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Selective Impairment of Grammatical Morphology due to Induced Stress in Normal Listeners: Implications for Aphasia

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The traditional clinical picture for English nonfluent aphasics has generally presented the deficit as one of total loss of control over grammatical morphology, with some sparing of word order. This is at odds with recent research involving nonfluent aphasic speakers of highly inflected languages, which has shown that agrammatic performance is characterized by morphological substitution rather than omission errors. If the deficit associated with focal brain damage cannot be adequately accounted for in syndrome-specific ways, we may need to look for language-specific processing explanations. One such explanation has to do with language-specific response to global processing difficulty. The current experiment is designed to study the effects of a stress-related limitation on morphological processing. Normal speakers of a language with a relatively rich morphological system (German) are compared with those of a comparatively impoverished system (English) on different forms of a sentence comprehension task. In one form, "clean" stimuli permit full reliance on all available cues to meaning in each language. In another test, a low-level noise mask partially obscured the stimulus sentences. English speakers, who rely almost exclusively on word order cues, were not affected by the noise manipulation. German speakers relied heavily on morphological and semantic information rather than on word order under "clean" conditions. However, under noise Germans made significantly less use of grammatical morphology, with a trend toward compensatory reliance on word order. The results indicate that a global reduction in processing capacity can affect some aspects of language more than others and suggest that such factors must be taken into account in trying to understand specific impairment of morphology in aphasia.

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INTRODUCTION

The distinction that is normally drawn between agrammatism and paragrammatism depends on the notion that Broca's area plays a special role in processing grammatical morphology. An anterior lesion involving Broca's area is thought to interfere with the normal processing of closed-class items, producing errors of omission. Paragrammatism, on the other hand, is associated with posterior lesions and characterized by errors of substitution rather than omission.

While this distinction seems to hold well for English, recent findings from languages which provide a much wider range of morphological markings have called the traditional clinical picture into question. In particular, a total loss of control over grammatical morphology is incompatible with the frequent occurrence of substitution errors observed even in nonfluent patients who are speakers of highly inflected languages such as Hebrew, Italian, Serbo-Croatian, or German (Grodzinsky, 1982; Lukatela, Crain, & Shankweiler, 1988, Miceli, Silveri, Romani, & Caramazza, 1989; Menn & Obler, 1990; Smith & Mimica, 1984; Smith & Bates, 1987).

In a series of cross-language studies of aphasia, Bates, Friederici, and Wulfeck (1987a,b) found that grammatical morphology was selectively impaired in language processing in two highly inflected languages, German and Italian, by both Broca's and Wernicke's aphasics. In a study of elicited production (picture description), morphological substitution errors were observed in both groups. In addition, language-specific ratios of closed-class morphology were preserved in both groups, suggesting that the classical view of the agrammatism/paragrammatism distinction, based mainly on data from English, does not take sufficiently into account the different role morphology can play across languages.

A separate study of sentence interpretation patterns (Bates et al., 1987a) found that while the morphological "shape" of German and Italian was preserved in the comprehension strategies of both Broca and Wernicke patients, word order was selectively spared while morphology was selectively impaired. The status of grammatical morphology in a language appears to be a better predictor of the incidence of omission/substitution errors than the clinical definition of aphasia.

This point is underscored by a further finding reported in Bates et al. (1987b). The same sentence interpretation task administered to agrammatic and paragrammatic patients was given to a range of Italian patients including anomics, neurological patients with no evidence of cortical damage, and patients from an orthopedic ward with no evidence of nervous system damage. Evidence for receptive agrammatism was found in each group of patients who showed no grammatical impairment in spontaneous speech. In a separate study involving two other highly inflected languages, Turkish and Hungarian, MacWhinney, Osmán-Sági, and Slobin (this issue)

found a similar dissociation of morphological vulnerability between receptive and expressive processing in anomics and a subset of nonneurological patient controls. Taken together, these findings support the notion that a selective impairment of grammatical morphology may result from a global perceptual/cognitive limitation in processing. Such a limitation may result from stress induced by a variety of causes, including (but not limited to) focal brain damage, neurological impairment, hospitalization, or a reduction in processing capacity brought on by the normal processes of aging (see Heeschen, Ryalls, & Hagoort, 1988).

The current experiment is designed to study the effects of a stress-related limitation on morphological processing. Native speakers of English and German performed a sentence interpretation task similar to that used in Bates et al. (1987b). Briefly, the task involves listening to sentences consisting of two nouns and a verb and deciding which of the nouns is the actor. The cues to thematic role are word order, verb agreement morphology, and animacy. In Part 1, subjects listened to normally produced, "clean" stimuli. This portion of the experiment will serve as a baseline, allowing us to observe cross-language differences in the use of different cues to sentence meaning. In Part 2, a partial noise mask consisting of "pink noise" (i.e., random noise restricted to the speech band) was added to the stimuli, making the task perceptually more difficult. Inducing stress in this manner is an example of what Norman and Bobrow (1975) have called "data-limited processes," which are processes that operate the best they can on an impoverished input. These contrast with "resource-limited processes," such as cognitive overload in a dual-task situation.

Given the differential reliance on morphology as a cue to meaning in English and German (about which more below), we can observe whether the partial noise mask has different consequences for processing, depending on the degree of reliance on cues which are more or less vulnerable to noise. To anticipate our findings, we ought to find that a global cue such as word order will be more robust and survive despite a noise mask, while a local, perceptually less salient cue such as verb agreement morphology will be more vulnerable.

Since the design and interpretation of the findings reported here are based on the Competition Model, a psycholinguistic model of language performance, we will need to mention some of its central features before continuing. A more detailed account is available in MacWhinney and Bates (1989).

THE COMPETITION MODEL

Within the Competition Model, the notion of cue validity is a central construct and the most important notion for our purposes. MacWhinney and Bates (1989), following Brunswick (1956) and Gibson (1966), argue

that human behavior is organized according to mechanisms which take into acount the validity or information value of cues in their environment. MacWhinney, Bates, and Kliegl (1984) define cue validity as the information value of a particular linguistic device as a cue to an underlying meaning. Cue validity is broken down into three components, availability (is the cue there when you need it?), reliability (when it is there, to what degree can you count on it to give you the right interpretation?), and conflict validity (a measure of the ways that cues behave when they conflict with other cues). Cue validity has proven to be useful in accounting for a range of cross-language processing differences, e.g., why the "same" cue does not always behave the same way in different languages.

In Competition Model terms, word order is high in reliability in English, which maintains a rigid SV(O) order, but relatively low in reliability in German, which allows a high degree of word order variation. However, the availability of reliable cues in the form of grammatical morphemes is much higher in German than in English. These cross-language differences have been borne out in several empirical studies. Under normal processing conditions, German and English speakers make manifestly different use of available cues to sentence meaning (cf. MacWhinney et al., 1984; Kilborn, 1989). German speakers tend to rely heavily on grammatical morphology, followed by semantic/pragmatic cues, and make almost no use whatsoever of word order as a cue to thematic role. In contrast, English speakers overwhelmingly rely on word order, relegating morphological and semantic cues to a lower processing status.

In this experiment we shall exploit the processing differences based on the validity of different cues to meaning in English and German. Grammatical morphology, a heavily weighted cue to meaning in German, should be perceptually more vulnerable to a partial noise mask than word order, the favored cue in English. Accordingly, performance should be more disrupted for speakers of German than for speakers of English.

METHOD

Subjects. Twenty-four English-speaking undergraduate students at the University of California, San Diego, received psychology course credit for participation. Twelve subjects served in the "clean" baseline experiment, while the remaining 12 received the version with a partial noise mask.

A group of 15 native German subjects was also recruited in the San Diego area. These subjects, who were paid for their participation, were part of a larger project on second language learning and received only the "clean" version. Seven subjects from this group received an English version of the sentence interpretation task 2 to 4 weeks before the German version, while eight subjects received the German version first. A preliminary analysis showed that order of language presentation had no effect on performance in German. The results from the German component of this project correspond in detail to findings reported from an experiment (MacWhinney et al., 1984) in which only monolingual German subjects participated, which lend support to the claim that the bilingual nature of the larger experiment had no important effects on the native German processing data.

A further group of eight native German volunteers was recruited from West Germany. These subjects participated in the "noise" portion of the study only.

Design and materials. The current experiment is intended to investigate the contribution of three primary information sources—word order, animacy and verb agreement—to the process of sentence interpretation. The independent variables varied along the following dimensions:

Word order	NVN (noun–verb–noun) VNN (verb–noun–noun) NNV (noun–noun–verb)
Noun–verb agreement	AG1 (agreement favors first noun only) AG2 (agreement favors second noun only) AGB (agreement favors both nouns) AG0 (agreement favors neither noun)
Animacy	AI (first noun animate, second noun inanimate) IA (second noun inanimate, first noun animate) AA (both nouns animate) II (both nouns inanimate)

Stimulus items for both English and German are shown in Table 1. Three subsets of stimuli were constructed for each language, consisting of a single verb (third person singular), two singular and two plural animate nouns, and two singular and two plural inanimate nouns. All possible combinations of two nouns and one verb from within each subset were presented, resulting in 48 sentences per subset (three word orders × four noun–verb agreement orders × four animate/inanimate orders), for a total of 144 sentences. Sample sentences are shown in Table 2. No two particular sentences were ever repeated; however, there were exactly three repetitions of each sentence type (i.e., there were three sentences of the type NNV/AG1/IA, but the sentence, "The telephone the cowboys pushes" appeared only once). The orthogonal crossing of word order, animacy, and noun–verb agreement cues results in a design in which subjects must make an interpretation in the face of sometimes conflicting cues. By placing cues into competition and coalitions with one another, we can see by the response patterns which cues "win" and which "lose" in various sentence configurations.

Case marking, another important source of thematic role information in German, was held constant by including only feminine nouns, which receive the same case marking on definite articles ("die") in both nominative and accusative cases. The same form is also used for all nominative and accusative plurals. Thus, articles did not provide disambiguating case or number information. Also, each of the verbs in the German language experiment permits only accusative objects, so the article form itself is never the source of positive or negative information about thematic role.

One additional remark regarding grammaticality is in order. The orthogonal design in which word order, animacy, and verb agreement are varied results in some combinations which are more marked or even ungrammatical. For instance, when neither noun agrees in number with the verb (AG0 trials), the sentence is ungrammatical regardless of animacy or word order. However, this situation is not entirely unnatural. Jordans (1986) has documented an extensive range of case errors in written (e.g., newspapers) as well as spoken German. The fact that such errors by no means render an utterance uninterpretable underscores the need for natural language processing to be robust and tolerant of "noise" in the signal, whether in the medium or in the form of the message.

Procedure. All materials were recorded by a female native speaker. Stimulus words were spoken in isolation and as intonationally neutral as possible. Each set of items was digitized, and an experimental program directed retrieval by computer from a hard disk in the proper

TABLE 1
MATERIALS FOR THE SENTENCE INTERPRETATION TASK

English	German
the cowboy	die Köchin (cook)
the cowboys	die Köchinnen (cooks)
the waitress	die Studentin (student)
the waitresses	die Studentinnen (students)
the telephone	die Tür (door)
the telephones	die Türen (doors)
the necklace	die Jacke (jacket)
the necklaces	die Jacken (jackets)
pushes	stösst (pushes)
the soldier	die Kuh (cow)
the soldiers	die Kühe (cows)
the butler	die Katze (cat)
the butlers	die Katzen (cats)
the television	die Handpuppe (puppet)
the televisions	die Handpuppen (puppets)
the wristwatch	die Wurst (sausage)
the wristwatches	die Würste (sausages)
hits	schlägt (hits)
the secretary	die Frau (woman)
the secretaries	die Frauen (women)
the teacher	die Oma (grandmother)
the teachers	die Omas (grandmothers)
the pencil	die Tasse (cup)
the pencils	die Tassen (cups)
the basket	die Decke (blanket)
the baskets	die Decken (blankets)
kicks	kitzelt (tickles)

TABLE 2
SAMPLE SENTENCES

Sentence	Available cues		
the waitress pushes the cowboys	NVN	AA	AG1
the telephones pushes the cowboy	NVN	IA	AG2
hits the wristwatch the television	VNN	II	AGB
the soldiers the wristwatches hits	NNV	AI	AG0
die Köchin stösst die Studentin	NVN	AA	AGB
die Türen die Köchin stösst	NNV	IA	AG2
schlägt die Wurst die Katzen	VNN	IA	AG1
die Würste die Handpuppen schlägt	NNV	II	AG0

sequence. This method results in fairly natural sounding sentences, without obtrusive overlap or pauses between words within a sentence. Sentences constructed in this manner were played via headphones to the subject. A second set of stimuli was constructed by mixing "pink noise" (i.e., random noise restricted to the speech band) into the audio recordings of each stimulus word. The level of the noise used was the same for all items. Care was taken in the recording process to provide a signal/noise mix that created a partial mask, resulting in sentences that are somewhat more difficult than normal but still quite possible to understand.

Subjects were tested individually in a quiet room. Subjects were instructed to listen carefully to each sentence and to decide as quickly as possible which of the two nouns was the actor or grammatical subject in that sentence. All instructions were given verbally in the appropriate language. Button 1 on a response box was pressed if the subject selected the first noun played, Button 2 for the second noun. The computer recorded noun choice and reaction time on each trial. We shall consider only the noun choice data here (for a detailed consideration of reaction time data in the nonnoise version of this experiment, including a second language processing component, see Kilborn, 1989). For practical reasons, an IBM AT equipped with an AD/DA translation board was used in the English portions and in the German nonnoise portion of the experiment, while an Apple Macintosh Plus equipped with MacRecorder software and hardware was used in the German noise portion. Despite this difference in equipment, the "subject interface," consisting of nearly identical button boxes and headphones, was the same in each experimental version.

RESULTS AND DISCUSSION

The dependent variable choice-of-actor obtained under "clean" and "noise" conditions was entered into separate analyses of variance for each language group in a 3 × 4 × 4 design (word order × agreement × animacy), with subjects as a random factor, and a separate analysis with task condition ("clean" versus "noise") as an additional between-subjects factor. The data from the nonnoise version of this experiment were reported previously in Kilborn (1989). Below we consider each of the cues to thematic role in turn.

Word Order

The effect of word order is shown in Fig. 1. Starting with the "clean" task in English, there is strong preference for the first noun as actor in NVN strings (94% SVO interpretation). In noncanonical strings, there is a marked preference for the second noun (16% first-noun choice in VNN, 12% in NNV). This main effect of word order was significant, $F(2, 22) = 123.4$, $p < .001$.

Under noise, a separate group of native English speakers exhibits a virtually identical pattern of dependence on word order, also shown in Fig. 1 (solid circles). There was no significant interaction ($F(2, 44) = 0.21$, n.s.) between group and word order within English. This is unsurprising, given that word order is a global cue that is inherently robust in the face of a low-level noise mask.

Turning to German, a very different picture emerges. Under normal conditions, there is a weak first-noun preference (58% overall) reflected

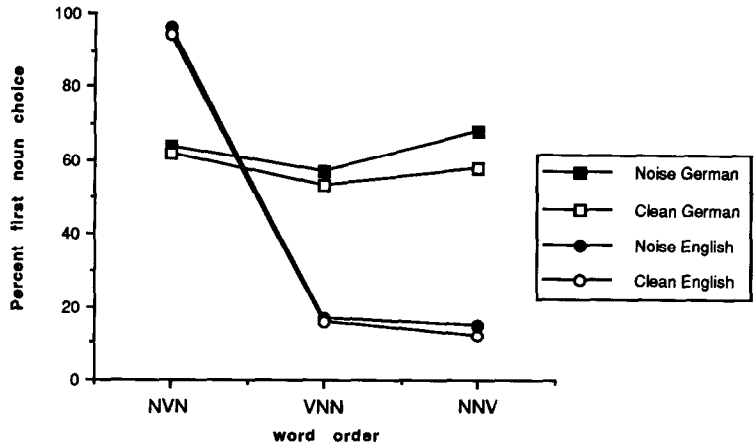

FIG. 1. First-noun choice as a function of word order in English and German under "clean" and "noise" conditions.

in all word order variations (61% in NVN, 53% in VNN, 58% in NNV), but no significant differences among the types. These data are shown by the open squares in Fig. 1. This is consistent with the fact that German allows a high degree of word order variability; word order alone is thus not an especially reliable indicator of thematic role.

Under noise, the first-noun preference in German rises slightly to 63% overall, but this is not significantly higher than under nonnoise conditions. However, the word order factor did emerge as a significant main effect under noise, $F(2, 14) = 5.2$, $p < .05$. A planned comparison showed that the first noun was chosen significantly more often (Wilcoxon $T = 1.0$, $p < .05$) in NNV orders (68%) than in VNN orders (57%). First-noun choice was also significantly higher in NVN (64%) than in VNN strings (Wilcoxon $T = 2.0$, $p < .05$), but the difference between NNV and NVN did not reach significance. These data are also shown in Fig. 1 (solid squares).

A subsequent ANOVA comparing the "noise" and "clean" groups showed that while the main effect of word order reached significance ($F(1, 21) = 4.9$, $p < .013$), there was no significant interaction between group and word order.

Verb Agreement

In English, verb agreement played virtually no role in sentence interpretation. Under normal conditions, the main effect of verb agreement did not reach significance. These data are shown in Fig. 2 (open circles) for comparison (from Kilborn, 1989).

Under noise, the main effect of verb agreement in English monolinguals

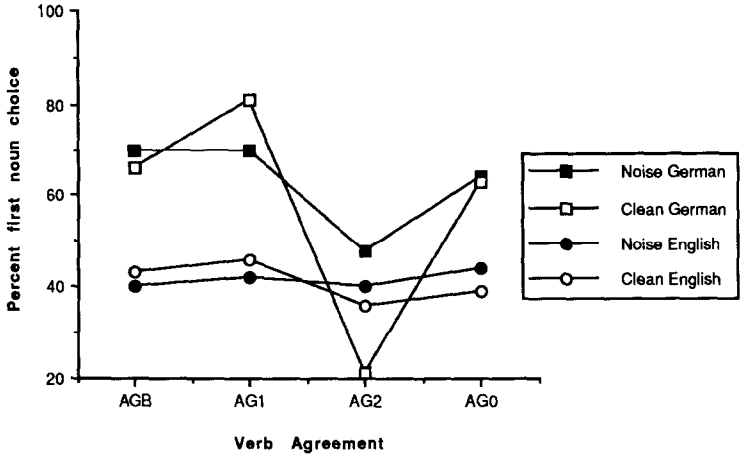

FIG. 2. First-noun choice as a function of verb agreement in English and German under "clean" and "noise" conditions.

was marginally significant, $F(3, 33) = 2.9$, $p < .05$. First-noun choice rates, also in Fig. 2 (solid circles), were slightly higher in AG0 conditions (44%) than in AG1 pairs (42%), followed closely by AG2 and AGB (both 40%). Despite this marginal main effect, no paired comparisons or interactions involving task conditions and verb agreement were significant.

In German, verb agreement played a central role in sentence interpretation. As shown in Fig. 2 (open squares), when a morphological contrast was available, it strongly determined noun choice (81% first-noun choice in AG1, i.e., when the first noun only agreed in number with the verb, compared with 21% in AG2, i.e., when morphology favored the second noun alone). When no morphological distinction could be made, the weak overall first-noun preference prevailed (63% when agreement favored neither noun and 65% when both nouns agreed).

A similar, though somewhat ameliorated pattern of reliance on German verb agreement emerged under noise. The first noun was chosen in AG1 trials 70% of the time, compared with 48% in AG2 pairs. When both nouns agreed, the first noun was chosen 71% of the time; when neither noun agreed with the verb, the first noun was chosen 64% of the time. The main effect of verb agreement within the noise group, also in Fig. 2 (closed squares), was significant, $F(3, 21) = 3.1$, $p < .05$.

Comparison with the "clean" group shows that the morphological strategy is severely reduced under noise. The group by verb agreement interaction was significant, $F(3, 63) = 4.3$, $p < .01$. The direction of this interaction suggests that under noise, AG2 trials, with a response rate of 48%, seem to have given up much of their ability to draw second-noun

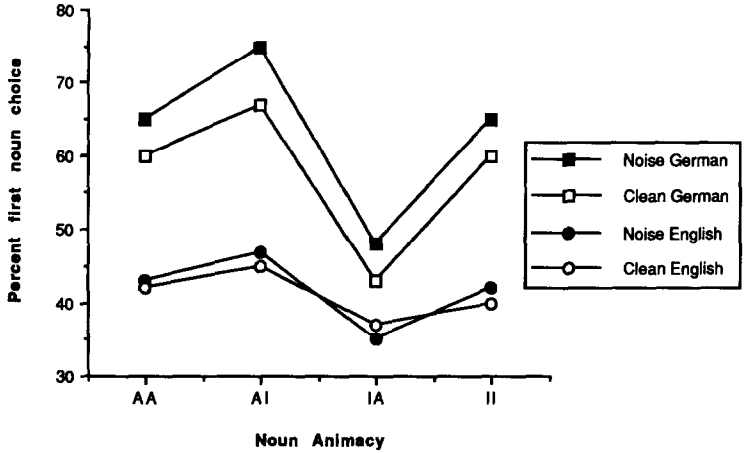

FIG. 3. First-noun choice as a function of animacy in English and German under "clean" and "noise" conditions.

choices. This impression is supported by a Scheffé test, which shows that the source of the interaction is in the AG2 cell ($p < .05$).

Animacy

In normal conditions in English, animacy produced a small but significant main effect ($F(3, 33) = 5.2$, $p < 0.004$), shown in Fig. 3. When a contrast was available, English speakers chose the first noun in AI pairs 45% of the time, compared with 37% in IA pairs.

As Fig. 3 shows, this pattern did not change under more difficult processing conditions. Under noise in English, AI pairs produced 47% first-noun choice and IA pairs produced 35% first-noun choice. This main effect was also significant, $F(3, 33) = 3.4$, $p < 0.03$. There was no interaction involving animacy in the English versions.

Turning to German, animacy was again shown to be an important factor. This main effect, also shown in Fig. 3, was significant ($F(3, 42) = 13.1$, $p < 0.001$). When a contrast was available, German subjects preferred the first noun 67% of the time in AI pairs and 43% of the time in IA pairs.

Under noise, the distinction between animates and inanimates in German appears to remain an important factor. Subjects chose the first noun in AI pairs 75% of the time, compared with 48% of the time in IA pairs. AA and II pairs each produced response rates of 65%. This main effect, illustrated in Fig. 3, was significant ($F(3, 21) = 5.1$, $p < .01$).

There was no significant interaction of group by animacy, indicating that this cue was relied on equally regardless of task conditions.

GENERAL DISCUSSION

The stress induced by a partial noise mask in the sentence interpretation task resulted in a selective breakdown of grammatical morphology in normal, healthy speakers of German. This is evidenced by the direction of the significant interaction between the noise and nonnoise groups and the factor verb agreement: under normal processing conditions, German subjects make extensive use of morphological information as cues to sentence meaning. When the signal is partially masked by pink noise, there is a significant reduction in the use of this information. The source of the interaction was specifically seen to be in the AG2 cell; when the second noun agrees uniquely with the verb, subjects in the "clean" version were as likely to choose the second noun as they were to choose the first noun in AG1 sentences. Under noise, the agreement cue appears to lose support when it favors the second noun.

There was also evidence for a compensatory trend toward greater reliance on the word order cue in German. German subjects were significantly more likely to choose the first noun as actor in NNV and NVN strings than in VNN strings. It is interesting that performance should rise above chance on these two orders first. Cases have been made for both SVO and SOV as basic word order in German (Koster, 1975; Ross, 1970). This may reflect an emerging strategy to exploit whatever processing information basic or canonical word order can provide. Given that the signal-to-noise ratio was still high enough to allow some dependence on morphological cues despite an overall reduction in availability, it seems likely that an even higher noise level might have resulted in still greater dependence on word order information.

The noise manipulation which decreased reliance on morphological cues in German did not affect the maintenance of reliance on animacy in German.

The same global perceptual difficulty experienced by native English speakers resulted in no measurable performance decrement in their use of word order. Animacy, which produced marginally significant results under normal conditions was not different under noise. One seemingly anomalous finding was that verb agreement, which did not reach significance under normal conditions, did produce a significant main effect under noise. However, the pattern of results does not indicate that English-speaking subjects are using verb agreement to determine thematic role; the difference between AG1 and AG2 conditions, where a morphological contrast is available, was a nonsignificant 2 percentage points. In addition, there was no significant interaction between group and verb agreement, suggesting that the overall pattern of performance on the verb agreement cue was not substantially affected by the noise manipulation.

Our findings from normals under stressed conditions in German at least

partially mirror results reported for German Broca's aphasics (Bates et al., 1987b). In a similar sentence interpretation task, German Broca patients showed a reduction in the use of agreement morphology, with a concomitant increase in reliance on word order and animacy. This suggests that some portion of the variance in language performance data from aphasics may be accounted for in terms of response to global stress and not solely due to syndrome-specific conditions.

It may appear that a morphologically rich language could place its speaker at a processing disadvantage. Under the noise conditions imposed in the experiment reported here, this is true. However, under normal conditions, and even under some conditions of stress, there may be an advantage associated with speaking a morphologically rich language. In a German word monitoring experiment (Kilborn, 1987) adapted from Marslen-Wilson and Tyler (1980), subjects listened for target words in sentences that were constructed normally, as "syntactic prose" (e.g., Colorless green ideas sleep furiously), or "random prose" (e.g., Green furiously colorless sleep ideas). Reaction times from Germans in German normal and random sentences were identical with those from English speakers in English. In syntactic prose, however, German subjects were significantly faster than their English counterparts. German provides a high degree of grammatical redundancy, much of it encoded in morphology. If a German listener knows the target in advance, then he or she also knows a number of morphological facts that can help to predict whether the "next word" will be the target, for example prenominal gender and number markings on articles and adjectives. This advantage of German over English disappears in normal prose, where any language may provide, from different sources, abundant enough information to narrow down the range of items that can occur in upcoming sentence slots. But in some stress situations—e.g., if meaning is stripped—a rich morphological code can work to the speaker's advantage. These findings also accord with results from a study of cue convergence in Serbo-Croatian agrammatics by Smith and Bates (1987). They found that patients performed near random levels when given case, gender agreement, or word order cues in isolation. But allowed to exploit a convergence of these cues, agrammatic performance approached normal levels, suggesting that a coalition of cues can overcome a deficit that leads to failure when a high degree of redundancy is not available.

In addition to these empirical demonstrations that morphology is "globally vulnerable," there are also solid theoretical grounds for the idea that a global reduction in processing capacity can affect some aspects of language more than others (Shallice, 1988). Specifically, a global reduction in capacity may selectively spare one domain and impair another, if there is a difference in the shape of the underlying function that relates performance and capacity in each domain. Figure 4 illustrates three such

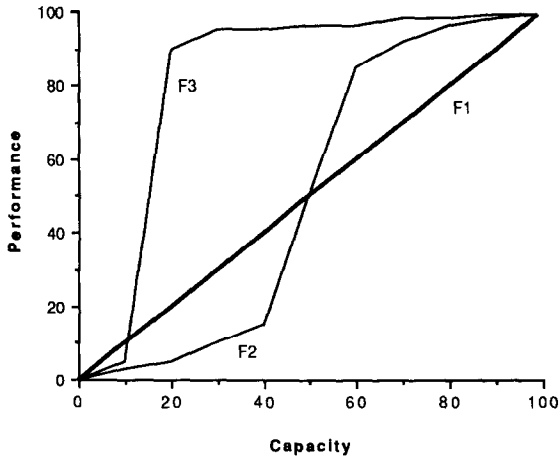

FIG. 4. Hypothetical linear and nonlinear distributions between performance and capacity.

performance curves: F1, a linear function (where any drop in capacity leads to an equivalent drop in performance); F2, a nonlinear S-shaped function with a sharp and early drop-off point (where a 40% reduction in capacity has very little effect, but a 50% reduction is catastrophic); and another nonlinear function, F3, with an early rise to asymptote (showing virtually no change in performance until capacity is reduced by more than 90%). For normal individuals performing under optimal conditions (100% capacity), all three curves yield perfect performance. However, normals subjected to varying degrees of noise or stress would begin to show a differential "softening" among these three domains—not because of damage to specific mechanisms, but because these aspects of performance are differentially sensitive to the same global reduction in capacity (e.g., a 50% loss leads to a clear reduction in performance in the first two functions, but leaves performance spared on the third). In fact, nonlinear functions of this sort are quite common in the world of attention and performance, and it is quite likely that they contribute to some of the patterns of sparing and impairment that we observe in aphasic patients—particularly those that are shared by Broca's and Wernicke's.

Response to global difficulty in processing may be manifest in language-specific ways. The particular response may depend on the extent to which the language in question makes use of relatively vulnerable morphological units to carry out grammatical processing chores. In this study, we reported data which suggest that global stress is one factor that must be taken into account when trying to disentangle global versus specific causes of morphological impairment. We suggest that further investigations along these lines will be a necessary complement to ongoing research directly with

patient populations in understanding and eventually overcoming language performance deficits.

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