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Two Routes to Repetition: Evidence from a Case of 'Deep Dysphasia'

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Abstract

The immediate repetition performance of a jargon aphasia case was studied over a period of 2 years. The patient, MEG, performed poorly when repeating single words, and made semantic errors in the attempt. This pattern has been called 'deep dysphasia'. The effects of her speech production problems on the reproduction of both single words and phrases were studied. Her ability to repeat phrases was far better than could be expected from her single word repetition. This, together with her semantic errors, suggests that she uses for repetition tasks, a process that engages syntactic and semantic processes that is independent of a non-semantic route from auditory input to articulatory output.

Introduction

Deep dysphasia is characterized by semantic errors when repeating heard speech. This case supports the classical Wernicke-Lichtheim claim for two routes to repetition: a phonological route and a semantic route. Since this is the first reported jargon aphasic with this condition, it allowed us to explore the contribution of speech production deficits to the characteristic impairments of performance. It is found that repetition is better when words are part of the patient's productive vocabulary and when they are embedded in meaningful sentences, demonstrating that the preserved route involves lexical, syntactic and semantic processing.

It is relatively uncommon to find a patient who is unable to repeat immediately a single word, despite adequate auditory perception and articulation. The first report of such a case was made by Goldstein (1906; in Goldstein, 1948, the patient is referred to as case 7). McCarthy and Warrington (1984) have shown that very poor reproduction of single words can be a highly specific deficit in patients where comprehension was relatively well preserved. Like Wernicke (1874) and Lichtheim (1885), McCarthy and Warrington (1984) attribute the poor verbatim repetition to damage to the processing route from verbal input to phonological output that does not engage semantics. This syndrome, called 'conduction aphasia' is to be contrasted with transcortical motor aphasia, where naming and propositional speech are gravely impaired, but where word production in a repetition task can be virtually intact.

Goldstein's patient, PS, made semantic errors when trying to repeat single words (Goldstein, 1906). Several subsequently reported patients have made semantic errors (Goldblum, 1979, 1980; Michel and Andreewsky, 1983; Metz-Lutz and Dahl, 1984; Duhamel and Poncet, 1986; Howard and Franklin, 1988, 1990; Katz and Goodglass, 1990). This condition was termed 'deep dysphasia' by Michel and Andreewsky (1983) on analogy with 'deep dyslexia', where readers made semantic errors reading aloud single words (Marshall and Newcombe, 1973).

Howard and Franklin (1988) reviewed previous reports and noted that although all deep dysphasic patients are aphasic, the type of language impairment varies considerably. For example, Duhamel and Poncet's (1986) patient was reported to have 'relatively preserved' comprehension, while Goldblum's (1979) patient, BF, had 'poor' comprehension. The speech production in these patients can also vary considerably: from good (Metz-Lutz and Dahl, 1984) to fluent but replete with phonemic paraphasias (Michel and Andreewsky, 1983). Their own patient, MK, described in great detail by Howard and Franklin (1988, 1990), could be clinically classified as Wernicke's aphasic, with impaired comprehension but fluent speech.

As is well-known, Wernicke (1874) proposed that deficits of repetition could be accompanied by relatively well-preserved speech comprehension and production. The underlying idea was that in 'conduction aphasia' verbatim repetition could not utilize a system that went

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directly from an auditory–verbal input to articulatory output without involving the conceptual system. McCarthy and Warrington (1984) similarly argue that errors in the immediate repetition of single words implicate a failure in a direct route. Since their conduction aphasic patients were better when the words were embedded in sentences, they argued that there must be two routes from input speech to speech output: one direct and one via semantics. Howard and Franklin (1988) note that there must be both lexical and non-lexical mapping from auditory input to phonological output, and that in these patients, there are deficits to both routes, since it is clearly possible, at least in principle, to repeat a word accurately as a meaningless string of phonemes. MK, like the other patients producing semantic errors, failed to repeat non-words.

Previous reports have focused on input processing of speech and on the characteristics of the stimuli to be reproduced. However, it is important to remember that failures to repeat a word may be due to problems in speech production. Thus, comparisons between non-words and words has been normally between experimenter-defined vocabulary items, taken from a list of real words, versus experimenter-constructed phoneme strings. Patients with an aphasia may have lost vocabulary, so that for them items from the real word list may be treated as non-words. There is the additional problem that experimenter constructed non-words may differ in some crucial but unanticipated way from real words. Of course, discovering which words a speaker knows is difficult. Any corpus of speech is a sample in which a particular item may happen not to occur. Accessible vocabulary items may change over time, and in recovery, their number may increase. Nevertheless, it is important to try to identify words which the speaker is able to use in speech.

Since speech consists not just in the production of single words, but normally of words in grammatical construction, deficient and preserved aspects of speech production cannot all be determined from single word tasks. It has long been known that words in sentential context, rather than presented in isolation, are easier to identify, even for normal subjects (Miller *et al.*, 1951). This may assist in repetition tasks where a non-semantic phonological route is partly affected. Words in phrases and sentences have rarely been tested in deep dysphasics. In their one reported test of sentence repetition with their patient MK, Howard and Franklin (1990) found that he was able to repeat accurately two four-word sentences out of 18 (*I combed my hair, What are they doing*?) despite very poor performance when function words were presented singly (~10% correct; Howard and Franklin, 1988, p. 83). On the other hand, the patient, SM, described by Katz and Goodglass (1990), showed very poor performance with both single words and three-word sentences.

Sentential context may assist repetition in two ways: by providing syntactic structure to support lexical identification and by encouraging semantic interpretation. Miller and Isard (1963) found that repetition was helped by both syntactic structure and meaningfulness. Repetition in conduction aphasics is aided when a syntactic and semantic interpretation of the input is carried out. For example, conduction aphasics (RAN and ORF) repeated a single word less accurately when it was presented in isolation than when it was the last word of a three-word sentence whose sensibleness they were asked to judge (McCarthy and Warrington, 1984). These patients were also better at repeating sentences than clichés of the same length. They argued that words in a novel sentence need semantic and syntactic integration, while idioms are treated like single, polysyllabic words, a claim that is in line with data on the processing of idiomatic expressions in normal subjects (Swinney and Cutler, 1979; Cutler, 1983).

In this study we report a severe jargon aphasic patient, MEG, who made semantic errors in repeating single words. We focus on her speech production difficulties and their consequences for her immediate repetition of single words and of words in construction. If the patient's attempts at repetition are restricted to use of the semantic route, her performance on materials that require the full engagement of this route, such as novel phrases, should be better than single words or idioms. This is a striking prediction, since intuitively it should be easier to repeat a single word when presented alone than as part of a phrase to be repeated. Repetition of syntactically coherent phrases was explored systematically as as whether repetition performance in such patients is affected by syntactic and semantic processing.

In order to assess whether there was real lexical involvement in MEG's repetition, her active speech vocabulary was sampled over a 2-year period. This enabled us to assess more effectively than before whether single word repetition is better when the word is in the speaker's actual current vocabulary. Previously, the contents of the vocabulary have been estimated on the basis of word frequency: it is simply assumed on the basis of group data that for any patient, the vocabulary will comprise higher frequency words. Following standard accounts of normal speech production (e.g. Butterworth, 1980; Levelt, 1989), it is assumed that phonological lexical representations of these words are accessed from semantics in ordinary speech, naming, and also in repetition via the semantic route.

Case description

MEG (d.o.b. 25.8.26), a 59-year-old secretary, was first admitted to the National Hospital on 25.1.85 for investigation of focal seizures and a severe language impairment. She was re-admitted on 16.6.86 and again on 22.4.87 for a re-appraisal of her medication and further investigations of her language impairments.

During this 2-year period her neurological status, apart from some improvement in her language functions,

remained fairly static. On examination in 1986 there was a mild right-sided sensory loss and a minor degree of right-sided inattention. There was a complete homonymous hemianopia. These neurological signs were essentially unchanged in 1987.

CT scans showed extensive left posterior temporo-parietal low attenuation with a mature left-middle cerebral infarction. In addition there was an area of low attenuation in the medial aspect of the left occipital lobe consistent with infarction in the territory of the posterior cerebral artery (see Fig. 1).

MEG was first assessed on the performance scale of the WAIS on 1.3.85 when she obtained a performance IQ of 78. At this time she was unable to score on any of the verbal tests of the WAIS. She was unable to cope with the task demands of any formal tests of language function. At this time, several recordings were made of her spontaneous speech, which contained neologistic jargon and stretches of phonemic jargon.

MEG was assessed on a shortened form of the Wechsler Adult Intelligence Scale (WAIS) in 1986 and again in 1987. Her pro-rated verbal and performance IQs together with the individual age-scaled subtest scores are given in Table 1. She was re-assessed on Raven's coloured matrices in 1986 and 1987 and she obtained scores of 28/36 and 21/36 respectively. She was unable to cope with the task demands of verbal memory tests. Her recognition memory for faces was tested in 1986 and 1987 when she obtained low average (39/50) and borderline (31/50) scores.

MEG's spontaneous speech had improved by 1986 to the extent that neologisms were infrequent. Her language output was still gravely impaired – it was empty of content and word-finding difficulties were very obvious. It was possible to administer formal tests of language function during her 1986 and 1987 admissions where her comprehension at the single word level was impaired. On the Peabody Picture Vocabulary test she obtained a score of 78 correct in 1986 and in 1987 her score had only improved to 93 correct. On a word–picture matching test that probes knowledge of verb meaning she scored a creditable 17/20 correct (McCarthy and Warrington, 1985). At sentence level her performance was also impaired. On the Lesser test of syntax comprehension she scored 59/80 correct in 1986 and 60/80 in 1987. On the test for the reception of grammar (TROG) test of sentence comprehension (Bishop, 1982) she scored 52/80 correct in 1986, producing errors with both the lexical and the syntactic distractors. In summary, a fairly global and stable deficit of comprehension was documented.

Her naming skills were severely compromised and there was very little change between 1986 and 1987. On the Oldfield naming test she scored 1/30 on both admissions.

In 1986 she attempted half of the items from a simple naming test that consisted of 10 high frequency items from each of five categories. She scored 1/25 correct. In 1987 the full set of 50 items was presented; she scored 6/50 correct. Her errors consisted mostly of circumlocutions or general terms. Typical responses are as follows: ice-cream – 'food', lemon – 'food', sprouts – 'food', buns – 'food, sweet things', jam – 'quite nice'. She produced no phonemic paraphasias.

Her ability to produce common verbs as names of actions in a formal test seemed better than her ability to produce nouns, managing 10 out of 30.

Spontaneous conversational speech was in general well-articulated in 1986, but some parts consisted of mumblings that were untranscribable; neologisms and verbal and phonemic paraphasias, and paragrammatisms were still present. By 1987, articulation was good, neologisms had disappeared, although phonemic paraphasias were produced.

Table 1. WAIS IQ qnd age-scaled subtest scores

	1986	1987
Verbal IQ	57	63
Performance IQ	95	89
Arithmetic	0	4
Similarities	6	6
Digit span	0	0
Vocabulary	5	7
Picture completion	9	9
Block design	11	10
Picture arrangement	5	3

Experimental investigation

Speech

MEG was tested at three periods about a year apart. Vocabulary was assessed from 11 spontaneous conversations with the authors and also Dr R. McCarthy and Ms Chris Brown. A total of some 5800 words were classified by grammatical category (following Quirk *et al.*, 1972). The statistical distribution of grammatical categories used by MEG were compared with norms of Francis and Kucera (1982) for texts and Wepman and Jones (1966) for spoken discourse. The frequency of words spoken was calculated from the Kucera and Francis (1967) corpus.

Analysis conventions

1. Grammatical categories followed Quirk *et al.* (1972) – Noun, Verb, Adjective, ADVerb (Open, ADV.O, – such as 'happily', and Closed, ADV.C, – 'only', 'not'), Preposition, PROnoun (including pro-forms such as 'one', 'anyone'), AUXiliary verbs, DETerminers (including demonstratives), CONJunctions and OTHER.
2. Type counts treated inflected forms with their citation form, including some irregular forms with special functions. Thus 'would' was treated as a token of

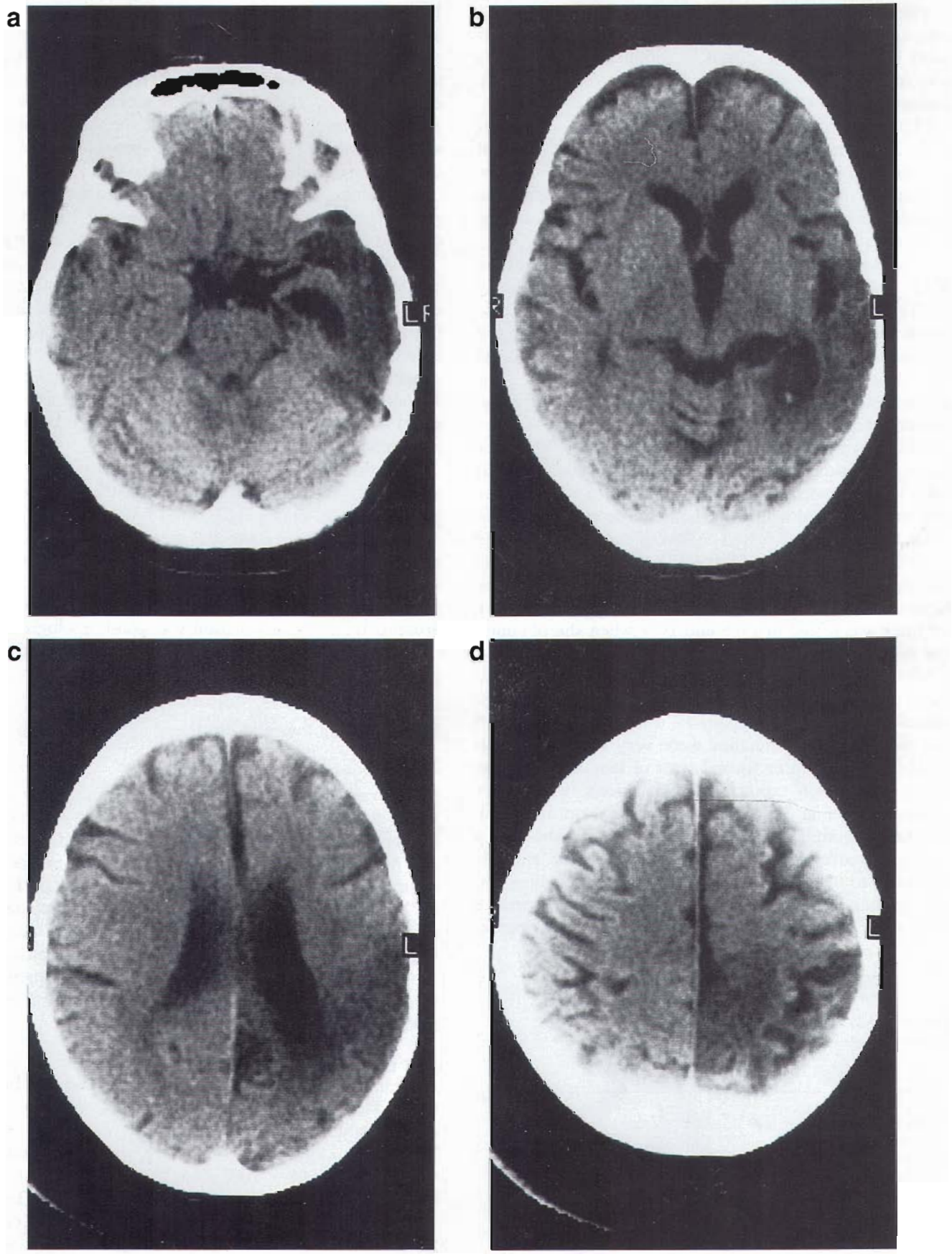

Fig. 1. See text for explanation.

'should', 'will' as a token of 'shall' (but 'could' was not treated as a token of 'can', nor 'might' as 'may').
3. Category was determined by syntactic function. Thus parts of the verb *be* could be either in AUX or in V; *as* could be either CONJ or ADV,
4. Numeral words and quantifiers ('few', 'many') in Adjectival positions were classified as DET.
The data are presented in Table 2.

Although the changes in type/token ratio suggest that active vocabulary has improved slightly by 1987, if sample size is taken into account as recommended by Miller and Chomsky (1963), no real improvement in vocabulary has occurred.

However, the actual vocabulary does seem to have changed. Of the 254 types used in 1987, only 190 are common to the previous vocabularies, while 64 are new, of which half are nouns and adjectives. Similarly, there were some 90 words that were previously used but do not appear in the 1987 vocabulary.

To assess selective deficits of grammatical category, the distribution of MEG's category use was compared with two estimates of normal category use. MEG's words have been reclassified to fit with those used by Francis and Kucera in Table 3 and Wepman and Jones in Table 4.

Comparison with normal corpora 1: Kucera and Francis

For this comparison, AUX has been included with V, the two kinds of ADV have been combined, PRO includes possessives (which were in DET for Table 1) but excludes relative pronouns. Other here is all the remaining items.

Inspection shows that MEG uses far fewer nouns than expected from the Francis and Kucera corpus. From the normal corpus some 27% of all words were nouns, while only 5% of for MEG's words were nouns in 1985, with 10 and 8% on subsequent samples. Correspondingly, she produced far more pronouns – 21–27% of all words – and far more than would be expected from the corpus. She also uses far more verbs than expected. Since, roughly, there is one verb per clause, MEG seems to be using very short clauses. (χ^2 comparisons of the expected with percentages for each year with the Francis and Kucera population, shows differences significant at $P < 0.001$, df = 5. 1985: $\chi^2 = 27.605$; 1986: $\chi^2 = 21.626$; 1987 $\chi^2 = 31.779$. Note that more extreme χ^2 values are obtained by using numbers of words rather than percentages for both the population and MEG's speech.)

Comparison with normal corpora 2: Wepman and Jones

Wepman and Jones's (1966) smaller sample of spoken language yields a much lower expected proportion of nouns, 13%, and a higher proportion of pronouns, 19%, than Francis and Kucera. This makes MEG's grammatical performance look more normal, but not completely so (see Table 4).

For this comparison, AUX is treated separately from V, and the two ADV categories have been combined.

Inspection shows that nouns were less frequent than normal, while pro-forms were more frequent than normal, despite a much higher proportion of pronouns in spoken than in written English. Again, verbs were much more frequent than expected, supporting the proposal that clauses were abnormally short.

Neologistic output

In the 1985 samples, MEG's neologistic production was very extensive. Stretches of neologizing could last several seconds with no clear division into word-like units. This is in contrast with the case reported by Butterworth (1979) or the Italian patient described by Panzeri *et al.* (1987), where neologisms appeared to occur in place of single

Table 2. Vocabulary from 1985 to 1987

	1985 Types	Tokens	1986 Types	Tokens	1987 Types	Tokens
N	44	92	41	249	40	118
V	52	334	55	446	48	294
A	26	48	44	155	35	81
ADV.C	33	201	35	228	34	157
ADV.O	9	15	4	6	8	14
PRO	32	408	37	585	34	381
P	23	210	14	173	10	81
AUX	11	122	11	123	8	111
CONJ	15	143	13	217	12	56
DET	27	229	22	223	20	120
Other	8	60	5	50	5	41
Totals	280	1862	281	2455	254	1454
Type/token ratios	0.15		0.11		0.17	

See text for analysis conventions.

Table 3. Grammatical categories in MEG's speech at three sample dates, compared with the Francis/Kucera Corpus of written English

CAT.	Francis /Kucera	1985 MEG	Per cent	1986 MEG	Per cent	1987 MEG	Per cent
N	26.8	92	4.9	249	10.0	118	8.1
V	18.2	456	24.4	589	23.7	405	27.9
A	7.1	48	2.6	155	6.2	81	5.6
ADV	5.2	216	11.6	234	9.4	171	11.8
PRO	6.6	407	21.9	616	24.8	386	26.5
Other	36.1	643	34.6	642	25.8	293	20.2
Totals		1862		2485		1454	

Table 4. Grammatical categories in MEG's speech at three sample dates, compared with the Wepman/Jones Corpus of spoken English

CAT.	Per cent	1985 MEG	Per cent	1986 MEG	Per cent	1987 MEG	Per cent
N	13	92	4.9	249	10.0	118	8.1
V	12	334	17.9	466	18.8	294	20.2
A	5	48	2.6	155	6.2	81	5.6
ADV	7	216	11.6	234	9.4	171	11.8
PRO	19	408	21.9	585	23.5	381	26.2
P	12	210	11.3	173	7.0	81	5.6
AUX	13	122	6.6	123	4.9	111	7.6
Other	19	432	23.2	500	20.1	217	14.9
Totals		1862		2485		1454	

(The percentages have been estimated from Fig. 20 in Wepman and Jones, 1966.)

words. In both of these speakers, but especially in the speech of the Italian patient, word boundaries were frequently marked by appropriate morphology. This was rarely true of MEG's output at that time, when neologizing was often characterized by mumbling and reduced volume, which made transcription of limited value. However, where articulation was clearer, it was possible to identify the pattern of neologizing, but the 'word' boundaries were nevertheless indeterminate. The following transcript is from the second 1985 sample.

(Typographical conventions: ə is schwa, ? is glottal stop, ʃ as in *shoe*, ʒ as in beige, ʌ as in *up*, θ as in *the*)

EKW Did you miss your coffee after lunch?

MEG /ə/ yes something /hæptə:n/. That's right they did go and sort of /əm/.

EKW What happened?

MEG /ˈda:kitʃaɪzd - 'kukɪn 'futu:n/

EKW Yes

MEG Then a /ˈmæksæn/ kicked off and a /ˈmaəm/ camed out and somebody came and it, some /ˈsonof/. So that stayed and /ə/.

EKW Yes

MEG /ˈwaɪˈzaɪ 'dɪsaɪd/ I /splent/ than I stunted something /ˈokənraɪt/ and /ə/, off I go on the /hɪks/ and oh the /θərʌn/. There's nothing for it in at all.

.

.

BB Do they both live at home?

MEG /ə:/ Yes, there's nowhere for /ə/ - my

/ˈʌndɪ stʌtiˈmʌltʃɪmeə maɪəm 'foti:wəzədəzfo?/

My /ʌndɪst- ˈʌndɪstˈbaɪtəndi:nə/ and three /ˈbɪktənəˈdʒəuəz/ are working with the /ˈpæmədʒin/....

Roughly, about half the total speech time consisted of neologistic production.

By 1986, the neologising had largely vanished, as can be seen from the next sample. However, portions were still untranscribable quiet mumblings.

EKW What was your own job?

MEG Mine. Yes. I've got a bit /enbɪt/ don't I?

EKW Let's go back in time. Where did you go to school?

MEG Oh my word, that's a long way. It was in a very place.

EKW Where did you live when you were a schoolgirl?

MEG I can't say that, love. I can't say that. (Untranscribable). No, no, a long way away. (Untranscribable). In the - my father - waked with another house with a doct- no, he was working with other folk - /fo - k- fəuwəwə:dz/ but for where, this is very /'ɪθɪn/.

The neologisms in this sample frequently seem phonologically related to other words in the immediate context, and may be the result of the perseveration or anticipation phonological material from real words. This mechanism has been attested in other jargon patients (Butterworth, 1979; Panzeri *et al.*, 1991) as well as in normal speech errors (Fromkin, 1971 etc.).

By 1987, neologisms had completely disappeared, but phonemic paraphasias were occasionally noted.

MEG Oh yes. that's funny. Different job people want to do, and you have - you can sit and somebody else will do it. Pretty. Won't it be. Nice. Beautiful. It's a /jobd/. I can't do it.

Speech summary

MEG's speech has resolved from dense neologistic jargon to fluent speech with a very small vocabulary, and a rather reduced range of syntactic structures. As can be seen from the samples above, even where the speech is free of neologisms, it is often without proper syntactic organization.

The vocabulary she uses in her speech seems to have changed from 1985 to 1987. Twenty-four per cent of 1987 word types were not found in the previous years, while 36% of the word types found in the 1986 corpus were not found in the 1987 corpus. Although the vocabulary has changed, it does not seem to have become larger. When adjustment for sample size is taken into account, there is no improvement in type/token ratio. To some extent this lack of improvement in vocabulary is reflected in formal testing. Her performance on the Oldfield naming test, for example, was 1/30 in both 1986 and 1987.

The distribution of grammatical categories also appears to have changed. There is a slightly higher proportion of nouns, for example, in 1987; but there is also a higher proportion of pronouns (21–27%).

Counting both types and tokens for each part of speech, we observed that there was a significant impoverishment of nouns, and a corresponding preponderance of pronouns in nominal positions. Overall, the type/token ratios indicated a severely reduced vocabulary for all parts of speech. Verbs appeared marginally better preserved in both spontaneous speech and in picture naming. These observations are of course typical of a severe Wernicke's aphasia. The main point of interest of this analysis is that the jargon resolved while her active vocabulary did not change significantly.

Repetition

During the earliest interviews, we observed that MEG was often unable to repeat the last word she had spoken spontaneously. We were struck by this observation and the following series of tests of repetition of single words, and of phrases and sentences, were designed to identify the factors that facilitated or inhibited her accurate repetition. Her repetition was not testable in 1985.

Single word repetition

MEG's most common repetition failure was simply failing to respond. However, she did make several different types of error. Of most theoretical interest were her semantic repetition errors. Some examples are given in Table 5.

MEG also made phonological errors, substituting a similar-sounding word for the target, as in *fish* → *fuss, cold* → *coal, chair* → *their*. A few inflexional and derivational errors were noted for noun and verb targets – for example, *child* → *children, think* → *thinking*. More common were non-word errors which usually sounded like the target: e.g. *wall* → /wold/, *mother* → /mʌsk /, *present* → /krosənt/; but sometimes they did not, as in *sleep* → /renlət/, *sell* → /fʌnʃ/.

In Table 6, the proportion of errors of different types is presented for the 1986 tests. It can be seen that overall, <40% of single words are correctly repeated.

The effects of vocabulary

Single word repetition was tested several times during the 1986 and 1987 admissions. The following results combine the test materials for each period, classified by

(1) appearance in the vocabulary of the speech samples described above, thus each word could be in the *current*

Table 5. Examples of semantic errors in single word repetition

	Target	Response
Nouns	pot	bake
	cot	children
	pound	money
	number	two
	potatoes	meat
	clothespeg	washing
Verbs	steaming	hot
	sleep	tired
	sleeping	resting
	kissing	loving
Adjectives	good	bad
	hot	warm
	hot	cold
	young	boys
	young	people
	big	fat
	thin	fat

Table 6. Single word repetition error for each word class, in the 1986 sample (proportion correct in parentheses)

	Correct	Semantic errors	Phonological errors	Non-word responses	Other responses	Total
Nouns	35 (0.44)	10	15	17	3	80
Verbs	28 (0.40)	6	12	12	12	70
Adjectives	27 (0.34)	8	9	10	26	80
Totals	90 (0.39)	24	36	39	41	230

vocabulary or *not current* which included words from previous samples, as well as words not attested. The not attested words were generated by the experimentors, who attempted to make them similar to those in her vocabulary. It was sufficient for a single token of a word to be uttered, whether appropriate to the context or not, for it to be counted as in her vocabulary. Post hoc analysis allowed the following factors to be analysed for current vocabulary, previous vocabulary and not attested:

(2) length in syllables;

(3) frequency of occurrence in the Kucera and Francis list;

(4) grammatical category, here restricted to Noun, Verb, Adjective, Function Word.

Further analyses of the effects of vocabulary on repetition were carried out for the 1987 testing. The proportion of words correctly repeated by MEG is given in Table 7, arranged according to the major lexical categories. Overall the results from 500 words are presented, taken from several sessions on two sample periods, June 1986 and April 1987. The words are classified according to whether they occur in the speech samples collected around the time of the tests 'Current vocabulary' or not 'Not current'. This latter class includes words used during the previous sample periods.

It is clear from Table 7 that words in the current vocabulary are better repeated than those not in the current vocabulary, at both testing periods. It is also clear that overall repetition has improved for both classes of word.

Table 7. Proportion of single words correctly repeated according to whether the test stimulus is in MEG's current vocabulary (from 1986 and 1987 samples)

	Current vocabulary	Not current
1986		
Adjectives	0.41	0.14
Nouns	0.69	0.11
Verbs	0.38	0.28
Mean	0.51	0.17
1987		
Adjectives	0.80	0.63
Nouns	0.75	0.43
Verbs	0.69	0.59
Mean	0.73	0.55

In the 1987 test, it possible to compare words found in both 1986 and 1987 speech, which are presumably well-established in MEG's vocabulary, with words found in just one sample and those in no sample (Table 8).

It is clear that words from MEG's speech are better repeated than those not so attested (taking just nouns, verbs and adjectives, since all function words are common to both samples, One way analysis of variance: $F(2,243) = 22.15$, $P < 0.001$, MSe = 1193264). Nevertheless, her performance is by no means perfect even for words she has been producing for 2 years.

It might be thought that words to be found in her vocabulary are likely to be higher frequency than other words used in the tests. However, there is no significant difference in the mean word frequency of the words she repeats accurately and those she does not. The log10 word frequency (Kucera-Francis) for correctly repeated words was 2.114, while for incorrect it was 2.13 ($t = 0.15$, df = 197).

Nor is there an effect of word length, at least comparing one and two syllable words. One syllable words were repeated correctly 56% of the time, while two syllable words were correctly repeated 66% of the time ($t = 1.40$, df = 123).

The effects of grammatical category were overall not significant (One way analysis of variance: $F(3,272) = 2.04$, $P = 0.109$, MSe = 0.241). (Percentages correct: nouns 51%, verbs 62%, adjectives 67%, function words 47%.)

Verbs in naming and repetition

In 1986, MEG was given a series of 30 pictured actions to name. She was able to produce 10 verbs correctly, which,

Table 8. Repetition as a function of vocabulary in 1987

	Neither sample	One sample	Both 1986 and 1987	Total
Not repeated	74	10	31	115
Repeated	75	30	56	161
	149	40	87	276

Targets are classified as to whether they were found in both 1986 and 1987 speech samples, in one sample or in neither sample.

TABLE 9. Repeating idioms and phrases

Table 9A. Repeating idioms

Idioms	Content words	Words in idioms	Whole idioms
3-word e.g.:			
right as *rain*	14/16	2/24	0/8
4-word e.g.:			
so *far* so *good*	9/16	5/32	0/8
5-word e.g.:			
too *long* in the *tooth*	11/16	7/40	0/8
	34/48	14/96	0/24

Table 9B. Repeating phrases taken from MEG's own speech

Phrases	Content words	Words in phrases	Whole phrases
3-word e.g.:			
a *lovely house*	7/16	20/24	6/8
4-word e.g.:			
a *lot* of *work*	6/16	21/32	3/8
5-word e.g.:			
the *children* have had *boys*	9/16	24/40	2/8
	22/48	65/96	11/24

Two content words from each idiom or phrase were presented separately in a single word repetition task (content words) or as part of an idiom or phrase (words in construction).

though poor, compares well with her performance with nouns (1/30). When asked to repeat the set of 30 verbs, she managed only seven, with no advantage detectable for the verbs she was able to produce in the picture test. It may appear that verbs fail to show the vocabulary effects of other parts of speech, but it should be noted that with only seven items correct, this lack of advantage may be due to the small sample size. Note also that picture naming is a different criterion for vocabulary inclusion than attestation in free speech, where indeed verbs in current vocabulary are repeated better than those not in current vocabulary (see Table 7).

Phrase repetition

In the next study, MEG's performance on short phrases was compared with her performance on repeating the words in the phrase tested in isolation. Phrases were three, four or five words long.

Phrases of two types were employed: idioms such as 'so far so good' (taken from McCarthy and Warrington, 1984) and short sentences taken verbatim from MEG's own speech (1986 sample), such as 'a lot of work'. The testing took place in April 1987. There is evidence that the construction of a novel syntactic-semantic representation of the input, as would be induced by non-clichéd material, might induce deeper processing and hence, for patients unable to use a non-semantic route to repetition, significantly improved performance (McCarthy and Warrington, 1984). Thus if MEG lacks this route, then repeating her own phrases should be markedly better than repeating the words from these phrases, while for the idioms, single word presentation could be better since the idioms will be treated in manner akin to supra-span lists unsupported by an integrated syntactic semantic structure.

It can be seen from Table 9a, that although 71% of the single words are repeated accurately when presented separately, performance on the idioms was considerably worse, whether measured in terms of words correct or whole idioms correct.

In the next test, on the same day, MEG was presented with phrases she had spoken herself the previous year. The results are given in Table 9b. MEG was better at repeating phrases than idioms, in terms of both words in construction correct (67 versus 15%) and whole strings correct (46 versus 0%), in spite of the fact that when she was repeating the component words separately she was

Table 10. Repeating words in idioms and phrases compared with repeating the same words in isolation

	Words in isolation	Words in construction
Idioms	34	14
Phrases	22	65

worse (46 versus 71%). The main facts are summarized in Table 10 (χ^2 (1) = 26.4, $P < 0.001$).

Repetition of sentences

During her 1987 admission, MEG was tested on repeating sentences. Her speech during a morning session was transcribed, and 10 new sentences of four to seven words were constructed from the transcripts. These were presented for repetition the same afternoon. One of the sentences was not properly heard, and the data are taken from nine.

MEG managed to repeat correctly four of the nine sentences, and 40 of the 48 words. When the words were presented singly, she performed rather worse, repeating 34 of them correctly. This again suggests that she performs better when she is able to recode the material semantically and syntactically.

Repetition summary

MEG's single word repetition was very poor, improving from only 40% in 1986 to just 60% in 1987. She made a variety of errors including semantic errors. Her performance on phrases and sentences was under some conditions better than for single words, when tested in 1987. These data support the idea that MEG is using a route involving syntactic and semantic processing to carry out verbatim repetition tasks. Normal support from a phonological trace of the input does not seem available to her.

In general, repetition of words known to be in her spoken vocabulary, are repeated more accurately. Even so, a large proportion of these words are not repeated. Her repetition performance is affected neither by word frequency nor word length (one versus two syllables). Overall there was no significant effect of grammatical category.

Discussion

MEG was a jargon aphasic with very poor comprehension and florid neologistic speech when she was first tested in 1985. Over the following two years the jargon resolved into fluent speech with impoverished vocabulary. This is a characteristic pattern of recovery (Pick, 1931; Buckingham and Kertesz, 1976). However, the reduction of neologistic output did not seem to be consequent upon recovery of her vocabulary since her spoken vocabulary did not appear to improve, measured by type/token ratios. In particular, by 1987, her speech still showed far fewer nouns than would normally be expected. The reduction of neologisms without a corresponding improvement in vocabulary has been previously attested, and has been explained in terms of changing strategies to compensate for poor access to words (Panzeri *et al.*, 1987).

The grammatical structure of her utterances was harder to assess, since in 1985 and 1986, neologisms made structural analysis impossible. By 1987, her utterances still frequently lacked proper grammatical organization. The larger than expected proportion of verbs in her speech indicates that she was using abnormally short clause structure.

Her ability to repeat was untestable in 1985, but improved from 1986 to 1987. However, even in 1987, immediate repetition of single words was still ~60% overall. Like other reported patients with poor single word repetition, she made semantic errors, repeating 'clothespeg' as 'washing', 'sleeping' as 'resting' and 'thin' as 'fat'. This has been taken to indicate that a non-semantic process mapping auditory input onto articulatory output is impaired, and that the repetition task has to be achieved via (possibly impaired) semantic mediation. These two distinct routes for repetition have been proposed by Wernicke (1874) and Lichtheim (1885), McCarthy and Warrington (1984) and Howard and Franklin (1988), among others. Selective impairment of a non-semantic route leading to semantic errors has been termed 'deep dysphasia' by Michel and Andreewsky (1984).

The one factor significantly affecting single word repetition in MEG turned out to be whether the word was attested in her current spoken vocabulary or not. The usual predictors, such as length and frequency, did not determine performance. This finding demonstrates that access to the phonological form of words (phonological lexical representations) is part of the semantic repetition route. In ordinary speech production, semantics drives lexical access (Butterworth, 1980; Levelt, 1989). If semantic access to the lexicon forms part of the semantic repetition route, as seems plausible, then it is not surprising to find this lexicality effect. However, her small spontaneous vocabulary and her very low naming scores show that access to lexical phonology from semantics was impaired. Thus the presence of a word in her current vocabulary, although a significant aid to repetition, was not sufficient: even for these words, she only managed to repeat 73% accurately by 1987. This confirms the original clinical observation that she was often unable to repeat on request a word she had just uttered.

Despite her very poor scores on single word repetition, MEG performed relatively well when asked to repeat three-, four- and five-word novel phrases. Even though she was able to repeat fewer than half the words when they were presented singly, she managed better than two-thirds of the words when they appeared in a phrase. This supports the contention of McCarthy and Warrington (1984), among others, that there is an independent way of repeating input that engages the cognitive system, including grammatical processes. Strikingly, familiar idioms failed to produce the same advantage for words in construction. It cannot be that the words making up the

idioms are more difficult to remember, since repetition of these words, presented singly, is twice as good as the words composing the non-idiomatic phrases. McCarthy and Warrington (1984) suggested that idioms do not induce as deep semantic processing as ordinary phrases or sentences, because idioms are treated essentially as single (highly abstract) polysyllabic words (see Swinney and Cutler, 1979; Cutler, 1983; for comparable normal results).

In summary, we have documented a further kind of case in which single word repetition leads to semantic errors. Like the other cases, MEG suffers an aphasia, but unlike the previously reported cases, she began with florid jargon. Her recovery to a fluent, if paragrammatic, anomia, is very clearly demonstrated. Failure to repeat single words, and the presence of semantic errors indicates that she is unable to use a non-semantic route for repetition – the analogy of the Wernicke-Lichtheim route from 'auditory word images' to 'motor word images' classically disconnected in conduction aphasia (see Butterworth, 1993, for a discussion). Of particular theoretical interest, is the finding that MEG can repeat phrases far better than could be expected from her single word repetition – or indeed from her repetition of idioms. This, together with her semantic errors, suggests that she uses for repetition tasks, a process that engages syntactic and semantic processes that is independent of a non-semantic route from auditory input to articulatory output, confirming the dissociation observed in conduction aphasics by McCarthy and Warrington (1984).

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