Studies in the development and breakdown of the use of names

Part IV The effects of word frequency

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It has long been recognized that when a person's speech is impaired through an organic cerebral lesion (dysphasia) the loss is relative rather than absolute. Attempts to describe the pattern of impairment have been based on explanations relevant to the fluency of normal language behaviour.

Most of these explanations derive directly from evolutionary models of behaviour developed at a time when aphasia was receiving considerable attention from neurologists. Hughlings Jackson (1932) distinguished between automatic and voluntary utterances and between propositional and emotional speech. Other factors affecting the ease or difficulty of language tasks and noted by early writers were the age of acquisition of skills, practice, recency of rehearsal, and the symbolic content of a proposition (Ross, 1887; Freud, 1891; Bateman, 1890; Head, 1926). Clinicians have added little to these factors which are variously supported by Goldstein (1948), Eisenson (1954, 1959), Nielsen (1946), and Wepman (1951). Howes (1961), and Geschwind (1961), using experimental methods, support the view that frequently used words would be more easily aroused than rare ones, and Rochford and Williams (1962) in a study of dysphasic language suggested that, in an object naming task, item difficulty was correlated with word frequency. In the latter study it was also reported that when normal subjects are asked to name objects in conditions of auditory distraction and time pressure a general relationship is observed between the number of failures and word frequency, but this was less clear over the middle range of word frequencies. Oldfield and Wingfield (1965) have shown that the time taken by normal adults to name pictures of objects is linearly related to the logarithm of word frequency, and further studies by these authors (Newcombe, Oldfield, and Wingfield, 1964) have shown that the time taken to name objects by subjects with localized

cerebral lesions, including dysphasics, shows a similar relationship with word frequency.

The present paper attempts further to examine the effect of frequency on word finding in dysphasia and to elucidate the conditions under which it operates.

EXPERIMENT 1

NAMING OBJECTS Probably the most popular clinical test of dysphasia is simply to ask the subject to name a series of objects. The following investigation was an attempt to determine the effect of word frequency upon the dysphasic's ability to name objects, the hypothesis being that there is a correlation between item difficulty and word frequency.

Word frequency was assessed according to the Thorndike and Lorge (1944) word count which uses the following notation:—

AA indicates words occurring more than 100 times per million words. A indicates words occurring between 50 and 100 times per million. Other words are given a number indicating the number of occurrences per million words.

PROCEDURE Eighteen objects were drawn in simple outline on plain white cards. The names for these objects ranged from words occurring over 100 or between 50 and 100 times per million (symbolized as AA and A words) to words occurring only eight times per million. They were all objects which normal adults can name without difficulty, and the following with their word frequencies were used:—

Book (AA) heart (AA) castle (A) key (A) telephone (A) angel (47) candle (43) pencil (40) drum (40) kettle (27) anchor (26) piano (26) web (14) rake (13) skull (12) skeleton (11) dice (8) whale (8).

The cards were shuffled and presented in random order with the following instructions:—

'I have here some pictures of things. I just want you to tell me what they are called.'

Each card was presented for 10 seconds and a verbatim report of the subject's response was taken.

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SUBJECTS Thirty-three subjects were investigated. They were all patients referred by the neurological services of the United Oxford Hospitals as showing evidence of speech disorder in association with localized cerebral lesions. Their ages ranged from 20 to 70, with most of them falling between 40 and 65 years of age. There was one girl of 12. Twenty were men, 13 women. There was considerable variation in degree of language impairment, from some who could make only the simplest verbalizations to those with minimal disturbance in only one language modality. All showed some impairment on a short test covering all the different language functions (Rochford and Williams, 1964).

RESULTS Table I shows the number of failures to name recorded against each item for the 33 subjects. Analysis by Spearman's rank order correlation coefficient yields $r_s = 0.79$, $p < 0.01$. There is thus a significant correlation between word frequency and item difficulty.

TABLE I

RESULTS OF WORD FREQUENCY TESTS IN 33 DYSPHASICS

Frequency and Item	No. of Failures	Frequency and Item	No. of Failures
AA—book	10	27 kettle	12
AA—heart	11	26 anchor	21
A—castle	13	26 piano	13
A—key	8	14 web	16
A—telephone	13	13 rake	17
47—angel	18	12 skull	24
43—candle	13	11 skeleton	16
40—pencil	15	8 dice	20
40—drum	14	8 whale	23

 $r_s = 0.79$ $p < 0.01$

FURTHER EFFECTS OF WORD FREQUENCY In a further series of investigations word frequency was used to control the task items in the study of dysphasic language. Results reported here refer mainly to the value of word frequency as a controlled variable. However, an indication is given concerning other variables being studied such as verbal cues, semantic and visual context, which can add some refinement to the general law of word frequency. The procedure is the same as that outlined above unless indicated. Most of the tasks represented the same basic situation, namely, showing a picture and asking the subject to name the object drawn on it.

EXPERIMENT 2

NAMING BODY PARTS In experiment 1, the objects were presented entirely without context. In this experiment subjects were asked to name parts of the body, which were indicated on the experimenter's own body with the request, 'What do we call this?' Thus the full visual context was provided and, in addition, following Luria and Vinogradova (1959), a specific semantic field, *i.e.*, words for body parts, was alerted. Both factors should facilitate the searching for a word.

PROCEDURE Ten dysphasic subjects were each compared on two tasks, (1) naming objects and (2) naming body parts. The objects test (Rochford and Williams, 1964) and body parts test contained the following items:—

Book	AA	Ear	AA
Candle	43	Nose	AA
Drum	40	Palm	37
Anchor	26	Chin	27
Rake	13	Elbow	26
Dice	8	Wrist	17
Whale	8	Eyebrow	12
Scarecrow	1	Knuckles	5

The objects test was administered according to experiment 1 above. The body parts were indicated on the experimenter's own body, and the subject asked, 'What do we call this?'

RESULTS Table II shows the scores (failures out of eight) for each subject on the two tasks. There is a close relationship between each individual's scores on the two tasks. For all 10 subjects the two tasks have mean scores of 4.1 and 4.2 and median scores of 3.5 and 5.5 respectively. The mean difference between scores per individual is 1.5. Spearman's rank order correlation coefficient yields $r_s = 0.67$, $p < 0.05$.

TABLE II

NUMBER OF FAILURES IN NAMING OBJECTS AND NAMING BODY PARTS COMPARED IN 10 DYSPHASICS

Subject	Objects (8 items)	Body Parts (8 items)
a	8	6
b	8	8
c	7	8
d	6	5
e	4	0
f	3	5
g	2	6
h	2	2
i	1	1
j	0	1
Total	41	42

Mean difference for pairs of scores ignoring signs = 1.5
 $r_s = 0.69$ $p < 0.05$

Table III shows the relationship between the word frequency of the body parts and the number of

TABLE III

WORD FREQUENCY AND THE NAMING OF BODY PARTS IN 10 DYSPHASICS

Body Part	Word Frequency	No. of Failures
Ear	AA	2
Nose	AA	2
Palm	37	5
Chin	27	6
Elbow	26	6
Wrist	17	6
Eyebrow	12	9
Knuckles	5	6

Spearman's $r = 0.86$ $p < 0.01$ one-tailed

failures recorded against each item for the 10 subjects, yielding $r_s = 0.86$, $p < 0.01$.

It can be concluded that the visual and semantic context provided when naming body parts does not facilitate the word search and that this task offers further evidence for the correlation between word frequency and relative word finding difficulty reported above.

EXPERIMENT 3

EVOKING COMPOSITE WORDS Composite words which name objects can be distinguished by the comparative frequency of their syllables. Such words may be composed of two syllables which are each themselves words, *e.g.*, hedge-hog. Thus it is possible while controlling the frequency of the whole word, to compare words with different frequency distributions in their syllables. In this investigation three groups of objects with composite words were used:—(1) Words of which the first syllable was commoner than the second. (2) Words of which the syllables were of equal frequency. (3) Words of which the first syllable was rarer than the second. Between all groups the composite words themselves were of about equal frequency. The three groups used with their syllable and composite word frequencies were as follows:—

	Frequency	
	Syllables	Whole Word
1 <i>Common-rare</i>		
Wheel-barrow	AA—3	2
Sun-dial	AA—8	1
Penny-farthing	38—4	—1
Hedge-hog	32—14	3
2 <i>Common-common</i>		
Lighthouse	AA—AA	7
Penknife	A—A	1
Horseshoe	AA—AA	4
Bagpipe	AA—AA	4
Crossword	AA—AA	3
Bull-dog	36—AA	1
3 <i>Rare-common</i>		
Spinning-wheel	11—A	11
Padlock	17—A	1
Knapsack	—1—30	2

Predictions were that (1) the ability of dysphasics to name the object would differ between the three groups; and (2) the differences would reflect the word frequency distribution of the syllables as follows:—Words with two common syllables would be easiest to evoke, those with one common and one rare would be next easiest, and those with one rare and one common syllable would be hardest. These predictions, if fulfilled, would define one major category of word search in which the frequency of the whole word is too gross a measure of comparative difficulty. Since most composite words contain at least one very common word syllable, the effect of this as a cueing-in device can be estimated.

PROCEDURE The objects were each drawn on white card. All three groups of items were mixed together and shown

in random order as to syllable distributions. Subjects were 10 dysphasic patients.

RESULTS The proportion of errors made in each group by the 10 dysphasic subjects was as follows:—

Common-common0.63
Common-rare0.67
Rare-common0.93

The proportion of errors made by each patient in each group is shown in Table IV. There are significant differences between the three groups (Friedman $\chi^2 = 10$, $p < 0.01$) and in particular between common-common and rare-common ($p = 0.01$, one-tailed) and between common-rare and rare-common ($p = 0.025$, one-tailed), but not between common-common and common-rare groups ($p > 0.25$), (Wilcoxon signed ranks matched pairs).

TABLE IV

SUBJECTS' SCORES ON THREE GROUPS OF COMPOSITE WORDS IN 10 DYPHASICS
Proportion of Errors by Dysphasics

Subject	Common-Common (1)	Common-Rare (2)	Rare-Common (3)
a	0.83	1.0	1.0
b	0.83	0.75	1.0
c	0.16	0.25	1.0
d	0.83	0.75	1.0
e	0.00	0.25	0.8
f	1.0	1.0	1.0
g	0.16	0.50	0.8
h	1.0	1.0	1.0
i	1.0	1.0	1.0
j	0.5	0.25	0.6
Friedman $\chi^2 = 10$	$p > 0.001$, < 0.01		
Wilcoxon T = 0	$p = 0.025$	Column 2 $\times$ 3	
T = 0	$p = 0.01$	Column 1 $\times$ 3	
T = 8.5	$p > 0.25$	Column 1 $\times$ 2	

Considering the high proportion of failures in the rare-common group, 0.93, a comparison with the fourth possible group, rare-rare syllables, could only produce a significant result if results went contrary to the consistent trend under the conditions here reported. (Experiment 4 below shows further results consistent with this trend.) It can, therefore, be concluded that when the word frequency of composite words is held constant it is the frequency of the first syllable only which determines the ease with which the word is found by dysphasic subjects.

EXPERIMENT 4

NAMING ABBREVIATIONS Ten dysphasics were tested for their ability to give the full word for an abbreviation. Each abbreviation was printed on a plain card, and subjects were asked to give the word to which the abbre-

viation referred. Responses were recorded simply as success or failure.

Two groups of abbreviations were used: one group in which the abbreviated form of the words was rare and the full form common, and the other group in which both abbreviation and full word were comparatively rare. The actual items used with their frequencies were as follows:—

Group I		Rare-common	
min.	(1)	minute	(AA)
Prof	(2)	Professor	(A)
Oct.	(3)	October	(A)
Doz.	(3)	Dozen	(A)
Group II		Rare-rare	
Qt	(2)	Quart	(17)
gal	(5)	gallon	(12)
Rev	(2)	Reverend	(11)
cwt	(1)	hundredweight	(6)

RESULTS The number of failures recorded in each group by the 10 dysphasic subjects is shown in Table V. Group I items show a total of 18 errors and Group II items a total of 22 errors. Analysis of individual performances reveals no significant differences between the two tasks ($P = 0.344$).

TABLE V

NUMBER OF ERRORS MADE ON TWO GROUPS OF ABBREVIATIONS PER SUBJECT BY 10 DYSPHASICS

Rare Abbreviation (common full)	Rare Abbreviation (rare full)
4	4
1	3
3	3
1	1
0	0
4	3
1	3
0	1
3	2
1	2
18	22
$P = 0.34$	

It is possible that the proximity of the tasks is due to the overriding effects of the verbal cues provided by the abbreviations themselves which are approximately matched for word frequency. This result is comparable with the result obtained in experiment 3 in which no significant difference was found between composite words differing only in the frequency of their second syllables. In both Experiments, the raw data show a minimal trend consistent with the expected effects of word frequency reported in this paper, with the abbreviation acting as a semantic cue in rather the same manner as the first syllable of a composite word, the full word for the abbreviation providing only a minimal frequency effect. It is as if once the dysphasic gets

started on a word the frequency of the whole word has little effect upon the completion of the response, the initial word search being the crucial problem. (In motor dysphasia this might not hold.)

EXPERIMENT 5

WORD FREQUENCY AND WORD USAGE The Lorge-Thorndike semantic count (1938) enables us to distinguish between different meanings or uses of the same word. For example, the word 'bat' is more often used in reference to cricket bat than to the flying mouse. A group of items was presented to dysphasic subjects with the prediction that such words would be more easily evoked with their commoner references.

The following items were used:—

Word	Commoner Reference	Rarer Reference
Bat	Cricket	Animal
Teeth	Mouth	Comb
Bridge	Transport	Spectacles
Eye	Seeing	Needle

Each item was represented by a simple drawing on plain card and presented in random order to a group of nine dysphasics. The subjects were asked to name each item and responses were scored simply as successes or failures.

RESULTS Table VI shows the responses in each pair of uses per subject. It will be observed that there is a total number of nine failures for the commoner use and 22 for the rarer.

TABLE VI

ABILITY TO EVOKE THE (C) COMMONER AND (R) RARER USES OF WORDS BY NINE DYSPHASICS

Word	Dysphasic Subjects									Total Failures
	1	2	3	4	5	6	7	8	9	
Bat	C	✓	✓	x	x	x	✓	x	✓	4
	R	✓	✓	x	✓	✓	✓	x	✓	2
Teeth	C	✓	✓	✓	✓	✓	x	✓	✓	1
	R	✓	x	x	x	x	x	✓	x	7
Bridge	C	✓	✓	x	✓	✓	x	✓	x	3
	R	✓	x	x	x	x	x	x	✓	7
Eye	C	✓	✓	✓	✓	✓	x	✓	✓	1
	R	✓	x	x	✓	x	x	✓	x	6
Total	C	0	0	2	1	1	0	4	0	9
Failures	R	0	3	4	2	3	3	4	1	22

Looking at individual scores, all subjects performed better on the group of commoner items (Table VII). Analysis of the size and the direction of the differences between scores for individuals on the two groups of items show these results to be significant beyond the 0.01 level (Wilcoxon $T = 0$, $p < 0.01$, one-tailed). Frequency of context, therefore, has a significant effect upon the ability of dysphasics to employ different meanings of the same

TABLE VII

NUMBER OF FAILURES ON COMMONER-RARER USE OF WORDS BY NINE DYSPHASICS SCORED AS NUMBER OF ERRORS OUT OF FOUR

<i>Dysphasic Subjects</i>	<i>Commoner Use</i>	<i>Rarer Use</i>
a	0	0
b	0	3
c	2	4
d	1	2
e	1	3
f	0	3
g	4	4
h	0	1
i	1	2
Total	9	22

Wilcoxon T = 0
p < 0.01 (one tailed)

word. A word is more easily evoked for its commoner reference than for its rarer one.

EXPERIMENT 6

ASCRIBING VERBS It is sometimes argued (Broadbent, 1872, 1884; Nielsen, 1946; Wepman, 1951; Eisensohn, 1954, 1959), particularly by those supporting a regression theory of language impairment, that nominal aphasia is a discrete symptom and that the ability to use words other than nouns will either not be affected or will be conspicuously less affected than the use of nouns themselves. An experiment was therefore carried out to see whether dysphasic subjects show the same word-finding difficulties with verbs as with nouns and whether the relative difficulty of verbal items would follow the frequency hypothesis.

Accordingly word frequency was used to control the items in a task of ascribing verbs. Pictures were selected from the Gates reading test representing people engaged in obvious activities, the verbs for which covered a range of word frequencies. The following items and word frequencies were used:—

<i>Verbs</i>			
Shooting	..	..	AA
Praying	..	..	A
Ploughing	..	..	17
Yawning	..	..	15
Scrubbing	..	..	14
Ski-ing	..	..	6

Eleven dysphasic subjects were tested in the manner described above (experiment 1), except that they were asked to say what the central character was doing in each picture instead of what the objects were called.

RESULTS Table VIII shows the number of failures recorded against each item for the 11 subjects on the verbs test and on the short object naming test (of experiment 2). There is a positive correlation between performances on the two tasks (Spearman's $r = 0.88$, $p < 0.01$). Subjects who are poor at naming objects tend also to have a comparable difficulty in evoking verbs.

Table IX shows the number of failures against the word frequency of the items for the verbs test. There is a clear word frequency effect observed.

It can therefore be concluded that failure to name objects is associated with a comparable failure to evoke verbs and that the difficulty of items in a verb naming test is positively related to the frequency of usage of the verb.

TABLE VIII

NUMBER OF FAILURES IN NAMING EIGHT OBJECTS AND ASCRIBING SIX VERBS BY 11 DYSPHASICS

<i>Subjects</i>	<i>Objects (8 items)</i>	<i>Verbs (6 items)</i>
a	8	6
b	8	4
c	7	5
d	6	3
e	4	1
f	3	1
g	2	3
h	2	1
i	1	1
j	1	0
k	0	0

$r_s = 0.88$
 $p < 0.01$

TABLE IX

ASCRIBING VERBS BY 11 DYSPHASICS

<i>Verb</i>	<i>Frequency</i>	<i>No. of Failures</i>
Shooting	AA	3
Praying	A	1
Ploughing	17	4
Yawning	15	5
Scrubbing	14	4
Ski-ing	6	8

DISCUSSION

It is clear that frequency of usage has a measureable effect upon the word-finding behaviour of dysphasic and normal subjects. Indeed it would be surprising if this factor, which is so well known to affect behaviour, did not reveal itself in language responses. The experiments here reported confirm the frequency hypothesis and demonstrate the usefulness of the Thorndike-Lorge word count for controlling this semantic variable. In addition they suggest some important refinements to the general rule.

When naming body parts, dysphasic subjects show how specifically verbal their impairment is. The addition of a full visual context does not help the dysphasic to find words. Nor does there appear to be any effect from limiting the word search to a single semantic field, though we feel that more refined measures should be taken to investigate this, in view of work on semantic generalization (Luria and Vinogradova, 1959) and on word associations (Howes and Osgood, 1954).

Experiment 3, which involved the finding of composite words, suggests that availability of words is a function not only of their overall frequency of usage but also of the frequency of their parts, the initial syllable providing a cue which increases the response probability expected from the frequency of the whole word. Work relevant to this by Lansdell, Purnell, and Laskowski (1963) suggests that high frequency of the first phoneme of a word facilitates its production in dysphasia following an injection of sodium amyltal into the carotid artery of the dominant hemisphere. It appears that for a cue to be effective it need only relate to the beginning of a word. In composite words, *i.e.*, names composed of two words, the semantic search is not duplicated by the two halves, the finding of the first half being the critical task.

Further evidence of the importance of cueing-in devices comes from two other experiments reported here. First, in the experiment which involved finding the full word for abbreviations, the number of errors was related to the frequency of the abbreviation rather than to the frequency of the whole word. Secondly, in an experiment in which subjects were asked to name two objects bearing the same name, the number of errors was closely related to the frequency of the association between object and word rather than to the frequency of the word alone.

From this latter observation it might appear that words are stored according to their semantic coding and that a single word will be stored separately according to any number of different uses. There may, however, be some communication between the semantic stores with a common motor response, since retrieval of words in their commoner context has already been shown to increase their availability in the rarer context (Rochford and Williams, 1962). Thus if a subject cannot name the teeth on a comb and is then asked to name the teeth in the mouth, he may have an 'aha!' experience immediately applying the word to the initial stimulus.

Although naming objects is an easy task to control and is thus amenable to investigation, it should not be thought that 'nominal dysphasia' is specifically a loss of the ability to name objects. When asked to ascribe verbs the same word-finding problems arise and the law of frequency is again observed. Our results suggest that whatever the group of words studied, the commoner items within the group will be more available to the dysphasic than the rarer ones. In saying this, it should be remembered that most English verbs are also used as nouns in contexts which are so closely related semantically that any distinction between nouns and verbs in terms of relative difficulty of evocation is hardly meaningful.

Realization of the effect of frequency helps to make

some of the earlier interpretations of dysphasic word-finding more operationally meaningful. The 'automatic' language responses of Hughlings Jackson are undoubtedly those which throughout life have been most used, and Goldstein's 'concrete' language functions are again probably more commonly in use than his 'abstract' ones. It has previously been suggested by the present authors (Rochford and Williams, 1962) that the theory of regression (Wepman, 1951) is an artefact in that earlier learnt responses tend also to be the most frequently used responses throughout life. Indeed they are learnt early because of their great communication value and high frequency of usage and this is the factor mainly responsible for their easy accessibility.

SUMMARY

Six experiments are described in which dysphasic subjects were asked to find words of varying frequency of usage. These words applied to simple common objects, parts of the body, objects named by composite words, verbal abbreviations, words used in two different contexts, and actions.

Using the Thorndike-Lorge word count a relationship was established between word frequency and word finding difficulty. The ease with which a word is found was thought to depend also on other semantic and contextual variables which probably act by narrowing the field of search or by alerting the appropriate motor response.

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