GRAMMATICAL MORPHOLOGY IN APHASIA: EVIDENCE FROM THREE LANGUAGES

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In the English-language literature on grammatical impairment in aphasia, a distinction is often drawn between agrammatic and paragrammatic symptoms (Goodglass and Kaplan, 1968). *Agrammatism* is defined by *omission* of grammatical inflections and function words, usually accompanied by a marked reduction in phrase length and syntactic complexity, giving the patient's speech a "telegraphic look". These symptoms are generally reported for Broca's aphasics, i.e. for non-fluent patients with anterior focal lesions involving Broca's area. In fact, agrammatism is often viewed as a criterial symptom for a diagnosis of Broca's aphasia (as distinct, for example, from non-fluency associated with dysarthria alone).

Paragrammatism is defined by *substitution* rather than omission errors. This kind of simptom is usually reported in fluent patients who suffer from moderate to severe word-finding problems; the same patients may also produce a large number of other substitution errors (i.e. semantic and phonemic paraphasias), leading to the suggestion that paragrammatism and paraphasia have a common base. Although paragrammatisms are occasionally reported for patients from a variety of diagnostic categories, in English these symptoms are most often associated with posterior lesions. They are particularly likely to occur in Wernicke's aphasia, though paragrammatism is not a criterial symptom for this syndrome (which is usually defined primarily by the presence of moderate to severe comprehension deficits, with fluent but semantically empty speech).

The agrammatism/paragrammatism distinction has worked fairly well in English language studies of aphasia, and seems to be a useful marker variable at the clinical level. However, for a variety of reasons reviewed briefly below, the whole concept of agrammatism has recently come under fire. Among other things, substitution errors seem to be more common than omission errors in richly-inflected languages like Hebrew or Italian, even in non-fluent aphasics (c.f. Grodzinsky, 1982; Lapointe, 1985; Miceli and Mazzucchi, 1985; Menn and Obler, 1985, 1987). We will present some related findings here: in German and Italian, substitution errors are common for *both* Broca's and Wernicke's aphasics — and neither group omits closed class elements at anything approaching the levels of omission observed for English patients.

Nevertheless, we will also demonstrate some qualitative differences in the morphological production of fluent and non-fluent aphasics in these languages, revolving around subtle aspects of morpho-syntactic structure. The patterns of morphological sparing and impairment obtained in the present study lead to a different view of the speech planning processes that distinguish Broca's and Wernicke's aphasia — a view that takes the patient's preserved knowledge of his native language into account.

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Agrammatism and Paragrammatism: Historical Background

The distinction between agrammatism and paragrammatism is usually attributed to Arnold Pick (1851-1924), who was also the first aphasiologist in modern times to focus specifically on the question of grammatical impairment in aphasia (c.f. translation by Brown, 1973). It is important for our purposes here to underscore the fact that Pick worked almost exclusively with German and/or Czech-speaking patients — that is, with patients who where speakers of richly-inflected, case-marked languages. This means that the nature and extent of the errors produced by Pick's aphasic patients are likely to be quite different from the errors observed in English (which Pick himself refers to as an "essentially formless language of high standing" — translation by Brown 1973, p. 80).

Pick distinguished between two forms of expressive agrammatism: frontal and temporal. (He also discussed the nature and source of sensory or receptive agrammatism, but this issue does not concern us here). Frontal agrammatism corresponds most closely to the form of grammatical impairment that we commonly associate with Broca's aphasia. In Pick's terms, it is *telegrammatic*, involving reduced complexity and occasional omission of function words and inflections (note the insistence that omissions are only occasional — a point to which we shall return later on). Pick believed that the grammatical symptoms associated with frontal lesions were essentially motoric in nature, the result of a principle of economy applied during the passage from inner speech to its outer realization. By contrast, Pick defines temporal agrammatism as follows:

"...Temporally determined expressive agrammatism is characterized by erroneous grammatical constructions (paragrammatism), in contrast to the frontal type with its telegraphic style... This temporally determined form is characterized, in pure cases, by disturbances in the use of auxiliary words, incorrect word inflections, and erroneous prefixes and suffixes... In contrast to motor agrammatism, the tempo of speech is not retarded, tending rather to logorrhea with intact sentence pattern and intonation. Occasionally some motor (i.e. telegrammatic) phenomena are found, such as the dropping of inflections, with juxtaposition of the words which comprise the skeleton of the sentence." (pp. 76-77, in Brown).

In view of the tendency for English-speaking aphasiologists to equate agrammatism with Broca's aphasia, it is notable that Pick spends most of his chapter on agrammatism speculating on the nature and source of grammatical impairments in fluent aphasics. In Pick's view, temporal agrammatism is actually the more interesting of the two syndromes, arising from "a stage deeper than telegrammatism" (p. 83). However, the problem is not one of grammatical knowledge. Temporal patients (like frontal aphasics) retain a certain amount of knowledge or "feeling for language" ("Sprachgefuhl"), evidenced in the fact that they often notice their errors and may actually try to correct them (usually without success). The real problem in temporal agrammatism, according to Pick, lies in the access or use of grammatical forms, during a stage in which "grammatical processes are applied and so serve to match what is to be said to the thought pattern" (p. 85). In other words, temporal agrammatism involves a disruption at the deepest level of linguistic formulation; frontal agrammatism occurs at a later stage, when a great deal of structure has been assigned.

Pick's writing suggest that there should be a qualitative difference between frontal and temporal agrammatism in the kinds of grammatical errors produced

(in particular, a relative difference in the distribution of omissions versus substitutions). However, the predicted difference still has little support. Lesser (1978) cites a study of German-speaking Broca's and Wernicke's aphasics by Lowe, comparing the morphological errors produced by patients from both categories. This study failed to produce any qualitative differences between fluent and non-fluent aphasics in the omission and/or substitution of grammatical inflections and function words. This is quite remarkable from the point of view of the English-language literature, which abounds with reports on the serious grammatical problems associated with Broca's (but not Wernicke's) aphasia. Indeed, English-speaking investigators have argued that Broca's area plays a crucial role in the representations and/or computations required for grammatical processing (Zurif and Caramazza, 1976). Because this claim is relevant to a cross-linguistic study of grammatical impairments, let us turn briefly to the more recent literature on agrammatism in English.

Agrammatism in English

Modern arguments in favor of a central agrammatic deficit rested on certain parallels between the expressive and receptive language skills of non-fluent Broca's aphasics, in particular patients who are native speakers of English (Zurif and Caramazza, 1976); Heilman and Scholes, 1976; von Stockert and Bader, 1976; Caramazza and Berndt, 1978). At a clinical level, comprehension seems to be relatively intact in these patients. This fact led earlier investigators (including Pick) to view Broca's aphasia as a motor deficit, i.e. "motor aphasia" (see Lesser, 1978, for a review). This interpretation seemed to make good neuro-anatomical sense, in view of the fact that Broca's area lies next to the motor strip. However, a host of studies in the 1970's suggested that non-fluent patients do have difficulty interpreting sentences if they are required to rely entirely on morpho-syntactic cues — precisely the same elements that are missing or impaired in their expressive language. From this point of view, the agrammatism of Broca's aphasia could reflect impairment of a central grammatical processor. From the same point of view, it seemed reasonable (at least within English) to reinterpret Wernicke's aphasia as a selective impairment at the level of lexical semantics — resulting in severe comprehension deficits regardless of sentence structure, and semantically-empty but grammatically well-formed speech.

The proposed double dissociation between grammar and semantics has been very appealing to linguists and psycholinguists who believe in the modular architecture of brain and mind (Fodor, 1983), because it appears to support the idea that grammar and semantics each involve circumscribed and dedicated brain centers. However, several more recent lines of evidence have challenged the existence of a unitary agrammatic syndrome — with corresponding implications for the view that Broca's and Wernicke's aphasia represent a double dissociation of linguistically defined components or modules.

As stated succintly by Caramazza, Berndt, Basili and Koller (1981, p. 348):

"Although it is possible that Broca patients may suffer from deficits in addition to this syntactic processing deficit, it should be the case that all patients classified as Broca's aphasics will produce evidence of a syntactic impairment in all language modalities."

But there is now substantial evidence against this hypothesis. There are several case studies of Broca patients who show agrammatic symptoms in production, but not in comprehension (Naeser, Haas, Auerbach, Helm-Estabrooks and Levine, 1984; Miceli, Mazzucchi, Menn and Goodglass, 1983; Kolk, van Grunsven and Guper, 1982). There are even more reports of patients who show agrammatic symptoms in comprehension despite fluent production (Caramazza, Basili, Koller and Berndt, 1981; Caplan, 1985; Smith and Bates, 1987; Bates, Friederici and Wulfeck, 1987). Finally, patients who are agrammatic in both comprehension and production have proven to retain a surprising degree of sensitivity to violation of grammatically (Linebarger, Schwartz and Saffran, 1983; Wulfeck, (in press); Crain, Shankweiler and Tuller, 1984). In view of findings like these, Badecker and Caramazza (1985) have recently suggested that "agrammatism is not a natural kind", i.e. there is no such thing as a unitary syndrome of grammatical impairment.

If there is no unitary syndrome of agrammatism, then it becomes still more difficult to maintain that Broca's and Wernicke's aphasia represent a double dissociation between grammar and semantics. The relative *absence* of grammatical symptoms in English Wernicke's aphasics is still of interest.

However, in view of Pick's reports concerning temporal agrammatism, we have to ask whether the *presence* of grammatical symptoms in English Broca's and the *absence* of grammatical symptoms in English Wernicke's might not say more about the English language than it says about the organization of the brain.

These are very serious criticism, enough to suggest that patients should not be grouped together under the assumption that they all share the "same" grammatical deficit. But we do not believe that the failure of agrammatism leads inevitably to the conclusion that group studies are wrong-headed from the start (cf. Caramazza, 1987).

Neurologists and speech pathologists have worked for well over a century with the useful distinction between fluent and non-fluent aphasia. This contrast is quite robust, and it has been reported in every language studied to date. The two syndromes each seem to be associated with grammatical impairments of some kind — although the nature and source of these impairments are now in question. The well-known differences between these two patient groups deserve a further explanation, even if the concept of agrammatism fails in its original form. In fact, this strikes us as an excellent time in the history of aphasia research to "go back to the drawing board", examining the full range of grammatical impairments that can occur across natural languages and across patients with different aphasic symptoms.

The Comparative Approach

In this paper, we will compare and contrast patterns of morphological breakdown in Broca's and Wernicke's aphasics, in three different languages, under controlled conditions. As outlined in more detail later on, we will define the two patient groups in neurobehavioral terms that are familiar to neurologists and speech pathologists in many language communities. The definitions look similar in the abstract, although they will of course be realized in different ways from one language to another.

(1) *Broca's aphasia* is defined by non-fluent and dysprosodic speech, with reduced utterance length and sentence complexity, together with more omission of function words and/or grammatical inflections than we would expect in a normal speaker of that language. Patients should demonstrate relatively normal comprehension, at the level of clinical interviews and reports from the family about the patient's functioning in everyday life.

(2) *Wernicke's aphasia* is defined by fluent but semantically empty speech, with superficially normal melodic line, in patients who neverth less demonstrate moderate to severe problems in the comprehension of everyday language. These patients also demonstrate problems in word-finding, accompanied by frequent or occasional paraphasias.

These definitions are quite uncontroversial in clinical practice, in all of the communities that participate in our cross-linguistic project. Our strategy has been to apply these traditional definitions independently within each language community, and then compare the patterns that emerge when we take a cross-linguistic view. In other words, we treat language differences as an empirical question; they do not go into our definition of the patient populations.

In this study, we elicited speech under a standard set of conditions from Broca's aphasics, Wernicke's aphasics and normal controls in three language groups: English, Italian and German. We used the "given-new" procedure originally used by MacWhinney and Bates (1978) in a cross-linguistic study of normal children and adults. In this task, native speakers are asked to describe a series of three-picture cartoons depicting simple transitive and intransitive events. In each picture triplet, one element varies (i.e. the actor, the action, the object, a location, or the dative recipient of an object) while the others remain constant (e.g. little girl is first pictured eating an apple, then a cookie, then an ice cream cone). This gives us control over both the semantic and pragmatic structure of the event to be described. Since we know so much about the range of target utterances that a normal speaker is likely to produce, our analyses of morpho-syntactic structure can be based entirely on the objective picture constraints (i.e. the grammatical structure that *ought to be there*).

This is a particularly important issue in a study of morphological errors. Consider the sentence "Mommy make dinner", typical in the speech of young normal children. It is clear that a morphological error has been made. However, to understand the nature of that error, we need to know more about the target structure that the child might have in mind: "Mommy is making dinner", "Mommy made dinner", "Mommy is going to make dinner", and so forth. Child language researchers usually handle this problem by making extensive use of the verbal and non-verbal context to uncover the child's semantic intention. This "method of rich interpretation" has often been criticized, because there are so few constraints on the way that context can be used. The same criticism is all the more serious in studies of aphasic patients, who once had full control over all the normal variations in their language and may still have a broad range of target structures in mind (despite problems in accessing the necessary elements to express their intentions).

Consider, for example, the following error cited by Butterworth (1979): "We went the train to London". This error could be interpreted in at least three ways. The patient may have omitted the function word "on" required for the well-formed utterance "We went on the train to London". Or he may have intended to produce "We went by train", substituting "the" for "by". Or, in yet another

reconstruction, the patient may have substituted the more frequent verb "went" for the target verb "took". In the first two interpretations, the error would reflect a difficulty in accessing closed class morphology-resulting in omission in the first instance, substitution in the second. In the third situation, the error would be attributed to the patient's difficulty in accessing the correct open class verb ("went" vs. "took"), with a confusion over verb arguments arising only secondarily from this semantic paraphasia. These problems of interpretation will not disappear entirely, even in a constrained speech task. But we stand a much better chance of reconstructing the patient's intentions if we can constrain the range of possible targets within reasonable limits.

The MacWhinney-Bates paradigm was adopted by Bates et al. (1983) to study the effects of local brain damage on pragmatic expression in English-speaking Broca's and Wernicke's aphasics. In this study, we have reanalyzed the Bates et al. data from a morphological perspective, adding a small number of English subjects in San Diego, and extending the paradigm to normal and aphasic speakers of German and Italian. Pragmatic aspects of performance on this task are discussed in detail by Wulfeck, Bates, Friederici and Zurif (in preparation). That paper confirms and extends the pragmatic findings of Bates et al. (1983), demonstrating that all patients in all three languages are sensitive to the given-new manipulation in at least some aspects of their speech (e.g. lexicalizing new information and omitting old information; pronominalizing old information more than new; using indefinite articles for new information and definite articles for old). Syntactic aspects of the same data are discussed by Bates, Friederici, Wulfeck and Juarez (in press), who have shown that all patient groups in all languages retain normal use of basic Subject-Verb-Object word order, normal ordering of elements around a locative preposition, and near-normal access to certain complex or marked syntactic structures that are extremely frequent and/or useful in the language. Against this background of preserved pragmatic and syntactic competence, the morphological deficits that we will discuss here provide confirmation for at least *some* form of agrammatism. However, as we shall see, the deficits vary markedly in nature from one language to another. To understand the differences, we need to provide a brief account of morphological contrasts in these three languages.

Overview of English, Italian and German

Most of the case studies that have played a major role in "agrammatism revisited" have one interesting feature in common: they are based on patients whose native language is not English (e.g. Italian in Miceli et al.; Dutch in Kolk et al.: French in Nespoulous et al.). And yet the language difference itself is not highlighted in any of these studies. Instead, the cases are presented as individual exceptions to a pattern of agrammatism built primarily on English data. There may be another way of looking a these critical cases: perhaps they are not "exceptions" at all, but simply reflect facts about the way that grammar breaks down in a richly inflected language.

English, Italian and German are all Indo-European languages, where the basic or pragmatically-neutral word order is Subject-Verb-Object (SVO). But they also differ along several dimensions that are important for our purposes here.

TABLE I

Indefinite/Definite Article Forms in German

Case	Masculine	Feminine	Neuter	Plural
Nominative	ein	eine	ein	-
	der	die	das	die
Accusative	einen	eine	ein	-
	den	die	das	die
Dative	einem	einer	einem	-
	dem	der	dem	den
Genitive	eines	einer	eines	-
	des	der	des	der

The first dimension is case morphology, i.e. grammatical markers on the noun or noun phrase that tell the listener "Who did what to whom". English and Italian have both evolved from case-marked languages, but they have lost all remnants of case except for a few contrasts in the pronoun system (e.g. nominative "I" vs. accusative "me" vs. genitive "my"). German does have an important and highly productive case system. But unlike most case languages, where information is marked by a suffix on the noun, German marks case on the article preceding the noun. Table I summarizes the full range of possible article forms in German, classified according to case and gender.

Case languages usually permit considerable variation in basic word order, because the morphological system provides enough information to convey basic semantic/syntactic relations. German certainly permits much more variation than we see in English: SVO is the most "neutral" word order, but SOV constructions are very common (and obligatory in some contexts), and several other structures do occur under special semantic/pragmatic conditions (in particular VS). Surprisingly, however, Italian permits even more variation than German. All possible sentence orders can and do occur under particular pragmatic conditions (Bates, 1976). In fact, it is even possible to vary constituent order within subordinate clauses — a rare feature across languages. Since Italian has no case system, listeners must be relying on other, compensatory sources of information. Research suggests that Italians rely heavily on their rich system of agreement markers (MacWhinney, Bates and Kliegl, 1984). First, the subject agrees with the verb in person and number — similar to English and German, except that the markings are almost always unambiguous. In fact, subject marking on the verb is so informative that Italians omit the subject over 70% of the time in informal conversation. Second, all no un modifiers agree with the noun in number and/or gender. In this fashion, information about the identity of a noun propagates across the noun phrase at almost every point, including the article:

- Una bambina buona è sempre bella.

- A-FEM.SING girl-FEM.SING. good-FEM.SING. is always beautiful-FEM.SING.

Finally, there is agreement in person, number and gender between direct or indirect objects and a set of clitic direct and indirect object pronouns. These pronouns are optional, but when they occur they are placed obligatorily before the verb — thus "broadcasting" the identity of the object to come in any VO structure. Furthemore, if there is a clitic object in a participial construction (e.g. "John [her] has kissed), the past participle of the verb must also agree in gender

and number with the object. These multiple agreement markings seem to function as a kind of "pseudo-case" system, used extensively by normal Italian adults as cues to sentence meaning.

In contrast with German and Italian, the system of inflectional morphology in English is relatively degraded, and evidence suggests that it is eroding even further. Sentences like "Tom and me went to the movies" or "He gave a copy of the book to Tom and I" are common in substandard English — and well educated speakers are often observed making some of the same confusions over pronominal case (possibly one reason for the now-ubiquitous use of "myself", as in "As for myself" or "Tom and myself were present").

These differences in the *stability* of morphological marking in English may or may not be related to another difference, in the relative *probability* of inflections and function words even in the purest and most stable aspects of the language. English tends to provide zero marking (i.e. no function word or inflection at all) in circumstances in which German or Italian provide an overt morpheme. Articles are a particularly interesting case in point. There are many contexts in which articles cannot be provided in English, e.g., in front of generic plurals ("Dogs are my best friends"), in noun phrases marked by possessives ("John's house"), before certain forms of abstract definite reference ("According to Government and Binding theory..."). These are all contexts in which the article is obligatory in German or Italian.

Perhaps because there are so many lawful instances of zero-marking in English, there is also a greater tendency for English speakers to drop the article in other, more informal contexts. The quasi-optional nature of articles is particularly clear in newspaper headlines (e.g. "President criticizes Congress"). Such omissions are quite rare in Italian headlines — including one that appeared in six inch letters a few years ago: "IL PAPA MORTE" or "THE POPE DEAD". A similar tendency shows up in informal spoken language. For example, Bates and Devescovi (in press) have shown that English children and adults often drop the article while describing simple cartoons (e.g. "Monkey eating a banana"); by contrast, Italian children and adults describing the same pictures never omit determiners.

In short, morphology is minimally and sometimes contradictorily marked in English, and it carries relatively little critical information in most sentence contexts (except for the sentences that experimenters like to devise for Broca's aphasics). By comparison, morphology is richly and consistently marked in both German and Italian, and listeners have come to rely heavily on those sources of information. This state of affairs leads to an interesting question about aphasia: If it is the case that agrammatic aphasics are particularly impaired in their production of grammatical morphology, are they at a greater communicative disadvantage in a morphologically rich language? Or, alternatively, will we find that aphasic patients struggle to retain the rich morphological "shape" of their language, despite problems in item retrieval (an illustration of Pick's rather vague notion of "Sprachgefuhl")?

The article system offers a particularly interesting way to answer this question in the three-way contrast among English, Italian and German. There are only three forms of the article in English (*the, a, an*). As we noted, these are often omitted in informal speech, and their presence is ungrammatical in certain formal contexts. There are three indefinite articles in Italian (un, una, uno) and six forms of the definite article: feminine singular "la", feminine plural "le", masculine singular "il", masculine plural "i", and two other masculine forms (singular "lo" and plural "gli") that are used only in front of words beginning in vowels, the

letter "z", or consonant clusters beginning in "s". While these six forms do not provide information about case, they do provide a great deal of disambiguating information about reference. Finally, the article bears essential information about sentence structure in German. There are 6 distinct forms of the indefinite article and 6 distinct forms of the definite article, in 28 possible gender/number/case combinations (Table I). If aphasics omit closed class elements in order to avoid retrieval problems, we should predict that German aphasics > Italian aphasics > English aphasics in rates of article omission — ordered in terms of the number of possibilities for error offered by each language. However, if aphasics are trying to meet the information demands of their native language, then we should instead that English aphasics > Italian aphasics > German aphasics in rates of article omission.

These opposing predictions can be summarized in terms of two different models of language breakdown in aphasia. According to an idealized *Syndrome Dominant Model*, we would expect focal lesions to degrade and perhaps even to destroy the characteristic "morphological shape" of a language. Regardless of their premorbid language, Broca's aphasics should be reduced to telegraphic speech with very few function words. And regardless of their premorbid language, Wernicke's aphasics should produce a very high ratio of "empty" function words and a correspondingly low proportion of content words. According to an idealized *Language Dominant Model*, we would instead expect to find that language-specific differences in morphological density are preserved in aphasia. This does not mean that there is no such thing as a fluent or nonfluent aphasic *within* a given language. We already know from the clinical literature in all three countries that aphasiologists recognize something like Broca's and Wernicke's aphasia within their language. Hence, we would always expect fewer function words in Broca's aphasics and relatively more "empty" terms in Wernicke's patients — *relative to normals in that language*. However, within each patient group we would also expect to find the same language differences observed among normals (e.g. higher ratios of function words and less article omission in German and Italian patients, relative to their English counterparts).

These idealized Language-Dominant and Syndrome-Dominant models are proposed as logical extremes to organize our thinking about the interaction between language and patient group. The truth will undoubtedly lie somewhere in between — particularly in view of the heterogeneity that always results when patients are grouped by symptoms and/or etiology. The question can be stated more precisely as follow: What constraints does the "morphological shape" of a language place on the range of symptoms observed in fluent and non-fluent aphasia? This is, in fact, a language-specific instantiation of the basic biological issue of functional plasticity: How many forms can a biological system take under a range of normal and abnormal conditions?

Materials and Method

Subjects

Subject selection criteria are always an important aspect of aphasia research, but they are particularly important in a comparative study across patient groups and languages. Suppose, for example, we find a difference between English and

German Broca's aphasics in rate of omission for definite and indefinite articles? We would like to conclude that this difference follows from life-long habits of language use. But it might also be an artifact of different patient selection criteria at the two respective research sites. That is, perhaps our English Broca's are just more severely impaired, across the board. Given this problem, we need to explain our approach to subject selection in some detail.

Our goal in this project was to select five to ten Broca's and Wernicke's aphasics in each of the three language groups, compared with an equal number of normal controls. Patients were referred to us for testing by neurologists and speech pathologists at the three respective research sites, with diagnoses of Broca's aphasia or Wernicke's aphasia. In support of each diagnosis, we were provided with neurological records (including CT scans in many cases), together with the results of standard aphasia batteries that used at the respective research sites: the Boston Diagnostic Aphasia Examination in the U.S. (Goodglass and Kaplan, 1968), the Aachen Aphasia Battery in Berlin (Huber, Poeck, Weniger and Willmes, 1983), and a battery of tests similar to the Boston Exam that are used in Rome. To eliminate the possibility that a patient had changed status since the diagnosis provided at referral, patients were all screened in a biographical interview administered prior to testing. In addition, we eliminated all patients with one or more of the following conditions:

(1) History of multiple strokes
(2) Significant hearing and/or visual disabilities
(3) Severe gross motor disabilities
(4) Severe motor-speech involvement such that less than 50% of subject's speech attempts were intelligible.
(5) Evidence that subject was neurologically or physically unstable and/or less than 3 months post onset.

Table II summarizes the final sample of patients and controls in each of the three languages. The majority of the aphasias were due to cardiovascular accidents in all language and patient groups. Exceptions included one of the eleven English patients (a Broca's aphasic suffering from trauma), three of the nineteen Italians, and three of the eighteen German patients. In analyses of individual patient data, those patients with exceptional medical histories did not show any obvious deviations from the group patterns described below. A similar range of age, educational level and occupation is also represented in each of the three languages.

The only noteworthy difference, other than native language itself, revolves around sex composition. The English patients were all males, residents or outpatients at U.S. Veteran's Administration hospitals. By contrast, seven of the

TABLE II

Summary of Patients by Language and Patient Group Production

	Broca's		Wernicke's		Controls	
	N	Age range	N	Age range	N	Age range
English	6	32-60	5	47-71	5	25-50
Italian	10	22-77	9	30-73	8	32-59
German	8	31-61	10	44-74	8	36-74

nineteen Italian patients and eleven of the eighteen Germans were female. In previous research on language differences in normal speakers, MacWhinney and Bates (1978) did not find differences associated with sex (see also MacWhinney and Bates, 1987, for a review of cross-linguistic processing research). And in the results reported below, there is also no evidence for a sex difference within either the German or the Italian populations. Insofar as the language differences obtained for aphasic patients correspond to the patterns shown by normals in previous research, there is little reason to believe that a sex difference could be responsible for the results.

But the problem of severity remains. How do we know that patients are matched for severity within our comparison groups? We do not — nor, in our opinion, is there any reasonable basis for such an assignment at this time.

The problem of matching across patient groups is an old one even within languages. For example, if our task or our instructions are at all complex, then we may end up comparing severe Broca's aphasics (who are nevertheless good at following instructions) with mild Wernicke's aphasics (i.e. the only Wernicke's patients with enough comprehension ability to participate in the experiment). Fortunately, the picture description procedure used in the present study is relatively simple and straightforward, requiring only a minimum of verbal instructions. It has been used successfully with children as young as 2-3 years of age, and did not present serious problems to any of the patients who met our other criteria for inclusion. This does *not* mean that we were successful at matching aphasics across categories. But it does mean that our procedures were not strongly biased against any of the patient groups.

Between languages, a second problem derives from the fact that patients were selected and screened at different research sites, in different countries — where there are invariably different diagnostic procedures and philosophies of patient treatment. Given this situation, one might be tempted to match in a straightforward fashion on the basis of site and extent of lesion. There are several problems with this approach. First, the technical facilities are markedly different from one site to another, making comparisons of radiological findings somewhat precarious. Second, insofar as the focus of our experiment is on linguistic behavior, it is not entirely clear what a match on the basis of lesion would actually achieve. It has been established that degree of behavioral disruption is correlated with size of lesion in posterior aphasias (Naeser, Haas, Auerbach, Helm-Estabrooks and Levine, 1984); but correlations between size of lesion and size of deficit are surprisingly small in anterior aphasias (Damasio, 1981). For these reasons, we decided that a selection based on conservative behavioral criteria would be more appropriate at this time, using neurological evidence to rule out complications that would make the behavioral data difficult to interpret.

The third and potentially most serious problem in patient matching derives from the very same cross-linguistic contrasts that are the focus of our research. Languages vary drastically in their baseline levels of morphological complexity. So exactly how do we equate patients for severity of impairment when they are coming from different linguistic baselines? This is analogous to a matching problem faced in cross-linguistic research on child language acquisition. Most projects (e.g., the Berkeley project under the direction of Dan Slobin) resort to matching subjects by age rather than linguistic level, because there is no sensible way to equate children across languages for Mean Length of Utterance. For example, the sentence "Wolves eat sheep" would receive a total morpheme count of four (using Brown's criteria for calculating MLU: Brown, 1973). The Italian

equivalent, "I lupi mangiano le pecore", could receive either a 10 or 12 morpheme count, depending on whether one decides to credit each contrast between unmarked masculine and marked feminine genders as an additional morpheme (see Bates, 1976, for a further discussion on this problem). Using English MLU criteria, Italian children of the same age generally look two to three times as advanced as their American counterparts. If we were to match English and Italian children on the basis of both age and MLU, we would essentially be comparing normal English-speaking children with language-disordered Italians. Similarly, if we were to match Italian and English-speaking aphasics on some common metric of Mean Length of Utterance and/or grammatical complexity, we would undoubtedly insure that patients are not matched in the severity of their underlying impairment.

We chose, then, to define patient groups within each language, according to their fit to a prototype used by neurologists and speech pathologists in that community. A prototypic Broca's would show reduced fluency and phrase length, and a tendency toward omission of functors — *relative to normals in that language*. A prototypic Wernicke's aphasic would display fluent or hyperfluent expressive language, with an apparently normal melodic line; this fluency would be accompanied by marked word-finding difficulties, semantic paraphasias and perhaps paragrammatisms, together with clinical evidence of an impairment in language comprehension. Hence patients are matched across languages only in the sense that they represent degree of deviation from a prototype developed out of observed variation within each language group.

Although we do not agree with Caramazza (1987) that group studies of patients within diagnostic categories are of no use, we do agree that generalizations across groups of aphasics must be accompanied by a careful consideration of within-group variation. By considering both the mean and the range of performance from language to language (e.g. comparing the "best" English patients with the "worst" Germans), we can at least determine how typical the modal pattern is within each language group. For example, we will show that the rate of article omission for our "worst" Italian agrammatic is comparable to the rate shown by the "best" English agrammatic — and that the performance of our "worst" German agrammatics is better still.

Finally, as we will demonstrate later, the relative preservation of morphology in Italian and German patients must be considered against the fact that their English counterparts show very good preservation of word order (i.e. the "strongest" component in that language — see Bates et al., 1986a, 1986b). So we are making comparison across languages not based on "global severity", but on a qualitative pattern of sparing and impairment that varies from language to language.

Procedure

There were nine picture triplets in all, presented to each subject in an individually randomized order. The order of presentation of individual pictures was also randomized within each triplet. Table III summarizes the content of the nine cartoon sets.

Patients were tested individually by experimenters who were native speakers of the patient's language. After an initial warm-up period, the picture stimuli were introduced with the simple instructions "I am going to show you some pictures. I

TABLE III

Given/New Stimuli

Series	Structure*	Sentence
1	**AV**	A (bear, mouse, bunny) is crying.
2	**AV**	A boy is (running, swimming, skiing).
3	**AVO**	A (monkey, squirrel, bunny) is eating a banana.
4	**AVO**	A boy is (kissing, hugging, hicking) a dog)
5	**AVO**	A girl is eating an (apple, doughnut, ice cream).
6**	**AVL**	A dog is (in, on, under) a car.
7	**AVL**	A cat is on a (table, bed, chair).
8	**AVOD**	A lady is giving a (present, truck, mouse) to a girl.
9	**AVOD**	A cat is giving a flower to a (boy, bunny, dog).

Legend: A = Agent; V = Verb; O = Object; L = Location; D = Dative
*The element in boldface type is the one that varies.
**In structure 6 the varying element is the predicate embodied by the preposition.

would like you to describle what you see in each picture". If a patient experienced difficulty getting started in describing one or more of the items, we provided very general prompts like "Can you tell me anything more?" or "What else do you see, what else is happening here?" No other prompts were used, to avoid changing the pragmatic focus conditions provided by the picture sets.

All responses were tape-recorded and transcribed by native speakers, using standard orthography for that language. False starts, repetitions, and extraneous comments were all included in the transcription, to give a faithful picture of the problems that the patient experienced in the task.

Results and Discussion

Proportions of Function Word Use

We first went through the data to extract some global measures of the degree of preservation of grammatical function words. We began with a gross count of the total number of words produced by each patient, across all picture descriptions (extraneous, off-task remarks were excluded from this and all subsequent analyses). This included both content words and function words (as defined earlier). We did not, however, make a separate tally of bound inflections (e.g. the "-ed" past tense marker on verbs, or the "-s" plural marker on nouns). In English, it is usually fairly obvious where the boundary is between a stem and its sufflix — except for certain irregular paradigms like the one relating "go" and "went". In Italian, there is rarely such a clear-cut physical separation between stem and inflection. For example, the singular of "boy" is "ragazzo"; the plural is "ragazzi", created by substitution rather than addition. In order to count up bound inflections within and between languages, we would have to incorporate into our analyses some kind of theory of *markedness* to tell us which form is "basic" and which form involves "additional marking" (e.g. Lapointe, 1985). There is no conventional, uncontroversial way of calculating markedness; hence we decided

to avoid the issue and restrict our morphology count entirely to free-standing function words. There were border cases involving contraction (e.g. "don't", which includes both "do" and "not"; the Italian "del", which includes both "di" or "of", and "il" or "the"). The rule we applied here was to count as a separate item any contracted form which *could* appear as a free-standing word (so that "don't" and "del" each count as two words). The resulting total word counts were entered into an analysis of variance with Language and Patient Group as between-subject variables.

There was, first of all, no main effect of Language on the total number of words produced ($F < 1.0$). But there was a main effect of Patient Group ($F = 20.18$, $p < .001$). Across all picture descriptions, Broca's produced an average of 98 words, normals produced an average of 129, and Wernicke's produced an average of 195. This is of course in line with a definition of Broca's aphasia as a non-fluent syndrome, and with the clinical impression of hyper-fluency reported for Wernicke's patients. In addition, however, we also found a significant interaction of Language $\times$ Patient Group in total words produced. Overall, the patient group differences in total words produced are much sharper in English, followed by Italian, with a much flatter function in German. In particular, German Broca's aphasics produce just as many words overall as German normal controls in the same task. Without knowing anything about the morphology of these three languages, we might simply assume that different subject selection criteria apply at the three sites. But as we shall see, the answer is much more interesting, revolving around the tendency for patients to provide grammatical function words if those words are particularly informative in their language.

Next, the total word counts were subdivided into two separate tallies, one for *content words* (i.e. the open class), and the other for *function words* (i.e. the closed class, restricted here to free-standing elements). These were used to construct a "closed class density" score, according to the formula: Total Function Words/(Total Function Words + Total Content Words). These scores were also analyzed in a Language $\times$ Patient Group design, to investigate the degree of preservation of free-standing morphology when total output is held constant.

Results provide support for the Language Dominant Model discussed in the introduction. There was a main effect for Language ($F = 11.22$, $p < .001$). As we would expect, closed class ratios were higher in the two richly inflected languages, averaged across patient groups: 46,5% for English speakers, 58,2% for Germans and 59% for Italians. There was also a main effect of Patient Group ($F = 10.59$, $p < .001$). This was also in the predicted direction: collapsed across languages, closed class ratios averaged 49.3% for Broca's, 56.5% for normals, and 61.2% for Wernicke's. There was, however, no significant Language $\times$ Patient Group interaction ($F < 1.0$). What this means is that, within each language, the expected patient group differences were found; but also, within each patient group, language-specific ratios of closed class density were also maintained. Aphasic syndromes do not "wipe out" the morphological shape of a language.

We were interested in finding out the locus of these patient group differences. Did they occur across the board in every aspect of the transcripts, or were they a product of specific kinds of symptom patterns? In particular, is the emptiness and "hyper-fluency" of Wernicke's aphasia restricted to the wealth of circumlocutionary comments that characterize their speech? For all the aphasic patients, picture descriptions involved language at two different levels: at the *object level*, where language refers directly to the objects and action depicted in the cartoons, and at the *metalinguistic level*, including circumlocutions, repetitions and self-

corrections, false starts, and comments about the problems that the patient was experiencing in trying to describe the pictures (e.g. "I know that one, but I can't say it..."). We speculated that structural differences between the three languages might emerge most clearly at the object level, when much of the language that derives from the patient's symptoms is "stripped off". Conversely, it seemed feasible that patient group differences would be most marked at the metalinguistic level, which derives in large measure from word finding problems (which are, in turn, generally assumed to be greater in fluent posterior aphasics). We therefore developed a set of coding criteria to separate "pure", object-level description from metalinguistic language. An example of this coding is presented below, where the material in parentheses falls within the metalinguistic count.

[What is that? Ice cream? NO...Girl...] Girl is eat ice cream.

The two respective portions of the transcript were then analyzed separately into the same categories described above: total words, total content words, total function words, and a resulting closed class density measure. These proportion scores then entered into a $3 \times 3 \times 2$ analysis of variance, with the three languages and the three patient groups as between-subjects variables, and the object level/metalinguistic comparison as a repeated measure.

In this analysis, we of course replicated the main effects of Language and Patient Group discussed above. Any new information would come from effects involving the Language Level factor (i.e. object-level vs. meta-level). There was indeed a main effect of Language Level ($F = 17.80$, $p < .001$). Closed class ratios averaged 51.6% in the "pure descriptions", compared with 59.8% in the metalinguistic commentary. In other words, the idioms used in circumlocution and global commentary do contain a higher proportion of semantically-empty terms. However, there were no interactions of the Language Level variable with any of the other factors. This means at least two things.

First, patient group differences in morphological retrieval are no more or less severe in the metalinguistic portion of the transcripts. At first this may seem somewhat surprising, because the circumlocutionary portion of aphasic speech usually "sounds" less telegraphic. Kohn, Perlman and Goodglass (1984) have shown that the nouns and verbs recovered by Broca's aphasics are often quite lacking in specificity (e.g. the use of the verb "making" as a substitute for many other action verbs). However, because we were trying to capture structural rather than semantic differences between open and closed class words, this kind of "non-substantive substantive" was included in the content word count. Hence words like "know" in "I don't know" went into the denominator in our closed class density calculations. It is certainly true that posterior patients used a larger *number* of circumlocutionary expression. Broca's used an average of 63 words in their pure descriptions, with 35 words at the metalevel. The numbers were similar for normals, who averaged 86 words at the object level and 44 words at the metalevel — proving that normals also spend a lot of time orienting themselves around the pictures before diving into their descriptions ("Let's see, what is this little guy here, he's a squirrel I think..."). But Wernicke's as a group produced 90 words at the description level, and 105 words at the metalevel — a replication of the well known clinical observation that these patients spend a lot of time trying to get to the point. Nevertheless, despite these differences in the sheer amount of circumlocution, degree of preservation of morphology appears to be the same at both language levels (i.e. description and circumlocution).

These leads to a second and perhaps more important point. Language-specific

differences in the ratio of function words seem to be conventionalized into every level of the language — including pure, spontaneous descriptions and the various frozen forms that constitute most metalinguistic commentary ("I can't think what that thing is..."). In fact, the robust and "frozen" nature of these language-specific morphology ratios may help to explain why they persist in aphasic patients.

We now turn to a series of more detailed analyses of one aspect of grammatical morphology: the system of definite and indefinite articles (see Table I).

Article Omission

In this analysis, we concentrated on overall rates of article use vs. article omission. Since there are differences among groups in the total number of nouns produced, a simple count of articles would be misleading. Hence, for each patient, we located all points in the transcript where an article *should have been used* (i.e. where the patient produced a noun phrase that should take an article in his native language). This procedure takes into account the baseline difference between English and the other two languages in the rules governing obligatory use or omission of the article (e.g. the fact that normal English speakers have to say "Squirrels don't eat bananas" in the same generic context in which an Italian must say the equivalent of "The squirrels don't eat the bananas").

Rates of article use were then calculated by dividing the total number of articles produced by each patient by the total number of "article contexts" in his picture descriptions. The use of ratios also insures that we are looking at a morphological phenomenon, and not at a by-product of noun-finding ability. These rates were entered into a 3×3 analysis of variance with Language and Patient Group as between-subject variables.

All three effects reached significance in this analysis. First, there was a main effect of Language ($F = 19.206$, $p < .001$). As expected, the highest ratios were observed in German (90.05%), i.e. the language in which articles carry the largest amount of information. Italians were close behind at 88.37%, followed by an English average of 60.64%. The main effect of Patient Group ($F = 17.838$, $p < .001$) was also in the predicted direction: 94.96% for normals, 87.07% for Wernicke's, and 67.25% for Broca's. Most interesting for our purposes, however, is a significant interaction of Language by Patient Group ($F = 4.698$, $p < .01$). This interaction is illustrated in Figure 1. Here at last we have some evidence for a Syndrome Dominant Model, where focal lesions distort the shape of language differences observed in normal speakers.

However, as we can see from Figure 1, this distortion occurs primarily in English. Here Broca's aphasics produce articles only 26.55% of the time — compared with 73.78% for Wernicke's and 88.42% for normals. In Italian, Broca's produce articles 77.5% of the time — compared with 90.78% for Wernicke's and 99.25% for normals. Finally, in German we find very little differentiation among patient groups: 84.96% article use in Broca's, 90.37% in Wernicke's, and 94.75% in normal controls. The locus of the Language per Patient Group interaction comes primarily from non-fluent English patients. German and Italian Broca's aphasics are actually producing articles three times as often as their English counterparts. For the English Broca's, the term "agrammatic" is well-deserved. Omission is extremely common, for these and for other function words. But in the two richly-inflected languages, omissions are much less common. Patients struggle to provide the article, in keeping with a lifetime habit of furnishing this

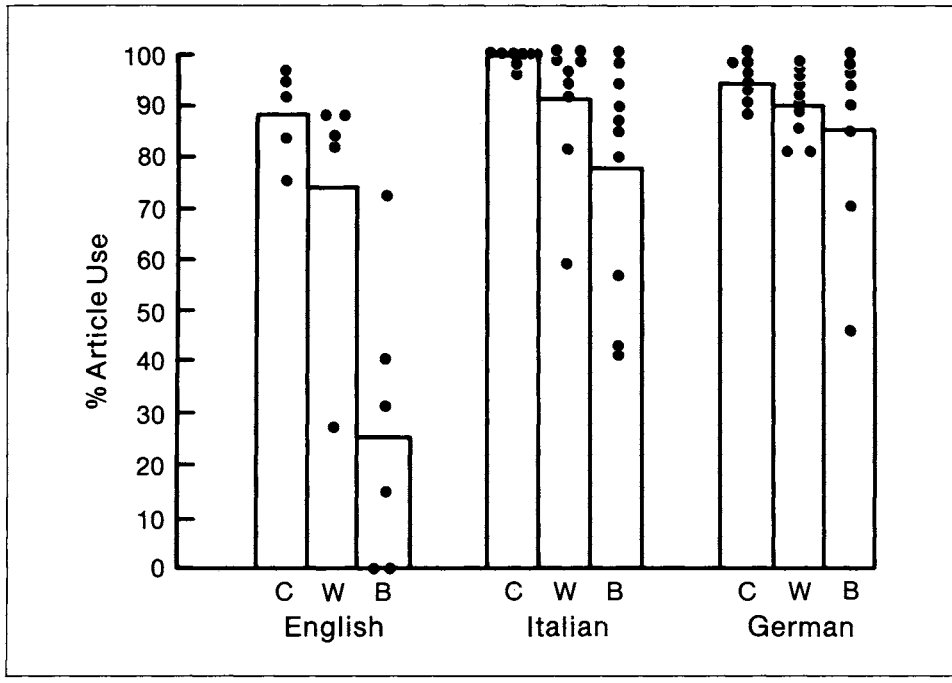

Fig. 1 — *Language by patient group interaction for article use.*

important piece of information.

Given the magnitude of the language differences within Broca's aphasics, it is particularly important for us to consider the range of variation as well as the means in each group. In Figure 1, illustrating the Language × Patient Group interaction in percent article use, we have overlaid data points indicating the performance by individual patients within each group. Although there are small sections of overlap between languages (e.g. it is possible to find an English Broca's aphasic who looks like an Italian on this measure), it is quite clear that the group data cited above provide a faithful representation of variance within and between languages. In particular, the *worst* Italian Broca's aphasics (i.e. the most severely impaired) are furnishing articles before the noun at a rate similar to the *best* of the English Broca's aphasics. The two worst Italian patients produced very few content words, restricted primarily to one or two per utterance. Nevertheless, when nouns were retrieved at all, they were more likely to occur with an article. These cases testify to the robustness of the morphological effects that we have presented so far.

How replicable are these findings? Is it possible that they reflect nothing more than sampling error, a profile that would not occur if the study were repeated with a different group of patients from each language? Obviously more research is needed to answer this question. However, some related evidence is provided in a recent study by Miceli, Caramazza, Silveri and Romani (in preparation). In a comprehensive new study of grammatical errors in Italian aphasia, Miceli and his colleagues have obtained large samples of free speech (including biographical interviews, the Cookie Theft, and a recount of a familiar fairy tale) from a

heterogeneous group of 20 patients selected only because they demonstrated some kind of problem with expressive grammar (omission and/or substitution errors). Ten of the patients are among the ones that we have studied here (although the speech samples do not overlap), and ten are new. There are a great many differences among these patients, including a mean phrase length ranging from 1.9 to 11 words (compared to a range between 7 and 12 for normals). Miceli et al. report little relationship between fluency and the proportion of grammatical errors the patients produce. Furthermore, the patients demonstrate a wide variety of "local" dissociations (e.g. one patient omits copulas but not auxiliaries, another shows the opposite pattern). Despite this variability, the average rate of article use in the Miceli et al. sample is strikingly similar to the results reported here: 70-80% in both Itlaian samples, compared with 20-30% in our English patients. The observed range of article use in the Miceli et al. study is wider than ours: from 100% (no article omission) to a low of 20% article use (80% omission) in one particularly impaired patient. It is possible, then, to find an Italian patient who omits articles somewhere down in the English mid-range. Nevertheless, the *incidence* of article omission seems to be reliably smaller in Italian. Furthermore, in contrast with our sample of English Broca's aphasics, none of the Italian patients studied to date has failed to provide any articles at all.

Article Errors

Although Italian and German patients are providing the article in obligatory contexts most of the time, they pay a price for their diligence in the form of occasional substitution errors. Comparable errors simply did not occur in English. Remember that there are only three forms of the article in English: "a", "an" and "the". Hence only two substitutions are possible for any given instance of article use. There were no cases in which a patient interchanged "a" and "an" (e.g. saying something like "a elephant"). This leaves only the possibility of an inerchange between definite and indefinite — an exchange that simply cannot be classified as an error. It is always possible to adopt either a definite or an indefinite stance in picture description. For example, a speaker can begin his description correctly with "The girl...", even on the first mention, because the picture of the girl is present in the situation and hence can take definite reference. Similarly, one can choose to describe each successive picture as a new event, using the indefinite article, without committing an error (e.g. sayng "Here a girl is eating an apple, and here a girl is eating an ice cream cone..."). As a result, the only article errors that we observed in English were omissions. For that reason, we will focus only on the Italian and German patients in this section.

German and Italian both permit a large array of errors in article use, including gender and number (in both languages), and case (in German only). From that point of view, it is surprising that we did not find a larger number of article errors in our sample. Both fluent and non-fluent patients assigned the correct article most of the time. Although substitution errors did occur, there were too few errors within any category to allow a parametric statistical test of differences across or within individual patients. Instead, we collapsed the errors of individual patients together within each patient group, and carried out non-parametric analyses treating errors as subjects.

Table IV summarizes the proportion of article substitution errors over total articles produced, within each language and patient group. Notice that, overall,

TABLE IV

Percent Substitution Errors on Articles for German and Italian Wernicke's and Broca's Aphasics

	German	Italian
Wernicke	17	2.7
Broca	16	7.5

patients in both languages are right far more often than they are wrong if they produced an article at all. The article was correct 84% of the time among German Broca's and 83% among German Wernicke's. Italians did even better, with Broca's aphasics producing the correct form of the article 92.5% of the time, compared with 97.3% for Wernicke's aphasics. This difference between German and Italian is consonant with the fact that there are simply more *opportunities* for error in German — where errors can involve case as well as gender and number. We should also note that these errors represent the first article produced by a patient in any given noun phrase. In many of these instances, the patient went on to correct himself, and ended up either with the correct form or a form that was closer to the target. In fact, some patients engaged in a lengthy and apparently deliberate search for the correct article, a search that is strikingly similar to the word-finding episodes that anomic patients display in trying to find a target content word (see Table V for examples).

These findings contrast with suggestions by Grodzinsky (1982) that Broca's aphasics select closed class elements randomly from a list of well-formed possibilities. Our patients are correct more than 85% of the time. Furthermore, when morphological substitution errors occur they are clearly not random; instead,

TABLE V

Article Production from Patiens in Different Language Groups

	Broca Aphasics
English	Mother pass... the mouse.
Italian	Il gatto porge una^{0} fiore alle^{0} coniglio. The^{1,4} cat^{1,4} extends a^{0,2,4} flower^{1,4} to-the^{0,2,5} rabbit^{1,4}.
German	Ein Mann tragt (die^{0,} der^{0,} da(s)^{0,} die^{0,} den) den Hund. A^{1,6} man^{1,6} carries^{3} (the^{0,2,9} the^{0,1,6} the^{0,3,9} the^{0,2,9} the^{1,7}) the^{1,7} dog^{1,7}.
	Wernicke Aphasics
English	And the dog is doing the flower to the bagetle... rabbit.
Italian	Allora, questo è il coso che, come si chiama, il gattino che porta la^{0}, il coso al coniglio. Well, this^{1,4} is the^{1,4} thing^{1,4} that, how is called, the^{1,4} kitty^{1,4} that brings (the^{0,2,4}), the^{1,4} thing^{1,4} to-the^{1,4} rabbit^{1,4}.
German	(Der^{0,} der^{0,} die,) die Katze beschenkt ein^{0}... Mann oder den Jungen ein^{0} Bibel (Bibel, ja, ja). (The^{0,1,6} the^{0,1,6} the^{2,6}) the^{2,6} cat^{2,6} gives-a-present-to a^{0,1,6} man^{1,8} or the^{1,8} boy^{1,8} a^{0,3,7} Bible^{2,7} (Bible, yes, yes).

0 = morphological error, 1 = Masculine, 2 = Feminine, 3 = Neuter, 4 = Singular, 5 = Plural, 6 = nominative case, 7 = accusative case, 8 = dative case, 9 = ambiguous between nominative and accusative

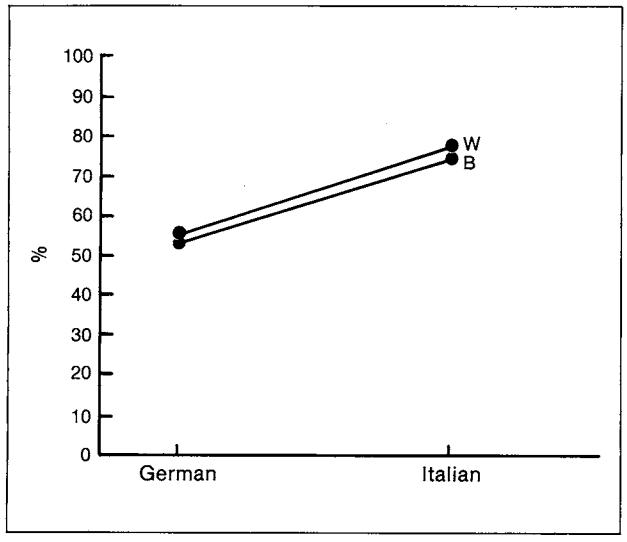

Fig. 2 — *Gender errors as a percentage of totale article substitution errors.*

they represent approximations to a clearcut morphological target. Overall, then, patients seem to have a fairly good grasp of the morphological forms required in their respective languages (see also Miceli and Mazzucchi, 1985).

Some further information comes from a subclassification of article errors along different morphological dimensions. First we considered gender errors, a possibility shared by both German and Italian. Figure 2 presents the proportion of gender errors in the total set of article substitution errors produced by each language and patient group.

In Italian, 78% of the substitution errors involved gender, while the remaining 22% involved number. These ratios were almost identical for Broca's and Wernicke's aphasics. There were very few instances of an error involving *both* number and gender — proof again that the errors were not generated randomly from the set of possible legal forms (cf. Grodzinsky, 1982). In German, the pattern is rather different: 55% of the errors involved gender only; the other errors involved case and/or number. Again, the proportions were almost identical for the two aphasic groups. The smaller proportion of gender errors in German makes sense, given the fact that the German case contrasts present opportunities for substitution that are not available in Italian. Again, however, errors along more than one dimension were rare — in line with the view that patients are aiming a fairly well defined article target, and rarely err by more than one feature.

The fact that gender errors do occur eliminates one possible hypothesis concerning article retrieval in this language. It has been suggested that nouns are stored in the lexicon with their articles attached. Within a sentence context, the speaker must fix the values "number" and "case"; but gender is an inherent part of the lexical item, and does not vary with context. If the article were in fact retrieved together with the noun, we would expect to find number and case errors but no errors of gender — because, assuming that the patient locates a noun at all, he should recover gender at the same time.

Some additional information comes from an analysis of error types within German only. Figure 3 illustrates the probability of case vs. gender errors in

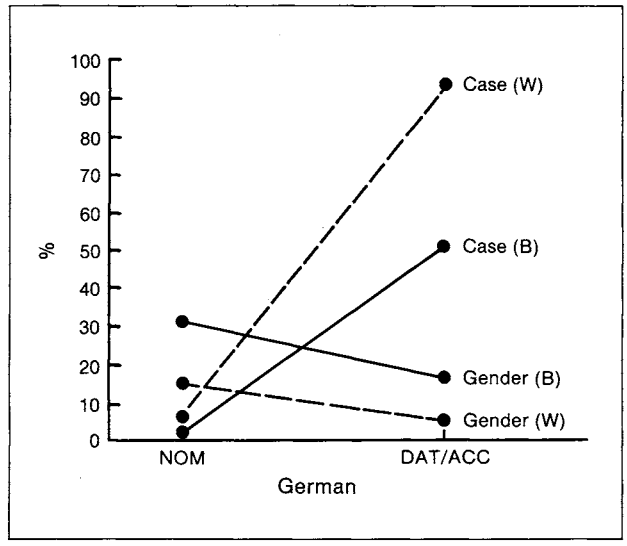

Fig. 3 — *Percentage of case vs. gender errors in article substitution for German aphasics.*

German, for the two patient groups. Remember that these figures represent percentages *within* the relatively small number of substitution errors produced by each group (i.e. percents within the 23 substitution errors produced by German Broca's, and the 34 substitution errors produced by German Wernicke's). In both patient groups, case errors were more common than gender errors. In addition, case errors were more likely to occur on the more "marked" and less frequent dative and accusative cases; gender errors were equally probable within the different case categories. These patterns were the same for Broca's and Wernicke's aphasics.

To summarize so far, the number and types of substitution errors in each language seem to be governed by several different aspects of lexical/morphological access.

(1) Errors are at least a partial function of the number of possible forms that are available, i.e. the "size of the article cohort" in each language — leading to more errors in German than Italian.

(2) Errors are also affected by the relative frequency of each morphological contrast. For example, plural forms are less frequent than singular forms in Italian, and substitutions of a plural for a singular target are rare in aphasic speech. Similarly, the more frequent nominative case seems to be easier for German aphasics to retrieve.

(3) Perhaps most important, errors are strongly affected by the nature of the target article that the patient has in mind — insuring that errors are rarely off by more than one contrast (e.g. case OR number OR gender, but rarely two or even three features at once).

The most puzzling finding so far is our failure to find either quantitative or qualitative differences between Broca's and Wernicke's aphasics in the probability of gender, case or number errors. The lack of a patient group difference raises

serious problems for the traditional distinction between agrammatism and paragrammatism. However, a more fine-grained analysis of German provides evidence for a qualitative difference between the two groups.

First, if we examine the trade-off between omission and substitution errors, we find a "shadow version" of the agrammatism/paragrammatism distinction. (Errors of substitution and errors of omission were added together to obtain the denominator for this analysis). For Broca's, 60.5% of their total errors (35/58) are due to omissions; 39,6% of their errors (23/58) are due to substitutions. For Wernicke's, 27.5% of the total errors are omissions (13/47) and 72.4% are substitutions (34/47). This distribution is significant by a chi-square test (chi-square = 11.87; $p < .05$).

Further differences emerge when we restrict our analysis to case substitution errors only, broken down into three subcategories:

(1) Substitutions of an unmarked nominative form for a marked or oblique case (9/18 or 50% of the case substitution errors among Broca's, vs. 1/24 or 4.2% among Wernicke's).

(2) Substitutions of a marked or oblique case form for the unmarked nominative (7/18, or 38.9% of the case substitution errors among Broca's, 5/24 or 20.8% among Wernicke's).

(3) Substitutions of one oblique case for another (2/18 or 11.1% for Broca's; 18/24 or 75% for Wernicke's).

This distribution is also significant by a chi square analysis (chi square = 24.58, $p < .05$).

Once again, if we consider these errors from the point of view of random selection among case options, then the performance of Broca's patients is definitely not random (see Miceli and Mazzucchi, 1985, for a similar point regarding production of verb forms by Italian patients). They are producing the nominative form incorrectly in exactly half of their errors. This shows a clear-cut preference for the least marked and most frequent form, in the direction predicted by Lapointe (1985) and Grodzinsky (1982). But the patients' preference for unmarked forms is far from absolute. Wernicke's patients are not random either, although their pattern is quite different. 75% of their substitution errors involve some kind of switch within the oblique, more marked cases.

This curious situation makes more sense when the morphological errors are evaluated within the syntactic context in which they occur. In Table VI, we summarize the proportion of all descriptions that were morphosyntactically inadequate in some way. This goes well beyond the specific article analyses; here we are asking what proportion of the time the patient failed to produce a description that was *both* lexically complete (mentioning all the obligatory elements in the picture) and morpho-syntactically correct (elements placed in the expected positions, with correct morphology). Since word order violations are extremely rare (c.f. Bates et al., 1986; Menn and Obler, 1985, 1987), a violation of morphosyntactic adequacy means that the target morphemes were either missing or incorrect. First, Table VI shows that Broca's and Wernicke's aphasics do differ in the kinds of morpho-syntactic construction they produce.

Notice that Wernicke's are *not* more likely than Broca's to produce an adequate morpho-syntactic structure. However, the nature of their errors is somewhat different. Broca's aphasics are more clearly influenced by the complexity of the target structure. And they deal with the complexity issue primarily by

TABLE VI

Percent of Morpho-Syntactically Inadequate Constructions by German Broca's and Wernicke's Aphasics (includes any omissions and/or substitutions)

Patient group	Intransitives	Transitives	Datives
Broca's aphasics	16.7	20.0	83.3
Wernicke's aphasics	35.4	57.7	58.3

avoiding it. In particular, on the three-argument dative items the non-fluent patients generally produced a more reduced construction: either a combination of simple transitives (e.g. the equivalent of "Girl has mouse... Mother gives") or a simple chain of object naming (e.g. "Mother...girl...mouse"). By contrast, Wernicke's plunged ahead with the effort of constructing a full dative construction — and made a significant nimber of case errors in the process.

These overall sentence planning differences are responsible for the high proportion of oblique-to-oblique case substitutions among the Wernicke's aphasics, and for marked-to-unmarked case substitutions among the Broca's. In particular, there seems to ben an effect of syntactic complexity on article errors, including both omission and substitutions. On simple intransitive items (AGENT-VERB or AV), Broca's produce article errors only 1.1% of the time, and Wernicke's produce no errors at all. On transitive items (AGENT-VERB-OBJECT or AVO), Broca's produce some kind of article error 6% of the time, compared with 3% for Wernicke's. Finally, on the two dative items (AGENT-VERB-OBJECT-INDIRECT OBJECT or AVOD), Broca's produce some kind of article error 7.5% of the time, compared with 13.6% for Wernicke's.

There are several ways to interpret the finding that morphological errors are greater in complex sentences. Sentences with oblique cases are by definition more complex at the *semantic* level, and they are usually longer. Hence conceptual constraints and/or memory limitations could increase the odds that a mistake will be made. In addition, the oblique cases are *less frequent* and *more marked* — factors which could increase the probability of error even if semantic complexity and length were held constant. Finally, oblique cases are much more likely to occur at the end of the sentence, while nominative case occurs more often at the beginning — creating a confound with sentence position that could change error probabilities in unknown ways. Given all these confounds, we cannot draw any conclusions at this time about the hierarchy of difficulty of case selection. However, we can conclude that Broca's and Wernicke's aphasics adopt somewhat different strategies for dealing with the situation. Broca's make fewer article errors here because they avoid the *context* for a marked case (Table V). Wernicke's make more article errors here because they persist in trying to produce a complex structure with the requisite marked case forms.

CONCLUSION

To summarize, Broca's and Wernicke's aphasics both seem to be significantly impaired in the production of grammatical morphology — particularly when their performance is compared with evidence for sparing of pragmatics (Wulfeck et al., in preparation) and word order (Bates et al., 1986) in the same transcripts. Nevertheless, both patient groups retain the "morphological shape" of their

native language-evidenced in the preservation of language-specific closed class ratios in both aphasic groups, and the very low level of article omission in Italian and German patients. This provides some explication and support for Pick's intuitively appealing but rather vague notion of "Sprachgefuhl" or "the feeling for language".

In their effort to avoid article omission, Italian and German patients do make a small but significant number of article substitution errors. These patterns are different for the two languages, as we might expect. However, within each language, Broca's and Wernicke's aphasics seem to make the same broad classes of errors. Up to this point, we have neither quantitative nor qualitative grounds for distinguishing between fluent and non-fluent aphasic patients. The usual contrast between agrammatism and paragrammatism seems to have disappeared, and the pattern of omission and substitution errors seems quite similar in the two patient groups. This kind of finding seems, at first glance, to contradict reports on the differential processing of closed class morphology by German Broca's and Wernicke's aphasics (e.g. Friederici, 1982).

However, a fine-grained qualitative analysis shows that there are differences between Broca's and Wernicke's aphasics, in the process by which they retrieve closed class morphemes in context. Broca's are slightly more likely to omit than substitute articles, and their substitution errors tend to derive from the avoidance of complex syntactic constructions. Wernicke's are slightly more likely to substitute than omit articles, and their substitution errors reflect their derailed efforts to carry through with more complex and morphologically-marked constructions.

Which group is more impaired? The Wernicke's are clearly less impaired in syntactic complexity —a well-documented finding in the aphasia literature. But in a richly inflected language, they pay a price for their fluency in a substantial number of substitution errors (i.e. paragrammatisms). The Broca's produce much more limited constructions, including a significant number of inappropriate unmarked forms. In a language like English, the production of an unmarked form would usually result in omission, i.e. in an agrammatic construction. In a language like German, the same effect is attained through a particular kind of substitution, i.e. a paragrammatic construction (see also Grodzinsky, 1982). Hence the underlying processes that differentiate between Broca's and Wernicke's aphasics may be the same across languages. But these processes result in very different products from one language to another.

Because our more fine-grained analyses were necessarily based on a small number of errors, this conclusion has to be very tentative at this point. German and Italian patients are right more than 85% of the time, and they frequently correct themselves when errors do occur. Clearly morphologhy is not *lost;* rather, focal brain damage seems to affect the patients' ability to *access* these morphemes. Within this framework, the similarities between patient groups were quite striking, in comparison with very large differences across languages. Nevertheless, the group differences reported here present a coherent picture: deliberate and controlled strategies of avoidance in Broca's aphasics, contrasted with less conservative and/or controlled error patterns in fluent patients. And they are relevant to several new proposals concerning the nature and origins and grammatical impairment in aphasia.

Grodzinsky (1982) was among the first to point out cross-linguistic differences in the distribution of substitution vs. omission errors in Broca's aphasia. Hence it may be worthwhile considering how our findings map onto his conclu-

sions. Grodzinsky proposed that Broca's aphasics retain access to a level of grammatical structure in which words from major classes appear in their proper order. These ordered strings also contain symbols indicating the *presence* of traces, inflections and/or function words in their proper position around each content word (e.g. that an auxiliary, a determiner, or a tense inflection must occur within a given costituent). However, at this level of structure the *values* of such minor class symbols remain unspecified; these values (e.g. which auxiliary, determiner and/or inflection to use) are assigned within the phonological component. Grodzinsky suggests that the agrammatic aphasic is unable to make the transfer between levels, and hence cannot make the proper morphological assignments. Under these conditions, the patient will do one of three things. If the morphological symbol refers to a free-standing item (e.g. an auxiliary), the patient will omit the item. If the morphological symbol refers to an inflection that cannot be omitted (which is always the case in an inflecting language like Hebrew), then the patient will make either make an assignment randomly from a set of well-formed possibilities, or he will assign the unmarked form of the inflection.

Grodzinsky also suggests that certain unspecified performance factors like frequency could play a role in the assignment of values — although frequency is so highly correlated with markedness that it is difficult to distinguish between these possibilities.

How does Grodzinsky's theory fare against our data? Not very well, although there are some interesting points of compatibility. First, like Grodzinsky, we find that substitution errors are more common than omission errors in richly-inflected languages. Second, his theory is compatible with the fact that our patients never misorder closed class morphemes (e.g. no patient ever says "monkey the"). If Broca's (and Wernicke's) aphasics retain access to a level of structure with ordered strings of symbols, then violations of order should not occur.

Beyond this point, we begin to run into contradictions. Grodzinsky's prediction that free-standing morphemes will be omitted is clearly disconfirmed by our data. English Broca's aphasics did omit most articles. But German and Italian patients provided the article more than 80% of the time. One could interpret the substitution of the German indefinite "ein" for "einem" as an omission; but the substitution of "das" for "der" is undeniably a paragrammatic error — the kind of error that occurred in both fluent and non-fluent patients. However, there are mechanisms in Grodzinsky's theory that can be used to account for this pattern. He proposes that certain bound morphemes must be assigned obligatorily even if the patient does not know *which* morpheme to use (e.g. Hebrew inflections). We might extend this idea to certain free standing items. Thus, the article slot might be marked as obligatory in German and Italian, by a mechanism similar to the one that requires obligatory inflectional assignment in Hebrew.

Even with this extension, the remainder of our findings are incompatible with Grodzinsky's prediction that patients will assign morphological values randomly, or stick with the least marked form. In our study, Italian and German Broca's aphasics assigned the correct article more than 85% of the time — against a chance baseline of 1/9 in Italian, and 1/12 in German. Even when they did commit an error, our patients seemed to have a definite target in mind. They were rarely "off" by more than one dimension in article selection (i.e. case, number, gender), and they often corrected themselves after producing an error (see also Miceli and Mazzucchi, 1985). Substitution of the nominative form for a more oblique case was more likely in Broca's aphasia — but this was true for only 50%

of their case substitution errors. So the performance by our patients cannot be attributed markedness, to frequency, or to any other simple performance factor. Rather, we have to conclude that Broca's aphasics (and Wernicke's aphasics) retain knowledge of the morphological shape *and* the morphological values that are assigned to sentence structures in their language.

So where the errors come from when they do occur? There are at least three reasons why a patient might err in article selection.

(1) *Thematic mapping.* Patients may occasionally suffer from an inability to assign the proper thematic role to a given noun phrase — a difficulty that would result in a case assignment error in German. This hypothesis is clearly not sufficient to account for our findings, but we cannot rule it out in every instance.

(2) *Noun finding.* In the languages studied here, articles come before the noun. In real time processing, patients may assign an article before they have decided which noun will follow (similar to an English speaker saying something like "The...uhm...the"); if they then experience difficulty in noun retrieval, they could come up with a noun that does not match the articles in gender and/or case.

(3) *Article finding.* Even if the patient knows what noun he wants to produce, he may experience a problem in retrieval of the article itself — resulting in a mismatch between noun and article that is impossible to distinguish from the above noun finding problem.

It this last respect, the errors of grammatical morphology observed here resemble word finding problems within the open class: substitutions that are only off by a few relevant features, together with evidence that the patient is trying to reach a particular target. This pattern seems to be more compatible with models that treat grammatical errors as a special case of lexical access — either within a single unified lexicon that combines open and closed class items, bound and inflected forms (c.f. Stemberger, 1985; Bates and Wulfeck, 1987), or within a "special" grammatical lexicon that has many though perhaps not all of the properties of lexical processing in general (Lapointe, 1985; Friederici, 1987). From this point of view, the noun finding explanation and the article finding explanation may both be correct, resulting from a common deficit in lexical processing.

We cannot decide among these three interpretations for those errors that do occur. Indeed, the similarities we have observed between Broca's and Wernicke's aphasics could be illusory: Broca's may make their errors for reasons # 1 and # 3, while Wernicke's make their errors for reason # 2. We can only conclude that, because patients are right far more often than they are wrong, these limitations operate only a small percentage of the time. Hence the limitations must involve *access* rather than *loss*.

The subtle but systematic differences that we did observe between patient groups are compatible with some recent proposals concerning the difference between Broca's and Wernicke's aphasia. Friederici (1982) has suggested that non-fluent Broca's aphasics are impaired in their ability to access grammatical forms in a rapid, automatic fashion (see also Blumstein, Milberg and Dworetsky, 1984; Grodzinsky, Swinney and Zurif, 1986). They are able to make use of morphological information, but only via a slow and deliberate process that may be qualitatively different from automatic grammatical processing in normal speakers. Fluent patients presumably retain this automatic process, so they are

right more often than they are wrong; but they have lost the ability to monitor their own output in a controlled fashion, and as a result their speech is subject to frequent interference between competing alternatives.

These results are also relevant to Adaptation Theory, a recent proposal by Kolk and Heeschen (1985) that revives Hughlings Jackson's notion of "positive symptoms" (Jackson, 1931; see Kolk and van Grunsven 1985, Heeschen 1985, and Kolk, van Grunsven and Keyser 1985). According to this view, many of the symptoms displayed by aphasic patients — particularly non-fluent Broca's aphasics — represent a deliberate attempt to avoid errors by producing brief but well-formed elliptical utterances. These positive symptoms can be contrasted with the "negative symptoms" that occur in patients who produce disorganized but fluent speech. Kolk and Heeschen seem to imply that the patient has considerable choice in the matter, vacillating between positive and negative symptoms from one moment to another. This last point is quite controversial, and there is nothing in our data to sustain it. However, the difference that we have reported here between the unmarked errors of Broca's aphasics, and the oblique case errors of Wernicke's aphasics, does seem to support a contrast between positive errors (i.e. a strategy of deliberate avoidance) and negative errors (i.e. uncontrolled substitution errors that occur in the effort to produce a fluent and complex utterance despite obvious problems in lexical/morphological access).

Despite recent critiques of the so-called syndrome of agrammatism, there are still interesting things to be learned from comparative studies of grammatical impairment in aphasia. To understand the selective effects of focal brain damage on lexical and morpho-syntactic processing, within and between patient groups, we recommend a great deal of further research on language breakdown in richly-inflected languages. In line with Arnold Pick's original recommendations, this research should focus on both the frontal and the temporal forms of agrammatism. By examining just how different the "same" syndromes can look across natural languages, we are bound to learn more about the universal mechanisms responsible for aphasic symptoms.

Abstract

Aspects of grammatical morphology in Broca's and Wernicke's aphasia were elicited under controlled conditions in three language groups: English, Italian and German. Results suggest that the agrammatism/paragrammatism distinction does not work well for richly-inflected languages. Language-specific ratios of closed class morphology were preserved even among non-fluent patients, with significantly more morphology produced by German and Italian patients. German and Italian patients were also much more likely to furnish the article before nouns — despite or perhaps because of the fact that articles are more complex and informative in those languages. Although patients assigned the correct article most of the time, there were a significant number of article errors (i.e. paragrammatic substitution). Error analyses showed that substitutions are not random, reflecting difficulty in access rather than loss. Substitutions were more common in German, where the complex case and gender markings on the article increase the probability of error. Within each language, error patterns were quite similar for Broca's and Wernicke's aphasics. However, at a detailed level patient group differences in error production were detected. German Broca's aphasics tend to avoid difficult case forms by substituting a simpler, less-marked morphosyntactic

frame. Wernicke's aphasics try instead to produce the more marked, oblique constructions, resulting in a less conservative error pattern.

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