Clinical Group* (Broca/Wernicke) × *Number of Pronouns* (one/two) × *Grammatical Relation* (direct object/indirect object with preposition), skipping the condition of one pronoun indirect object without preposition, revealed a significant main effect of *Grammatical Relation* ($F(1, 14) = 6.95$, $p < .05$) and a marginally significant effect of *Clinical Group* ($F(1, 14) = 3.21$, $p = .095$). There was also a marginally significant interaction between the factors of *Clinical Group* and *Grammatical Relation* ($F(1, 14) = 4.07$, $p = .064$). Separate analysis of the different *Clinical Groups* revealed that the main effect of *Grammatical Relation* was only significant for Wernicke's aphasics ($F(1, 7) = 15.29$, $p < .01$),

TABLE 3-c
INDIVIDUAL PATIENT HISTORY (FRENCH)

Subject	Sex	Age	Onset	Etiology	Classification	Token Test (error)
CH	M	46	82	CVA	Broca	42
LO	F	65	84	CVA	Broca	36
SL	M	73	—	CVA	Broca	26
QU	F	30	80	CVA	Broca	26
TH	F	40	83	CVA	Broca	16
AU	M	39	83	CVA	Broca	15
LE	F	61	84	CVA	Broca	—*
BE	M	55	—	CVA	Wernicke	23
GE	M	58	84	CVA	Wernicke	21
VI	M	58	63	CVA	Wernicke	21
BL	M	58	82	CVA	Wernicke	4
GL	M	56	81	CVA	Wernicke	4
MU	M	63	84	CVA	Wernicke	—*
VA	M	62	83	CVA	Wernicke	—*

* For these patients no Token Test data but only the Comprehension scores of the *Examen Linguistique de l'Aphasie* (Nespoulous et al.) are available.

LE:	one-word level	4/5
	simple sentences	2/3
	complex sentences	—
MU:	one-word level	5/5
	simple sentences	2/3
	complex sentences	4/5
VA:	one-word level	5/5
	simple sentences	4/5
	complex sentences	3/5

indicating that Wernicke's aphasics processed indirect pronouns better than direct pronouns. Since in this test the factor of *Grammatical Relation* is confounded with *Phrasal Category*, a further test involving only sentences with one pronoun was conducted to examine the effect of *Phrasal*

TABLE 4-a
PERCENTAGE OF CORRECT RESPONSES FOR FRENCH-SPEAKING APHASICS*

	One pronoun			Two pronouns		
	Direct object clitic	Indirect object clitic	Indirect object nonclitic	Direct object clitic	Indirect object nonclitic	Indirect object nonclitic
Broca (N = 7)	82.9	68.6	77.1	88.6	68.6	88.6
Wernicke (N = 7)	88.6	85.7	85.7	88.6	94.3	94.3

* For individual patient data see Appendix II-a.

TABLE 4-b
PERCENTAGE OF CORRECT RESPONSES FOR DUTCH-SPEAKING APHASICS*

	One pronoun			Two pronouns	
	Direct object	Indirect object	Indirect object (+ prep.)	Direct object	Indirect object (+ prep.)
Broca (N = 8)	72.5	80.0	77.5	72.5	72.5
Wernicke (N = 8)	47.5	57.5	75.0	55.0	65.5

* For individual patient data see Appendix II-b.

Category. The comparison between indirect pronoun as noun phrase and indirect pronoun as prepositional phrase revealed no significant effect either for Broca or for Wernicke patients. Although the difference between the performance of indirect pronoun as a noun phrase (58% correct) and indirect pronoun as a prepositional phrase (75% correct) for Wernicke patients is considerable, it does not reach significance (p = .18). A second test was conducted to test for the factor of *Grammatical Relation* at the level of one pronoun. The test involved direct object pronouns and indirect object pronouns as noun phrases. There was no significant difference in performance either for Broca patients or for Wernicke patients.

German

The mean percentages of correct performance for German-speaking aphasics in the different conditions are displayed in Table 4-c.

A first analysis tested whether these patients' performance was significantly different from chance. Broca's aphasics' overall performance was well above the chance level of 50% ($t(9)$ = 3.3, $p < .05$), whereas Wernicke's aphasics only performed marginally above chance ($t(9)$ = 2.7, $p < .07$).

An analysis of variance with the factors *Clinical Group* (Broca/Wernicke) × *Number of Pronouns* (one/two) × *Grammatical*

TABLE 4-c
PERCENTAGE OF CORRECT RESPONSES FOR GERMAN-SPEAKING APHASICS*

	One pronoun		Two pronouns	
	Direct object	Indirect object	Direct object	Indirect object
Broca (N = 10)	72.0	70.0	54.0	60.0
Wernicke (N = 10)	58.0	76.0	54.0	78.0

* For individual patient data see Appendix II-c.

Relation (direct object/indirect object) did not reveal any significant main effect or interaction.

DISCUSSION

The present study sought to examine the role of phonological and syntactic factors in aphasics' comprehension. The different factors tested did not dramatically influence pronoun comprehension in Broca's nor in Wernicke's aphasics.

French was the primary language for evaluating phonological status. In this language, pronouns can be realized as clitic and as nonclitic variants. Since the distinction between these variants based on phonological features is confounded with other factors, such as phrasal category and position, two additional languages which varied the two latter factors independently of the former were used for comparison with the aim of thereby determining the role of phonological status. Kean's prediction that phonological nonwords, here clitics, should be harder to process than phonological words was not borne out. Instead, the present findings suggest that the *Phonological Status* of a given element alone does not suffice to predict agrammatic Broca's aphasics' comprehension.[3]

The factor of *Grammatical Relation* also does not influence pronoun comprehension in particular. For no group or condition did we find an advantage of direct object pronoun performance over indirect object pronoun performance.

The factor of *Phrasal Category* also did not show a major impact on aphasics' pronoun comprehension. Pronouns inside NPs and PPs were treated alike.

The item's Position could not be varied independently of other factors within French. This is why we planned a cross-linguistic comparison with German. But the French data alone suggest that preverbal pronouns are not harder to process than postverbal pronouns, as predicted by a theory which holds that an argument's canonical position is relevant to how it is processed. Sentence-final elements were not processed markedly better than nonsentence-final elements across the different languages. Performance of pronoun comprehension, in general, was high across languages and conditions. This is also reflected by a lack of a difference between performance on one-pronoun and two-pronoun sentences.

Form ambiguity—one other aspect that might be considered in discussing the present data—also does not seem to affect aphasics' performance. Those French pronouns, the forms of which are ambiguous with respect to their function (pronoun/article), are not harder to comprehend than the pronominal forms of the other languages. The data suggest that

[3] Although language production may be affected by an element's Phonological Status, Nespoulous et al. (in press) found that French agrammatic aphasics are more likely to produce nonclitic (strong) than clitic (weak) pronouns.

plurifunctionalism of a given form does not affect adult aphasics' performance. A similar study with children had shown that this factor is of some influence during language acquisition (Weissenborn, Kail, & Friederici, 1990).

The present data show that Broca's aphasics, generally characterized by their limitations in retrieving a closed-class element's syntactic information, such as argument, case, and categorical features, are able to recognize at least the semantic characteristics (e.g., +animate, +masculine) of pronouns, typically considered in the closed class, quite well in comprehension as tested by a sentence–picture matching task.

These results agree with earlier findings of pronoun comprehension performance in aphasics. One study which examined processing of open- and closed-class elements in English gave the first hints that agrammatic Broca patients process pronouns better than other elements of the closed class (Zurif & Caramazza, 1976). Zurif and Caramazza (1976) attributed the observed performance for pronouns to the lexical–semantic status of these elements. Blumstein et al. (1983) found that aphasics' performance for pronoun comprehension in English decreased dramatically when only syntactic cues were available. Their pronoun findings and our results from three languages, however, can be reconciled with Friederici's (1985) findings on prepositions (discussed in (1–2) above) and with findings on morphology (Tyler & Cobb, 1987) by a view which considers the lexical–semantic *and* the syntactic information encoded in certain closed-class elements, as Friederici's (1985) account does.

Within a computational framework that assumes different processing systems for lexical–semantic and syntactic information, she argued that processing of these different linguistic aspects can be disrupted selectively even when both types of information are carried by the same element. What seems important for a particular closed-class element to be processed successfully in comprehension is the item's lexical status.

In sum, both phonological status and the closed/open-class distinction provide rough characterizations of the classes that lexical items fall into. However, further research is showing that these divisions are too coarse-grained. The level—inside lexical items—where syntactic and semantic information is represented seems to be the relevant one for processing.

APPENDIX

Test Sentences

Person(s) to which the critical pronoun (underlined) refers in the picture material is indicated in parentheses below each sentence: The first noun indicates the correct corresponding picture and the second noun represents the distractor picture. The dimension along which the distractors differ from the correct answer is indicated after each sentence by N = Number, G = Gender and NG = Number and Gender.

Appendix I-a: German Test Sentences

One Pronoun

Direct object

1. Der Junge zeigt *ihn* dem Polizisten. (1 Clown / 2 Clowns)	N
2. Der Koch zeigt *ihn* dem Skifahrer. (1 Doktor / 1 Tänzerin)	G
3. Die Tänzerin zeigt *sie* der Indianerin. (2 Königinnen / Königin)	NG
4. Die Fee zeigt *sie* der Hirtin. (1 Verkäuferin / 1 Mann)	G
5. Der Motorradfahrer zeigt *sie* dem Holzfäller. (2 Feuerwehrmänner / 1 Feuerwehrman)	N

Indirect object

6. Die Tänzerin zeigt *ihnen* die Indianerin. (2 Königinnen / 1 Königin)	N
7. Die Hexe zeigt *ihr* die Braut. (1 Krankenschwester / 2 Krankenschwestern)	N
8. Der Motorradfahrer zeigt *ihm* den Feuerwehrmann. (1 Holzfäller / 2 Indianerinnen)	NG
9. Der Astronaut zeigt *ihr* den Clown. (1 Braut / 2 Polizisten)	NG
10. Der Astronaut zeigt *ihr* den Seeräuber. (1 Frau / 2 alte Männer)	NG

Two Pronouns

Direct object

11. Der König zeigt *sie* ihm (Bandit). (2 Mädchen / 1 Mann)	NG
12. Der Astronaut zeigt *ihn* ihm (Bandit). (1 Pirat / 1 Dame)	G
13. Der Koch zeigt *sie* ihm (Skiläufer). (2 Doktoren / 1 Doktor)	N
14. Der König zeigt *sie* ihm (Bandit). (1 Mädchen / 1 Mann)	G
15. Der Matrose zeigt *ihn* ihm (Indianer). (1 Polizist / 2 Polizisten)	N
16. Der kleine Junge zeigt sie (2 Clowns) *ihnen.* (2 Mädchen / 1 Mädchen)	N
17. Die Köchin zeigt ihn (Mann) *ihr.* (1 Dame / 2 Clowns)	NG
18. Die Sängerin zeigt sie (Lehrerin) *ihm.* (1 Mann / 2 Verkäuferinnen)	NG

19. Die Fee zeigt *sie* (Verkäuferin) ihr. N
(1 Hirtin / 2 Hirtinnen)
20. Die Hexe zeigt sie (2 Bräute) *ihnen.* NG
(2 Männer / 1 Krankenschwester)

Appendix I-b: Dutch Test Sentences

One Pronoun

Direct object

1. De danseres toont *haar* aan het indianenmeisje.
(koningin / koninginnen) N
2. De fee toont *haar* aan de verkoopster.
(bruid / man) G
3. De kok toont *hem* aan de skiër.
(dokter / danseressen) NG
4. De danseres toont *hen* aan de houthakker.
(koninginnen / koningin) N
5. De visser toont *hen* aan de houthakker.
(brandweer / verpleegster) NG

Indirect object

6. De visser toont *hem* de brandweerman.
(houthakker / houthakkers) N
7. De kok toont *hem* de dokter.
(skiër / bruid) G
8. De heks toont *haar* de bruid.
(verpleegster / houthakkers) NG
9. De ruimtevaarder toont *hun* de zeerover.
(oude mannen / oude man) N
10. De heks toont *hun* de bruid.
(verpleegsters / houthakker) NG

Indirect object (plus preposition)

11. De moeder toont de kleine meisjes *aan haar.*
(secretaresse / secretaresses) N
12. De zangeres toont de lerares *aan haar.*
(zwemster / man) G
13. De matroos toont de cowboy *aan hem.*
(opperhoofd / dames) NG
14. De zangeres toont de lerares *aan hun.*
(zwemster / zwemsters) N
15. De jongen toont de clown *aan hun.*
(agenten / indianenmeisje) NG

Two Pronouns

Direct object

16. De fee toont *haar* aan haar (bruid).
(verkoopster / verkoopsters) N

17. De visser toont *haar* aan hem (brandweerman). (verpleegster / houthakker) G
18. De ruimtevaarder toont *hem* aan hem (oude man). (zeerover / dames) NG
19. De moeder toont *hen* aan haar (secretaresse). (kleine meisjes / kleine meisje) N
20. De jongen toont *hen* aan hem (agent). (clowns / indianenmeisje) NG

Indirect object

21. De koningin toont haar (kleine meisje) *aan hem.* (dief / dieven) N
22. De matroos toont hem (agent) *aan hem.* (opperhoofd / zwemster) G
23. De ruimtevaarder toont hem (oude man) *aan hem.* (zeerover / dames) NG
24. De koning toont haar (kleine meisje) *aan hun.* (dieven / dief) N
25. De ruimtevaarder toont hem (zeerover) *aan hun.* (kleine meisjes / oude man) NG

Appendix I-c: French Test Sentences

One Pronoun

Direct object (clitic)

1. La danseuse *la* montre à l'indienne. (reine / reines) N
2. La fée *la* montre à la marchande. (mariée / monsieur) G
3. Le cuisinier *le* montre au skieur. (docteur / danseuses) NG
4. La danseuse *les* montre à l'indienne. (reines / reine) N
5. Le pêcheur *les* montre au bûcheron. (pompiers / infirmière) NG

Indirect object (clitic)

6. *Le pêcheur lui* montre le pompier. (bûcheron / bûcherons) N
7. La mère *lui* montre la petite fille. (bergère / bergères) N
8. La sorcière *lui* montre la mariée. (infirmière / bûcherons) NG
9. Le cosmonaute *leur* montre le pirate. (grand-pères / grand-père) N
10. La sorcière *leur* montre la mariée. (infirmières / bûcheron) NG

Indirect object (nonclitic)

11. Le cuisinier montre le docteur *à elle.* G
(mariée / skieur)
12. La chanteuse montre la maîtresse *à elle.* G
(nageuse / monsieur)
13. Le marin montre le cowboy *à lui.* NG
(indien / dames)
14. La chanteuse montre la maîtresse *à elles.* NG
(nageuses / monsieur)
15. Le garçon montre le clown *à eux.* NG
(agents / indienne)

Two Pronouns

Direct object (clitic)

16. La fée *la* lui (mariée) montre. N
(marchande / marchandes)
17. Le pêcheur *la* lui (pompier) montre. G
(infirmière / bûcheron)
18. Le cosmonaute *le* lui (grand-père) montre. NG
(pirate / dames)
19. La mère *les* lui (bergère) montre. N
(petites filles / petite fille)
20. Le garçon *les* lui (agent) montre. NG
(clowns / indienne)

Indirect object (clitic)

21. Le roi la (petite fille) *lui* montre. N
(bandit / bandits)
22. Le marin le (agent) *lui* montre. G
(indien / dame)
23. Le cuisinier le (monsieur) *lui* montre. NG
(dame / pirates)
24. Le roi la (petite fille) *leur* montre. N
(bandits / bandit)
25. Le cosmonaute le (pirate) *leur* montre. NG
(petites filles / grand-père)

Indirect object (nonclitic)

26. Le roi la (petite fille) montre *à lui.* N
(bandit / bandits)
27. Le marin le (agent) montre *à lui.* G
(indien / nageuse)
28. Le cuisinier le (monsieur) montre *à elle.* NG
(dame / pirates)
29. Le roi la (petite fille) montre *à eux.* N
(bandits / bandit)
30. Le cosmonaute le (pirate) montre *à elles.* NG
(petites filles / grand-père)

Appendix II-a: Number of Correct Responses for French-Speaking Patients

	One pronoun			Two pronouns		
	Direct object clitic	Indirect object clitic	Indirect object nonclitic	Direct object clitic	Indirect object clitic	Indirect object nonclitic
Broca (N = 7)						
CH	3	2	5	3	2	4
LO	4	3	3	4	4	5
SL	2	2	3	4	2	4
AU	5	5	4	5	4	5
TH	5	4	5	5	4	5
AN	5	4	5	5	5	5
LE	5	4	2	5	3	3
Wernicke (N = 7)						
BE	3	2	4	3	4	4
GE	3	4	4	3	5	4
VI	5	5	5	5	5	5
BL	5	4	4	5	4	5
CL	5	5	4	5	5	5
MU	5	5	4	5	5	5
VA	5	5	5	5	5	5

Appendix II-b: Number of Correct Responses for Dutch-Speaking Patients

	One pronoun			Two pronouns	
	Direct object	Indirect object	Indirect object (+ prep.)	Direct object	Indirect object (+ prep.)
Broca (N = 8)					
DR	4	2	3	4	5
SO	2	4	3	2	3
WE	1	4	4	4	4
ZO	4	4	4	3	3
HO	5	5	4	4	5
VS	5	5	4	5	5
KA	4	5	5	3	3
SE	4	3	4	4	1

Wernicke (N = 8)					
HE	3	1	5	2	1
VE	2	5	4	2	4
VL	2	3	2	2	4
JA	2	2	4	2	3
KA	5	4	5	4	5
KE	1	2	3	4	2
RI	2	2	3	3	3
RO	2	4	4	3	4

Appendix II-c: Number of Correct Responses for German-Speaking Aphasics

	One pronoun		Two pronouns	
	Direct object	Indirect object	Direct object	Indirect object
Broca (N = 10)				
PR	4	5	2	4
RE	4	3	4	1
DI	2	1	2	3
LA	2	3	3	3
JU	2	3	3	2
WI	4	5	3	3
WA	4	3	1	4
BA	4	4	3	4
KU	5	4	3	3
TH	5	4	3	3
Wernicke (N = 10)				
OR	4	2	2	5
BR	3	4	3	3
GE	1	4	2	4
EI	3	5	2	4
DI	4	4	3	4
PE	2	2	3	3
SI	2	2	3	3
HA	4	5	1	5
BÖ	2	5	5	4
HI	4	3	3	4

REFERENCES

Bradley, D. C. 1978. *Computational distinction of vocabulary type.* Unpublished doctoral dissertation, MIT Press, Cambridge, MA.

Bradley, D., Garrett, M., & Zurif, E. 1980. Syntactic deficits in Broca's aphasia. In D. Caplan (Ed.), *Biological studies of mental processes.* Cambridge, MA: MIT Press.

Bates, E., Friederici, A., & Wulfeck, B. 1987. Grammatical morphology in aphasia: Evidence from three languages. *Cortex,* **23,** 545–574.

Blumstein, S. E., Goodglass, S., Statlender, S., & Biber, C. 1983. Comprehension strategies determining reference in aphasia: A study of reflexivation. *Brain and Language,* **18,** 115–125.

Chomsky, N., & Halle, N. 1968. *The sound pattern of English.* New York: Harper & Row.

De Renzi, E., & Vignolo, L. A. 1962. The Token Test: A sensitive test to detect receptive disturbances in aphasia. *Brain,* **85,** 556–678.

Frazier, L., & Friederici, A. 1991. On deriving the properties of agrammatic comprehension. *Brain and Language,* **40,** 51–66.

Friederici, A. 1982. Syntactic and semantic processes in aphasic deficits: The availability of prepositions. *Brain and Language,* **15,** 249–258.

Friederici, A. 1985. Levels of processing and vocabulary types: Evidence from on-line comprehension in normals and agrammatics. *Cognition,* **19,** 133–166.

Garrett, M. F. 1975. The analysis of sentence production. In G. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory.* New York: Academic Press. Vol. 9.

Graetz, P., de Bleser, R., Willmes, K., & Heeschen, C. 1991. *De Akense Afasietest (AAT): Constructie van de Nederlandstalige versie.* (The Aachen aphasia test (AAT): Construction of the Dutch version.) Unpublished manuscript, Max-Planck-Institut, Nijmegen.

Grober, E., & Kellar, L. 1981. Semantic influences on pronoun assignment in aphasia. *Applied Psycholinguistics,* **2,** 253–268.

Huber, W., Poeck, K., Weniger, D., & Willmes, K. 1983. *Aachner Aphasie Test.* Göttingen: Hogrefe.

Kean, M.-L. 1977. Linguistic interpretation of aphasia syndromes. *Cognition,* **5,** 9–46.

Kean, M.-L. 1979. Agrammatism: A phonological deficit? *Cognition,* **7,** 69–84.

Kean, M.-L. 1980. Grammatical representation and the description of language processing. In D. Caplan (Ed.), *Biological studies of mental processes.* Cambridge, MA: MIT Press.

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

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

Nespoulous, J.-L., Dordain, M., Perron, C., Ska, B., Bub, D., Caplan, D., Mehler, J., & Lecours, A. R. 1985. *Agrammatism in sentence production without comprehension deficits: Reduced availability of syntactic structures and/or of grammatical morphemes? A case study.* Théophile-Alajouanine Laboratory working papers.

Nespoulous, J.-L., Lecours, A. R., Puel, M., Lafond, D., Lemay, A., Puel, M., Joanette, Y., Cot, F., & Rascol, A. (in press). *Protocole Montréal-Toulouse d'examen linguistique de l'aphasie.* Montréal: Didier.

Orgass, B. 1976. Eine Revision des Token Test. Part I and II. *Diagnostica,* **22,** 70–87, 141–156.

Tyler, L., & Cobb, H. 1987. Processing bound grammatical morphemes in context: The case of an aphasic patient. *Language and Cognitive Processes,* **2,** 245–262.

Weissenborn, J., Kail, M., & Friederici, A. 1990. Language-particular or language-independent factors in acquisition? Children's comprehension of object pronouns in Dutch, French and German. *First Language,* **10,** 141–166.

Zurif, E., & Caramazza, A. 1976. Psycholinguistic structures in aphasia: Studies in syntax and semantics. In H. Whitaker & H. A. Whitaker (Eds.), *Studies in neurolinguistics.* New York: Academic Press. Vol. 1.