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Verb Retrieval and Sentence Production in Aphasia

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This paper presents a subject with a selective verb retrieval deficit. Nouns were produced more successfully than verbs in spontaneous speech, picture naming and when naming to definition. The word class effect was not observed in comprehension tasks, reading aloud or writing. This indicated that it was due to a specific problem in accessing verbs' phonological representations from semantics. The second part of the paper explores the implications of the verb deficit for sentence production. Analyses of narrative speech revealed a typically agrammatic profile, with minimal verb argument structure and few function words and inflections. Two investigations suggested that the sentence deficit was at least partly contingent upon the verb deficit. In the first, the subject was asked to produce a sentence with the aid of a provided noun or verb. The noun cues were not effective in eliciting sentences, whereas verb cues were. The second investigation explored the effects of therapy aiming to improve verb retrieval. This therapy resulted in better verb retrieval and improved sentence production with those verbs. These findings suggest that an inability to access verbs' phonological representations can severely impair sentence formulation. Implications for models of sentence production are considered.

INTRODUCTION

Many studies have described verb retrieval deficits in people with aphasia (e.g., Williams & Canter, 1987; Kohn, Lorch, & Pearson, 1989; Berndt, Mitchum, Haendiges, & Sandson, 1997a). These deficits can arise at different levels within the language processing system. In some cases, the problem is in semantics and both production and comprehension are affected (e.g., McCarthy & Warrington, 1985). In others, the deficit is confined to the retrieval of either phonological or orthographic word forms. This was most strikingly demonstrated by Caramazza and Hillis (1991). They described two subjects with selective verb output deficits, one of whom showed the effect only in writing and the other only in speech.

Verb deficits are often, although not always, associated with impaired sen-

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tence production (e.g., Myerson & Goodglass, 1972; Hand, Tonkovich, & Aitchison, 1979; Miceli, Silveri, Nocentini, & Caramazza, 1988; Berndt, Haendiges, Mitchum, & Sandson 1997b, but see Berndt, Haendiges, & Wozniak, 1997c). This association is supported by studies showing that subjects with agrammatism have impaired verb retrieval while subjects with anomic or Wernicke's aphasia have greater difficulty retrieving nouns (e.g., Miceli, Silveri, Villa, & Caramazza 1984; Zingeser & Berndt 1990; Bates, Chen, Tzeng, Li, & Opie, 1991).

This association suggests that a common underlying deficit may exist. One possibility is that some degree of sentence processing is required to activate verb entries and that this fails in agrammatism. The impairment is, in other words, the product of a more general syntactic deficit. Several findings argue against this syntactic hypothesis, however. As Berndt et al. (1997a) point out, it has difficulty explaining why verb deficits appear in single word tasks, such as naming or reading aloud (Miceli et al., 1984). It is further challenged by evidence that retrieval need not be influenced by the complexity of the target sentences (Berndt et al., 1997a). Finally this account predicts that a syntactic impairment must always be accompanied by some degree of verb retrieval difficulty. Consequently the existence of subjects who process verbs well, despite syntactic problems, is a further problem (Berndt et al., 1997c).

A different version of this syntactic hypothesis suggests that the verb impairment is the result of the morphological impairment found in agrammatism. In this account verbs are more difficult to produce than nouns because of their greater morphological complexity. However, Bates et al. (1991) showed that word class effects occur even in an uninflected language like Chinese, where no morphological difference exists between nouns and verbs.

The problems encountered by the syntactic hypothesis suggest that alternative explanations of the association should be explored. One alternative is the proposition that the sentence processing disorder is itself a consequence of a lexical deficit for verbs (e.g., Saffran, Schwartz, & Marin, 1980). This lexical hypothesis suggests that sentence construction requires information which is stored within the verb representation. Without access to these representations, sentence construction cannot proceed. This account predicts that a one way dissociation between verb and sentence processing skills may occur. Verbs may be accessed to supply the required syntactic information, but sentence generation and comprehension might fail for other reasons. However, the converse dissociation, that a verb deficit may occur *without* a deficit for sentences, should not be possible.

A more sophisticated version of the lexical hypothesis suggests that the effects on sentence processing will differ with the level of the verb retrieval impairment. Several commentators have suggested that a verb's semantic representation is crucial for the construction of a sentence's predicate argument structure (e.g., Garrett, 1988; Levelt, 1989). Such a deficit should severely compromise sentence construction. In support of this view several

subjects have been reported with a deficit for the semantics of verbs and very poor sentence construction skills (e.g., Jones, 1986; Byng, 1988; Marshall, Pring, & Chiat, 1993; Marshall, Chiat, & Pring, 1997).

Berndt et al. (1997a,b) argue that a deficit for verbs at the phonological level will have less far-reaching consequences. The availability of the semantic representation will allow the generation of the predicate argument structure to proceed and evidence of this should be seen in the person's output. This prediction was partly born out in their findings. They studied five people with dysphasia who had greater difficulty retrieving verbs than nouns. One showed evidence of a deficit at the phonological level. Most of his errors were phonological and his production was strongly influenced by word frequency. This subject had fluent, rather than agrammatic production with little evidence of structural problems. His output lacked verbs but when these were provided for him the structure of his sentences changed very little. The authors suggest that this was because he could already construct adequate sentence frames.

The lexical hypothesis may be tested through the study of people with dysphasia who have particular difficulty accessing verbs. The hypothesis predicts that impaired sentence construction will improve when verbs become available either through cueing or by therapy which targets their retrieval. Failure to improve might suggest that no functional relationship exists between verb and sentence deficits. Their common co-occurrence may arise because they are supported by neighboring neural structures. As a result, lesions affecting one are likely to affect the other (Miceli et al., 1988).

This study explores the relationship between verb and sentence level impairments in a subject with a strong word class effect favoring nouns over verbs in spoken naming. In the first part of the paper this word class effect is investigated. Evidence from writing, comprehension and reading aloud suggests that the problem lies in accessing the phonological representations of verbs from semantics. The second part of the paper presents data from connected speech. This showed a typically agrammatic pattern. Production was dominated by nouns and had very limited structure and few spontaneous function words and inflections. Evidence on sentence production after cueing of verb retrieval and after therapy aimed at improving that retrieval is presented. If sentence production improves under these circumstances it will suggest that it requires access to both the phonological and the semantic representations of verbs.

THE SUBJECT

EM had a left CVA in 1989 when she was 52. Her stroke resulted in a severe dysphasia and a right hemiplegia. Although the hemiplegia resolved, the dysphasia persisted and in 1990 she was diagnosed as a Broca's dysphasic on the Boston Diagnostic Aphasia Examination. Her output displayed

reduced phrase length, few spontaneous verbs and few function words and inflections. Comprehension was relatively spared. EM showed no signs of confusion. She lives independently and has resumed several previous interests, including driving and attending local Adult Education Classes. Unfortunately, no brain image information is available.

EM is a widow with three adult children. At the time of her stroke she was working as a receptionist in a sports center and prior to that held various administrative and secretarial posts. She is right-handed and a monolingual English speaker.

PART 1: INVESTIGATION OF THE WORD CLASS EFFECT

Verbs rarely occurred in EM's spontaneous output. This apparent word class effect was first investigated in a range of naming tasks.

Verb and Noun Naming Tasks

i. *Spoken naming of object and action pictures (see Byng, 1988).* The stimuli in this task are pairs of action and object photographs, which can be described with phonologically matched nouns and verbs. For example, the noun member of one pair showed a square of butter and the verb member someone buttering bread. Thus the task assessed whether EM's ability to access a phonological form was influenced by word class. The 42 action and object photographs were administered on separate occasions to avoid priming. With the action pictures EM was shown each one in turn and asked to say in one word what the person was doing. She was given as much time as she needed to produce a verb. Responses to both sets of pictures were recorded on audio tape.

EM scored 38/42 with the object pictures (90%). Two errors were phonological (e.g., ''spool'' for ''spoon''). On the other two occasions, EM produced related nouns (e.g., ''orange . . .'' for ''peel'') which she knew were not the target. Responses to the action pictures were scored correct if they were the specific target or were judged to be acceptable for the picture. Despite this liberal scoring, EM achieved only 25/42 (59%), which was significantly worse than her performance with the nouns ($\chi^2 = 9.143$, $p < .01$).

Various errors occurred to verb targets. Six were omissions, although relevant nouns were achieved, e.g., ''. . . the hoover'' (hoovering). Five employed inappropriate verbs and verb structures, e.g., ''the woman's helping the books and the case'' (boxing books). Three were related verbs which EM knew to be incorrect, e.g., ''the lady's mowing the lawn . . . its er dig no'' (target hoeing). Three responses were aborted at the point where the verb was required and one was a phonological error. Interestingly, when a verb was achieved, it tended to be produced within a complete sentence, e.g., ''The man's putting the belt on.''

ii. *Written naming of action and object pictures (see Byng, 1988).* The naming of action and object pictures test was readministered and EM was asked to produce a written response. Apart from the modality of response, the test procedure was unchanged. Object and action pictures were administered separately and EM was given as much time as she needed to produce a response.

The written version of the task eliminated the word class effect. EM scored 38/42 with the nouns, and 35/42 with the verbs. The latter was significantly better than her spoken performance (25/42 vs. 35/42, McNemar $\chi^2 = 7.143$, $p < .01$). Errors with verbs were made up of omissions (2), the inappropriate use of nonspecific verbs (2), spelling errors (2), and one semantic error.

As in the spoken version of the task, many of EM's correct verbs were produced in sentences. Fourteen of these were entirely correct, e.g., ''the lady whisks the eggs.'' It was also striking that when EM had written a sentence she often read it aloud. Her only errors in reading were with the function words and inflections.

iii. *Spoken naming of nouns and verbs from definitions.* This task required EM to produce either a single noun or verb in response to a spoken definition.

Examples: To die in water is to . . . (drown).
A map of the world that looks like a ball (globe).

The targets consisted of 33 nouns and 33 verbs matched pairwise for cumulative frequency (Francis and Kucera 1982) and syllabic structure.

The relative difficulties of the noun and verb definitions were checked by asking 10 subjects without dysphasia (age range 25–69) to do the task. They produced 62 responses which differed from the intended targets. Twenty-seven were to verb items and 35 to noun items. Seven subjects produced more nontarget responses to nouns and 3 to verbs. This piloting suggested that the noun and verb definitions were equally successful in accessing the intended responses. Any bias seemed marginally in favor of verbs.

In contrast, EM was significantly more successful with the noun targets (29/33 vs. 16/33, $\chi^2 = 10.06$, $p < .01$). She was aware of her noun errors which were all semantically related to the target. Nine of EM's verb errors involved the production of related nouns, e.g., ''menu'' for ''eat.'' The remainder consisted of omissions (6), production of a nonspecific verb (1), and one semantic error. EM's naming was not influenced by frequency, with either the nouns or the verbs.

Conclusions from the naming tasks. EM's spoken naming showed a marked advantage for nouns both when naming from a picture or a definition. This effect was seen when nouns and verbs were matched phonologically or when they were matched for frequency. In contrast, written naming showed no word class effect. This suggested that her verb deficit may be due to impaired access to phonology. Tests of comprehension and reading were carried out to confirm this hypothesis.

Single Word Comprehension Tests

i. *Word to picture matching.* EM was shown a single picture and asked a yes/no question about its name. The questions offered the target (80 items), a gross distractor (40 items) or a semantically related word (80 items). Half the pictures were of objects and half were of actions. Examples:

Picture	Question
An axe	Is this an axe (target)?
A wheel nut	Is this a fish (gross distractor)?
A parachute	Is this a plane (semantic distractor)?
A man peeling an orange	Is this peeling (target)?
Water being poured into a glass	Is this breaking (gross distractor)?
A man pushing a car	Is this pulling (semantic distractor)?

EM was virtually faultless on this task. She scored 100/100 with the nouns and 99/100 with the verbs.

ii. *Comprehension of reverse role verbs.* The word to picture-matching task showed that EM understood the core meaning of verbs, or the type of action that they describe. It is possible that her comprehension of their thematic properties was less intact.

A further task was designed to explore this. EM was shown a picture of a transaction, such as a woman selling a car to a man and was asked to point to one of the participants in response to a spoken question, e.g., ''which one is selling?'' To succeed on this task, EM had to process the thematic properties of the verb. Thus, she had to know that ''sell'' focuses on the goal of the transaction, rather than the source (as would be the case with ''buy'').

EM performed well (19/20). Her one error with ''lend'' possibly reflected her London dialect, since borrow and lend are used interchangeably by many London speakers. This result suggested that EM knew about the grammatical aspects of verbs.

Sentence Comprehension Tests

i. *Sentence judgment task.* In this task 80 sentences were read aloud to EM, half of which contained violations. EM had to indicate whether the sentences were correct or not. Twenty of the anomalies were purely semantic, in that they violated either the selection restrictions of the verb or the relationship between the verb and an optional modifier, e.g.,

The man drinks the cake.
The man bashed the ball gently.

Knowledge of the verb's core meaning is needed to succeed on these items.

TABLE 1
Performance on the Reversible Sentence Comprehension Test with Comparative Control Data from Black et al. (1992)

Sentence type	Score (%)	Normal range (%)
Action verb, active structure e.g., The astronaut scolds the clown	90*	80–100
Action verb, passive structure e.g., The judge is weighed by the pilot	85*	80–100
Nonaction verb, active structure e.g., The astronaut dreads the clown	55**	60–100
Nonaction verb, passive structure e.g., The swimmer is heard by the workman	60*	50–100
Adjectives e.g., The dancer is exasperated with the cook	77*	70–100
Locatives e.g., The plane is above the cloud	95*	80–100

* All errors involved the selection of the reversal distractor.
** Three errors involved the selection of the lexical distractor.

The other 20 anomalies violated the verb's argument structure. In half, the verb was used with an inappropriate syntactic structure, e.g.,

The thug dies the woman.

In the other half the syntactic structure was correct. However, the mappings onto that structure were not. Thus, in the following example a probable goal, rather than theme, has been mapped onto the direct object position:

The man pours the glass.

Knowledge of the verb's argument and mapping properties are required for these items. The test was piloted with five nondysphasic control subjects (age range 25–69). These subjects made just two errors, both of which were with verb/argument violations. EM scored 76/80 on this task. Three of her errors involved verb/argument violations and one the rejection of a correct sentence. This high score confirmed that EM could comprehend sentences which required knowledge of the semantic and structural properties of verbs.

ii. *Reversible sentence comprehension test (Black, Nickels, & Byng, 1992).* In this test, a written or spoken sentence has to be matched to one of three pictures. The pictures show the target, a semantic reversal and a lexical distractor which illustrates a different predicate. Four types of predicate are tested: action verbs, which assign the roles of agent and patient; nonaction verbs, which assign the roles of stimulus and experiencer; adjectives and prepositions. The action and nonaction verbs are presented in active and passive forms. Examples of the sentences are given in Table 1.

EM was tested on a written and auditory version of the task. As no signifi-

cant differences were found between modalities, the results were combined. Table 1 gives her performance and that of controls without aphasia (Black et al., 1992).

On all sentence types, EM scored within, or near to, the controls' range. Her errors were also similar, in that most involved the selection of the reversal distractor.

Although EM is similar to controls on this task, she made numerous errors with the nonaction verbs. These items were also responsible for her few lexical errors. The possibility that she had a particular difficulty with these verbs was investigated in a final sentence completion task.

iii. *Sentence completion task.* EM was required to complete written sentences using one of four provided verbs. Of 22 sentences, 12 were active and 10 passive. In all cases, the target was a nonaction verb which assigned the roles of stimulus and experiencer. The distractors were a nonaction verb, which would be correct for the reversed word order (reverse distractor); an action verb, which was semantically associated with one of the sentence nouns (semantic distractor); and an unrelated nonaction verb (gross distractor). The option verbs were presented in uninflected forms to avoid syntactic priming. Example:

Children . . . games	Provided verbs:	Enjoy (target)
		Entertain (reverse distractor)
		Jump (semantic distractor)
		Shock (gross distractor)

To carry out this task EM had to deduce a possible sentence meaning on the basis of the provided nouns (no pictures were given). This narrowed the selection to the target and the reversal. She then had to infer the probable roles of the sentence nouns and process the assignment rules of the verbs; i.e., in the example, she had to know that ''enjoy'' maps the experiencer onto subject, whereas ''entertain'' maps it onto object. This knowledge would enable her to reject the reversal and select the target. Thus the task assessed her understanding of both the core meaning and assignment principles of nonaction verbs. EM scored 20/22. Both her errors were with passive sentences.

Conclusions from the comprehension tests. EM's single word comprehension was virtually unimpaired. She rarely accepted semantically related items as picture names, either with nouns or with verbs. She could comprehend reverse role verbs, such as ''buy'' and ''sell,'' which are particularly problematic for many agrammatic subjects (e.g., McCarthy & Warrington, 1985; Byng, 1988; Marshall et al., 1997). She also showed impressive input skills with sentences. For example, she could judge anomalous sentences, even when those judgments depended upon knowledge of the verbs argument structure. She was also well above chance in comprehending most semanti-

TABLE 2
Performance in Reading Aloud and Naming from Definition 32 Frequency Matched Nouns and Verbs

	Reading aloud	Naming from definition
Nouns	32/32	28/32
Verbs	30/32	15/32
Total	62/64	33/64

cally reversible sentences. The latter task did suggest a difficulty with nonaction verbs which express stimulus/experiencer relations; however, a subsequent sentence completion task confirmed her ability with these items. We can conclude that verbs' semantic representations are available to EM. She appreciates not only core aspects of verb meaning but also subtle features, such as the number of arguments commanded by a verb and how the verb maps its arguments onto sentence positions. These results are not consistent with a semantic impairment for verbs.

Investigations of Reading

The comprehension tests suggested that EM's verb retrieval deficit was not due to a semantic deficit. Therefore, the most likely source of her problem was a phonological impairment. This might take two forms. Verbs' phonological representations may be lost or degraded, or they may be difficult to access. Assessment of reading offered a means of adjudicating between these options.

i. *Nonword reading.* EM was asked to read aloud 24 monosyllabic nonwords, which ranged in length from 3 to 6 letters (PALPA test No. 36; Kay, Lesser, & Coltheart, 1992). She found the task extremely difficult and scored only 7/24. This result suggested that she has great difficulty reading nonlexically and that her reading of words must rely on access to their stored phonologies. If these are damaged, a word class effect similar to that in her naming will be seen.

ii. *Reading aloud nouns and verbs.* EM read aloud 64 of the frequency matched nouns and verbs from the definitions naming task (one item, ''bow'' and its partner, was excluded, because of its ambiguous class status in the written form). The stimuli included both regular and irregular words. Her performance is shown in Table 2, with comparative naming data. EM's reading was markedly better than her naming owing to her much better reading of verbs (McNemar $\chi^2 = 14.67$, $p < .001$). Her two reading errors with verbs were both derivational: ''sharp'' for ''sharpen'' and ''teacher'' for ''teach.''

Conclusions from the reading tasks. EM reads better than she names, particularly with verbs. This cannot be attributed to sublexical letter to sound conversion, given her poor performance with nonwords, and the lack of any regularity effect. We can therefore conclude that when reading aloud she accesses the stored lexical phonologies of words.

EM might do this in two ways. One possibility is that she summates activation from the semantic and sublexical reading routes (Hillis & Caramazza, 1995). However, her very poor reading of nonwords suggests that any contribution from the sublexical route is minimal. The other possibility is that she reads by a nonsemantic reading route which directly connects the input and output orthographic lexicons. Deciding between these options would require further testing. For present purposes, it should be enough to argue that EM's excellent reading is heavily, if not entirely, dependent upon lexical phonological entries. This, in turn, confirms that these entries are available to her and that her problem in accessing verbs in speech stems from an inability to access verb phonologies from semantics.

Discussion of Part 1

EM's spoken naming showed a strong word class effect. Nouns were named significantly more successfully than verbs. This occurred across different tasks and despite matching of the targets for frequency and phonological form.

This advantage for nouns might arise either because of a central semantic impairment for verbs or because of a loss of their phonological entries, or because access to the latter from the former is impaired. Assessments of comprehension suggested that EM retained considerable semantic knowledge for verbs. She could discriminate related and reverse role verbs and could call upon verbs' argument and mapping properties in a range of sentence level tasks. Furthermore her good written naming of verbs suggests that her access to their orthographies from semantics is unimpaired. EM can read aloud nouns and verbs but is poor at reading nonwords. This suggests that the phonologies of nouns and verbs are available to her and that her problems in naming arise at access to phonology where there is a selective impairment for verbs.

A previous case in the literature describes a similar dissociation, although in the reverse direction. HY (Zingeser & Berndt, 1988) named verbs better than nouns. He comprehended both word classes well and his repetition indicated that phonological entries were retained since he could repeat nouns and verbs equally well, but not nonwords. The authors therefore concluded that HY's deficit lay in the connections between the semantic system and the output lexicons which were impaired in such a way as to cause a word class effect. HY's impairment was specific to nouns. EM's was specific to verbs.

EM differed from HY in two ways. HY's word class effect was seen in both speech and in writing, whereas EM's was confined to speech. Thus, EM's impairment only affected the connections between semantics and phonology, whereas HY's disrupted the connections to both phonology and orthography. HY's production was also strongly affected by word frequency. In contrast, the tests described above did not detect an effect of frequency in EM's naming of verbs. A frequency effect might be expected in such circumstances and the failure to find it questions our conclusion that she has an access impairment. Although the inconsistency is puzzling, the results reported above leave little doubt that EM has adequate semantic representations for verbs and that she can access their phonologies in reading. Thus they strongly favor an access interpretation of her verb deficit.

PART 2: SENTENCE PRODUCTION

Many aspects of verb processing were intact for EM. She retained considerable semantic skills with verbs, and could employ these skills in sentence comprehension. Of interest, was whether she could also employ those skills in production. For example, EM's semantic knowledge should enable her to form predicate argument structures. Evidence of such structures might be found in her output even if verbs were omitted. Utterances in which noun phrases are ordered appropriately around a ''missing verb'' might be found. We might also expect her to use strategies to compensate for the phonological problem with verbs. For example, the verb position might be realized with nonspecific general verbs or with gestures or neologistic substitutes.

This part of the paper presents data on EM's connected speech. This was typically agrammatic in character. Contrary to the above expectations, there was little evidence of any structure. For example, her output contained few systematically conjoined noun phrases.

Finally, we shall present the results of cueing and therapy for verb access which explored the relationship between her verb deficit and her failure to produce well structured sentences.

Analyses of Connected Speech

An example of EM's conversational speech is given in Table 3. Her output consists almost entirely of single nouns. There are no verbs and no verb related structure, although her responses to questions suggests that predicate argument information is understood.

Her output was formally investigated in two analyses. The data for these consisted of a narrative sample which was elicited using the methodology described by Saffran, Berndt, and Schwartz (1989). EM was required to retell two well known fairy stories: Cinderella and Snow White. This resulted in a corpus of only 100 words, which is less than the 150 recommended by Saffran et al. However, EM found the story task so effortful that further

TABLE 3
An Example of EM's Conversational Speech

Therapist:	How was your Christmas?
EM:	Fine . . . fine . . . fine . . . fine . . . um New Year and Christmas . . . um Daren
Therapist:	Did he come to you?
EM:	No (gestures away from self) . . . yes
Therapist:	You went to him. How long did you stay with him?
EM:	Well . . . it's um Christmas and um New Year no . . . um Boxing Day
Therapist:	What did you have?
EM:	Turkey and stuffing . . . potatoes . . . cauliflower . . . sprouts . . . carrots . . . Swede

elicitation appeared to be inappropriate. Appendix 1 shows the raw data from one narrative sample, with analyzed utterances in bold.

The sample was subjected to two analyses. The first identified the range of phrase structures used by EM, and counted the instances of each structure (Byng & Black, 1989). The results are presented in Table 4.

The table confirms the word class effect seen in the single word investigations. The majority (72%) of EM's utterances consisted of single noun phrases. Although 13 of these phrases consisted of single nouns the remainder revealed a degree of internal structure e.g., ''the loveliest woman in the land,'' ''the wicked witch.'' Only 26% of EM's utterances contained a verb. Even this may have been an overestimation, since five of EM's single verbs were ambiguous with respect to class (e.g., ''bite,'' ''cooking'').

Four of EM's verbs are accompanied by at least one argument. However, this is the only sign of any structure. There was only one utterance consisting of conjoined phrases without a verb, and this was not a combination of two arguments (''then Cinderella''). There are also no utterances created around substitute, empty verbs. In summary, EM's output is almost totally lacking in verbs and verb-related structure.

TABLE 4
The Number of Utterances in Each Category Produced in the Narrative Sample

Structure	Number of utterances
Single noun phrase	33
Single verb	8
Noun phrase + verb	2
Verb + Prepositional Phrase	1
Noun phrase + Verb + Prepositional Phrase	1
Nonargument Phrase + Noun Phrase	1
Total number of utterances	46

TABLE 5
The Quantitative Analysis of Narrative Speech Samples

Total number of words analyzed:	100
Morphological measures	
Closed class:total narrative words	0.32#
Nouns:pronouns	45.00
Proportion of nouns with determiner	0.62#
Proportion of verbs with inflections	0.5#
Aux score	1.6
Structural Measures	
Nouns:verbs	3.46#
Proportion of words in sentences	0.16#
Proportion of sentences that are well formed	0.33#
Frequency of embeddings	0#
Sentence elaboration index	1.0#

Note. # indicates measures within the range of agrammatic speakers (Saffran et al., 1989).

The second analysis explored morphological, as well as structural features (Schwartz et al., 1989). This is presented in Table 5. On most of the measures, EM performed very similarly to the agrammatic subjects investigated by Schwartz et al. Like them, she showed a reduction in closed class elements and little evidence of word order structure; for example a very small proportion of her words appeared in sentences. There were three exceptions to this pattern. One was in her use of pronouns, which occurred less frequently than in the agrammatic subjects. This may be because EM has few opportunities to use pronouns owing to her difficulties in constructing a coherent narrative. Another exception was her ''aux score.'' This records the ability to realize verb morphology in sentences. Conclusions here must be guarded as only three utterances qualified as sentences according to the criteria demanded by this analysis. However, the score suggests that when EM accesses a verb she is able to realize the morphology of the verb phrase. Finally, EM's production of noun determiners was in the upper range of the agrammatic subjects, most of whom scored below 0.5.

Conclusions from the analyses of connected speech. EM's speech was structurally impoverished, with typical signs of agrammatism. None of the anticipated structural features were found nor were there utterances in which a general verb, gesture, or neologistic utterance substituted for the unavailable verb phonology. Most of her output consisted of isolated noun phrases with no evidence that she was producing sentence frames without a verb.

EM could readily produce nouns in response to pictures and to definitions. Table 3 shows that she could also list nouns in conversation when responding to a specific question. Her ability to access nouns is not evident in her spontaneous speech, however. When required to produce structured output independently, her speech was strikingly impoverished.

These investigations revealed two problems in EM's output and called into question the nature of the relationship between them. She has particular difficulty accessing the phonologies of verbs and fails to capitalize on her relative strength for nouns when attempting to construct sentences. It is possible that these are independent impairments. Alternatively it may be that her difficulties with verbs underly her problems in sentence construction. Two experiments were conducted to investigate the relationship between EM's problems. In the first, the effects of providing nouns and verbs to cue her production were investigated. In the second, therapy was administered with the aim of improving her ability to access verb phonologies. In each case the effects on EM's subsequent sentence production were of interest. If cueing and therapy succeeded in improving access to verbs without affecting sentence production, we may conclude that they are separate deficits. If corresponding changes occurred in sentence production, we may conclude that access to a verbs phonology plays a central role in sentence construction.

Cued Production

In this task, EM was asked to generate spoken sentences from provided nouns and uninflected verbs. The stimuli consisted of the 64 frequency matched nouns and verbs used in the reading aloud task. They were presented in written form and EM read them aloud. Nouns and verbs were presented in a random order. The number of correct sentences generated from the cued words was counted. To be judged correct, sentences had to be syntactically well formed, in terms of both word order and grammatical morphology, and had to convey true or meaningful information.

EM produced correct sentences. With 11/32 of the noun cues, & 27/32 of the verb cues. This difference is significant ($\chi^2 = 14.57$, $p < .001$). Ten of her correct noun sentences used specific verbs (belt, cane, clean, sleep (2); bake, open, read, kick, and bark) and only one used a general verb (go).

Of her errors to noun cues, 8 used general verbs inappropriately, e.g.,

The woman is having the shoe.
The lady was flowers in the vase.

Ten were aborted at the point where the verb was demanded, e.g.,

In the autumn, the leaves . . . .

and 3 were attempts to create pseudo verbs from the provided noun,

The man is globing the world (cued with ''globe'').

Only five sentences were judged incorrect after verb cues. In two cases she failed to generate the appropriate arguments, or mapped them inappropriately round the verb,

TABLE 6
The Range of Structures Produced in Utterances Cued by Verbs

Structure	Number of utterances
NP + Verb e.g., ''The little boy is bleeding''	2
NP + Verb + NP e.g., ''The judge hanged the murderer''	19
NP + Verb + PP e.g., ''The man is sitting down''	1
NP + Verb + Modifying Phrase e.g., ''The girl was drowned in the pool''	2
NP + Verb + NP + Modifying Phrase e.g., ''The girl ripped the trousers in the tree''	3
Total number of correct utterances	27

pray . . . pray for . . . .
melting the snow . . . the snow is melting the sun.

The remaining errors involved omissions of morphology, e.g.,

The woman is listening the play on the wireless.

Although most of EM's correct sentences after verb cues were of SVO structure there was some structural variation (see Table 6). Verb cues also seemed to facilitate noun production. Excluding general terms, like ''man'' and ''woman,'' EM produced 36 novel nouns in the utterances cued by verbs but only 20 in response to noun cues. The latter contained only 10 specific verbs.

Conclusions from cued production. When cueing EM's output, the class of the cue was crucial. Verbs were significantly more successful at stimulating correct sentences than nouns. Indeed, when provided with a verb, 84% of EM's responses were syntactically and semantically correct. Providing the verb overcame many of her problems in generating sentences. This finding suggested that verb facilitation through therapy might be equally effective.

Therapeutic Verb Facilitation

The cueing task suggested that EM's structural problems owed much to her verb deficit. If therapy can improve verb access, associated gains in sentence production should also be observed. This hypothesis was tested in a therapy experiment.

Several experiments have shown that noun retrieval can be facilitated by semantic tasks (see Nickels & Best, 1996, for review), especially when those tasks also involve the processing of the spoken or written word form (Le

Dorze, Boulay, Gaudreau, & Brassard, 1994). Such tasks include word to picture matching, and answering semantic questions about target items. Positive effects have been observed from these treatments in cases where the anomia, as in EM's case, arose from a phonological access problem (e.g., Marshall et al., 1990).

The experiment treated 35 verbs drawn from five semantic categories: (i) nonaction verbs, which assign roles of stimulus and experiencer (e.g., ''bore'' and ''pity''); (ii) verbs expressing change of possession and communication (e.g., ''buy'' and ''learn''); (iii) locative verbs, which express the movement of an entity to or from a location (e.g., ''pack'' and ''peel''); (iv) verbs expressing change of state (e.g., ''melt'' and ''cook''), and (v) verbs expressing different manners of movement (e.g., ''spin'' and ''drive'').

Production of verbs was tested pre- and posttherapy via a picture description task, in which EM was presented with individual action pictures and asked to say what was happening. Her output was scored for two features, the production of the target verb and the production of a syntactically and semantically correct sentence with that verb. Thirty-five control verbs, drawn from the same semantic categories and matched in frequency to the treated verbs, were similarly tested. It was anticipated that, if effective, treatment should improve access to the verbs and stimulate sentence production with those verbs. Evidence of improved verb access *without* sentence gains would challenge the treatment hypothesis.

Two final evaluation tasks were administered. In one, EM was asked to produce abstract words in response to a sentence completion cue, e.g.,

Someone who lives on unemployment benefit is usually very . . . (poor).

In the other, the stimulus words had to be produced in response to a synonym cue, e.g.,

Can you think of another word for impoverished?

These tasks aimed to probe for improvements in speech production which extended beyond the specific aims of therapy. Evidence of such improvements would suggest that therapy has coincided with a period of spontaneous recovery, or that treatment had brought about general language benefits.

The therapy approach used with EM was similar to that in previously reported cases of therapy for anomia. Initially, treatment used only comprehension and reading tasks. For example, EM was required to match written target verbs to pictures or perform an odd one out judgment with written verbs. These tasks encouraged her to process the semantics of the targets, while the reading aloud component compelled her to access phonology. In the second phase, naming tasks were introduced, for example EM was required to access verbs from provided nouns, or generate a verb in response to a spoken scenario. None of the treatment tasks explicitly worked on sentence

TABLE 7
Pre- and Post-Verb and Sentence Production with the Treated and Control Items

	Treated items		Control items	
	Pre-	Post-	Pre-	Post-
Verb Production				
Semantic category				
Nonaction verbs	0/5	3/5	2/5	2/5
Change of possession/communication	7/10	8/10	6/10	8/10
Locatives	6/10	9/10	5/10	6/10
Change of State	3/5	5/5	2/5	3/5
Manner of Movement	3/5	5/5	2/5	3/5
Total	19/35	30/35	17/35	22/35
Sentence production				
Nonaction verbs	0/5	3/5	2/5	1/5
Change of possession/communication	4/10	7/10	3/10	8/10
Locatives	4/10	9/10	4/10	5/10
Change of State	3/5	4/5	0/5	3/5
Manner of Movement	2/5	3/5	0/5	2/5
Total	13/35	26/35	9/35	19/35

processing, although EM did generate some spontaneous sentences with the target verbs. A selection of the therapy tasks is summarized in Appendix 2. Twenty hours of verb therapy were administered over a 14-week period.

Results of the therapy. Table 7 shows EM's performance on the picture description task, with the treated and control verbs. EM's ability to access the treated verbs improved significantly (McNemar $\chi^2 = 9.09$, $p < .01$). A small but not significant change was found in the control verbs.

Sentence production showed corresponding gains. Before therapy, EM produced 22 correct sentences; after therapy, she produced 45. In the post-therapy assessment there were only 7 instances in which EM produced the verb, but not a sentence. The improvement in sentence production was highly significant with the treated group (McNemar $\chi^2 = 11.26$, $p < .001$) and just significant with the untreated group (McNemar $\chi^2 = 4.05$, $p < .05$).

Finally, EM's performance with the abstract word production tasks remained unchanged after therapy. With the sentence completion task her performance was static (20/36). With the synonyms there was a slight, but insignificant improvement (7/36 to 11/36).

Conclusions from therapeutic verb facilitation. The results of therapy showed that, as anticipated, EM's verb naming increased with a corresponding gain in her sentence production. There was one unexpected finding, in that EM's improvements in sentence production extended to the control verbs. Closer inspection of her scores suggests that her sentence production with this group might have been slightly depressed at baseline, given that she produced eight verbs which were not accompanied by sentence structure. Alternatively, the generalization may have been due to the selection criteria

which ensured that treated and control verbs were drawn from the same semantic categories. However, previous therapy studies for word finding have shown that untreated items rarely improve, even when they are semantically related to those treated (Marshall et al., 1990). A final explanation could be that therapy brought about a general improvement in language, with a resultant improvement in verb and sentence production. While it is always difficult to entirely rule out such explanations, this view is challenged by EM's time postonset and by her stable performance on the abstract word production tasks.

Although EM's improvement with the control verbs was puzzling, it did not severely challenge the therapy hypothesis. This stated that EM's structural problems stemmed from her verb deficit. Therefore, if verb production could be improved, sentence production should also benefit. The results of the therapy study supported this hypothesis, since the anticipated parallel gains were observed.

GENERAL DISCUSSION

EM's spoken naming showed a significant advantage for nouns over verbs. The assessments carried out found no word class effect in either semantics or in phonology. Her good performance on comprehension tasks at both the single word and the sentence level and her ability to write nouns and verbs equally well both suggest that no difference exists between nouns and verbs at the semantic level. Her oral reading of nouns and verbs was also virtually unimpaired. She does not read sublexically, since she is poor at reading nonwords and showed no effect of regularity in her reading of words. This means that she must read by accessing the stored phonological representations of words and suggests that no word class effect exists at this level. Consequently her problem in naming verbs must arise at the access to phonology from semantics.

EM's knowledge of verb meanings did not benefit her spoken output. It might have been expected that this knowledge would allow her to generate the verb argument structures necessary to complete the Functional Level of sentence production (Garrett, 1988). We might anticipate that her sentences would show evidence of such structure but lack appropriate verbs. Analysis of her connected speech was not consistent with this expectation, however. Her speech was typically agrammatic and dominated by single noun phrases. Function words and inflections were reduced and there was little verb argument structure. Critically, there were no utterances which showed evidence of structure without a lexicalized verb.

Two studies tested the theory that EM's difficulty constructing sentences was a direct result of her inability to access the phonological representations of the verbs required. In a cued production task, the provision of an appro-

priate verb was found to be more beneficial than the provision of a relevant noun and, following a therapy program, verb naming improved and a corresponding improvement was found in the structures of sentences containing the verbs. These findings converge on the somewhat unexpected conclusion that both the semantics and the phonology of a verb are required to construct sentences. The effects of adequate verb semantics and a failure to access phonology are not limited to the omission of the verb but severely handicap sentence production.

Before accepting this conclusion we should consider alternative explanations. Berndt et al. (1997a,b) reported on two subjects whose difficulties in accessing verbs and forming well-structured sentences appear similar to those shown by EM. However, the deficits in their subjects seem to be independent of one another. In a task similar to that used with EM, neither subject was able to produce significantly more structure when cued with a verb. It seemed that a difficulty in constructing sentences existed over and above their problems accessing the necessary verbs.

One of the subjects, ML, was also investigated in a therapy study (Mitchum & Berndt, 1994). The first stage of therapy aimed to improve access to a small corpus of verbs. As in the present investigation, it was anticipated that improving access to the verb phonology might also lead to an improvement in sentence production. After treatment ML was significantly better at producing the treated verbs in isolation, but was unable to use them to construct sentences thus providing further evidence of the independence of the two deficits.

The differing responses to therapy by ML and EM might be accounted for by differences in the therapy itself. ML's therapy was less extensive than EM's. He was treated for 4 h (20 for EM) and on only 8 verbs (35 for EM). Consequently one may wonder whether ML received too little therapy to improve his output of sentences or whether EM received so much that sentence structure benefited despite being functionally independent of the problem of accessing a verb's phonology. Neither possibility seems likely. ML's therapy was sufficiently extensive to improve his naming of the targeted verbs but failed to benefit the structures of sentences containing them. Equally, though EM's therapy was more sustained, it was confined to naming. No sentence level work was undertaken. Thus a treatment aimed purely at naming also resulted in gains at the sentence level. Moreover, EM's therapy results are consistent with her improvement in sentence production after being cued with verbs.

A second difference was in the content of the therapies. EM's therapy involved mainly semantic tasks, whereas ML's was mainly naming practice. However, the semantic content of EM's treatment did not focus on sentence semantics. The tasks invited her to think about the core meanings of verbs, rather than their argument properties and no mapping or event analysis tasks

were undertaken (cf., Jones, 1986; Byng, 1988; Marshall et al., 1993). It seems unlikely, therefore, that this semantic content could account for the sentence level gains.

That EM's verb production benefited from semantic treatment might suggest that she had a deficit at the semantic level after all. However, this conclusion has difficulty accounting for her excellent pretherapy verb comprehension, her ability to write verbs, and her response to being cued with a verb. Furthermore, naming studies for people with an anomia due to impaired ability to access phonology have shown that they profit from semantic approaches to therapy (e.g., Howard et al., 1985; Marshall et al., 1990; see Nickels & Best, 1996, for a review). It seems that positive outcomes after semantic treatment are not, in themselves, diagnostic of a semantic impairment.

A final possibility is that EM's output reflects a strategic response to her deficit. Since her sentence judgments and comprehension were good, we may assume that she is aware of the semantic and syntactic failings in her output. This ability to monitor her own speech may inhibit her output. In particular, she may be unwilling to produce sentence elements without a lexicalized verb. Again it is difficult to refute this possibility entirely. Equally it does not seem very plausible. It assumes that EM is sacrificing potentially useful output rather than commit grammatical errors and is at odds with other indications that she values communication above accuracy.

None of these explanations offers a very convincing account of the contrasting deficits shown by EM and ML. EM's problems are most economically accounted for by concluding that the phonological representation of a verb includes structural information which is crucial to the construction of its syntactic frame. This information is necessary but not sufficient for sentence construction. EM demonstrates that sentence construction is greatly facilitated when it is available; ML demonstrates that this is not always the case. The information itself may take the form of prosodically specified verb phrases, which mark the major and minor elements contained within those phrases. For example, the phonological representation of ''pour'' may include information that it can be followed by two prosodic phrases, the second of which contains a weak form (or preposition). The absence of this phonological information may seriously handicap attempts to realize the predicate argument structure. Thus EM may know that ''pour'' optionally takes two arguments with the roles of theme and goal, but without the prosodic verb information she cannot construct the surface phrases to contain those arguments.

The proposal is consistent with studies of early language acquisition. Many commentators suggest that prosody is used as a bootstrapping mechanism in the acquisition of syntax. This view is encouraged by evidence showing that important syntactic features, such as word class information, clause

and phrase boundaries tend to be marked prosodically (Morgan & Demuth, 1996). Applying this to the subcategorization frames of verbs, it seems possible that when acquiring a verb's phonological representation, children might encode information about the prosodic structures in which that verb appears. Accordingly, if access to that representation is compromised by neurological damage, this crucial prosodic/structural information is lost.

In some ways, this proposal is also consistent with Garrett's model of sentence production. Within this model, two levels of representation are formed. The first, the functional level, specifies the semantic relationship between the verb and its arguments. This level contains no information about the surface realization of that structure. This is achieved at the next, positional, level. Here the phonological representations of the content words are retrieved and a planning frame is composed. The latter lays out the word order of the sentence and contains minor items such as verb morphology. We have argued that the verb's phonological representation may contain information vital for the creation of that frame or, at least, for the elements of the frame which are within the verb phrase. Applying this model to EM, it seems that the functional level, which depends upon semantic verb information, is largely intact. In contrast, the positional level, which depends upon the verb's phonological and prosodic information, is not.

This account is supported by data from a further subject. PB (Marshall et al., 1997) showed symptoms typical of a mapping impairment. His verb comprehension was poor and fell to chance when he was tested with reverse role verbs, such as ''buy'' and ''sell.'' It seemed that he was unable to access verbs' semantic representations and, in particular, their argument and thematic properties. His output was also very impaired, with verb omissions, semantic errors with verbs, and word order errors. Despite these problems, PB showed a particular strength. On those occasions when a verb was accessed, it was likely to occur within an appropriate syntactic structure. Thus, in 374 verb phrases, only 27 (7%) contained syntactic errors. This syntactic integrity was surprising, given PB's obvious lack of semantic verb information. One explanation, considered by the authors, was that PB may have been exploiting prosodic information which was contained in the phonological representation of the verb.

Several previous studies have stressed the role of verbs in sentence generation (e.g., Schwartz et al., 1980). In so doing, most have emphasized the importance of semantic verb information. This study suggests that a verb's phonological representation may be equally crucial. The availability of that representation allows PB to generate appropriate syntactic structures despite the fact that his speech contains frequent semantic anomalies. In contrast, EM has little difficulty with the semantics of verbs, but her inability to access phonological representations seriously hampers her attempts to build structure.

APPENDIX 1

Narrative sample: Snow White

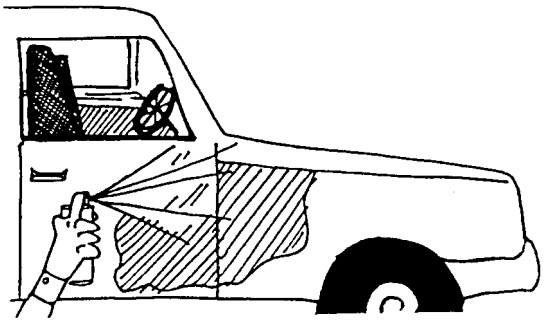
Therapist:	What happens in the beginning?
EM:	**king and queen** and its er I don't know I don't know (2 secs) oh dear it um oh dear um (5 secs) /ləda/ **woods** woods
Therapist:	We missed a bit there. There's something about a mirror isn't there?
EM:	oh yes yes yes **the queen is** um I don't know (2 secs) think its (2 secs) I don't know **this** /dʒreɪm/ **rhyme**
Therapist:	Yes good there's a rhyme
EM:	um /kə kə/ **queen and king** and its **magic mirror** and um oh I don't know um (3 secs) um the/wɪmɪ/ no **mirror on the wall** um I don't know
Therapist:	yes that's ok
EM:	and um er /weɪ/ um /kæm/ oh I don't know I don't know um oh (2 secs) oh dear **the way** um **woods** and its um **eight** /drəʊ/ **dwarfs** and er it um **cleaning and cooking** and um I don't know um **prince** I don't know um **the** er **marriage** er **the loveliest woman in the land.**
Therapist:	Well done that's good. So he wants to marry the prettiest woman in the land. What happens next?
EM:	I don't know um (5 secs) **the queen is um um changed as the wicked witch.**
Therapist:	Right
EM:	yes er **fruit**
Therapist:	yes you're right. Go on.
EM:	and er **knock on the door** and um /ækɪ/ um **apples** and um its um **beautiful apples** and um its um **bite**
Therapist:	So yes she's bitten the apple and what happens next?
EM:	**sleeps**
Therapist:	I think the prince comes along and he kisses her
EM:	I don't know I don't know its um **Sleeping Beauty.**

APPENDIX 2

Examples of the Tasks Used during the Verb Facilitation Therapy

Task 1

Word to picture matching, e.g.,



spread

polish

strip

spray

post

This required EM to label a target verb from five written options. The options included two semantic distractors (polish and strip), a phonological/semantic distractor (spread), and a gross distractor (post). The target had to be read aloud.

Task 2

Odd one out

In this task, EM was presented with three written verbs. She had to read these aloud and choose the odd one out, e.g.,

spray spatter flow

Task 3

Producing verbs from a spoken scenario.

A situation was described to EM for which she had to generate a verb, e.g., ''If you were a very keen gardener and your roses were covered in greenfly, what would you do?'' (spray)

If EM could not generate a verb, she was provided with written options to chose from. These were the same as those used in Task 1.

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