Brain and Language **69,** 253–303 (1999)
Article ID brln.1999.2167, available online at http://www.idealibrary.com on IDEAL®

POSTER SESSION 1: VERBS, MORPHOLOGY, AND SEMANTICS

Finite Verbs in Agrammatism

Ron van Zonneveld and Roelien Bastiaanse

Introduction

The production of finite verbs is difficult for agrammatic aphasics. This has been mentioned for several languages that differ in morphology and syntax of verbs, e.g., English, Hebrew, and Dutch. The latter is of special interest, as in this language the finite verb appears in different positions in the matrix and embedded clause. It is generally assumed that the canonical word order in Dutch is subject–object–verb and that there is a rule that ''moves'' the finite verb to second position in the matrix clause:

Dutch	Jan	heeft	een sigaret	gerookt
Lit. translation	John	has	a cigarette	smoked
Dutch	. . . dat	Jan	een sigaret	rookt
Lit. translation	. . . that	John	a cigarette	smokes
Dutch	Jan	$rookt_i$	een sigaret	i
Lit. translation	John	smokes	a cigarette	

Knowing that Dutch agrammatics have problems with finite verbs, one might wonder whether this is due to the finiteness as such (a morphological problem) or to the structural position in the sentence (a syntactic problem).

Bastiaanse and Van Zonneveld (1998) reported the results of a sentence completion test in which the agrammatics had to complete matrix and embedded sentences with either a finite or a nonfinite verb. The results demonstrated that the agrammatics were significantly worse filling in finite verbs in *second* position in the matrix clause than at filling in finite or nonfinite verbs in *final* position. This was taken as support for the hypothesis that the underlying disorder was a syntactic one: the agrammatic patients had problems with verb movement.

An objection against this interpretation may be that the results were caused

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by an artifact. They could equally well be explained by a nonlinguistic factor: completion in clause final position is easier than filling in a word in the middle of a sentence.

Hence, a new test was developed to find out whether the results of the Bastiaanse and Van Zonneveld study were robust and whether the results were correctly interpreted as indicating a syntactic disorder. The hypothesis was that the production of finite verbs is more difficult in second position than in final clause position, because agrammatic patients suffer from a syntactic disorder that prevents them from correctly applying verb movement.

Methods

Subjects. Six agrammatic Broca's aphasics, who had Dutch as their native language, participated in this study. All patients were aphasic due to a single stroke in the left hemisphere.

Materials. The patients were presented with two pictures in which the same person was performing the same action with a different person or object. The patient was asked to complete a sentence. There were two conditions: (1) a matrix clause that should be completed with a *finite verb–object* and (2) an embedded clause with the intended answer *object–finite verb.* There were 15 sentences in each condition. Two examples follow.

Condition 1: target = finite verb–object

Tester: Dit is de man die de tomaat snijdt en dit is de man die het brood snijdt. Dus deze man snijdt de tomaat en deze man . . . [*Patient: ''snijdt het brood''*].

Tester: This is the man who the tomato cuts and this is the man who the bread cuts. So, this man cuts the tomato and this man . . . [*Patient: ''cuts the bread''*].

Condition 2: target = object–finite verb

Tester: Deze man snijdt de tomaat en deze man snijdt het brood. Dus dit is de man die de tomaat snijdt en dit is de man die . . . [*Patient: ''het brood snijdt''*].

Tester: This man cuts the tomato and this man cuts the bread. So, this is the man who the tomato cuts and this is the man who . . . [*Patient: ''the bread cuts''*].

Results and Discussion

The results are summarized in Table 1. Completing a matrix clause was more difficult than completing an embedded clause ($t = -2.79$, $df = 5$, $p < .05$). This holds for all patients with one exception. The outlier is the patient who is most severely aphasic. An error analysis (see Table 1) shows that in the matrix clauses one error type is most prominent: producing the embedded

TABLE 1
The Numbers Correct, Error Types in the Matrix, and Embedded Condition for the Individual Subjects

	Correct		Errors matrix clause			Errors embedded clause		
Subject	Matrix	Embedded	Emb order	V-omis.	Other	Matr order	V-omis.	Other
1	5	11	3	7	—	1	—	3
2	10	8	2	—	3	6	—	1
3	7	14	3	5	—	1	—	—
4	7	13	7	—	1	—	—	2
5	10	14	5	—	—	1	—	—
6	12	14	1	2	—	1	—	—
Mean	8.50	12.33	3.50	2.33	0.67	1.67	0	1.00

word order, that is, producing the object followed by the (finite) verb in its base-generated position. This is quite remarkable, as Dutch agrammatics never produce this construction (object–finite verb in a nonembedded clause) in their spontaneous speech: when they do not move the verb in spontaneous speech, they always produce a nonfinite form, either the infinitive or the participle (see Bastiaanse & Van Zonneveld, 1998). Notice that the opposite, a finite verb in second position in the embedded clause, is produced more than once only by the patient who shows the deviant pattern (patient 2).

This suggests that Dutch agrammatics are able to produce finite verbs in their base-generated, that is, clause-final position. The problems they encounter are in producing these same verb forms in Verb Second position. Since the agrammatics were asked to produce both the object and the finite verb in both conditions, it seems as though the findings obtained earlier by Bastiaanse and Van Zonneveld (1998) were not caused by an artifact, but correctly reflect the problems with ''verb movement'' in agrammatic Broca's aphasics, implying that the problems with finite verbs are syntactic and not morphological in nature.

Interesting in this respect is a recent finding of Indefrey et al. (1999), who performed a PET-scan study in which they compared the production of a sentence with a finite verb in second position and a ''subject–object–nonfinite verb'' string in German. Their results show significant activation in the left frontal operculum for the verb second condition, a cortical area that is usually affected in Broca's aphasia.

REFERENCES

Bastiaanse, R., & Van Zonneveld, R. 1998. On the relation between verb inflection and verb position in Dutch agrammatic aphasics. *Brain and Language,* **64,** 165–181.

Indefrey, P., Brown, C. M., Hagoort, P., Hellwig, F., Herzog, H., & Seitz, R. J. 1999. The left frontal operculum is sensitive to local and sentence-level syntactic encoding: A ^{15}O-butanol PET study. Poster presented at CUNY, New York, March 1999.

Trade-Off between Lexical-Semantics and Morphosyntax in the Production of Verbs in Agrammatic Broca's Aphasia

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Introduction

One of the characteristics of agrammatic aphasia is telegraphic speech. It has often been mentioned that telegraphic speech lacks verbs and that the verbs which are produced lack inflection. Several studies showed that agrammatics are poor performers on an action naming test, but only a few authors linked the lexical-semantic and the inflectional problems (Berndt et al., 1997; Bastiaanse & Jonkers, 1998), with different outcomes.

The present study focuses on verbs in the spontaneous speech of a group of Dutch agrammatic aphasics. Dutch is an interesting language in this respect, because the position of the verb is dependent on finiteness of the verb: the finite verb is in second position (called Verb Second position) in the main clause, but in final position in the subordinate clause; nonfinite verbs are always in final position. Considering that agrammatic patients are poor in verb inflection raises the question whether they are sensitive to the relation between finiteness and verb position. A second question is, is there a relation between the lack of finite verbs and the lack of verbs?

Methods

Subjects. Twelve agrammatic Broca's aphasics (mean age 57.8 years) participated in this study. All patients were right-handed and aphasic due to a single stroke in the left hemisphere. For comparison a group of eight healthy speakers was included.

Materials. From each patient a sample of spontaneous speech was available, containing answers to questions such as ''could you tell me how your speech problems started,'' ''could you tell me something about your hobbies,'' and ''could you tell me about the work you used to do?'' To obtain samples that were comparable with respect to verb tense, the healthy speakers were asked about their last illness, their previous job, and their hobbies. All interviews were audiotaped and transcribed orthographically.

Analysis. For the analysis with regard to verb position the entire sample of all patients was analyzed. For each (lexical) verb, auxiliary, copula, and modal, it was scored whether it was finite or nonfinite (infinitives and participles) and whether it was in Verb Second or final position. For analyzing the

relation between finiteness and lexical-semantic contents of the verbs, samples of a fixed size (300 words) were used, a condition for a reliable lexical-semantic analysis. The samples of eight of the patients contained sufficient spontaneous speech to be included in this second analysis.

From each clause containing a lexical verb, auxiliary, copula, or modal, it was established whether it was finite or nonfinite. The number of finite clauses was divided by the total number of clauses containing a lexical verb, auxiliary, modal, or copula. This resulted in the so-called *finiteness index:* the proportion of finite clauses. As a measure for lexical-semantic content, the diversity of the verbs was considered most suitable and therefore a type–token ratio was used: the number of different lexical verbs (types) divided by the total number of lexical verbs (tokens). This was done for all the lexical verbs together and for the finite and nonfinite lexical verbs separately.

Results

The results are presented in Table 2. The data show that agrammatics are sensitive to the relation between finiteness and verb position. Only 2 of 133 nonfinite verbs are not in their proper position and hardly any finite verbs are produced in clause final position.

Although the finite and nonfinite verbs are in their proper position, the proportion of clauses containing a finite verb is reduced: the finiteness index of the agrammatics is significantly lower than normal ($z = -2.95$, $p = .003$). The proportion of finite lexical verbs to the total number of finite verbs (including copulas, modals, and auxiliaries) is the same for both groups ($z = -1.11$, $p = .268$).

The total number of lexical verbs produced by the agrammatics is normal, but the diversity, as measured by the type–token ratio, of the lexical verbs is significantly lower ($z = -2.00$, $p = .045$). When the type–token ratios

TABLE 2
Results of the Spontaneous Speech Analysis with Respect to Verb Position, Verb Finiteness, and Verb Diversity (*$p < .05$)

	Agrammatics	Controls
Position		
Finite verbs in correct position	251/253 (99.2%)	
Nonfinite verbs in correct position	131/133 (98.5%)	
Finiteness		
Finiteness index	0.72*	0.96
Finite lexical/total finite verbs	0.51	0.44
Diversity		
Number of lexical verbs	29.13	31.50
Diversity lexical verbs	0.51*	0.65
Diversity finite lexical verbs	0.52*	0.72
Diversity nonfinite lexical verbs	0.62	0.74

for finite and nonfinite verbs are analyzed separately, it is demonstrated that this is due to the low diversity of the finite verbs ($z = -2.107$, $p = .035$); the diversity of the nonfinite verbs is normal ($z = -1.05$, $p = .294$).

Discussion

This group of agrammatics produces a normal number of lexical verbs and they are sensitive to the relation between finiteness and verb position. It is difficult for them to produce sentences with *finite* verbs, however. If they do so, they use a normal proportion of modals, copulas, and auxiliaries and, therefore, a normal proportion of lexical verbs. The *diversity* of these finite lexical verbs, however, is lower than normal.

These findings suggest that many aspects of agrammatic verb production are not deviant from normal speech. First of all, the proportion of lexical verbs to the total number of words is normal. Second, although the proportion of finite clauses is reduced, the proportion of modals, copulas, and auxiliaries is normal, although these are usually considered function words, a notoriously difficult category for agrammatics. Third, the lexical diversity of nonfinite verbs is normal.

Hence, the major problem concerning verb production seems to be with *finite* verbs in second position. The finding that the finite lexical verbs have a *low diversity* suggests that there is a *trade-off effect* at stake here: although the agrammatics show a normal diversity of verbs in their spontaneous speech, the diversity of the finite verbs is reduced, meaning that if the patients produce finite verbs, a construction that is difficult for grammatically impaired speakers, it is at the cost of the lexical-semantic content of the finite clause. In nonfinite clauses, which are produced to avoid finite verbs, there is a normal variety in the verbs produced.

REFERENCES

Bastiaanse, R., & Jonkers, R. 1998. Verb retrieval and action naming in spontaneous speech in agrammatic and anomic aphasia. *Aphasiology,* **12,** 951–969.

Berndt, R. S., Mitchum, C. C., Haendiges, A. N., & Sandson, J. 1997. Verb retrieval in aphasia. 2. Relationship to sentence processing. *Brain and Language,* **56,** 107–137.

The Relation between the Realization of Subject and Object Determiners and the Production of Verbs in Dutch Agrammatic Aphasia

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Introduction

This study focuses on the relationship between the production of verbs and determiners by Dutch agrammatic aphasics. According to the Govern-

ment and Binding theory, subject DPs (Determiner Phrases) are assigned nominative Case by the inflected verb, INFL, whereas object DPs are assigned accusative Case by the verb, V. Each overtly realized DP must have Case, which is assigned to the determiner. When there is no Case assigner, no Case can be assigned and therefore no determiner can be produced. This means that when no finite verb is produced, the subject remains without Case, and its determiner cannot be realized. The object is assigned accusative Case by the verb, implying that no object determiners can be produced when no verb is produced.

Ruigendijk et al. (1999) analyzed the spontaneous speech of Dutch and German agrammatic aphasic speakers with regard to Case assignment. It was, however, not always possible to decide whether a DP was a subject or an object when no verb was produced. For the present study, the data of a sentence construction test were analyzed. When the target is known, the sentences without verbs can also be considered to evaluate whether there is determiner omission when an object DP is produced without a verb.

The following hypotheses were formulated:

The realization of determiners in subject DPs is dependent on the presence of a finite verb and the realization of determiners in object DPs is dependent on the presence of a verb.

Methods

Subjects. Fourteen Dutch agrammatic Broca's aphasics (mean age 58.6) participated in this study. All were aphasic due to a single stroke in the left hemisphere and at least 3 months postonset.

Materials. The speech production was elicited with a sentence construction task. A picture was presented to the patient and s/he was asked to tell in one sentence what was happening in the picture. The actions depicted were related to transitive (30 items) and intransitive (30 items) verbs.

Scoring. From each sentence it was established: (1) which syntactic role the realized DP(s) had; (2) whether the determiner was realized; (3) for the subjects, whether there was a finite verb present; and (4) for the objects, whether a verb was produced. DPs with a pronoun were not taken into account, as they were often used perseverately.

Results (Table 3)

The results show that determiners in subject DPs are mainly produced when a Case assigner (the finite verb) is present; the same holds for objects: when there is no verb, hardly any determiners are produced in the object DPs (only 4 times on 420 possible objects, meaning less than 1%). The high SDVs are caused by the fact that we did not analyze the pronouns; some patients used many pronouns and relatively few nouns, and other patients showed the reverse pattern.

TABLE 3
The Group Means for DPs Containing a Determiner in Relation to the Presence of Their Case Assigner

	Subject DP + finite verb	Subject DP − finite verb	Object DP + verb	Object DP − verb
Determiner produced	10.29 (11.52)	4.57 (6.24)	8.36 (7.93)	0.29 (0.61)

Discussion

The hypothesis was that DPs with a determiner should have an overtly realized Case assigner, as the determiner is the Case-bearing word. This hypothesis is supported only for the object DPs, which hardly ever occur without a Case assigner, but with a determiner. For the subject DPs, the results support the hypothesis only in the sense that determiners are more often produced when there is a Case assigner present. When no Case assigner is produced, subject DPs still occur with a determiner. How can this determiner be produced when there is no Case assigner present?

The answer lies in assignment by a so-called *default strategy*. It is assumed that Case assignment to the subject is possible by a strategy that says assign nominative Case (i.e., in Dutch) to a subject DP when there is no Case assigner present. This does not seem a very elegant solution: a finite verb is needed to assign nominative Case to a subject DP, but when there is no finite verb, this nominative Case can also be assigned by default. Notice, however, that it is only ''coincidental'' that the structural Case, as assigned by the finite verb, and the default Case are the same. This is true for Dutch, but not for English. In English, the default Case is accusative: Me Tarzan, you Jane; Me and you and a dog named Boo.

No default Case for object DPs exists and hence, object DPs that are used without a Case assigner hardly ever contain a determiner.

Cross-linguistic research is needed to find out whether English-speaking aphasics produce subjects in accusative Case when no Case assigner is present; this, of course, can only be done by eliciting sentences that contain pronouns, as this is the only word class, in English, in which Case is visible. In Russian, Case is visible only on nouns. By testing Russian-speaking agrammatics it will be possible to find out what Case the object DPs without a determiner bear.

REFERENCES

Ruigendijk, E., van Zonneveld, R., & Bastiaanse, R. 1999. Case assignment in agrammatism. *Journal of Speech, Language and Hearing Research*, in press.

Facilitation of Verb Form Retrieval in an Agrammatic Aphasic: A Multiple Baseline Study

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Introduction

Amidst the theoretical controversies that surround the phenomenon of agrammatism, there is also a general consensus regarding the multifaceted nature of this condition (Schwartz, Fink, & Saffran, 1995). In agrammatic language production, a wide variety of symptoms were reported (Jonkers & Bastiaanse, 1996; Saffran et al., 1989; Thompson et al., 1995). Agrammatic aphasics are poor in action naming, and their spontaneous speech is characterized by a lack of lexical verbs and reduced verb inflection. Goodglass (1993) observed that the agrammatic aphasics have a tendency toward preference for present progressive tense inflections rather than past tense forms.

Some recent neurolinguistic studies support the view that regular and irregular past tense forms in English are computed by different cognitive and neural mechanisms (Jaeger et al., 1996). According to ''dual system theories'' regular past tense forms of verbs are generated by rules, whereas irregular past tense forms are computed by activating some aspect of lexical memory in which these forms are supposedly stored. Using PET scan imaging technique, Jaeger and her colleagues have verified the dual system hypothesis. Their results indicated that computation of regular and irregular past tense forms of English verbs involved activation of dorsolateral prefrontal cortex and midtemporal cortex of the left hemisphere. Activation of Broca's area was seen for both forms of verbs, which was interpreted as an indication that the manipulation of the grammatical feature past tense may occur in this area.

Some contemporary aphasia treatment studies support the view that modular treatment of agrammatism that focuses on tense inflection of verbs facilitates recovery of language in chronic aphasics (Mitchum & Berndt, 1994; Schwartz et al., 1995; Weinrich et al., 1997). The present study reports a method of treatment that facilitated past tense inflection of both regular and irregular verbs in an agrammatic aphasic. The objective of the present study is to test the efficacy of modular treatment of tense inflection of regular and irregular verbs in an agrammatic Broca's aphasic.

Method

Subject. The subject is a 51-year-old male aphasic with symptoms of Broca's aphasia.

Materials. This study targeted three groups of verbs, namely, intransitive–imperative, regular, and irregular types, for the training of the aphasic client. Fifteen verbs in each type were elicited in sentential contexts. Only the regular and irregular forms of verbs could be inflected for the past tense. The intransitive–imperative form cannot be inflected for the past tense.

Procedure. The present study used a single-subject multiple-baseline method to train the client in the target areas (Hesketh, 1986). In Task 1 (intransitive–imperative), each stimulus presentation included a description of a picture and a question. The target response for each question was predetermined (Helm-Estabrook, 1981). Each stimulus was printed on a 6 × 9-in. card. The sentence and the associated question were intended to elicit an intransitive–imperative verb or verb phrase (kneel, wake up, etc). To obtain a baseline performance of the client, the client answered the question by choosing the appropriate intransitive–imperative form. Each correct response was given one point. In the treatment phase, the therapist modeled the appropriate forms for a couple of stimuli and then only hinted when the client chose the wrong verb or phrase. Each correct response was given one point, regardless of the cues made available to the client for any given stimulus. In the second baseline phase, that is, after the treatment was completed following the response criterion of 90% accuracy level, the patient's response was elicited without any help from the clinician. For Tasks 2 and 3 (regular and irregular verbs), the procedures were as follows. In the baseline phase, the regular (Task 2) or irregular (Task 3) past tense form of verb was elicited without any assistance of the therapist. The following are some examples for regular and irregular types, respectively. The teacher asked him many questions. He ____ every question [(1) Answered, (2) Know, (3) Feel]. Last weekend we visited Mall of America. My sister ____ lots of clothes [(1) Charge, (2) Stopped, (3) Bought]. In the treatment phase, the therapist auditorily presented the missing appropriate inflected form and pointed at it on the card. The therapist also explained how the story/sentence completion task required the choice of an inflected form of verb from the three alternatives. Each spontaneously generated appropriate inflected form was given one point. Any response generated with cues from the therapist was not given any point. Following the criterion of 80% accuracy level, the treatment phase of both Task 2 and Task 3 was terminated. In the second baseline phase, the procedure was the same as that of the first baseline. As the modified multiple-baseline method demands, the baseline, treatment, and (second) baseline were carried out in such a way that when one area was under treatment, the other two areas were being baselined (see Fig. 1).

Results

LK demonstrated maintenance of treatment gains following withdrawal of treatment.

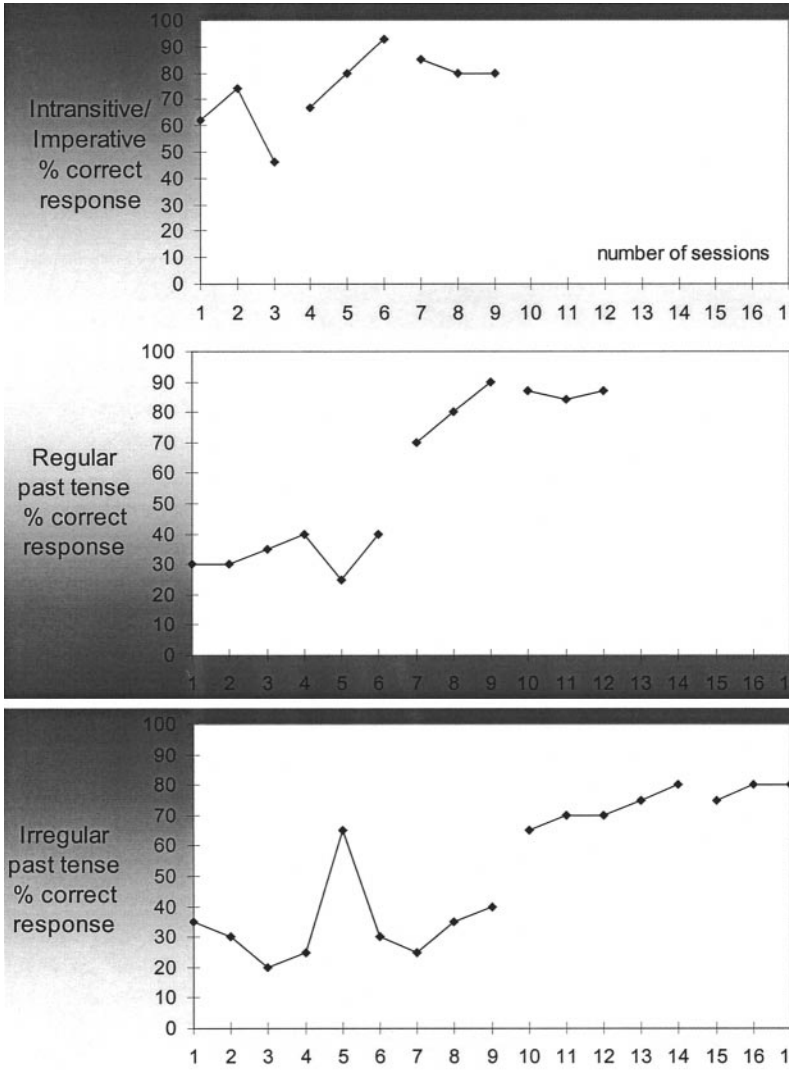

FIG. 1. Multiple baseline data on LK's performance.

REFERENCES

Goodglass, H. 1993. Aphasic agrammatism. In *Telerounds,* Vol. 10. Tucson: Univ. of Arizona.

Helm-Estabrooks, N. A. 1981. Helm elicited language program for syntax stimulation (HELPSS). Austin, TX: Exceptional Resources.

Hesketh, A. 1986. *British Journal of Disorders of Communication,* **21,** 47–62.

Jaeger, J. J., Lockwood, A. H., Kemmerer, D. L., Van Valin, R. D., Murphy, B. W., and Khalak, H. G. 1996. *Language,* **72,** 451–497.

Jonkers, R., & Bastiaanse, R. 1996. *Brain and Language,* **46,** 65–97.

Mitchum, C. O., & Berndt, R. S. 1994. Verb retrieval and sentence construction: Effects of targeted intervention. In G. W. Humphreys & M. J. Riddoch (Eds.), *Cognitive neuropsychology and cognitive rehabilitation.* Hove, UK: Lawrence Erlbaum.

Saffran, E. M., Berndt, R. S., & Schwartz, M. F. 1989. *Brain and Language,* **37,** 440–479.

Schwartz, M. F., Fink, R. B., & Saffran, M. 1995. *Neuropsychological Rehabilitation,* **5,** 93–127.

Thompson, C. K., Shapiro, L. P., Li, L., & Schendel, L. 1995. *Clinical Aphasiology,* **23,** 121–140.

Weinrich, M., Shelton, J. R., Cox, D. M., & McCall, D. 1997. *Brain and Language,* **58,** 23–45.

The Role of Semantic Complexity in Verb Retrieval: Part 2

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Many aphasic patients have more difficulty producing verbs than nouns (e.g., Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser & Berndt, 1990). Breedin, Saffran, and Schwartz (1998) speculated that semantic complexity might play a role in the verb retrieval of aphasic patients. To test this hypothesis, they compared patients' retrieval of *general* and *specific* verbs (e.g., to go vs to walk) using a task that combined story completion with delayed repetition. Short paragraphs were created that could contain either of the two contrasting verbs followed by a question designed to elicit the verb:

The bus stopped and let people on.
Marty *went/walked* to the back.
There were plenty of seats there.
What did Marty do when he got on the bus?

Patients were more likely to retrieve the verb if they heard the story with the specific verb than with the general verb. In addition, an error analysis revealed that when patients retrieved incorrect verbs, they tended to be semantically more complex than the target verb.

While these findings suggest that verb representations may be compositional, we do not know whether the specific verbs were easier to retrieve because they were more complex (i.e., have a greater number of semantic components) or because their meanings were more specific. General verbs can occur in many different contexts and their meaning is often modified by that context (e.g., take a cookie, take a wife, take a trip). In contrast, specific verbs appear to be less flexible with respect to the contexts in which they can appear (e.g., grab a cookie, *grab a wife, *grab a trip). Consequently,

it may be that when a specific verb is activated, only one meaning is retrieved, whereas activation of a general verb may generate a number of meanings, causing the patient difficulty in selecting the one that is appropriate to the context.

To address this question, we designed a set of materials in which the verbs were similar in the specificity of their meaning; however, they varied in complexity. One set of verbs differed in whether they implied a specific instrument (e.g., crawl vs race). A second set of verbs differed in whether they specified negation (e.g., forbid vs allow). A third set of verbs differed in whether they specified an intention to carry out the action (e.g., watch vs see). Finally, to investigate the impact of the verb sharing morphology and meaning with a noun, we included a set of verbs that differed in whether they specified the instrument for carrying out the action (e.g., spoon vs sprinkle).

Patient Descriptions

Two aphasic patients who had difficulty retrieving verbs were tested. Both patients were better at naming pictures of objects than pictures of actions on Zingeser and Berndt's (1990) noun–verb naming test. One of the patients, MD, showed no difference between noun and verb comprehension on the Philadelphia Comprehension Battery (nouns = 0.80; verbs = 0.80). In contrast, patient MG showed a trend toward better comprehension of nouns than verbs (nouns = 1.00; verbs = 0.87).

Materials

There were 22 stories comparing *instrument implied* and *no instrument* verbs, 13 stories comparing *positive* and *negation* verbs, 18 stories comparing *no intention* with *intention* verbs, and 20 stories comparing *instrument specified* and *instrument not specified* verbs. The story contexts were designed to elicit either verb equally and data were collected from normal subjects to verify this. The verb sets were matched in overall frequency of occurrence or the more complex verb set was lower in frequency. Thus, word frequency would favor retrieval of the less complex verbs.

Procedure

Patients heard a story followed by a question and were instructed to try to answer the question with a complete sentence. They were given five practice trials followed by the test trials.

Results

Patients' responses were scored as correct if they produced the target verb regardless of whether it was used in a sentence (see Table 4). In general, both patients were better at retrieving the semantically complex verbs. For

TABLE 4
Proportion of Verbs Correctly Retrieved in the Story Completion Task

Verb type	MG	MD
Instrument implied	0.75	0.82
No instrument	0.61	0.45
Difference	0.14	0.37*
Negative	0.77	0.69
Positive	0.69	0.62
Difference	0.08	0.07
Intention	0.61	0.78
No intention	0.64	0.44
Difference	−0.03	0.34*
Instrument specified	0.85	0.65
No instrument specified	0.55	0.60
Difference	0.30*	0.05

* $p < .05$

MG, the difference in performance seemed localized to verbs that contained an instrument component, and he showed more of an effect if the verb shared the morphology and meaning of a noun (e.g., spooned the sugar). For patient MD, the implication of an instrument seemed to improve performance but the addition of shared noun morphology did not add anything to her performance. She also showed a significant effect of the addition of an intention component to the verb.

Discussion

We have presented preliminary data from an ongoing study of the effects of semantic components on aphasic patients' verb retrieval. Both patients seem better at accessing verbs that have additional semantic features. As in the Breedin et al. (1998) study, the more complex verbs tend to be lower in frequency as well. In the case of MG, the benefit of semantic complexity appeared limited to the presence of an instrument. Thus, his performance seems to benefit from the presence of noun information within the verb's semantic representation. Note that MG shows a slight advantage in comprehension for nouns over verbs. However, MD's performance cannot be accounted for simply by recourse to nouns, as her performance was improved by the abstract semantic feature of intention. These results suggest that the semantic complexity effect reported in Breedin et al. may indeed be due to semantic complexity rather than specificity.

REFERENCES

Breedin, S. D., Saffran, E. M., & Schwartz, M. F. 1998. Semantic factors in verb retrieval: An effect of complexity. *Brain and Language,* **63,** 1–31.

Miceli, G., Silveri, C., Villa, G., & Caramazza, A. 1984. The basis for the agrammatic's difficulty in producing main verbs. *Cortex,* **20,** 207–220.

Zingeser, L. B., & Berndt, R. S. 1990. Retrieval of nouns and verbs in agrammatism and anomia. *Brain and Language,* **39,** 14–32.

Verb Comprehension in Frontotemporal Dementia

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Introduction

Studies of category-specific deficits have focused on concrete nouns such as natural kinds and manufactured artifacts. While studies of categories such as these have provided compelling evidence about dissociations that are informative for theories of semantic memory, we use concrete words surprisingly uncommonly in our spontaneous speech. Other categories of words should be investigated as well to establish the generalizability of these category-specific observations. In this report, we describe studies of a category-specific deficit for verbs. Consistent with the modality-specific approach to semantic memory organization (e.g., Allport, 1985), it has been argued that this deficit for verbs is associated with frontal cortices because of the important role of this brain region in implementing motor patterns (e.g., Damasio & Tranel, 1993). However, patients with Alzheimer's disease (AD) who have disease primarily in posterior temporal and inferior parietal regions also have been noted to have verb naming and recognition difficulty (e.g., Robinson et al., 1996). In the present study, we sought to assess verb comprehension and the association of this difficulty with frontal cortices. Moreover, we tested the modality-specific approach to semantic memory organization by administering motion verbs as well as cognition verbs. Finally, because of the problems associated with testing verb processing with static pictures, we used stimuli consisting of film loops and definitions.

Methods

Subjects. We assessed 16 patients with AD whose disease has compromised temporal–parietal cortices, 6 patients with a frontotemporal form of degeneration (FTD) whose disease has affected primarily frontal cortices, and 11 healthy older control subjects. All patients were right-handed native English speakers with a high-school education.

Materials. We administered 40 verbs (20 motion verbs and 20 cognition verbs) and 40 nouns (20 concrete nouns and 20 abstract nouns) matched across grammatical form class category and semantic subcategory for frequency and familiarity. We developed film loops and brief definitions to portray each verb and noun, and these materials were presented in sessions separated by at least 1 month. Subjects were asked to select the one of four available words that best labeled the presented stimulus. The three foils were systematically related to each choice [for verbs agent–theme reversal, semantically related to the target, semantically related to the reversal choice (low associate); for nouns opposite, semantically related, semantically related to the opposite (low associate)]. The foils were matched for frequency, familiarity, and associativity to the target.

Results

We evaluated group differences for word–film/definition matching decisions using an ANOVA with a group (3) $\times$ grammatical category (2) $\times$ semantic category (2) $\times$ material (2) design. We found significant main effects for group [$F(2, 30) = 23.05$; $p < .001$] and grammatical category [$F(1, 30) = 57.44$; $p < .001$] and a group $\times$ grammatical category interaction [$F(2, 30) = 8.90$; $p < .001$]. These findings are summarized in the top of Fig. 2. *t* tests demonstrated that FTD patients and AD patients differ from control subjects for verbs [FTD $t(15) = 7.06$, $p < .001$; AD $t(25) = 5.59$, $p < .001$] and nouns [FTD $t(15) = 7.44$, $p < .001$; AD $t(25) = 5.13$, $p < .001$]. FTD patients were more impaired than AD patients for verbs and nouns. Within-group comparisons did not reveal any differences between motion and cognition verbs nor between film and definitions. An analysis of the patients' errors with an ANOVA using a group (3) $\times$ grammatical category (2) $\times$ type of error (3) design revealed significant main effects for group [$F(2, 30) = 22.50$; $p < .001$], grammatical category [$F(1, 30) = 38.41$; $p < .001$], and type of error [$F(2, 60)] = 11.05$; $p < .001$] and interaction effects for group $\times$ grammatical category [$F(2, 30) = 6.77$; $p < .005$], group $\times$ type of error [$F(4, 60) = 2.85$; $p < .05$], and group $\times$ grammatical category $\times$ type of error [$F(4, 60) = 4.99$; $p < .005$]. The findings are summarized in the bottom of Fig. 2. FTD and AD patients differed significantly from control subjects for all types of errors. Direct contrast of FTD patients and AD patients revealed a significant difference for the noun-low associate choice, a type of error made more often by FTD patients (the difference for the verb-reversal error approached significance). Among FTD patients, verb-reversal errors occurred significantly more often than verb-associate and verb-low associate errors, and verb-reversal errors were significantly more common than noun-opposite errors. Among the AD patients, verb-reversal errors were significantly more common than verb-related errors, noun-opposite errors were less common than noun-related er-

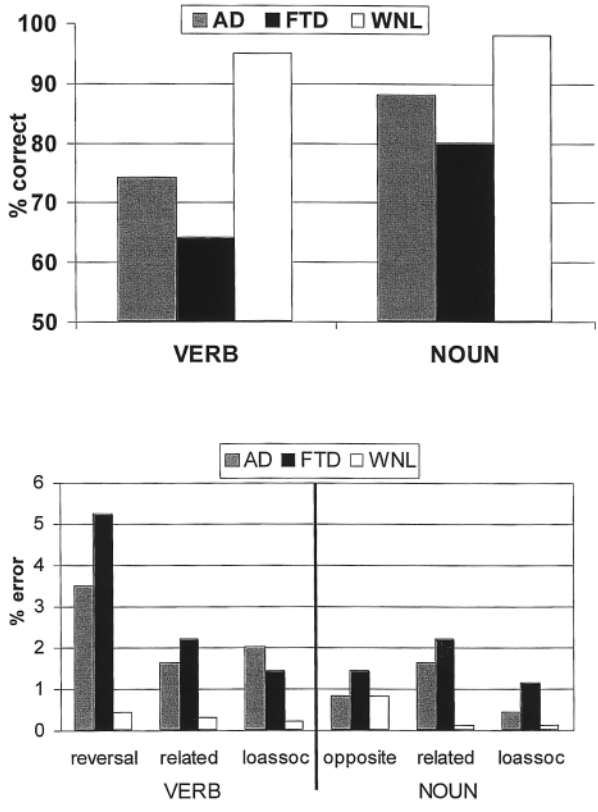

FIGURE 2

rors, and verb-related errors were more common than noun-opposite errors (all within-group differences significant at least at the $p < .05$ level, according to *t* tests).

Discussion

These findings indicate that FTD patients and AD patients have difficulty understanding verbs, regardless of the verb semantic subcategory or the manner of presentation. This broadly confirms the previously observed association of verb comprehension difficulty with frontal brain regions. However, the claim that the action component of verb meaning is the link with frontal cortices does not receive strong support since cognition verbs were equally difficult for FTD patients. Verb comprehension appears to be compromised in AD patients as well, but distinct error profiles in FTD and AD suggest different underlying deficits in these patient groups. Taken together, our observations emphasize the multifaceted nature of verb meaning.

Optionality and Inflections in Agrammatic Speech

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The morphological errors made by agrammatic speakers reflect the nature of the language spoken in that errors may be observed as omission in some languages, for example English, but not in languages in which an omission would violate lexical well formedness as in Hebrew or Italian (Grodzinsky, 1984, 1990; Miceli, 1989). A case has been made for classifying all errors as substitutions, so in the aphasic utterance *he go home* the use of *go* rather than *goes* is interpreted as the substitution of the nonfinite form of the verb rather than the omission of the third-singular *s*. In this analysis, errors are interpreted as symptoms of an aphasic speaker's difficulty with selecting the correct form of a verb.

Similar inflectional errors of young children have been explained as the optional use of the infinitive rather than inflectional omissions. Is there a common account for the phenomena observed in child language and aphasic errors? Jakobson (1968) proposed that the breakdown in aphasia was identical, but opposite in direction, to the order of language acquisition, and a detailed discussion of the Regression Hypothesis is given in Grodzinsky (1990). If there is any merit in this notion, we might expect to find similarities of type and distribution of the inflectional errors in both aphasic and child speech. Strong claims have been made that inflectional errors made by a young child are evidence of the optional infinitive stage (Wexler, 1994; Harris & Wexler, 1996). Proponents of the Optional Infinitive Hypothesis (OIH) claim that a young child's grammar generates both root infinitives, e.g., *she go,* and inflected forms, *she goes.* However, the child's grammar does not allow for random allocation regardless of sentence type. The child will not say *she doesn't goes* but *she not go* as the Head Movement Constraint in English prevents the verb from raising over negation.

In this paper, we discuss elicited aphasic data within the context of the OIH. The aphasic data contain many inflectional errors; the infinitive form is frequently used but there is variation, as in the child data. In other words, the use of the infinitive looks optional. However, unlike the child speakers, these aphasic speakers do inflect verbs following negation, a feature ruled out by the OIH. The inflectional errors exhibited by the aphasic speakers are incompatible with the OIH.

Method

Subjects. Five monolingual, English-speaking subjects with aphasia participated in the study, two males and three females; mean age was 60 years. Aphasia was subsequent to a left-hemisphere CVA at least 3 years before

testing. The subjects were judged to be agrammatic by language therapists and the first author, by their spontaneous speech and results of a number of tests.

Materials. Two elicitation tasks were used. (1) Thirty sentences were presented orally and in written form with a picture depicting an activity. Subjects were required to supply verbs in the appropriate tense. (2) Subjects were shown 15 pairs of pictures and given an oral and written version of a declarative sentence about the first picture of each pair. They were then asked to produce a sentence containing negation, e.g., *he doesn't shave,* to match the second picture. A test of grammatical judgment comprising 30 sentences taken from the previous tests but containing correctly or incorrectly inflected verbs was also given.

Results

In the declarative sentences, the subjects frequently made inflectional errors including using the infinitive, e.g., *he shave every morning.* Looking at the errors in the group data, 26% of the sentences contained the infinitive form of the verb. The subjects made inflectional errors in the negative sentences and these errors included inflection of the verb following negation. In the group data, 26.7% of the sentences had these errors. All subjects performed at chance level in the grammaticality judgment task.

Discussion

Clearly there is no similarity here in the distribution of the aphasic inflectional errors and the errors children make in the optional infinitive stage. The child's grammar at this stage allows for inflected and noninflected forms although not randomly. The presence of negation stops the child inflecting the verb. This is not true for aphasic speakers. Our data from the elicitation tasks suggest that, unlike the children, the presence of negation did not have the same restraining effect on the use of inflections. Harris and Wexler reported that inflection of verbs in negated sentences occurred in only 9% of their child data, a smaller proportion than we found in our aphasic data. Harris and Wexler dismiss the 9% of inflected verbs in negated sentences as ''performance error,'' an explanation we are reluctant to adopt for our data. Does the greater frequency of inflection in negated sentences in the aphasic data point to damaged grammar rather than performance error? If the grammar is intact but some stage of production is impaired then we would expect the subjects to be able to judge the grammaticality of sentences in which inflection has been tampered. Our subjects were not able to do this.

The range and distribution of inflectional errors made by our aphasic subjects suggest that optionality is not a feature of aphasic speech. These errors evidence a damaged grammar.

REFERENCES

Grodzinsky, Y. 1984. The syntactic characterisation of agrammatism. *Cognition,* **16,** 99–120.

Grodzinsky, Y. 1990. *Theoretical perspectives on language deficits.* New York: MIT Press.

Harris, T., & Wexler, K. 1996. The optional infinitive stage in child English: Evidence from negation. In H. Clahsen (Ed.), *Generative perspectives on language acquisition, empirical findings, theoretical considerations and crosslinguistic comparisons.* Amsterdam: John Benjamins.

Jakobson, R. 1968. *Child language aphasia and phonological universals.* The Hague: Mouton.

Miceli, G., Silveri, M. C., Romani, C., & Caramazza, A. 1989. Variation of omissions and substitutions of grammatical morphemes in the spontaneous speech of so-called agrammatic aphasics. *Brain and Language,* **36,** 447–492.

Wexler, K. 1994. Finiteness and head movement in early child grammars. In D. Lightfoot & N. Hornstein (Eds.), *Verb movement,* pp. 305–350. Cambridge, UK: Cambridge Univ. Press.

The Mental Representation of Italian Derived Adjectives: A Study in Aphasia

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How are morphologically complex words mentally represented and processed? While some theories assume the existence of a full list, others hypothesize a decomposed representation. Compromise theories hypothesize that, depending on factors like word frequency and semantic transparency, some words would be fully listed while others would be composed online from separate constituents.

So far most studies have focused on inflectional morphology, devoting limited attention to derivational morphology. Also, theories concerned with derivational morphology typically do not take into account the grammatical category of the complex word. However, it may be important to investigate separately the case of each grammatical class.

The present work seeks information on adjectives, a well-represented class in the Italian lexicon. They can be either morphologically simple or derived from nouns and from verbs. A neuropsychological approach is used. Aphasic patients who are demonstrated to process simple words via the lexicon may be considered ideal subjects for this investigation. Two of the patients participating in the present study also have a dissociation between the ability to retrieve nouns (relatively spared) and the ability to retrieve verbs (severely impaired). We hypothesized that, if derived adjectives are processed through

the activation of the representations of their constituent morphemes, participant patients should produce more errors with derived than with simple adjectives and should produce more errors with adjectives derived from verbs than with those derived from nouns.

Case Reports

(1) MB was a 25-year-old man, with 10 years of education, who sustained a vascular lesion in the frontoinsular areas of the left hemisphere. The AAT demonstrated a Broca's aphasia with severe agrammatism. The features of his linguistic deficit have been described in detail in Mondini et al. (1997). MB was a phonological/deep dyslexic, he was sensitive to the morphological status of the stimulus to be read, reading simple nouns better than inflected, derived, and compound ones; he also showed a clear verb–noun dissociation both in reading and in confrontation naming.

(2) FB was a 40-year-old man, with 12 years of education, who suffered an ischemic lesion in the area of the left middle cerebral artery. The AAT demonstrated a Broca's aphasia with severe agrammatism. FB read and repeated words better than legal nonwords. In reading words he showed a frequency effect, but no length effect. He did not show a word class effect.

(3) ER was a 65-year-old man, with 15 years of education, who sustained a vascular lesion in the area of the left middle cerebral artery. The AAT demonstrated a Broca's aphasia with agrammatism. In reading and repetition ER made significantly more errors with legal nonwords than with words and showed no length effect. He showed a verb–noun dissociation both in reading and in confrontation naming. In confrontation naming he proved to be sensitive to the morphological status of the target, naming simple nouns better than derived nouns and compounds.

Experimental Study

Adjectives in Italian can be productively derived from nouns and from verbs. They are also inflected for gender and number, but, for the purposes of this study, only the masculine singular was used.

From Thornton et al. (1994) we chose 39 deverbal adjectives (3 to 5 syllables long) and 39 denominative adjectives of comparable frequency and length. It was not possible to create classes of length and classes of frequency including the same number of items because of the distributional properties of this class of words. In Italian simple adjectives are usually shorter than derived ones and there is no simple adjective 5 syllables long. Therefore, in order to compare complex and simple adjectives a subset of 26 deverbal and 26 denominative adjectives (3 to 4 syllables long) was also selected to be paired with 26 simple adjectives.

TABLE 5

		MB				FB				ER			
		Reading		Repetition		Reading		Repetition		Reading		Repetition	
Stimuli	*N*	Err	% Err	Err	% Err	Err	% Err	Err	% Err	Err	% Err	Err	% Err
Adjectives													
Denominative	26	17	65.38	0	0.00	15	57.69	3	11.54	11	42.31	3	11.54
Deverbal	26	18	69.23	3	11.54	13	50.00	5	19.23	8	30.77	1	3.85
Simple	26	19	73.08	0	0.00	10	38.46	4	15.38	12	46.15	2	7.69
Denominative	39	29	74.36	1	2.56	20	51.28	6	15.38	16	41.03	4	10.26
Deverbal	39	31	79.49	5	12.82	21	53.85	10	25.64	17	43.59	1	2.56
Total	104	79	75.96	6	5.77	51	49.03	20	19.23	45	43.27	7	6.73
Nonwords													
Denominative	26					17	65.38	11	42.31	24	92.31	19	73.08
Deverbal	26					14	53.85	12	46.15	23	88.46	14	53.85
Simple	26					19	73.08	14	53.85	21	80.77	14	52.94
Denominative	39					26	66.67	20	51.28	36	92.31	28	71.79
Deverbal	39					25	64.10	21	53.85	34	87.18	24	61.54
Total	104					70	67.31	55	52.88	91	87.50	66	63.46

The final list included 104 adjectives: 18 (17.31%) were high frequency, 17 (16.35%) medium frequency, and 69 (66.35%) low frequency.

We also built a list of 104 nonwords derived from real adjectives by substitution of one letter in the root. Derivational affixes were thus the same in words and nonwords.

The randomized total list of 208 stimuli was read and repeated by the participants.

Results

Reading. For none of the participants (see Table 5), was reading performance reliably different for the three categories of adjectives: denominative, deverbal, and simple (MB $\chi^2(2) = 0.36$, n.s.; FB $\chi^2(2) = 1.95$, n.s.; ER $\chi^2(2) = 1.39$, n.s.). Likewise, no type of derivation effect was observed on nonwords. In all three patients virtually all errors, across all categories, were of the visual type. The difference between adjectives and nonwords was significant for ER ($\chi^2(1) = 31.12$) and FB ($\chi^2(1) = 7.13$, $p < .01$). MB often refused to read (and repeat) nonword stimuli: therefore his performance with this kind of stimuli is not reported.

Repetition. There was no difference between the three categories of adjectives (see Table 5). As in the reading task there was a significant difference between words and nonwords for ER ($\chi^2(1) = 25.33$, $p < .001$) and FB ($\chi^2(1) = 124.32$, $p < .001$). All errors could be determined by phonological similarity.

Discussion

No substantial difference in the quality and number of errors between the three classes of adjectives was found in any of the three patients. The case of MB is particularly important: he shows derivational effects with compounds and with derived nouns, but not with derived adjectives.

A decomposition hypothesis, therefore, cannot be supported by such data. Several crucial factors remain to be investigated, including frequency, though the prevalence of low-frequency items in the experimental corpus would have favored the emergence of decomposition phenomena rather than the contrary.

REFERENCES

Mondini, S., Luzzatti, C., Semenza, C., & Calza, A. 1997. Prepositional compounds are sensitive to agrammatism: Consequences for models of lexical retrieval. *Brain and Language,* **60,** 78–80.

Thornton, A. M., Iacobini, C., & Burani, C. 1994. *Bdvd. Una base di dati sul vocabolario di base della lingua italiana.* Roma: Bulzoni.

Acknowledgment. This research was supported by MCRI Grant 412.95.0006.

Derivation by Prefixation in Slovenian: A Study in Aphasia

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Introduction. Derivation by prefixation is a very frequent phenomenon in Slovenian morphology. In particular many verbs are modified in meaning by being prefixed with prepositions. This modification leads to many other verbs, whose semantic relation with the nonprefixed verbs may be either transparent or opaque. For instance, the verb *jéti* [to begin], combined with the prepositions *na* [on], *ob* [to], and *za* [from], becomes respectively *najéti* [to rent], *objéti* [to embrace], *zajéti* [to surprise]. Prefixation with the prepositions frequently also modifies nouns and adjectives. Unlike other derivational processes, derivation by prefixation never changes the grammatical class of the word.

The present study is concerned with a Slovenian-speaking patient who was asked to produce, in various conditions, verbs, nouns, and adjectives derived by prefixation with prepositions.

Case report. SA, a 60-year-old female worker with 8 years of education, sustained an ischemic lesion in the border area between the left anterior and the middle cerebral arteries' territories. Her basic linguistic abilities were assessed via an unpublished Slovenian version of the Paradis battery (Paradis and Libben, 1985). Her aphasia was of the Broca type: she produced many phonemic and relatively few phonetic errors in her nonfluent, very reduced, spontaneous speech and on visual confrontation naming; her repetition was also severely affected while her comprehension was almost perfect when she did not depend on syntactic analysis only. Unfortunately SA died of a further brain infarction during this study. The collected data allow, however, significant observations.

Experimental study. The experimental material consisted of verbs, nouns, and adjectives derived by prefixation as well as of nonprefixed simple and compound words. These words had to be produced in the following conditions: reading, repetition, and writing on dictation. Prefixed verbs included the following prepositions: do, iz, na, nad, ob, od po, pod, pred, pri, es, vi, za, z, u, izpod, pona, spo, spod, spre; prefixed nouns included brez, do, iz, med, na, nad, ob, od, po, pod, pred, pri, proti, v, z, za; prefixed adjectives included brez, cez, do, iz, med, na, nad, ob, od, po, pod, pred, pri, proti, s, v, za.

SA produced, in most cases, neologisms, often but not always phonologically related to the target (see Table 6). What distinguished her production of prefixed words, regardless of the category, was the frequent preservation

TABLE 6
SA's Performance in Writing, Reading, and Repetition of Words in the Different Grammatical Classes (All Incorrect Anwers Were Neologisms)

		Neologisms		
	Correct/*N*	Same prep.	Different prep.	Omission of prep
Writing				
Simple				
Nouns	4/8			
Adjectives	1/4			
Verbs	0/3			
Prefixed				
Nouns	4/37	20	3	10
Adjectives	1/20	10	2	7
Verbs	1/26	17	1	7
Reading				
Simple				
Nouns	11/94			
Adjectives	4/24			
Verbs	4/52			
Prefixed				
Nouns	23/124	88	12	1
Adjectives	22/128	85	20	1
Verbs	43/294	189	52	10
Compound nouns	2/31			
Repetition				
Simple				
Nouns	110/84			
Adjectives	11/48			
Verbs	11/87			
Prefixed				
Nouns	14/124	100	8	2
Adjectives	17/128	100	11	
Verbs	24/294	208	58	4
Compound nouns	1/26			

of the initial preposition (for instance, *iztatoti** instead of izkopati [to dig up], *pozazito** instead of povabilo [invitation]). The initial phonemes in nonprefixed words were not preserved more than the other phonemes in the words (for instance, *oobta** instead of jokati [to cry]); thus, the preservation of prepositions could not simply be attributed to phonological factors. Moreover, very seldom initial prepositions appeared in errors with simple words. When prefixations consisted of a double preposition, the noninitial preposition was preserved as well. Except in writing, in several cases the initial preposition was substituted by another preposition. The substituting preposi-

tions, especially in the case of verbs, were many and not just one or two, idiosyncratically used (for instance, *pridati** instead of vlepiti [to stick] and *podpodedati** instead of napovedati [to announce]).

Discussion. SA's performance has features never reported before in literature. An interpretation in terms of mere phonological factors may be excluded on several grounds. The remaining conclusion is that SA could parse prefixed words into their components. This is interesting for at least two reasons. First, at least the substitutions of prefixes appeared to be authentic morphological errors. This is on its own interesting since it has been quite rightly argued that it is hard to distinguish morphological errors from phonological, semantic, and visual ones. None of these alternatives is, however, preferable with regard to SA's errors. Second, these errors are evidence of morphological decomposition: while this phenomenon has been reported before (e.g., Laudanna, Cermele, & Caramazza, 1997; see Semenza, 1999, for a review) it was never described for derived adjectives. The relative preservation of prepositions in a patient who shows agrammatism at least in comprehension (the limited production might have very likely covered the problem) is also an interesting and unusual feature of this case.

REFERENCES

Laudanna, A., Cermele, A., & Caramazza, A. 1997. Morpholexical representations in naming. *Language and Cognitive Processes,* **12**(1), 49–66.

Paradis, M., & Libben, G. 1985. *The assessment of bilingual aphasic.* Hillsdale, NJ: Laurence Erlbaum.

Semenza, C. 1999. Lexical semantic disorders in aphasia. In G. Denes and L. Pizzamiglio (Eds.), *Handbook of Neuropsychology.* Hove, England: Psychology Press.

Acknowledgment. This research was supported by MCRI Grant 412.95.0006.

Grammatical Gender Knowledge in an Italian Agrammatic Patient

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In Italian all nouns belong to one of two gender classes, masculine or feminine, irrespective of the natural gender of the items. For nouns referring to living beings the grammatical gender usually (but not always) coincides with the natural one that can be derived from the underlying semantic knowledge. If the referred entity has no natural gender, grammatical gender

is then a purely lexical and morphological feature. Gender of nouns percolates on articles (Masc: *il;* Fem: *la*) and on the large majority of the adjectives.

To most nouns, which in Italian are inflected also in the citation form, the following rules apply: the suffix *-o* is usually masculine (*il toro,* bull; *il vaso,* vase), *-a* feminine singular (*la suora,* nun; *la bocca,* mouth). However, both natural and grammatical gender are not always reflected in these rules. Thus, the suffix *-a* may sometimes apply to masculine singular, both in cases in which the natural gender is masculine (e.g., *il poeta,* male, poet) and in cases in which there is no natural gender (e.g., *il diploma,* diploma); in the same way the suffix *-o* may apply to a few grammatically feminine words (e.g., *la mano,* hand). In some further cases the ending prevails on the natural gender in determining the grammatical gender, as in the case for *la guardia,* policemen, or *la sentinella,* sentinel. There is a further singular suffix *-e,* whose gender is unpredictable, i.e., which can be either masculine or feminine (e.g., *il ponte,* bridge, is masculine, while *la torre,* tower, is feminine). Therefore, here again, the grammatical gender is an entirely lexical feature.

In compound nouns gender depends on the morphological structure and the position of the head. Noun–noun compounds take the grammatical gender of the head of the compound (e.g., for left-headed compounds, *la* ***casa*** *albergo,* boarding house, or *il* ***bagno****schiuma,* bubble bath, and for right-headed ones, *la ferro****via,*** railway (lit.: iron way), or *il via****dotto,*** viaduct). Verb–noun compounds are exocentric and are generally masculine, irrespective of the noun entering the compound—that can be either masculine ending with *-o* (e.g., il *segnalibro,* bookmark) or feminine ending with *-a* (e.g., il *colapasta,* colander).

In derived nouns, the suffix determines the gender of the noun. Thus, for example, the suffixes *-aggine* and *-udine* indicate a feminine grammatical gender (e.g., la *similitudine,* similitude) while the suffixes *-ore* and *-iere* indicate a masculine gender (e.g., il *bollitore,* kettle).

Luzzatti and De Bleser (1996) described an agrammatic patient (D.R.) showing a dissociation between regular (preserved) and irregular (impaired) inflections. D.R. correctly assigned the article to derived nouns, but failed with pseudoderived nonwords. Luzzatti and De Bleser interpreted these findings as a result of parsing defect rather than as a morphological impairment. Thus, D.R. would not parse the derivational suffix and therefore access gender information if the suffix was attached to a nonreal stem. This result is, however, in little agreement with the results obtained by Burani and Laudanna (1993) on lexical decision time of derived words and nonwords, showing that derivational suffixes undergo standard morphological parsing also when they are bound to nonwords.

We report here the performance of an Italian agrammatic patient who was given the task of producing the appropriate masculine (*il*) or feminine (*la*)

article agreeing with each item in a list of nouns encompassing most existing suffixes.

Case report. M.B. was a 24-year-old male who suffered from a vascular lesion in the left frontoinsular lesion. The Aachen Aphasia Test demonstrated Broca's aphasia and his speech production was agrammatic; his sentences were very short with omission of free and bound grammatical morphemes. His repetition was flawless, while his reading matched with phonological/deep dyslexia.

Experimental investigation. The patient was given the list of items used by Luzzatti and De Bleser (1996). In this task, a patient has to assign the gender of nouns by adding the article. The experimental material consisted of 75 simple masculine and feminine nouns with different endings (35 items had a conceptually based natural gender, e.g., *suora,* nun, feminine, that matched with the grammatical one; another 40 items designated objects and had a neutral natural gender, so that the grammatical one could not be guessed from the meaning of the noun), 20 noun–noun compounds (10 right-headed and 10 left-headed) with constituents of different gender (masculine noun ending in *-o* + feminine noun ending in *-a;* feminine noun ending in *-a* + masculine noun ending in *-o*), 20 verb–noun compounds whose noun component was either feminine ending with *-a* or masculine ending with *-o;* nonwords were either simple elements ending with *-o* or *-a* or pseudoderived nonwords modified by a nominal derivational suffix (*-ore, -iere, -trice, -aggine, -udine*).

Results. M.B.'s performance is reported in Table 7. He failed with items with no natural gender, in which the ending vowel (*-e*) does not contain morphological cues. He was, however, perfect in applying (and often generalized) the major ending rule (Masc. *-o;* Fem. *-a*) on both words and nonwords. He was also flawless in gender assignment of pseudoderived nonwords, for which he made gender choice based on the derivational suffix (e.g., *-aggine* is feminine; *-iere* is masculine). M.B. failed compounds, for which he decided mostly on the basis of the second name ending. The patient used the same strategy also with verb–noun compounds, assigning gender on the basis of the (right) nominal ending. He was therefore accidentally successful only with verb–noun compounds ending in *-o.*

Discussion. M.B. seems thus to display a dissociation between semantically based and rule-based gender assignment on one hand, which he performs correctly, and gender assignment on lexical knowledge on the other hand. M.B's behavior differs to some extent from that observed in other agrammatics. In particular an interesting difference was there with Luzzatti and DeBleser's (1996) patient D.R. This patient performed exactly like M.B., except for failing with nonwords containing derivational endings, which he was unable to parse. His parsing was limited to the inflectional ending, and gender assignment failed where morphological rules could not be used. In

TABLE 7
M.B.'s Errors in Gender Assignment by Article Agreement

Item	*N*	Ending	Example	Natural gender	Inflec. ending	Gramm. gender	Correct	(%)
			Simple nouns					
	5	-a	*Suora*	F	F	F	5	100
	5	-o	*Toro*	M	M	M	5	100
	5	-e	*Madre*	F	N	F	3	60[a]
	5	-e	*Padre*	M	N	M	4	80
	10	-a	*Poeta*	M	F	M	8	80
	5	-a	*Sentinella*	M	F	F	4	80
	5	-a	*Bocca*	N	F	F	5	100
	5	-o	*Vaso*	N	M	M	4	80
	5 + 5	-e	*Ponte, torre*	N	N	M, F	7	70[a]
	5	-a	*Diploma*	N	F	M	3	60[b]
	5	-o	*Mano*	N	M	F	3	60[b]
	10	Consonant	*Tunnel*	N	M/N	M	9	90
Total	75						61	81%
			Compound nouns					
NN	10		*Bagno-schiuma*	N		M/F	7	70[c]
NN	10		*Ferrovia*	N		M	6	60[c]
VN	10	v -a	*Colapasta*	N		M	3	30[c]
	10	v -o	*Segnalibro*	N		M	9	90
Total	40						25	63%
			Nonwords					
Simple	10	-a	*Gora*			F	10	100
	10	-o	*Trido*			M	10	100
Derived	10	-ore	*Galtore*			M	10	100
	10	-aggine	*Furaggine*			F	9	90
Total	40						39	98

[a] Overgeneralization of the ending -e as a masculine ending.
[b] Generalization of the major rule (Masc. -o; Fem. -a).
[c] Overuse of morphological rules with no access to lexical knowledge on compounds.

M.B., knowledge of derivational rules seems, instead, to be intact. This provides further evidence of morphological and gender representation at the lemma level.

REFERENCES

Burani, C., & Laudanna, A. 1993. Units of representation for derived words in the lexicon. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning. Advances in psychology,* Vol. 94. Amsterdam: North-Holland.

Luzzatti, C., & De Bleser, R. 1996. Morphological processing in Italian agrammatic speakers: Eight experiments in Lexical morphology. *Brain and Language,* **54,** 26–74.

Acknowledgment. This research is supported by MCRI Grant 412-95-0006.

Integration of Verbal Morphology and Sentence Structure in a Topic-Comment Language: Normal and Aphasic Comprehension in Indonesian

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Indonesian verbal morphology does not mark tense, case, or agreement, but is associated with assignment of thematic roles to NPs. In sentences with *meng-* (AT, for Agent Topic) like (1a), the preverbal NP is agent, whereas with *di-* (PT, for Patient Topic) like (1b), the preverbal NP is patient or theme. The passive is not more morphologically complex than the active form, whereas in English, the passive requires past participial verbs and ''by'' phrases.

(1a) *Allen **men**cium Susan.*
Allen AT-kiss Susan.
''Allen kissed Susan.''
(1b) *Susan **di**cium Allen.*
Susan PT-kiss Allen.
''Susan was kissed by Allen.''

Indonesian is a topic-comment, discourse-oriented language: the important discourse element is preserved in sentence-initial position. (1a) is appropriate in a discourse context in which Allen is the prominent character. (1b) emphasizes not what Allen did, but what happened to Susan. Passive constructions in Indonesian are three to four times more frequent than in English, in part because passives are used to maintain continuity of topic.

In coordinate sentences like (2a), Allen is topic, by virtue of its sentence initial position. Allen is also topic in the subject relative (2b). However, in object relatives like (2c), while Allen is topic as in (2a and 2b), the relative pronoun *yang* highlights Susan. Thus Allen is topic of the first clause and Susan is topic of the second clause.

(2a) *Allen mencium Susan dan mendorong Nando.*
Allen AT-kiss Susan COORD AT-push Nando.
''Allen kisses Susan and pushes Nando.''
(2b) *Allen yang mencium Susan mendorong Nando.*
Allen REL AT-kiss Susan AT-push Nando.
''Allen who kisses Susan pushes Nando.''
(2c) *Allen mencium Susan yang mendorong Nando.*
Allen AT-kiss Susan REL AT-push Nando.
''Allen kisses Susan who pushes Nando.''

The topic NP can be assigned two thematic roles simultaneously by vary-

ing the prefixes on the verbs in each clause. In (3a and 3b), Allen is agent of the first verb and patient of the second.

(3a) *Allen **men**cium Susan dan **di**dorong Nando.*

''Allen kisses Susan and is pushed by Nando.''

(3b) *Allen yang **men**cium Susan **di**dorong Nando.*

''Allen who kisses Susan is pushed by Nando.''

If language-specific factors determine aphasic symptoms, then Indonesian aphasics should comprehend passive *di-* verbs, unmarked in Indonesian, at least as easily as active *meng-* verbs. Furthermore, if subjects have difficulty interpreting sentences with more than one highlighted NP, then they may find object relatives like (2c) harder than sentences like (2a and 2b). Finally,

TABLE 8

Structure types	Verb 1 prefix	Verb 2 prefix	Sample sentences
Coordination	meng-	meng-	*Allen mencium Nando dan mendorong Susan.* ''Allen kisses Nando and pushes Susan.''
	meng-	di-	*Nando mendorong Allen dan dipeluk Susan.* ''Nando pushes Allen and is hugged by Susan.''
	di-	meng-	*Nando didorong Susan dan memukul Allen.* ''Nando is pushed by Susan and hits Allen.''
	di-	di-	*Nando dicium Susan dan dipukul Allen.* ''Nando is kissed by Susan and is hit by Allen.''
Subject relative	meng-	meng-	*Allen yang mencium Susan menggaruk Nando.* ''Allen who kisses Susan scratches Nando.''
	di-	meng-	*Susan yang didorong Nando menendang Allen.* ''Susan who is pushed by Nando kicks Allen.''
	pro-	meng-	*Allen yang Nando-garuk mencium Susan.* ''Allen who Nando scratches kisses Susan.''
	meng-	di-	*Susan yang mendorong Allen disentuh Nando.* ''Susan who pushes Allen is touched by Nando.''
	di-	di-	*Susan yang dicium Allen disentuh Nando.* ''Susan who is kissed by Allen is touched by Nando.''
	pro-	di-	*Allen yang Nando-dorong dicium Susan.* ''Allen who Nando pushes is kissed by Susan.''
Object relative	meng-	meng-	*Nando mencium Allen yang memeluk Susan.* ''Nando kisses Allen who hugs Susan.''
	meng-	di-	*Allen menggaruk Susan yang didorong Nando.* ''Allen scratches Susan who is pushed by Nando.''
	meng-	pro-	*Nando menggaruk Allen yang Susan-peluk.* ''Nando scratches Allen who Susan hugs.''
	di-	meng-	*Nando digaruk Susan yang memukul Allen.* ''Nando is scratched by Susan who hits Allen.''
	di-	di-	*Susan dicium Nando yang ditendang Allen.* ''Susan is kissed by Nando who is kicked by Allen.''
	di-	pro-	*Allen didorong Susan yang Nando-garuk.* ''Allen is pushed by Susan who Nando scratches.''

if subjects have trouble assigning both agent and patient roles simultaneously to topic NP, then they should perform worse on sentences like (3a and 3b) than (2a and 2b).

Design and method. Two native Indonesian-speaking aphasic stroke patients and one normal control subject were tested in Manado, Indonesia. Patient ''LH'' suffered left-hemisphere damage and exhibited nonfluent speech but good comprehension. Patient ''RH,'' whose right hemisphere was affected, had speech impediments but maintained excellent comprehension. Subjects were read coordinate, subject-relative or object-relative sentences and were asked to act out their meanings with three mannequins. Verbs were prefixed with *meng-*, *di-*, or, in embedded clauses, nominal clitic ''pro-'' replacing *di-*. There were five tokens of each type ($5 \times 16 = 80$ sentences) (Table 8).

Results and conclusions. RH and the normal subject had trouble enacting object relatives: both used a strategy of switching the relative clause head from the second (object) to the first (subject) NP, to preserve the first NP as topic. This result indicates the awkwardness of topically ambiguous sentences and the importance of sentence-initial position as topic position in Indonesian.

Overall, LH manifested a reduced linguistic computational capacity. He misinterpreted sentences in which an NP was simultaneously patient of the first verb but agent of the second, avoiding two different thematic roles attributed to one argument. Moreover, he showed a preference for enactments in which the topic NP was agent of both verbs. In 43% of his responses, he made the first NP agent of both verbs, whereas he made the first NP patient

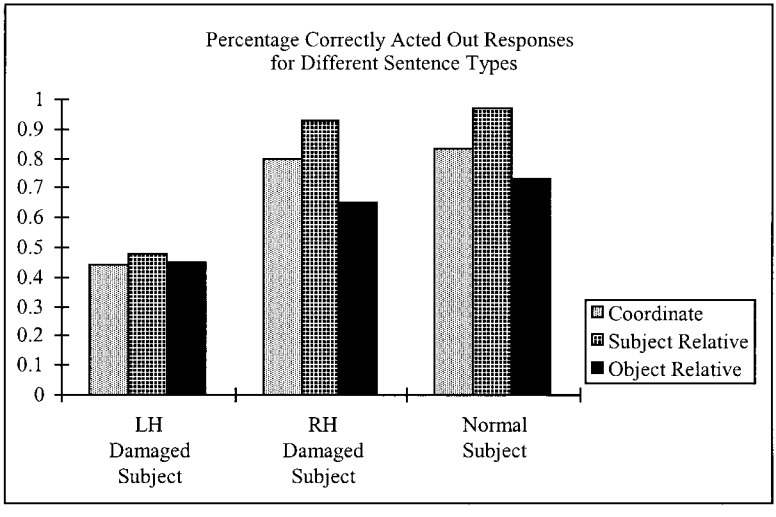

FIGURE 3

of both verbs in only 17% of his responses. This pattern was the opposite of both RH's responses (22% agent topic in both clauses vs 32% patient topic in both clauses) and the normal subject's responses (20% agent topic in both clauses vs 38% patient topic in both clauses). LH's preference must be explained by a default strategy of agent topic, despite the primacy of patient topic in Indonesian (Fig. 3).

REFERENCE

Postman, W., & Martohardjono, G. 1998. Disorders of morphosyntactic comprehension in aphasia in Indonesian. Poster presented at the Academy of Aphasia 36th Annual Meeting, Santa Fe, New Mexico.

Selective Impairment of Morphosyntactic Production in a Neurological Patient: Evidence for Impaired Feature Processing

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Several authors have maintained that production of inflectional morphology dissociates in a predictable manner in agrammatism: material in lower nodes of the syntactic tree is preserved while material in higher nodes is inaccessible (Hagiwara, 1995; Friedmann & Grodzinsky, 1997). In this paper, we discuss a patient whose production impairment is almost completely restricted to bound inflectional morphology, providing a unique opportunity to examine disrupted inflection in the absence of omitted free morphology.

Subject. R.B., a right-handed, well-educated, Caucasian, monolingual English-speaking 37-year-old female, presented with impaired syntactic production after sustaining a closed head injury and, subsequently, a series of epileptic seizures. MRI and SPECT scans administered after her injury were normal, although EEG revealed left frontotemporal abnormality. R.B.'s comprehension was found to be unimpaired using the Philadelphia Comprehension Battery for Aphasia (Saffran et al., n.d.) and the Northwestern University Sentence Comprehension Test (Thompson, n.d.), although she made errors detecting tense, agreement, and number errors in a grammaticality judgment task.

Procedure. Three free narrative samples and two reading samples were collected. In the narrative tasks, R.B. provided descriptions of the events in fairy tales using pictorial cues; the same fairy tales were used for the reading tasks. Additionally, a written discourse sample was acquired. All samples were transcribed and segmented into utterances based on semantic, syntactic, and prosodic criteria, as per the coding method developed by Thompson et al. (1995). Sample transcription, segmentation, and coding were checked for interrater reliability, resulting in high agreement across examiners. Verbs

and nouns were separated into regular and irregular groups and further analyzed with regard to functional categories.

Results. R.B. evinced no difficulty with production of complex sentential structures, and her ratio of simple to complex structures was similar to that of normal subjects under similar conditions. She freely produced utterances containing moved *wh* elements, relative pronouns, and embedded clauses containing complementizers and subordinating conjunctions. Free morphology was also largely intact. R.B. omitted few subjects ($n = 2$), articles ($n = 2$), copulas ($n = 5$), and auxiliaries ($n = 4$) across all samples; two auxiliary omissions occurred with the aspectual marker *-ing.*

In contrast, R.B.'s production of bound inflectional morphology on both verbs and nouns was substantially impaired (see Table 9). She showed errors on agreement, tense, and aspect. Production of agreement was impaired in all conditions. On regular verbs, R.B. both omitted *-s* (the wolf *run*) and appended extraneous *-s* (I *thinks* about you). On irregular verbs, R.B. usually substituted the citation form of the verb (It *be* such a beautiful city) but sometimes appended *-s* to an irregular citation form (she *bes* beautiful). Production of past tense was also impaired in all conditions. On regular verbs, *-ed* was omitted (the wolf *open* the door); errors on irregular forms involved both substitution of citation forms (This past March I *get*) and suffixation of *-ed* to citation forms (I *haved* a disease). R.B. had difficulty producing the aspectual morpheme *-ing* in the narrative and writing tasks, frequently substituting simple present where present progressive was clearly appro-

TABLE 9
Percentages of Correctly Supplied Free and Bound Morphemes by Morpheme Type and Task Type

	Spoken narratives	Written sample	Oral reading
Free morphology subjects (pleonastic excluded)	97% (58/60)	100% (57/57)	99% (150/151)
Auxiliary verbs	50% (2/4)	100% (29/29)	96% (44/46)
Main verbs	96% (75/78)	100% (71/71)	99% (215/218)
Verb objects	96% (25/26)	100% (36/36)	100% (72/72)
Determiners	97% (28/29)	100% (25/25)	99% (124/125)
Negation	100% (4/4)	100% (5/5)	100% (5/5)
Verb morphology			
Agreement–regular (*-s*)	10% (4/39)	0% (0/17)	0% (0/5)
Agreement–irregular	33% (4/12)	60% (3/5)	100% (2/2)
Tense–regular(*-ed*)	66% (2/3)	0% (0/8)	41% (25/61)
Tense–irregular	NA	0% (0/13)	95% (56/59)
Aspect (*-ing*)	50% (2/4)	0% (0/2)	93% (13/14)
Noun morphology			
Plural–regular (*-s*)	56% (5/9)	50% (3/6)	24% (7/29)
Plural–irregular	0% (0/2)	0% (0/3)	100% (5/5)
Possessive (*-s*)	100% (3/3)	NA	81% (9/11)

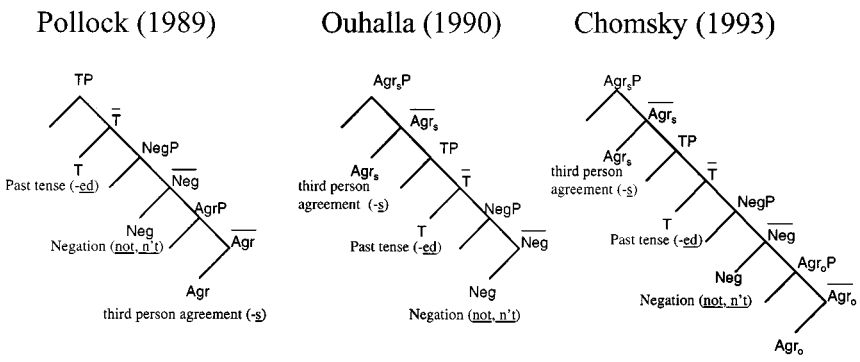

FIGURE 4

priate (The girl look like she *start* to laugh). Production of negative morphology (*not, -n't*) was unimpaired in all tasks.

On nouns, production of the possessive morpheme -*'s* was largely intact, with only two errors, while production of the plural morpheme -*s* was substantially impaired. All regular plural errors were omissions (one of her *shoe*); all irregular plural errors involved addition of -*s* to an irregular plural (peoples, feets).

Rates of correct production of irregular past tense, irregular agreement, irregular plural, and aspectual morphology were better in the reading tasks than in the narrative tasks or written sample (see Fig. 4).

Discussion. R.B.'s impairment pattern is not consistent with previous accounts of inflectional breakdown which hold that lower material is better preserved (Friedmann & Grodzinsky, 1997). Various locations for negation have been proposed by syntacticians, and some accounts would predict preserved negation with omitted tense and agreement. However, the fact that aspectual morphology is located below negative morphology (Hendrick, 1991) means that R.B.'s production does not always spare material in lower nodes.

R.B. both overproduced and omitted inflectional morphology. This pattern contrasts with agrammatic speech, which generally contains primarily omissions (in languages that allow bare stems). We suggest that her error pattern may be described as an impairment in *feature checking*, a process central to the Minimalist Program of syntactic research (Chomsky, 1995). Minimalist syntax holds that verbs and nouns are retrieved from the lexicon fully inflected and move to higher nodes to check their inflectional features against the inflectional features on the appropriate nodes. If checking were disrupted, overproduction as well as omission would be expected. This would also account for R.B.'s addition of regular morphemes to irregular forms (bes, haved, peoples); this extraneous affixation would result from misperception of feature information on irregular forms.

The feature-checking account becomes problematic when our finding that production of irregular forms was better in the reading tasks than in the narrative tasks or written sample is considered. We suggest that production of irregular forms improved in reading because reading may impose a lesser computational burden than writing and speaking, which require retrieval of lexemes including phonological representation (Tesak, 1992). Reading of irregular forms required only activation of a monomorphemic lexeme, leaving resources available for feature checking. Conversely, reading regular words activated a monomorphemic stem but also triggered a default grammatical rule for affixation, consuming more resources and leaving fewer available for purposes of feature checking. Finally, we suggest that the irregular/regular dissociation provides support for theories that irregular and regular forms are produced by distinct mechanisms (e.g., Pinker & Prince, 1991).

REFERENCES

Chomsky, N. 1995. *The minimalist program.* Cambridge: MIT Press. Friedmann, N., & Grodzinsky, Y. 1997. Pruning the syntactic tree. *Brain and Language,* **56,** 397–425.

Hagiwara, H. 1995. The breakdown of functional categories and the economy of derivation. *Brain and Language,* **50,** 92–116.

Hendrick, R. 1991. The morphosyntax of aspect. *Lingua,* **85,** 171–210.

Pinker, S., & Prince, A. 1991. Regular and irregular morphology and the psychological status of rules of grammar. *Berkeley Linguistics Society,* **17,** 230–251.

Saffran, E., Schwartz, M., Linebarger, M., Martin, N., & Bochetto, P. (n.d.). *The Philadelphia comprehension battery for aphasia.*

Tesak, J. 1992. Everything is the same. *Brain and Language,* **43,** 512–518.

Thompson, C. (n.d.) *Northwestern University sentence comprehension test.*

Thompson, C., Shapiro, L., Tait, M., Jacobs, B., Schneider, S., & Ballard, K. 1995. A system for the linguistic analysis of agrammatic language production. *Brain and Language,* **51,** 124–127.

Verb Inflection and the Hierarchy of Functional Categories in Agrammatic Anterior Aphasia

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Impairments of inflectional morphology and of syntactic ‘‘function words’’ are associated in agrammatic aphasia, as revealed by patterns of omissions and substitutions (see Goodglass, 1993). A unified account of this deficit from the perspectives of both grammatical theory and neuropsychol-

ogy has been elusive. We posit that a grammatical dysfunction of concatenation and/or of movement in agrammatic anterior aphasia impairs the computation of the syntactic hierarchy of functional categories and that this impairment can explain observed patterns of errors.

The class of syntactic theories known as the Principles and Parameters Framework (including recent extensions such as Minimalism) (e.g., Chomsky, 1995) posits that sentence computation involves the manipulation not only of lexical categories such as nouns and verbs, but also of functional categories. These largely correspond to function words and, crucially, can also license inflection (e.g., tense, agreement). Therefore a deficit in the syntactic manipulation of functional categories should impair not only function words, but also inflectional affixes (e.g., *-ed*) and nonaffixal inflection (e.g., past-tense irregulars). Most importantly for our purposes, functional categories are concatenated stepwise into hierarchical structures, from subordinate (lower) to superordinate (higher) categories. Likewise, they trigger verb movement stepwise from subordinate to superordinate categories (Chomsky, 1995). An impairment of the operations of concatenation and/or movement should lower the likelihood of success of each such operation. Because fewer such operations are necessary to compute lower than higher categories, the lower the category, the easier it should be to compute.

In English, the bottom-up order of categories in the syntactic hierarchy proceeds from the lexical category of verb (V^0) to the functional categories of (present and past) participial inflection (Asp^0), tense (T^0), and then agreement (Agr^0). We therefore predict that agrammatic anterior aphasia should be associated with greater success at the computation of unmarked forms (e.g., walk, drive) than of participial forms (walking, driven), than of tensed forms (walked, drove), than of 3sg forms (walks, drives).

Method. We investigated verb inflection errors of nonfluent (agrammatic) anterior aphasics and fluent posterior aphasics in (1) the elicited past-tense production of 20 regular and 16 irregular verbs in sentence contexts (''Every day I dig a hole. Just like every day, yesterday I ____ a hole.'') and (2) the isolated word reading of 17 irregular and 17 regular past-tense forms (see Ullman et al., 1997). The reading task examined whether syntactic categories underlie the processing of isolated inflected words. We examined errors of both affixal and nonaffixal (irregular) inflection. The production task was completed by two anterior and six posterior aphasics and the reading task by nine anterior and five posterior aphasics.

Results. For the anterior aphasics as a group, both the production and the reading tasks yielded the predicted error pattern of unmarked $>$ participial $>$ *-s*-suffixed. This pattern held for individual subjects as well; the only exceptions were two subjects with an unmarked $<$ participial pattern and one with a participial $<$ *-s*-suffixed pattern. The posterior aphasics did not show the same pattern as the anterior aphasics. They had a much lower rate of unmarked responses, there was no consistent relation between their re-

TABLE 10
Error Rates as Percentages of Items over Regular and Irregular Verbs

	Non-fluent anterior aphasics		Fluent posterior aphasics	
	Production	Reading	Production	Reading
Unmarked	29%	22%	7%	3%
Participle	20%	4%	0%	4%
-ing-suffixed	17%	3%	0%	4%
-en-suffixed	3%	1%	0%	0%
-s-suffixed	0%	1%	0%	0%

Note. Error rates for *-en*-suffixed forms were calculated over irregular verbs.

sponse rates for unmarked and *-ing*-suffixed forms, and they produced no *-en-* or *-s*-suffixed forms (see Table 10).

Discussion. Whereas the anterior aphasics' high rate of unmarked errors in the production task may be attributed in part to the fact that stems were provided, this cannot explain their similarly high rate of unmarked forms in the isolated-word reading task. Importantly, a third of their unmarked errors in both tasks were produced on irregular items. This shows that not all of the unmarked errors can be attributed to an impairment of morphological affixation. Furthermore, the high rate of unmarked errors on irregular items in the reading task shows that the unmarked forms cannot be fully explained by a tendency for the aphasics to stop reading once a well-formed word is encountered (e.g., *walked*). Finally, the inflectional errors on irregular verbs argue against a purely phonological explanation of the anterior aphasics' deficit (Kean, 1977). The distinct response pattern of the posterior aphasics suggests that they are not afflicted with the hypothesized impairment of concatenation and/or movement.

Conclusion. We have offered evidence that the pattern of inflectional errors in agrammatic anterior aphasia (but not posterior aphasia) reflects the hierarchical order of functional categories in syntactic structure, both in sentence contexts and, somewhat surprisingly, in isolated-word reading. These results are predicted by our proposal of an impairment of concatenation and/or movement in anterior (but not posterior) aphasia. They are also consistent with the hypothesis that higher projections are particularly impaired in agrammatism (Friedmann & Grodzinsky, 1997; Hagiwara, 1995) and with the view that agrammatic deficits are due to working memory or processing limitations (e.g., Just & Carpenter, 1992). However, the fact that the anterior (but not posterior) aphasics reported in this study also had greater difficulty producing and reading regular than irregular past tenses (Ullman et al., 1997) seems to suggest an impairment of concatenation, both in morphology and

in syntax. Finally, the contrasting patterns found for the anterior and posterior aphasics support the view that left anterior brain structures play a particularly important role in concatenation.

REFERENCES

Chomsky, N. 1995. *The minimalist program.* Cambridge, MA: MIT Press.

Friedmann, N., & Grodzinsky, Y. 1997. Tense and agreement in agrammatic production: Pruning the syntactic tree. *Brain and Language,* **56,** 397–425.

Goodglass, H. 1993. *Understanding aphasia.* San Diego: Academic Press.

Hagiwara, H. 1995. The breakdown of functional categories and the economy of derivation. *Brain and Language,* **50,** 92–116.

Just, M. A., & Carpenter, P. 1992. A capacity theory of comprehension: Individual differences in working memory. *Psychological Review,* **99,** 122–149.

Kean, M.-L. 1977. The linguistic interpretation of aphasia syndromes: Agrammatism in Broca's aphasia, an example. *Cognition,* **5,** 9–46.

Ullman, M. T., Corkin, S., Coppola, M., Hickok, G., Growdon, J. H., Koroshetz, W. J., & Pinker, S. 1997. A neural dissociation within language: Evidence that the mental dictionary is part of declarative memory, and that grammatical rules are processed by the procedural system. *Journal of Cognitive Neuroscience,* **9**(2), 266–276.

A Case of Prevailing Deficit of Nonliving Categories: Is Associative Information More Impaired Than Perceptual Information?

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Many reports of category-specific deficits show a prevailing impairment of knowledge of living categories; while few show a prevailing impairment of nonliving categories (Nielsen, 1946; Warrington & McCarthy, 1983, 1987; Hillis & Caramazza, 1991; Sacchett & Humphreys, 1992; Moss & Tyler, 1997). According to the ''modality-specific hypothesis'' concerning the organization of semantic knowledge (Warrington and Shallice, 1984), damage involving perceptual information would give rise to a living-categories deficit, whereas damage of functional information would generate a nonliving-categories impairment. According to the more recent ''domain-specific hypothesis'' (Caramazza & Shelton, 1998), the semantic system exhibits a truly categorical organization, so that when a domain is affected, the sensory and functional attributes are both damaged. Some published cases show that in living categories deficit, sensory, and associative attributes are not differently impaired (for a review see Caramazza, 1998); therefore the disproportionate damage to perceptual knowledge is not necessary to

cause this category-specific deficit. In the few published cases of nonliving category impairment, data on this aspect are not reported or do not disclose a significantly greater deficit of functional information (Moss & Tyler, 1997).

Categorical impairment has sometimes been considered artifactual and traced back to characteristics of the stimuli, such as frequency or familiarity. On average familiarity is different among categories and, in some cases, also gender specific: males are more familiar with tools and vehicles and females with fruits and vegetables (Capitani, Albanese, Barbarotto, & Laiacona, 1999). This latter observation is relevant when a prevailing deficit of living categories is observed in males or when a prevailing nonliving-categories deficit is observed in females.

In this study we describe a patient with a prevailing defect of nonliving categories in the course of progressive aphasia. We aimed (i) to verify if there was greater damage of the knowledge of associative properties of the stimuli, (ii) to disclose the role of item familiarity in generating the deficit, and (iii) to present some anatomoclinical correlations.

LP is a female, age 74, and a retired office clerk with 8 years of education. In 1997 she complained of progressive word-finding difficulty confined to proper names, extended in 1998 to common names. The neuropsychological examination disclosed slight verbal and spatial learning deficits and oral apraxia. When this study was performed, she was still able to attend to her everyday duties. LP underwent a language examination with AAT (Luzzatti, Willmes, & De Bleser 1994): her deficit could not be univocally classified and was compatible (54.7% probability) with Wernicke aphasia and (45.0% probability) with amnestic aphasia.

In a picture-naming task she was more impaired with nonliving categories. In order to assess the integrity of the stored knowledge of the visual characteristics of the stimuli, we submitted LP to an object decision task and the item match test (BORB, test 11). To assess semantic memory deficits, LP underwent a standardized examination including, in addition to picture naming, pointing to pictures and a verbal semantic questionnaire. Items belonged to 6 categories (3 living and 3 nonliving): animals, fruits, vegetables, tools, vehicles, and furniture. For each item verbal frequency, gender-specific familiarity, prototypicality, image agreement, visual complexity, and an index of difficulty were available. We compared LP's performances with living and nonliving categories by means of a logistic regression analysis. For each task we report in Table 11 the number of correct responses (%) separately for categories and type of question and the effects of category and type of question were calculated removing the concomitant effect of the variables known to influence the performances.

With respect to the first point of this study, the numbers of correct answers to perceptual and associative questions were similar, both considering all stimuli ($\chi^2 < 1$, ns) and with stimuli split into living ($\chi^2 = 1.086$, ns) and nonliving categories ($\chi^2 < 1$, ns). The difference between living and nonliving categories was significant for both perceptual and associative questions:

TABLE 11
Percentages of Correct Responses Given by LP on Different Tasks

Task	Overall	Living categories	Nonliving categories	Living vs nonliving categories comparison (χ^2, $df = 1$)
Picture naming ($n = 60$)	25%	37%	13%	10.676, $p = .001$
Pointing to picture ($n = 60$) (semantically related foils)	93%	97%	90%	<1, ns
Questionnaire (overall) ($n = 360$)	77%	83%	71%	13.355, $p = .0003$
Perceptive questions ($n = 120$)	76%	83%	68%	4.898, $p = .027$
Associative questions ($n = 120$)	72%	87%	57%	19.608, $p < .0001$
Object decision task ($n = 60$)	92%	87%	97%	
Item match (BORB) ($n = 29$)	90%	92% (12/13)	88% (14/16)	

the interaction between the type of question (perceptual/associative) and the stimulus category (living/nonliving) did not reach the significant level ($\chi^2 = 1.885$, $p = 1.170$, ns).

Gender-specific familiarity significantly influenced pointing to pictures ($\chi^2 = 4.427$, $p = .035$) but not naming. On the questionnaire its effect was present ($\chi^2 = 4.393$, $p = .036$), but indistinguishable from the frequency effect. Since category effects were confirmed introducing gender-specific familiarity as a covariate, these cannot be traced back to unbalanced familiarity.

On MRI a diffuse atrophy was evident, but particularly present on the left frontal and temporal lobes. In this latter the atrophy was greater in the anterior half.

In conclusion, the deficit presented by LP on nonliving categories does not arise from a general damage of the associative information: this replicates case ES (Moss & Tyler, 1997). Gender-specific familiarity plays a significant role, but it is not sufficient to account for the category effect. The radiological findings are not consistent with the data reported by Damasio, Grabowski, Tranel, Hichwa, and Damasio (1996) and suggest participation of more anterior temporal regions in the processing of nonliving categories.

REFERENCES

Capitani, E., Albanese, E., Barbarotto, R., & Laiacona, M. 1999. Semantic category dissociation, familiarity and gender. *Seventeenth European Workshop on Cognitive Neuropsychology,* Bressanone, Italy.

Caramazza, A., & Shelton, J. R. 1998. Domain-specific knowledge system in the brain: The animate–inanimate distinction. *Journal of Cognitive Neuroscience,* **7,** 161–189.

Caramazza, A. 1998. The interpretation of semantic category-specific deficits: What do they reveal about the organisation of conceptual knowledge in the brain? *Neurocase,* **4,** 265–272.

Damasio, A., Grabowski, T. J., Tranel, D., Hichwa, R. D., & Damasio, A. R. 1996. A neural basis for lexical retrieval. *Nature,* **380,** 499–505.

Hillis, A. E., & Caramazza, A. 1991. Category-specific naming and comprehension impairment: A double dissociation. *Brain,* **114,** 2081–2094.

Luzzatti, C., Willmes, K., & De Bleser, R. 1994. *Aachener aphasie test (AAT). Versione italiana.* Florence: Organizzazioni Speciali.

Moss, H. E., & Tyler, L. K. 1997. A category-specific semantic deficit for nonliving things in a case of progressive aphasia. *Brain and Language,* **60,** 55–58. [Presented at the Academy of Aphasia Meeting, Philadelphia, October 19–21, 1997].

Nielsen, J. M. 1946. *Agnosia, apraxia, aphasia: Their value in cerebral localisation.* New York: Hoeber.

Sacchett, C., & Hunphreys, G. W. 1992. Calling a squirrel a squirrel but a canoe a wigwam: A category-specific deficit for artefactual objects and body parts. *Cognitive Neuropsychology,* **9,** 73–86.

Warrington, E. K., & McCarthy, R. A. 1983. Category-specific access dysphasia. *Brain,* **106,** 859–878.

Warrington, E. K., & McCarthy, R. A. 1987. Categories of knowledge: Further fractionation and an attempted integration. *Brain,* **107,** 829–853.

Auditory Word List Priming in Left and Right Temporal Lobe Lesion Patients

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A well-known and replicated behavioral and electrophysiological finding is that the processing of a word is facilitated when it is preceded by a semantically related word. This effect is known as the semantic priming effect, which is reflected in shorter reaction times to and fewer errors with related words than unrelated words in lexical decision tasks (e.g., Neely, 1991) and in the N400 component in electrophysiological studies (e.g., Anderson & Holcomb, 1995). In addition, some research has focused on whether semantic information type (associative vs nonassociative) and presentation type (word pair or word list) can influence priming effects. Kotz (1998) reported auditory and visual word-list priming effects for associative relations in reaction time measures and an event-related potential (ERP) priming effect for associative (cat–dog) and nonassociative (horse–dog) relations.

Priming studies in aphasic patient populations have resulted in two critical

and controversial results. Most research indicates that the lexical-semantic deficit in aphasics is the result of modified processing operations rather than a loss of knowledge representation (Milberg et al., 1987). Wernicke patients show a priming effect delayed but comparable to that of normal control subjects (i.e., Hagoort, 1993; Milberg et al., 1987). Broca's aphasics do not demonstrate a stable semantic priming effect (i.e., Milberg et al., 1987; Ostrin & Tyler, 1993). It is assumed that Wernicke's aphasics have a processing deficit that affects postlexical processes (Hagoort, 1993) while the processing deficit in Broca's aphasics relates to automatic processes during lexical access (Milberg et al., 1987). Both of these conclusions make the implicit assumption that semantic priming relies on controlled and automatic processes. Evidence from semantic priming in normal populations indicates that both automatic and controlled priming mechanisms contribute to the semantic priming effect (Neely, 1991).

The current experiment followed up on a previous ERP priming experiment with language patients (Hagoort, Brown, & Swaab, 1996). We further explored the underlying mechanisms of priming by manipulating semantic information type (associative functional, associative categorical, and semantic categorical) and word-list presentation as a function of lesion sites. Eight patients with left-hemisphere temporal lesions and seven patients with right-hemisphere temporal lesions as well as normal controls participated in the experiment. Words were presented auditorily in a word list (SOA 1025 ms) and subjects were required to press a button when they heard a verb or an adjective (10%). ERPs were recorded from 32 electrodes (left mastoid reference). Presenting words in a list should prevent subjects from using postlexical strategies. The different word types and processing control should ensure a more conclusive result with respect to the nature of lexical-semantic deficits in temporal lobe lesions.

Normal controls made very few errors detecting verbs and adjectives in the word list. They showed the expected associative (functional/categorical) and semantic (categorical) N400 priming effects. Overall, the error rates between left- and right-hemisphere temporal lesion patients were comparable. Patients with left-hemisphere temporal lesions displayed the following pattern of N400 priming effects: no associative functional priming effect, an associative categorical priming effect (extended latency), and a delayed semantic categorical priming effect. Patients with right-hemisphere temporal lobe lesions, in contrast, showed an associative functional priming effect as well as an associative categorical priming effect. They also displayed a small semantic categorical effect, which was modified by a positivity around 200 ms at left-hemisphere electrode sites.

In conclusion, these data indicate that word-list priming in language-impaired patients is differentially modulated by semantic information type and word-list presentation depending on lesion site. The different ERP patterns for the two patient groups suggest that the left temporal lobe might

monitor functional associative priming, whereas the right temporal lobe might be involved in aspects of semantic categorical priming.

REFERENCES

Anderson, J. E., & Holcomb, P. J. 1995. Auditory and visual semantic priming using different stimulus onset asynchronies: An event-related brain potential study. *Psychophysiology,* **32,** 177–190.

Hagoort, P. 1993. Impairments of lexical-semantic processing in aphasia: Evidence from processing of lexical ambiguities. *Brain and Language,* **45,** 189–232.

Hagoort, P., Brown, C. M., & Swaab, T. Y. 1996. Lexical-semantic event-related potential effects in patients with left hemisphere lesions and aphasia, and patients with right hemisphere lesions without aphasia. *Brain,* **119,** 627–649.

Kotz, S. A. 1998. Comparing the auditory and visual sequential priming paradigm: An event-related potential study. *Journal of Cognitive Neuroscience,* **Suppl.,** 54.

Milberg, W., Blumstein, S. E., & Dworetzky, B. 1987. Processing of lexical ambiguities in aphasia. *Brain and Language,* **31,** 138–150.

Neely, J. H. 1991. Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G. W. Humphreys (Eds.), *Basic processes in reading—Visual word recognition,* pp. 264–337. Hillsdale, NJ: Lawrence Erlbaum.

Ostrin, R. K., & Tyler, L. K. 1993. Automatic access to lexical semantics in aphasia: Evidence from semantic and associative priming. *Brain and Language,* **45,** 147–159.

Similarity and Categorization: Neuropsychological Evidence for Dissociations in Categorization Tasks

Jules Davidoff & Debi Roberson

A series of experiments is reported on a patient (LEW) with difficulties in naming. The patient is a 60-year-old man who left school at 14 years. He suffered a left-hemisphere stroke 5 years previously that has left him with a right-sided hemiplegia. He has no presemantic visual deficits, full visual fields, and no neglect (Druks & Shallice, 1996a,b). He performed excellently on tests taken from the VOSP (Warrington & James, 1991). He scored 20/20 on Shape Detection, 19/20 on Object Decision, and 18/20 on Position Discrimination. His digit span (forward) was, at the time of this testing, 3; this compared unfavorably to that of six age- and occupation-matched controls (mean 4.66, $p < .05$). However, his short-term spatial memory as measured by the Corsi blocks test was normal. In summary, LEW is an aphasic patient who has limited speech production, reading, and writing but excellent comprehension (Druks & Shallice, 1996b).

The behavior of our patient allows reflection on the philosophical paradox known as the Sorites paradox. In essence, the paradox arises because of two presumptions: one, that a category is perceptual and two, that it possesses

a boundary. While these presumptions would appear valid for colors, the paradox can be seen by considering where a pair of color shades, which differ by less than one ''just-noticeable difference,'' are allowed to span a category boundary. If the category is genuinely perceptual, then the pair of color shades, being indistinguishable, cannot differ according to their category membership. Hence, they cannot be separated by a category boundary. Worse, the reasoning can be extended so that the conclusion is drawn that there can be no category boundary. For example, take the case of a series of color patches each of which is indistinguishable from its immediate neighbors. One such patch it is agreed can be called ''red.'' If red is a truly perceptual category then the immediate neighbors of this patch must also be called red. But, so by extension must their immediate neighbors. Pursuing the reasoning one arrives at the paradoxical conclusion that all colors in the series (even nonreds) must be called red. LEW sorts in exactly this paradoxical fashion.

On two separate occasions LEW was given the same large group of colored stimuli to sort. Fifty-eight stimuli were chosen so that normal categorization by hue required that variation in lightness and saturation must be considered. The relevant set of stimuli were randomly spread on the table and LEW was asked to place them in as many groups as he thought appropriate. No time limit was given for the sort. On both occasions, LEW produced a small number of groups that appeared to be based on a mixture of hue and lightness (e.g., pink with yellow and light purple). On one occasion he made four groups and on the other five; in each case the range of these groups did not correspond well to the ranges normally found in naming studies. LEW's freesorting, though impaired, was clearly not achieved at random; each member of a group always abuts another member. Control subjects rapidly sort most of the stimuli into eight groups in accord with their names and have difficulty in assigning only a few, all of which would be considered ''poor examples'' of any basic category. LEW was unable, on either occasion, to offer any names for the groups he had formed.

LEW's difficulty in sorting visual stimuli is not confined to color. Using a set of stimuli taken from Calder et al. (1996), LEW was also tested on freesorting and naming and pointing to named facial expressions. The stimulus set contained 15 faces that were morphed by computer in equal steps to range in a continuous band from expressions of fear to happiness, happiness to anger, and anger to fear. LEW was given, on three separate occasions, the 15 stimuli to group in any way he saw fit. The performance of LEW was compared to that of six matched controls. LEW made three groups on one occasion and two groups on both the others. On all occasions, unlike any control subject, he grouped together stimuli that have been consistently named as having different facial expressions.

LEW would spontaneously name some of the stimuli during freesorting and LEW would use his restricted naming ability to make a reasonably quick

categorization of those stimuli. For the others, LEW would take a very long time putting each face side by side with many other faces in order to find some perceptual similarity. If in the effort to find the most similar face he made an error, this could produce further errors. In this way, LEW would make categorization errors never produced by control subjects.

On other tasks, however, LEW revealed implicit understanding of some of the classic hallmarks of categorical perception; for example, in experiments requiring the choice of an odd one out, the patient chose alternatives dictated by category rather than by perceptual distance. Thus, underlying categories appeared normal and boundaries appeared intact. Furthermore, in a two-alternative forced-choice recognition memory task, performance was worse for within-category decisions than for cross-category decisions. We argue for a dissociation between these kinds of judgments in the freesort tasks. LEW's inability to make explicit use of his intact (implicit) knowledge is seen as related to his language impairment.

REFERENCES

Calder, A. J., Young, A. W., Perrett, D. I., Etcoff, N. L., & Rowland, D. 1996. Categorical perception of morphed facial expressions. *Visual Cognition,* **3,** 81–117.

Druks, J., & Shallice, T. 1996a. The production of verbs in an optic aphasic patient. *Brain and Cognition,* **32,** 246–248.

Druks, J., & Shallice, T. 1996b. Modality-linked naming impairment and multiple semantics. *Brain and Cognition,* **32,** 273–276.

Warrington, E. K., & James, M. 1991. *The visual object and space perception battery.* Bury St Edmunds: Thames Valley.

Shift from Defining to Characteristic Features in Alzheimer's Disease: When the Clothes Truly Make the Man

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The hallmark of Alzheimer's disease (AD) is early impairment in episodic memory, but deficits in semantic processing are also a common component of the cognitive decline associated with AD (Appell, Kertesz, & Fisman, 1982; Bayles, 1982). Different views of the semantic deficit have been advanced. One common view is that deficits represent a breakdown in the structure of semantic memory (Martin and Fedio, 1983; Huff, Corkin, & Growdon, 1986). However, use of implicit tasks such as semantic priming demonstrate slowed access but intact semantic memory in AD patients

(Ober & Shenaut, 1995). Nonetheless, Alzheimer's patients show deficits on a wide range of semantic memory tasks (Bayles & Tomoeda, 1983; Martin & Fedio, 1983).

Gonnerman et al. (1997) reported that the manifestation of the semantic deficit changes as the disease progresses. They argue that there is a difference in the representation of intercorrelated versus distinguishing features. Intercorrelated features occur across many concepts and are largely perceptual in nature (e.g., ''has-a-handle,'' ''is-heavy''), whereas distinguishing features are unique and tend to pick out one member of a category (e.g., ''pounds-nails''). The intercorrelated and distinguishing feature distinction may be similar to the characteristic and defining shift observed by Keil and Batterman (1984) in children learning language. Characteristic features tend to be perceptual but incidental, such as color or shape. Defining features are learned features that may not be physically obvious but constitute the agreed-upon meaning of a word. For example, knives are by definition used to cut, but they may be many shapes, sizes, materials, and colors. Keil and Batterman found an age gradient with responses of younger children based almost exclusively on characteristic features, while responses of older children were based only on defining features. If characteristic and defining features correspond roughly to what Gonnerman et al. call intercorrelated and distinguishing features, there may be a distinctive course of decline in Alzheimer's disease.

Subjects. The subjects were patients at the UC Davis Alzheimer's Disease Center (ADC) who had a diagnosis of probable or possible AD and a Mini-Mental State Examination (MMSE) score of 18 to 30 at the time of their most recent ADC evaluation. Normal elderly were selected from the control population maintained by the ADC. Subjects in both groups were native speakers of English with no prior diagnosis of learning disability or language disorder. Subjects were also free of other neurological or psychiatric illnesses, as well as substance abuse. Thus far, 8 normal controls and 11 patients have been enrolled in this study.

Methods. A set of 21 pairs of stories that contrast characteristic and defining features was adapted following Keil and Batterman (1984). For each pair, one story had the characteristic features of a term but lacked the defining features and the other had the defining features but lacked the characteristic features. The text was typed in large print on separate sheets of paper. Each story was presented to the subject in semirandom order. One story in each pair was randomly selected for presentation to the subject in the first half of testing, and the remaining story from the pair was presented in the second half of testing. The typed version of the story was placed in front of the subject and was read out loud by the examiner. The subject was then asked ''Is this an 'X'?'' where ''X'' was the concept for which the story was created. Answers were followed up with probe questions to clarify responses

and to understand how the subject reached a decision. All responses were tape recorded and transcribed for analysis.

Analysis. Quality of the responses was scored by two judges on a 3-point scale. One point was given if the subject relied only on characteristic features, 2 points were given for responses that considered both kinds of features important, and 3 points were given for cases in which defining features predominated responses. Our preliminary analysis of the data indicated that AD patients were significantly more dependent on characteristic features compared to controls in making their decisions (99.7 vs 116, $t = -3.17$, $p = .008$). Lower MMSE scores correlated highly with greater dependence on characteristic features use ($r = .75$, $F = 7.0$, $p = .02$). Although age was not systematically related to dependence on characteristic feature use ($r = .14$, $p > .05$), years of education did bias toward use of defining features ($r = .56$, $F = 7.9$, $p = .01$).

Discussion. These results indicate that the progression of AD is accompanied by greater dependence on characteristic (i.e., perceptual) features of objects and concepts. However, even the most impaired patients can recognize the importance of defining features and continue to use them in the easier stories. One interpretation of our data is that the ability to hold and weigh multiple features declines before patients lose sensitivity to defining features. As enrollment and 6-month longitudinal testing continue, our ongoing analysis will concentrate on the quality of responses to our probe questions to further understand the shift to greater dependence on characteristic.

REFERENCES

Appell, J., Kertesz, A., & Fisman, M. 1982. A study of language functioning in Alzheimer patients. *Brain and Language,* **17,** 73–91.

Bayles, K. A. 1982. Language function in senile dementia. *Brain and Language,* **16,** 265–280.

Bayles, K. A., & Tomoeda, C. K. 1983. Confrontation naming in dementia. *Brain and Language,* **19,** 498–510.

Gonnerman, L. M., Andersen, E. S., & Kempler, D. 1997. Category-specific impairments as a result of progressive semantic deterioration: Longitudinal data from Alzheimer's patients. *Brain and Language,* **60,** 58–60.

Huff, F. J., Corkin, S., & Growdon, J. H. 1986. Semantic impairment and anomia in Alzheimer's disease. *Brain and Language,* **28,** 235–249.

Keil, F. C., & Batterman, N. 1984. A characteristic-to-defining shift in the acquisition of word meaning. *Journal of Verbal Learning and Verbal Behavior,* **23,** 221–236.

Martin, A., & Fedio, P. 1983. Word production and comprehension in Alzheimer's disease: The breakdown of semantic knowledge. *Brain and Language,* **19,** 124–141.

Ober, B. A., & Shenaut, G. K. 1995. Semantic priming in Alzheimer's disease: Meta-analysis and theoretical evaluation. In P. A. Allen & T. R. Bashore (Eds.), *Age differences in word and language processing. Advances in psychology* (pp. 247–271). Amsterdam: North-Holland/Elsevier.

Semantic Processing of Auditory Words in Acute Recovery from Transcortical Sensory Aphasia and in Normal Subjects

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Introduction. Classical models of language functions assumed separate anatomical representations for lexical and conceptual representations. Important evidence for this separation came from dissociations between intact repetition and impaired comprehension that occur in transcortical sensory aphasia (TSA) with perisylvian language areas typically spared (Geschwind et al., 1968; Alexander et al., 1989). Several functional neuroimaging studies in normal subjects have demonstrated distributed semantic processing areas within the left prefrontal, extrasylvian temporal, and posterior parietal cortex, whereas auditory lexical processing was found to be associated with posterior perisylvian areas (cf. e.g., Price, 1998). In our study we compared the functional anatomy of semantic processing of auditory words in an acutely recovered patient with TSA and in normal subjects using fMRI.

Methods. R.C., a 65-year-old right-handed former machine engineer, suffered from a cardioembolic left-hemisphere stroke. His lesions were located around the first frontal sulcus and in the inferior parietal cortex, but did not involve classical Broca's or Wernicke's area. Aphasia was assessed using the Aachen Aphasia Test (AAT). On day 12 postonset, spontaneous speech was fluent. Severe word-finding difficulties, semantic paraphasias, and many circumlocutions were observed. Syntactic constructions were paragrammatic. Initially R.C. performed relatively well in Repetition (70th percentiles) in contrast to impairments of medium severity (31st to 53rd percentiles) on all the other subtests, i.e. Token Test, Comprehension, Written Language, and Naming. R.C. improved rapidly on all subtests except Comprehension within 5 weeks. Ten weeks poststroke, R.C. presented with only discrete difficulties in comprehension and in spontaneous speech. In the last AAT examination at 5 months, the time of fMRI scanning, the ceiling level was fully reached.

The fMRI-scanning procedure was identical for R.C. and the normal controls ($n = 14$, age 23–27 years, right handed). All experiments were performed on a 1.5-T Philips Gyroscan. For functional imaging a multishot T2*-weighted gradient echo EPI sequence was used (TR 4000 ms, TE 40 ms, FA 40°, matrix 64 $\times$ 64, FOV 250 $\times$ 250 mm, slice thickness 7 mm). Each experimental condition consisted of one session comprising six 44-s blocks alternating between rest (off) and activation (on).

The experimental paradigm consisted of auditory monitoring tasks which

were varied across three levels of word processing. (1) Auditory–phonetic: reversed words, i.e., real words played backward, had to be discriminated from complex sounds. (2) Phonological: concrete words versus reversed words. (3) Semantic: animal names versus names of other natural kinds. Subjects were instructed to detect targets according to the criterion given before each session (''weird word,'' ''normal word,'' ''animal name'').

The images were analyzed with statistical parametric mapping (SPM96; Wellcome Department of Cognitive Neurology, London, UK). Condition-specific effects were assessed by comparing the on periods of each task with their respective control conditions (off periods) and by determining specific interaction effects between the semantic (on–off) and the phonological (on–off) conditions. Conjunction analysis was employed to remove significant interactions between subjects and conditions and to obtain activation maps of voxels consistently activated in all subjects. Localization of activations in R.C. was determined using anatomical landmarks of the coregistered T1-weighted MRIs and based on the nonnormalized functional images. Maxima exceeding an individual voxel significance level of $p = .001$ ($z = 3.09$) and a cluster size >6 voxels are reported.

Results and discussion. In normal subjects, regions related to semantic word processing were located in the left middle and inferior frontal gyrus (BA 9, 45), the superior frontal gyrus (BA 10), and the posterior parietal lobe (BA 7/40). Similar prefrontal activations have been reported in several earlier studies (Gabrieli et al., 1998), comparable parietal activations were recently found by Warburton et al. (1996). Amodal conceptual representations were attributed to the parietal and inner semantic search functions to the prefrontal areas. These regions were affected by R.C.'s lesions. Nevertheless, only left cortical areas were activated in R.C. during semantic processing. This is at variance with findings by Weiller et al. (1995), who studied chronic stroke patients being recovered from Wernicke's aphasia.

Frontal activations occurred perilesionally in R.C. and were located in the left anterior inferior frontal, middle, and superior frontal gyri. These frontal activations roughly corresponded to areas consistently activated in normal subjects when considering a more liberal voxel level ($p = .05$). A remarkable finding was activation of the posterior part of the superior temporal gyrus, i.e., Wernicke's area, where the normal group showed no consistent activation. A single subject analysis, however, revealed one normal subject with a comparable posterior perisylvian activation. Additional bilateral thalamic activations were detectable in R.C., also visible in some normal subjects.

Conclusions. We were able to show that partial damage to the semantic word processing system itself instead of disconnection between intact conceptual and lexical representations can lead to TSA. The rapid recovery of language comprehension in our case was associated with left-hemisphere perilesional activations. All of these were shown to be associated with semantic processing in at least one normal subject. This suggests redundancy

recovery mechanisms within the left hemisphere, supporting distributed models of lexical-semantic processes and multiple left-hemisphere representations of closely related functions.

REFERENCES

Alexander, M. P., Hiltbrunner, B., & Fischer, R. S. 1989. Distributed anatomy of transcortical sensory aphasia. *Archives of Neurology,* **46,** 885–892.

Gabrieli, J. D., Poldrack, R. A., & Desmond, J. E. 1998. The role of left prefrontal cortex in language and memory. *Proceedings of the National Academy of Sciences USA,* **95,** 906–913.

Geschwind, N., Quadfasel, F. A., & Segarra, J. M. 1968. Isolation of the speech area. *Neuropsychologia,* **6,** 327–340.

Price, C. J. 1998. The functional anatomy of word comprehension and production. *Trends in Cognitive Sciences,* **2,** 281–288.

Warburton, E., Wise, R. J., Price, C. J., Weiller, C., Hadar, U., Ramsay, S., et al. 1996. Noun and verb retrieval by normal subjects. Studies with PET. *Brain,* **119,** 159–179.

Weiller, C., Isensee, C., Rijntjes, M., Huber, W., Müller, S., Bier, D., et al. 1995. Recovery from Wernicke's aphasia, a positron emission tomographic study. *Annals of Neurology,* **37,** 723–732.