The Classifier Problem in Chinese Aphasia

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In recent years, research on the relationship between brain organization and language processing has benefited tremendously from cross-linguistic comparisons of language disorders among different types of aphasic patients. Results from these cross-linguistic studies have shown that the same aphasic syndromes often look very different from one language to another, suggesting that language-specific knowledge is largely preserved in Broca's and Wernicke's aphasics. In this paper, Chinese aphasic patients were examined with respect to their (in)ability to use classifiers in a noun phrase. The Chinese language, in addition to its lack of verb conjugation and an absence of noun declension, is exceptional in yet another respect: articles, numerals, and other such modifiers cannot directly precede their associated nouns, there has to be an intervening morpheme called a classifier. The appropriate usage of nominal classifiers is considered to be one of the most difficult aspects of Chinese grammar. Our examination of Chinese aphasic patients revealed two essential points. First, Chinese aphasic patients experience difficulty in the production of nominal classifiers, committing a significant number of errors

of omission and/or substitution. Second, two different kinds of substitution errors are observed in Broca's and Wernicke's patients, and the detailed analysis of the difference demands a rethinking of the distinction between agrammatism and paragrammatism. The result adds to a growing body of evidence suggesting that grammar is impaired in fluent as well as nonfluent aphasia. © 1991 Academic Press, Inc.

Compared with most Indo-European languages, the structure of Chinese is conspicuously simple: The language has virtually no conjugation for its verbs and no declension for its nouns. For instance, for the various forms of the verb "to go" such as "go," "goes," "went," "gone," and "going," Chinese has the single from QU. Similarly, a single form SHU is used for the various forms of the noun "book" such as "book," "books," "to the books," and "of the books." (Wang, 1973). Hence, the inevitable requirement of an appropriate mapping between verb forms and noun forms known as subject–verb agreement, which is common in most Western languages, is totally absent in Chinese grammar. Furthermore, there is only a single form to stand for various forms of the third-person pronoun such as "he," "she," "his," "her," and "him," thus avoiding the complication involved in gender assignment. As Wang has cogently pointed out,

Perhaps it is this structural simplicity of the language that moved the anthropologist and linguist Edward Sapir to characterize it as 'soberly logical'. (Wang, 1973)

However, it is exactly this same simplicity that puzzles modern aphasiologists the most, with respect to the inevitable question: How in the world can one define agrammatism in the language behavior of a Chinese aphasic patient who, according to traditional theories, should produce agrammatic speech?

Based upon the observations of language breakdown in patients of Indo-European languages, grammatical impairments in aphasia have been divided into two categories: agrammatism and paragrammatism. The form of speech production associated with damage to the anterior portions (roughly Broca's area) of the dominant hemisphere is described as *agrammatic,* defined as the "dropping out of connective words, auxiliaries, and inflections so that grammar, in extreme cases, be reduced to rudimentary form–the juxtaposition of one- or two-word sentences." (Goodglass, 1976, pp. 237–239). The form of speech production associated with damage to the posterior portions (roughly Wernicke's area) of the dominant hemisphere is described as *paragrammatic* (Goodglass, 1968), defined as the substitution of an inappropriate grammatical form for the correct target, observed in speech that is typically fluent and well formed in other respects.

In the last 20 years, agrammatic symptoms have received much more

attention, and many attempts to provide an account of agrammatic pro-
duction have been motivated by alternative theories of syntactic structure
and syntactic processes (e.g., see papers in Kean, 1985). Particular em-
phasis has been given to the marked reduction of phrase length and
syntactic complexity that is typically observed in these patients, accom-
panied by omissions of inflections and function words that give the pa-
tient's speech a "telegraphic look."

Given our description of Chinese grammar in the opening paragraph,
it is not difficult to see that the above characterization of agrammatism
is neither suitable nor practical in its application to Chinese patients.
Clearly, under such a definition of agrammatism, it should be difficult to
detect any agrammatic disorder in Chinese Broca's patients, because (un-
der appropriate discourse conditions) so-called "telegraphic speech" can
be perfectly grammatical in Chinese. However, clinical as well as exper-
imental data are now available to show that nonfluent Chinese aphasic
patients do exhibit at least some of the linguistic symptoms associated
with Broca's aphasia in other languages (e.g., a problem with main verbs—
Bates, Chen, Tzeng, Li, & Opie, this issue; a problem with the particles
that mark verb aspect—Tzeng & Chen, 1988).

ON THE VALUE OF CROSS-LANGUAGE COMPARISONS IN APHASIA RESEARCH

The impracticality of the traditional definition of agrammatism is more
than just a Chinese problem (Bates & Wulfeck, 1989a,b). Take, for ex-
ample, an agglutinating inflectional language such as Turkish, in which
all derivational and inflectional morphemes are suffixed in a fixed order
at the end of a noun or verb, while the noun is preceded (again, in a
fixed order) by demonstratives, numerals, possessives, adjectives, and
relative clauses. It is interesting to note that examinations of speech by
nonfluent aphasic patients in this language suggest that this extremely
complicated structure is largely preserved, with hardly a trace of "tele-
graphic speech" (Slobin, this issue).

Such cross-language considerations present a timely and important chal-
lenge to the traditional view of grammatical impairments in aphasic pa-
tients. A series of cross-linguistic studies of the syntactic abilities and
disabilities of fluent and nonfluent aphasic patients, across both Indo-
European and Non-Indo-European languages, has provided compelling
evidence against traditional efforts to account for agrammatism in terms
of the breakdown of a unitary "grammar box" (Bates & Wulfeck, 1989a,b;
Menn & Obler, 1990). Results from these cross-linguistic studies have
shown that the "same" aphasic syndromes often look very different from
one language to another. This fact suggests that language-specific knowl-
edge is largely preserved in Broca's and Wernicke's aphasia, requiring an

account of language breakdown based on deficits in the processes by which this preserved knowledge base is accessed and deployed.

An example comes from Bates, Friederici, and Wulfeck (1987a), who examined sentence comprehension in three groups of speakers (Broca's aphasics, Wernicke's aphasics, and normal controls), in three different languages (English, Italian, and German). The materials used in this study consisted of 54 sentences in each language, representing orthogonal combinations of three sources of information about sentence meaning (i.e., who did what to whom): these included three levels of word order (NVN, VNN, NNV), three levels of noun animacy (either the first or the second noun or both were animate), and three levels of subject–verb agreement (either the first or the second or both nouns agreed with the verb in person and number). In its strongest possible form, the doctrine of agrammatism should predict no difference in the performance patterns of "agrammatic" nonfluent aphasic patients across the three languages, because a damaged syntactic processor could make no use of grammatical information during the process of sentence comprehension. Instead, results of the study (for groups of patients and for individual patients) unequivocally showed that there are cross-linguistic differences in sentence interpretation by patients from the "same" clinical category: English Broca's aphasics made more use of word order information than German patients, who in turn made more consistent use of such information than Italian patients; by contrast, Italian Broca's aphasics made more consistent use of subject–verb agreement than German patients, who in turn used such information more extensively than English patients. It is also interesting to compare these Broca's aphasics with normals within each language: English patients look more like English normal controls, Italian patients look more like Italian normal controls, and German patients more closely resemble German normal controls. In other words, it is clear that language-specific information is relatively well preserved in these patients, despite their brain injury and their agrammatic speech production.

With regard to speech production, another study by Bates, Friederici, and Wulfeck (1987b) shows that language-specific patterns are also preserved in the speech output of patients from the same three languages (English, Italian, German) and the same clinical categories (nonfluent Broca's aphasics and fluent Wernicke's aphasics compared with normal controls). All patients and controls were asked to describe the same set of three-picture cartoons depicting simple transitive, intransitive, locative, and dative events. Normal Italian speakers (because of the structure of their language) necessarily produced more bound and free-standing morphemes than normal speakers of German, who in turn produced a larger proportion of bound and free-standing morphemes compared with normal speakers of English. Although there was a marked reduction overall in

the rate of morpheme use by nonfluent aphasic patients within each language (compared with normals and with fluent aphasics), there were also significant cross-linguistic differences within each patient group: Italian Broca's and Wernicke's aphasics both produced a higher ratio of function words than their German counterparts, who in turn produced a higher ratio of function words to total vocabulary than their English counterparts. Further evidence for the preservation of cross-language differences in morpheme production came from a detailed analysis of articles and other determiners in the same picture description data: within each patient group (including Broca's aphasics), the highest rate of article production was observed in German (presumably because the article carries case information as well as information about gender, definiteness, and number and hence cannot be omitted easily without a breakdown in communication), followed by Italian (a language in which the article is richly marked for gender and number), with the lowest rate of article production (and highest rate of article omission) observed in English-speaking subjects. Furthermore, most of the articles produced by these aphasic patients were correctly inflected for case (in German) and/or for gender and number (in German and Italian). The traditional distinction between agrammatism and paragrammatism would lead to the prediction that Broca's aphasics would err by omission, while Wernicke's aphasics would err primarily by substitution. It was indeed the case that omission rates were higher for Broca's aphasics within each language, but occasional substitution errors were observed in both patient groups. Overall, there were more similarities than differences between the two patient groups in the errors observed by Bates et al. However, some subtle differences in substitution type were noted within the German sample: Broca's aphasics tended to substitute a high-frequency case form (i.e., the nominative) in contexts that required a less frequent form (e.g., the dative), while Wernicke's aphasics made errors in both directions. We will return to this point later, in our examination of the classifier substitution errors produced by Chinese patients.

Although few neurolinguistic investigators would currently hold on to the view that grammar is lost *in toto* in agrammatic patients, these findings provide a useful lesson: There is no adequate justification for drawing theoretical inferences from associations among deficits displayed by aphasic patients without taking language-specific information into account. This implication from cross-linguistic aphasia studies is more than theoretical; it also leads to an interesting methodological extension. That is, investigators should treat both the language-specific variation of grammatical devices and different patient groups (e.g., Broca's versus Wernicke's) as independent variables and look closely for interactions among these variables. The nature and degree of the interaction would enable

us to examine the validity of various theoretical proposals put forward in recent years.

A case in point is the puzzling dissociation between object naming and action naming observed in aphasic patients (Miceli, Silveri, Villa, & Caramazza, 1984; Miceli, Silveri, Nocentini, & Caramazza, 1988; Goodglass & Menn, 1985; Caramazza & Berndt, 1985; Zingeser, 1989; Gleason, Goodglass, Obler, Green, Hyde, & Weintraub, 1980; Osmán-Sági, 1987): nonfluent Broca's aphasics experience a selective difficulty with action naming, while fluent patients (including Wernicke's aphasics and anomic patients with preserved comprehension) are either equally impaired on both action and object names or (in some studies) even more impaired in object naming. The simple structure of Chinese grammar and its unique morphology help to clarify the source of this noun–verb dissociation. As summarized by Bates et al. (this issue), three kinds of explanations have been offered to account for this dissociation. First, the semantic–conceptual explanation is based on the assumption that the brain regions responsible for the semantic representation of actions lie closer to motor cortex, whereas the representations that underlie object names may involve more input from sensory association areas. Hence, the selective impairment of object naming and action naming by Broca's and Wernicke's aphasics, respectively, may be explained in terms of the differential damage to anterior and posterior cortex associated with these two behavioral syndromes. Second, according to the grammatical explanation, the main-verb problem in agrammatic Broca's aphasia can be viewed as a by-product of their syntactic and/or morphological impairment—due perhaps to the greater morphological load carried by verbs compared to nouns. This account rests, in turn, on the assumption that Broca's aphasics experience greater problems with grammatical morphology and, hence (by extension), greater problems with those lexical items that require more morphological processing. Third and last, the lexical account views the noun–verb disociation as a direct reflection of damage to different portions of an autonomous lexical component (independent of the meanings and/or syntactic functions associated with those lexical items). This account rests on the assumption that nouns and verbs are (somehow) spatially segregated in the brain, such that damage to one region of cortex leads to a selective verb deficit, while damage to another region selectively affects the patient's ability to access nouns.

It is difficult to decide among these three alternatives in studies of Indo-European. But the Chinese language offers an opportunity to test competing accounts of the noun–verb problem. Bates et al. (this issue) examined action naming and object naming in two groups of Chinese aphasic patients (Broca's and Wernicke's) and compared their data with a prior study of action and object naming in fluent and nonfluent Italians (Miceli

et al., 1984). Because there are no verb conjugations and no noun de-
clensions in Chinese, there is no reason to expect a relationship between
morphological impairment and action naming. And yet, their results
showed a clear interaction between patient group and action/object nam-
ing, in the predicted direction. In other words, the main-verb problem in
agrammatic Broca's aphasics is not a direct by-product of a morphological
difference between nouns and verbs, providing evidence against the mor-
phological account. This leaves us with a contest between lexical and
semantic–conceptual theories of the noun–verb dissociation. Evidence
relevant to this competition comes from the unique structure of word
compounds in Chinese. Many Chinese verbs are compounds consisting of
two parts: an action component and an object component. For example,
the Chinese translation of "to read" is KAN-SHU, literally "look-book."
If a strong form of the lexical account is correct, then this high-frequency
compound verb should be stored in the cortical regions responsible for
verbs (presumably somewhere in the anterior portion of the left hemi-
sphere). To the extent that this is true, both parts of the word should be
equally affected by damage to this area. Instead, Bates et al. found evi-
dence for a double dissociation within these word compounds: Broca's
aphasics erred more often by omission or substitution of the actional
component (e.g., KAN in KAN-SHU), while Wernicke's aphasics erred
equally often on both portions or (in many cases) committed more errors
on the nominal element within such word compounds (e.g., SHU in KAN-
SHU).[1] Bates et al. conclude that the Chinese evidence supports a se-
mantic–conceptional explanation for the noun–verb dissociation in
aphasia or for a modified lexical account in which the representations
associated with lexical items are distributed across different regions of
cortex, with some spatial separation between the action-associated and
object-associated components of a compound word.

This noun–verb study illustrates the advantages associated with treating
language type as a natural experimental condition, using the peculiar
characteristics of a single language to answer a question that would be
difficult to address in another language. In particular, the unique mor-
phosyntactic structure of Chinese provides a special opportunity for the
examination of the relationship between brain organization and language
processing, from a totally different perspective. For one thing, we can
start to think about the issue of agrammatism by asking an intriguing
question with respect to this particular language (a question which seems

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[1] The compound word KAN-SHU is often treated as a phrase because it allows the
insertion of an aspect marker such as -LE (meaning "finish") to yield a verb phrase KAN-
LE-SHU ("to have read books"). But there are other verbal compounds such as FU-WU
(literally "serve-duty") that cannot accept insertion of a word-internal marker. So it is
probably fair to say that compounds vary in their degree of "wordhood" in Chinese.

to make little sense from the standpoint of the western languages): If omissions and deletions of grammatical particles can be tolerated under appropriate contexts, then why should a Chinese aphasic patient bother to produce grammatical particles at all (e.g., aspect markers) in order to construct a syntactically complex sentence?

In this paper, we will provide a different example, focused on another unique aspect of Chinese grammar (i.e., nominal classifiers), in order to highlight the different types of grammatical and/or lexical processing associated with Broca's and Wernicke's aphasia.

NOMINAL CLASSIFIERS IN CHINESE

In addition to its lack of verb conjugation and an absence of noun declension, the Chinese language is exceptional in yet another respect: articles, numerals, and other such modifiers cannot directly precede their associated nouns; there has to be an intervening morpheme called a "classifier," an element that (in many cases) does not have any relevant semantic content (Wang, 1973). For example, in Chinese one cannot say SAN WEN ZHANG ("three articles") or NEI MA ("that horse"). Instead, one has to say SAN PIAN WEN ZHANG (roughly equivalent to "three piece article") or NEI ZHI MA ("that piece horse"). The classifiers PIAN and ZHI are translated as "piece" for the lack of a better counterpart in English. The classifier is determined by a semantic–morphological feature of the noun that cooccurs with it. For a word designating a flat object (like "paper," "desk," etc.), the proper classifier is ZHANG, while for words designating objects that are slender and long (like "thread," "road," "line," etc.) it is TIAO. In some respects, these classifiers are equivalent to gender in other languages: they are directly associated with the lexical item, they bear a transparent semantic relationship to that item in some cases but are entirely arbitrary in others, and their occurrence (or absence) is conditioned by structural (phrasal) constraints. The classifier system is considered one of if not the most difficult aspect of Chinese grammar. In conversation or in writing a composition, the speaker/writer often has to pause while groping for an appropriate classifier. It is also true that in language acquisition children take a long time to grasp the relationship between various classifiers and associated nouns. This may be one reason why there is a tendency toward the unification of classifiers in modern Chinese, with a single GE particle substituted for classifiers like ZHANG, TIAO, etc. (Yu, 1949). Nevertheless, at this point in the evolution of Chinese it would be considered ungrammatical (or, at the very least, strange) to substitute GE in all obligatory classifier contexts.

The breakdown of classifiers in production after left-hemisphere damage has also been noted by Poizner, Bellugi, and Klima (1987) in their examination of a deaf ASL (American Sign Language) signer who suffers

from a left-hemispheric lesion in the posterior area. ASL classifiers mark semantic categories such as human, animate, nonhuman, vehicle, and upright objects (Newport & Supalla, 1980; Supalla, 1982). These classifiers function as verbs of motion and location in sentences of ASL, specifying path and direction of movement of their noun referent. Classifier selection is determined by the particular noun sign that occurs in the utterance; it is triggered by lexical factors and not by the pragmatics of the situation. Poizner et al. found that their patient, PD, made relatively frequent substitutions of classifier morphemes in his signing. These data are interesting, but unfortunately their scope is limited by the small number of observations in this single patient and by the fact that classifier marking occurs on the verb and not on the noun itself in ASL. It has also been suggested that the classifier substitutions produced by the fluent deaf aphasic are by-products of a motor problem, with implications that are peculiar to classifier production in a manual language. From this point of view, it will be interesting to determine whether similar classifier substitutions occur in the speech of fluent Chinese-speaking aphasics. Packard (1990) has provided some evidence from his dissertation study, suggesting that the Chinese aphasic may have difficulty in the use of nominal classifiers. However, too few patients were invloved in the study which was concerned more with the problem of tone production than with classifier usage. To be sure, a systematic examination is required for a more precise characterization of the difficulties encountered by both Broca's and Wernicke's aphasic patients (cf. Gandour, Petty, Dardarananda, Dechongkit, & Muknfgeon, 1984).

In this study, two groups of Chinese aphasics (nine Broca's and five Wernicke's) were examined in the given–new task, which is the same picture-description task that has been used successfully in many different languages (English, Italian, German, Hungarian, Serbo-Croatian, and Chinese) by Bates and her associates. (Bates et al. 1987b; Bates, Friederici & Wulfeck, 1988a; Bates, Friederici, Wulfeck, & Juarez, 1988b; Chen, 1989; MacWhinney & Osmán-Sági, 1988, this issue; Slobin, this issue; Smith, 1990; Tzeng, Bates, & Wong, 1990; Tzeng & Chen, 1988). This task permits us to assess morphosyntactic structures under the control of both semantic factors (the simple-event structures depicted in the cartoons) and pragmatic factors (the given/new manipulation, whereby one element varies in each cartoon series while the others remain constant). Of particular interest are (1) whether there is a breakdown in the use of classifiers in speech production by Chinese patients, and (2) whether the nature and the degree of deficit, if any, vary according to the type of aphasia displayed by these patients.

METHOD

Subjects. Subject selection criteria were patterned closely after those adopted for cross-linguistic studies of aphasia by Bates and her colleagues (Bates et al., 1987a; Bates &

TABLE 1
THE NINE SENTENCE TRIPLETS

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, kicking) a dog.
5	AVO	A girl is eating an (apple, cookie, 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).

Note. A, agent in the nominative case; V, verb; O, direct object in the accusative case; D, indirect object in the dative case; L, locative phrase in some locative case.

Wulfeck, 1989a,b). In that cross-linguistic project, investigators at each research site are asked to select Broca's and Wernicke's aphasics on behavioral grounds, according to their fit to a prototype that practitioners in that community have developed for each clinical category. Specifically, they are asked to select Broca's aphasics who meet the following definitions: reduced fluency and phrase length and a tendency toward omission of functions— relative to normals in that language. Similarly, they are asked to select Wernicke's aphasics who fit the following definition: fluent or hyperfluent expressive language, with an apparently normal melodic line; this fluency should 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 degrees of deviation from a prototype developed out of observed variation within each language community.

For the present study, Broca's and Wernicke's aphasic patients were referred to us for testing by neurologists and speech pathologists from National Taiwan University Medical Center and National Veteran's Hospital of Taipei. In support of each diagnosis, we were provided with neurological records (including CT scans for most of them), together with their results on a Chinese adaptation of the BDAE (Boston Diagnostic Aphasia Examination—Goodglass & Kaplan, 1983). 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. Significant hearing and/or visual disabilities.

2. Severe gross motor disabilities.

3. Severe motor–speech involvement, such that less than 50% of subject's attempts were intelligible.

4. Evidence that the subject was neurologically or physically unstable and/or less than 3 months postonset.

In addition, five control subjects were recruited from the hospitals in order to provide a baseline measure for the production of classifiers given the set of stimulus pictures used in the present experiment.

Procedure. As noted earlier, the stimulus materials were the same ones employed in several other cross-linguistic sentence production studies (see especially Slobin, this issue, for Turkish and MacWhinney & Osmán-Sági, this issue, for Hungarian). 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

1 summarizes the content of the nine cartoon sets. Patients were tested individually by experimenters who were fluent in both Mandarin and Taiwanese. After an initial warm-up period, the picture stimuli were introduced with the following instructions: "I am going to show you some pictures. I would like you to describe 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 in Chinese characters. 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.

Data reduction. The given/new task presents at least 52 opportunities to produce a noun phrase. However, the speaker can describe the same pictured evidence in a number of ways. Some of these alternatives reduce the total number of noun phrase options. Examples range from simple refusal to describe one or more pieces of a picture to complex forms of ellipsis and gapping like "The girl is eating an apple, an ice cream, and a cookie" or "She's eating three things." Hence, although we have control over the context for noun phrase production, we cannot delimit the range of options that the patient chooses within each context. The problem is complicated further by the facts of Chinese: a noun classifier is obligatory only if the speaker decides to modify a noun phrase with a determiner, quantifier, or adjective.[2]

For this reason, each transcript was analyzed according to the number of contexts for obligatory classifiers that the subject produced. Within these contexts, utterances were coded for (1) provision of the right classifier, (2) omission of the classifier, (3) substitution of a neutral "all-purpose" classifier (i.e., GE in Mandarin and LE in Taiwanese), or (4) provision of a semantically marked but incorrect classifier (e.g, ZHANG for TIAO).

RESULTS

In this analysis, we concentrated on overall rates of classifier use vs. classifier omission across the three groups of subjects. Since there are differences among groups in the total number of nouns produced, a simple count of classifiers would be misleading. Hence, for each subject, we located all points in the transcript where a particular classifier should have been used (i.e., where the subject produced a noun phrase that should take a particular classifier in Chinese). Rates of classifier use were then calculated by dividing the total number of classifiers produced by each subject by the total number of "classifier contexts" in his/her picture description.

Table 2 reports the total number of "classifier contexts" produced by each subject, in each group, together with (1) the percentage of those classifier contexts in which some kind of classifier was provided, whether that classifier was correct or not, (2) the percentage of those classifiers that were produced which could be considered erroneous or ill-formed,

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[2] The requirement of a classifier when a noun is modified by an adjective occurs only in Taiwanese (not Mandarin). For example, it is acceptable to say DA TIAO DE YU ("big classifier DE fish") in Taiwanese, but the same expression in Mandarin will be commented on as being Taiwanese Mandarin. However, classifiers are obligatory with determiners and quantifiers in both dialects.

TABLE 2
CLASSIFIER CONTEXTS

Mean total number of obligatory classifier contexts*	(1)	(2)	(3)
Broca's	29.11	.27	.08	.08
Wernicke's	42.2	.70	.28	.19
Controls	51.0	.83	.10	.10

Note. Mean total numbers of obligatory classifier contexts produced by the three groups of subjects (Broca's patients, Wernicke's patients, and normal controls), together with (1) the percentage of those classifier contexts in which some kind of classifier is provided, whether that classifier is correct or not, (2) the percentage of those classifiers that are produced which could be considered erroneous or ill-formed, and (3) the percentage of all erroneous or ill-formed classifiers which are neutral forms.

* The computation of this number ignored repetitions of the same nouns in the patients' description of each picture shown. This is a very strict but least misleading way of computing the number of obligatory classifier contexts. Wernicke's patients produced more noun repetitions than Broca's patients, who in turn produced more repetitions than the normal controls.

and (3) the percentage of all erroneous or ill-formed classifiers which were neutral forms.

Starting with the number of obligatory classifier contexts produced, it is clear that aphasic patients (fluent as well as nonfluent) produce a smaller number of contexts overall. Normals produce an average of 51 contexts for the classifier in their picture descriptions (from a minimum of 48 to a maximum of 52). Compare this with only 29.11 contexts for the Broca's as a group (with a range from 24 to 39), and 42.2 contexts for the Wernicke's as a group (with a range from 13 to 48). We could conclude, then, that aphasic patients avoid (consciously or unconsciously) production of complex noun phrases that require the use of a nominal classifier. However, when we consider the fact that noun phrases without a classifier of any kind can be perfectly well formed, it is perhaps surprising that these patients (especially Broca's aphasics) do not avoid the classifier problem altogether.

Turning to rate of classifier production (as a percentage of obligatory contexts), we performed a simple one-way analysis of variance on group differences in classifier production and obtained a significant difference ($F(2, 24) = 6.44$, $p < .05$). Normals produced a classifier of some kind in a required context 83% of the time compared with 27% by Broca's aphasics and 70% by Wernicke's aphasics. This finding is compatible with the usual definition of agrammatic Broca's aphasia as a syndrome in which grammatical function words tend to be omitted. But this finding must be qualified in two ways: (a) classifiers were occasionally produced by non-

fluent as well as fluent patients and (b) occasional omissions were also observed in fluent Wernicke's aphasics.

The above analysis does not distinguish between correct and incorrect production. In the next analysis, we examined the percentage of all classifiers produced that could be considered erroneous or ill-formed. These results are somewhat surprising if we assume that problems with grammatical function words should be more common in Broca's aphasia. Not surprisingly, normals produced virtually no clear-cut errors in classifier use. Broca's aphasics produced an incorrect form 8% of the time (with a range from 0 to 28%), but Wernicke's aphasics produced an even higher rate of incorrect forms, averaging 28% (with a range from 10 to 61%). An independent t test with unequal subjects was used to evaluate the data, and the result showed that the difference is statistically significant, $t(13) = 5.67, p < .01$. In other words, Broca's are more likely to produce the correct form of the classifier, if and when they manage to produce a classifier at all.

Finally, let us consider the kinds of classifier forms (correct and incorrect) that were produced by these three groups. Among the normal controls, 12% of all correct classifiers were the neutral form GE (in Mandarin) or LE (in Taiwanese). Among the Broca's aphasics, 8% of their *correct* classifiers and 100% of their *incorrect* classifiers were neutral forms. Finally, among the Wernicke's aphasics, 18% of their *correct* classifiers and 68% of their *incorrect* classifiers were neutral. We may conclude that both groups of aphasic patients tend to overuse the high-frequency neutral form relative to normal controls. However, Wernicke's patients tend to be less "conservative"; that is, their errors also include substitution of a lower frequency-marked classifier type. This result is compatible with the analysis of errors on the German article reported by Bates et al. (1987b); Broca's are more likely to err by substituting an unmarked form for a less accessible construction, while the errors produced by Wernicke's aphasics are more variable.

DISCUSSION

The exotic nature of the Chinese language offers a glimpse at the tricks that Nature plays on its own linguistic inventions. As we have already pointed out, the basic sentence in Chinese has the order subject–verb–object as in English. But the language has no verb conjugations, no declensions on nouns, no agreement markers of any kind, and no markers to indicate sentence roles like subject or object. There are a number of one-syllable function words or particles, similar in some respects to short function words like "is," "in," or "the" in English, but in many circumstances these can be deleted as well. Taken out of context, a sentence with no function words or particles of any kind can be perfectly grammatical. In other words, a complete sentence in Chinese can sound exactly

like an English telegram! This property of Chinese grammar raises some fascinating questions about grammatical impairment in Chinese aphasics: Since it is possible to produce sentences with no grammatical markers of any kind, how can we identify the symptom patterns that characterize Broca's and Wernicke's aphasics in other, more richly inflected languages?

In this paper, we examined the richest and most difficult aspect of Chinese morphology, the system of nominal classifiers. At one level of analysis, the patterns that we observed in this sector of the grammar are quite compatible with 100 years of research on aphasia in Indo-European languages: Like their Indo-European counterparts (who have difficulty in the production of inflections and function words), Chinese aphasic patients experience difficulty in the production of nominal classifiers, committing a significant number of errors of omission and/or substitution. At a more detailed level, however, these results for Chinese contribute to a rethinking of the distinction between agrammatism and paragrammatism and they add to a growing body of evidence suggesting that grammar is impaired in fluent as well as nonfluent aphasia.

Overall, the number of classifier errors that we observed was lower than one might expect based on results for more richly inflected languages (i.e., English, German, Italian, Hebrew, and Hungarian), languages in which function words are frequently omitted and/or subject to substitution errors when they are produced. Chinese aphasic patients produced relatively few blatant errors in classifier selection. This is due in part to the fact that sentences with no function words at all are often legal in Chinese, depending on the discourse situation. In principle, patients with a deficit in classifier production could "hide" their deficit by avoiding all uses of adjectives, quantifiers, or determiners that create an obligatory context for a noun classifier. From this point of view, it is interesting that many of our Chinese Broca's aphasics did not take the option of deleting all function words entirely; instead they made a number of clear-cut substitution errors (albeit relatively few in number), indicating that they are still aware of the discourse conditions that require classifier use and still willing to attempt constructions that serve these discourse functions.

In fact, errors of omission and substitution were observed in both patient groups. Not surprisingly, we did find higher rates of classifier omission in our nonfluent Broca's aphasics, but clear-cut substitution errors did occur in both groups. We have already noted that the sign aphasic patient (PD) described by Poizner et al. (1987) made a relatively large number of classifier substitution errors in his signing. Our Chinese-speaking Wernicke's aphasics made similar errors of classifier substitution, a finding which speaks against the hypothesis that PD's errors reflect nothing more than a movement deficit restricted to production in a visual–manual language. Furthermore, the Chinese Wernicke's patients made errors that cross semantic class (e.g., SAN ZHI CHE for SAN LIAN CHE—"three

cars"). By contrast, the substitution errors produced by Broca's aphasics almost all involve substitution of a neutral classifier (such as GE in Mandarin or LE in Taiwanese). These substitutions are not "errors" in a strict sense because most native Chinese speakers would accept a certain number of them in free conversation. But to the ears of a native speaker, the overuse of neutral classifiers by Broca's aphasics sounds "funny," if not blatantly ill-formed.

This pattern of errors reveals two basic points. First, Chinese aphasics retain a great deal of linguistic knowledge despite their affliction. They know when some kind of classifier is required to make their point and they use their remaining knowledge to search for the right classifier form for a given noun. Second, in their struggle to find an appropriate classifier for a given noun, the Broca's aphasics in this study tend to be very conservative, choosing a neutral citation form to replace the one that they have difficulty with, whereas the Wernicke's aphasics make substitution errors that are much less systematic, suggesting that a more random selection process is at work. This pattern is compatible with the contrasting pattern of substitution errors observed by Bates et al. (1988b) in their analysis of case errors on the German article.

Assuming that this contrast in error types for Broca's and Wernicke's aphasia has some generality (see MacWhinney and Osmán-Sági, this issue, for another view), is there a theory of intrahemispheric organization that might account for the difference? On the surface, the substitution pattern of Chinese Broca's aphasics can be termed conservative, while the pattern displayed by Wernicke's patients has to be regarded as liberal, much too liberal indeed! Such an intrahemispheric differentiation is difficult to understand from the traditional syndrome-oriented dichotomy in which the linguistic disorders of Broca's and Wernicke's aphasic patients are characterized as production and comprehension deficits, respectively. Nor is it compatible with theories that attribute grammatical deficits to Broca's aphasia, with semantic deficits but spared grammar in Wernicke's aphasia. (Caramazza & Zurif, 1976; Kean, 1979). Our Broca's patients display too much knowledge of their language to support such a view, and our Wernicke's aphasics display problems with the Chinese classifier system that are at least as severe (albeit different in kind) as the deficits displayed by nonfluent patients. Therefore, any theory which puts the blame on a defective and localized "grammar box" cannot be correct.

The contrast between the conservative and the liberal patterns displayed by our two aphasic groups is compatible with other experimental data from an entirely different paradigm. In a recent study by Swinney, Zurif, and Nicol (1989), the effects of prior semantic context upon lexical access during sentence processing were examined for Broca's aphasic patients, Wernicke's patients, and neurologically intact control subjects. Subjects were asked to comprehend auditorily presented simple sentences con-

taining lexical ambiguities, which were in a context strongly biased toward just one interpretation of that ambiguity. While listening to each sentence, subjects also had to perform a lexical decision task upon a visually presented letter string. Their results provide evidence for priming of both meanings for visually presented ambiguous words, for Wernicke's aphasics as well as normal controls; by contrast, Broca's aphasics showed significant facilitation only for visual words related to the most frequent interpretation of an ambiguous word. At least two conclusions can be reached from these data. First, lexical access during sentence comprehension is not lost for either Broca's or Wernicke's patients. Second, when ambiguous words are presented, Broca's patients adopt a very conservative strategy, choosing only the most frequent meanings regardless of contextual bias. By contrast, Wernicke's seem to adopt a liberal strategy, i.e., they accept anything that is activated by the prime.

Similarly, Milberg and Blumstein (1981) compared a group of Wernicke's aphasics, a combined group of both Broca's and conduction aphasics, and a group of normal controls using a lexical decision task in which the target word was preceded by a related word, an unrelated word prime, or a nonword prime. The semantic priming effect (i.e., facilitation of response time due to prior exposure to a related word) was observed only for the Wernicke's patients and normal controls (see also Blumstein, Milberg, & Schrier, 1982). Based upon this finding, Milberg and Blumstein concluded that the linguistic disorder of Wernicke's patients cannot be due to a deficit in the underlying structure of the lexicon. Instead, they suggest that the lexical deficits displayed by these patients reflect deficits in the organization of the semantic system after words are activated. This point is underscored by the fact that Wernicke's patients perform poorly on metalinguistic judgments or tasks that require a conscious semantic decision, despite the apparent preservation of priming effects. By contrast, Broca's aphasics can perform reasonably well on these metalinguistic tasks, despite apparent limitations in lexical priming. Milberg and Blumstein conclude that the contrast between Broca's and Wernicke's aphasia should be reinterpreted as a double dissociation between automatic processes (impaired in Broca's aphasia) and controlled processes (impaired in Wernicke's aphasia). In both cases, lexical representations are preserved. The difference between these two patient groups revolves around the way that these lexical representations are accessed and deployed.

There are interesting parallels between these lexical effects and the contrast that we have observed here between the classifier substitutions produced by Broca's aphasics (i.e., a "conservative" tendency to substitute high-frequency forms) and the classifier substitutions produced by Wernicke's aphasics (i.e., a "liberal" tendency to substitute one marked semantic contrast for another). This contrast may follow from an inability on the part of Wernicke's patients to make a conscious choice among

alternatives. These fluent patients are able to activate a great deal of phonological, syntactic, and semantic information during sentence processing; however, it is difficult for them to filter out irrelevant information and make choices that are appropriate for a given discourse frame. The processing system of the Wernicke's aphasic may be characterized in terms of an overexcitation (i.e., too many alternatives are active) or underinhibition (a failure to eliminate inappropriate alternatives). As a result, they grasp at whatever comes by and produce errors that are much less systematic than the errors observed in Broca's aphasia. Indeed, it sometimes appears as if a random selection process is at work. In this regard, the errors produced by fluent aphasics are compatible with a theory of attentional processes that atrribute alerting and filtering roles to posterior regions of the brain (Posner & Petersen, 1990; LaBerge and Buchsbaum, 1990). By contrast, the errors produced by Broca's aphasics may involve areas of anterior cortex that are responsible for rehearsal and maintenance of lexical and morphological alternatives during sentence processing; if such areas are damaged, the patients may be forced to access highly frequent forms that are relatively easy to access and produce.

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