PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Neuropsychological Studies of Verbal Semantic Systems

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Neuropsychological studies of verbal semantic systems

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The selective impairment of verbal comprehension in patients with cerebral lesions provides a powerful and direct source of evidence regarding the properties of verbal semantic systems. Word frequency is shown to be an important determinant of performance for both spoken and written word comprehension, indicating that the aphasic patient may have a quantitative reduction in capacity according to task difficulty. But this cannot be an exhaustive account. Evidence for the vulnerability of subordinate as compared with superordinate information is reported, which it is argued indicates that the semantic representations of single words are hierarchical or ordered in their degree of specificity. Finally, evidence is presented for selective impairments of the comprehension of words from particular semantic categories. Double dissociations of deficits of the concrete–abstract and of objects–non-object concepts are reported. It is argued that the verbal semantic meaning systems are categorically organized.

Introduction

Comprehension of word meanings can be impaired in patients in whom other aspects of language function are relatively well preserved. I wish to emphasize that in identifying a deficit at the level of comprehension it is implicit that an auditory percept of the word has been obtained. In this presentation I shall attempt to review the evidence, mainly derived from single case studies, that illuminates the cerebral organization of the systems underlying verbal comprehension. Rather than restrict my evidence to deficits of spoken word comprehension, I shall draw also on deficits of written word comprehension, which serve both to corroborate and to give generality to the patterns of deficit that are emerging from investigations of the impairment of spoken word comprehension. The problem of the interrelation of spoken word and written word comprehension deficits is a complex subject and I shall not attempt to deal with it here.

Spoken and written word comprehension

I have previously described in some detail two patients, E.M. and A.B., in whom there was a particularly striking and selective deficit of spoken word comprehension (Warrington 1975). Repetition of single words was entirely normal, repetition of strings of words and sentences was above average. It is this ability to repeat spoken words that establishes very directly that word perception is intact. At the same time the patients' capacity to comprehend individual words was quite impaired. Their verbal comprehension vocabulary was impoverished and diminished. Yet abstract reasoning tests were performed at a high level. They were even able to read words that they could not comprehend and more important they were able to express themselves fluently and lucidly; in particular their syntax was intact within the limitations imposed by the loss of individual word meanings. These two patients (both university graduates) were unable to comprehend words that one can be confident were once within their vocabulary.

This could be shown clearly in a word definition task. For example, asked to explain the meaning of words such as 'trumpet', 'cottage', 'insult', both patients would use expressions such as 'I've forgotten', 'It sounds familiar', 'I can't remember'. This difficulty could not be accounted for by a deficit of verbal expression: E.M. and A.B. were able to define those words that remained within their vocabulary concisely and aptly. In short, these patients demonstrated that the comprehension of word meanings can be selectively impaired, despite the preservation of other aspects of language function.

TABLE 1. PERCENTAGE CORRECT OF HIGH AND LOW FREQUENCY WORD DEFINITIONS

(Modified from Warrington (1975).)

word frequency ...	AA & A ($n = 25$)	1–50 ($n = 45$)
A.B.	96	51
E.M.	96	51

TABLE 2. PERCENTAGE CORRECT OF HIGH AND LOW FREQUENCY WORD READING

(Modified from Warrington & Shallice (1979), Shallice & Warrington (1975) and Warrington (1981).)

word frequency ...	AA & A	1–50
A.R. ($n = 623$)	47	37
K.F. ($n = 425$)	58	24
C.A.V. ($n = 459$)	56	36

WORD FREQUENCY

For both of the patients E.M. and A.B., word frequency was a major determinant of their performance on tasks of spoken word comprehension. Both patients were asked to define the same subset of 70 words from the Brown & Ure (1969) list ranging in frequency from $1/10^6$ to over $100/10^6$ (Thorndike & Lorge 1944) and a lenient criterion was used for scoring. The percentage of spoken words correctly defined by E.M. and A.B., for words of two levels of frequency, is given in table 1. All of these words undoubtedly would have been within their premorbid vocabulary and it can be concluded that their performance on this task reflects a moderately marked defcit of spoken word comprehension that is proportionate to task difficulty defined in terms of word frequency.

Word frequency appears to be equally important for written word comprehension. There is a class of dyslexic patients (the deep–phonological dyslexic syndrome) in whom grapheme–phoneme correspondence rules are lost and their reading is achieved perforce by direct access to a 'sight' vocabulary. The residual reading skills of three such patients (A.R., K.F. and C.A.V. to whom I shall also refer below) have been previously described in detail (Warrington & Shallice 1979; Shallice & Warrington 1975; Warrington 1981). These three dyslexic patients were asked to read a large subset of the Brown & Ure words, and the percentage of high and low frequency words correctly read is given in table 2. Here, too, the effect of frequency was statistically significant in all three patients.

Group studies have, for the most part, emphasized that the impairment or degradation reflects the same order of task difficulty as for the control subjects; that is, a brain lesion results in a general reduction in capacity, proportionate to task difficulty. Many years ago Howes

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

(1964) reported quantitative evidence in support of this principle and more recently Poek and colleagues (Poek *et al.* 1973; Poek & Stachowiak 1975) have claimed that word comprehension deficits can be completely specified in terms of word frequency, i.e., the less frequently words are used, the more vulnerable they are. I would suggest that this is likely to be an over-simplification and that there is a very much more interesting approach to this problem. While there is no doubt that word frequency is important, it is by no means the only significant determinant of word comprehension. I shall argue that word comprehension deficits can be category-specific and can override the effects of task difficulty. But before turning to the question of categorical organization of classes of words it is useful to discuss the evidence regarding the semantic representation of single words.

Partial comprehension

The analysis of residual capacity can be highly instructive for revealing the underlying functional organization. The loss of spoken word comprehension in the two patients E.M. and A.B. was not an absolute deficit; neurological deficits often are not. Although the patients appeared to comprehend some words well and to comprehend others not at all, for some words partial knowledge appears to have been retained. In these instances it was observed that superordinate information was less vulnerable than subordinate information: broad concepts were retained, but not the more specific or precise semantic representations necessary for full comprehension. For example, a 'bucket' was defined as a 'container' but on further questioning no details of its size, weight, or its function appeared to be known. Similarly, the response to the word 'pigeon' was 'I know it is a bird but not which one'. These observations suggested that the organization of the semantic representation of a word was hierarchically ordered. Two tests of spoken word comprehension (Warrington 1975) and two tests of written word comprehension (Warrington & Shallice 1979) illustrate the relative vulnerability of these different levels of semantic knowledge.

Test 1

The test stimuli were 20 object names and 20 animal names about which increasingly specific questions were asked on each successive presentation, with a yes–no response being required throughout. On the first presentation, the test stimuli were spoken in random order, the patient being asked, 'Is it an animal?' Next, the animal names were spoken and the patient asked, 'Is it a bird?' Then the animal names were presented again, the patient being asked 'Is it foreign?' In the final presentation of the list the patient was asked, 'Is it bigger than a cat?' Similarly with object names, the list was presented three times, the patient being asked, 'Is it used indoors?' then, 'Is it made of metal ?'; and finally, 'Is it heavier than a telephone directory?' (the London A–D directory was shown as a standard). The percentage correct for each of these probes for E.M. and A.B. is given in table 3. For both patients, the superordinate probe (animal–object) was significantly above chance, as was the indoor–outdoor object probe. Performance with the other more subordinate probes for the most part did not differ significantly from chance (see table 3).

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Test 2

E.M. attempted a further task of spoken comprehension designed to probe different levels of semantic knowledge. The test items were names of animals, plants and objects in approximately equal proportion, 20 of which she had some vague comprehension of and 20 of which she did not appear to comprehend at all when asked previously to give word definitions. Two levels of semantic knowledge were explored, superordinate information and subordinate information, by using a three-choice probe. The first probe was common to all items (animal, plant or non-living). Each probe thereafter was appropriate to the individual item (see table 4). There was a highly significant difference between her performance on the superordinate probes and the subordinate probes (see table 4).

TABLE 3. SUPERORDINATE AND SUBORDINATE CATEGORIZATION: PERCENTAGE CORRECT FOR DIFFERENT LEVELS OF SEMANTIC PROBES (CHANCE SCORE = 50%)

(Modified from Warrington (1975).)

	animal or object	animals ? bird	animals ? foreign	animals ? size	objects ? indoors	objects ? metal	objects ? size
E.M.	85	65	60	55	80	55	35
A.B.	73	75	70	65	75	55	60

TABLE 4. SUPERORDINATE AND SUBORDINATE CATEGORIZATION (E.M.): PERCENTAGE CORRECT FOR DIFFERENT LEVELS OF SEMANTIC PROBES ($n = 40$) (CHANCE SCORE = 33%)

(Modified from Warrington (1975).)

superordinate probes		subordinate probe	
animal/plant/non-living	80	e.g. red/yellow/black?	65
e.g. fish/bird/insect?	83	e.g. 0 legs, 2 legs, 4 legs?	53

Test 3

Partial comprehension of written words was explored in a dyslexic patient A.R. (see above). The 125 stimuli comprised 25 words from each of five categories (animals, plants, foods, objects, parts of the body). He succeeded in reading (or identifying) 38 of these words; the remaining 87 words he could not read. A two-choice categorization task was attempted immediately afterwards with the 87 words he could not read (using each of the five category names as distractors equally often). A.R. correctly categorized 78% of the words he was unable to read, a score that is significantly better than chance.

Test 4

The test stimuli comprised 25 measurements words (e.g. acre, mile) and 25 acádemic subjects (e.g. maths, history). A.R. was unable to read or identify 38 of these 50 words, but nevertheless he correctly categorized 82% of these 38 words, a result that is significantly above chance.

From this and other evidence (see Warrington 1975; Warrington & Shallice 1979) it can be argued that there is an order or hierarchy that can be differentially impaired. The more

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

specific or precise representations of word meanings can be lost with retention of broad category information. I have never observed the converse. These findings suggest that the neural substrates underlying semantic representation are ordered in their degree of specificity. To some extent, these observations mirror the process of acquisition of verbal concepts claimed to occur in childhood; blunt, crude concepts gradually become differentiated until the limits of an individual's semantic knowledge is attained (Clarke 1973).

TABLE 5. CATEGORY SPECIFICITY: PERCENTAGE OF PATIENTS ($n = 135$) DISPLAYING A SELECTIVE PRESERVATION OR IMPAIRMENT IN EACH OF FIVE CATEGORIES

(Modified from Goodglass *et al.* (1966).)

	selective preservation	selective impairment
objects	14	4
actions	14	3
colours	5	12
letters	2	24
numbers	11	7

CATEGORY SPECIFICITY

I now turn from considering the semantic representation of single words to the organization of classes of words. It is a well known clinical observation that comprehension deficits may be disproportionately severe for particular verbal categories. For example, colour agnosia, which can take the form of a failure to comprehend colour names, and autotopagnosia, the failure to comprehend body part names, have long been singled out by neurologists as distinctive clinical syndromes.

Goodglass *et al.* (1966) reported the first quantitative investigation of category specificity of word comprehension deficits. Instead of averaging across groups of patients classified either according to the site of lesion, or more commonly according to type of dysphasia (a methodology frequently adopted by speech pathologists), they recorded the number of individuals who had disproportionate difficulty or facility with a particular verbal category. They tested a consecutive series of 135 aphasic patients for their comprehension of object names, action names, colour names, letters and numbers. An individual patient was classified as having a selective impairment of performance in one of these five categories alone (or at most one other category), if it was significantly worse than the performance on the remaining categories. Similarly, they classified an individual patient as having a selective preservation if performance on one of these five categories alone (or at most one other category) was significantly better than performance on the remaining categories. A summary of their findings is given in table 5. Goodglass *et al.* were impressed by the high incidence of dissociations and they suggested that category specificity may be the rule rather than the exception within an aphasic population.

Experimental psychologists have long distinguished between abstract and concrete categories of verbal concepts. Neuropsychological evidence is especially relevant to this distinction. One of the two patients discussed above, E.M., who had a spoken word comprehension deficit, had somewhat more difficulty with abstract words than with concrete words. By itself this is not surprising: an interpretation in terms of task difficulty readily comes to mind. The observation of the converse pattern, however, was quite unexpected and is of considerable theoretical

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Table 6. Concrete–abstract word definition: percentage of words correctly defined at each level of concreteness

(Modified from Warrington (1975).)

	concrete words ($C > 4.47$, $n = 40$)	abstract words ($C < 4.47$, $n = 30$)
E.M.	56	45
A.B.	24	85

interest. The patient A.B. (whose overall level of performance was the same as E.M.'s) was selectively impaired in the comprehension of *concrete* words; abstract words were by comparison relatively well preserved. For example, in a word definition task, he gave the following definitions of abstract words:

supplication 'making a serious request for help';
arbiter 'he is a man who tries to arbitrate – to produce a peaceful solution';
pact 'friendly agreement';
knowledge 'make oneself mentally familiar with a subject'.

These well expressed definitions serve to highlight his difficulty in defining concrete words, for example:

mosquito 'it sounds familiar';
needle 'I've forgotten';
geese 'an animal, I've forgotten precisely';
carrot 'I must once have known'.

I attempted to document this phenomenon quantitatively. The Brown & Ure words (for which a concreteness rating on a seven-point scale is available) which had been defined by E.M. and A.B. (see above) were assigned to high and low concreteness groups. The percentage correct for the words of high and low concreteness (1–50 frequency range) for these two patients is given in table 6. The salient finding that emerges is that A.B. was significantly worse than E.M. in defining the subset of words of high concreteness and E.M. was significantly worse than A.B. in defining the abstract words. Furthermore, A.B. was significantly worse on concrete words than on abstract words although the trend for E.M. to be worse on abstract words was not statistically significant.

This double dissociation between the impaired comprehension of concrete and abstract words has also been observed in the comprehension of the written word. A clear concrete–abstract discrepancy was observed in K.F. and C.A.V., two of the three dyslexic patients discussed above. K.F. had much greater impairment for *abstract* word reading. For example, he could read and comprehend words like 'theatre', 'newspaper', 'factory' and 'acorn', but he failed to read or comprehend words like 'get', 'easy', 'like' and 'ask'. Perhaps more remarkable is C.A.V.'s greater impairment with *concrete* word reading. For example, he could read and comprehend words such as 'ability', 'industry' and 'humour', but he failed to read words such as 'cat', 'table', 'salt' and 'man'. The percentage of high and low concrete words correctly read from the Brown & Ure list, from which these examples are taken, is given in table 7. The concrete–abstract dimension yielded highly significant effects for both patients (for a full description of these studies see Shallice & Warrington (1975) and Warrington (1981)).

The impairment of *concrete* word comprehension, as observed in A.B. for the spoken word

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

TABLE 7. CONCRETE–ABSTRACT WORD READING: PERCENTAGE OF WORDS CORRECTLY READ AT EACH LEVEL OF CONCRETENESS

(Modified from Shallice & Warrington (1975) and Warrington (1981).)

	concrete words ($C > 4.47$)	abstract words ($C < 4.47$)
K.F. ($n = 425$)	55	12
C.A.V. ($n = 459$)	36	55

and in C.A.V. for the written word, is of considerable theoretical significance. Not only is it likely that abstract words are in some sense more difficult either at the level of conceptual understanding or at the level of linguistic explanation, but I would argue that any explanation of these comprehension deficits in terms of task difficulty is completely untenable given the double dissociation of impairments between the concrete and abstract categories.

Equally, an explanation of the concrete–abstract discrepancy in terms of the dual encoding hypothesis must be rejected. This theory postulates that there is a right-hemisphere lexicon for concrete words from which the commonly observed concrete word advantage derives (Coltheart 1980; Saffran *et al.* 1980). Whatever the optimal potential capacity of the right hemisphere for verbal comprehension (associated, say, with early brain damage or inter-hemispheric transfer of function), this theory, which has been advanced to account for the concrete word *advantage*, cannot possibly also explain a concrete word *deficit*. I have argued that the only viable alternative explanation is in terms of category specificity and that the selective impairment of both concrete and abstract words reflects the categorical organization of verbal semantic systems (Warrington 1975, 1981). At any rate, whatever the explanation of the brain's capacity to differentiate between an abstract and a concrete word, it is tempting to speculate about the rationale for this dichotomy. The double dissociation of impairments for concrete and abstract categories implies that the neural substrates of these categories are also different. The difference between these two substrates may be based on a difference in organization of the semantic properties of the abstract and concrete concepts themselves. An abstract word is frequently placed on a continuum between two extreme and contrasting endpoints. Dictionaries tend to give definitions of abstract words in terms of close synonyms and antonyms. In contrast, a concrete concept is more often defined in terms of the superordinate category, together with its distinguishing attributes that differentiate it from other similar members of the class. Is it possible, then, that the semantic representations of abstract words are structured on a continuum or multiple continua and that concrete words are represented by complex tree structures?

SELECTIVE PRESERVATION OF OBJECT NAMES

Evidence is now emerging that there is categorical specificity within the concrete domain. Shallice and I have investigated a patient in whom we would argue there was selective impairment of particular categories of concrete words.

J.B.R. was a 24 year old graduate who had made only a partial recovery from a herpes encephalopathy. His full-scale I.Q. on the WAIS was only average (101). He was severely amnesic, having virtually no recall for current and past events. His linguistic skills appeared to be relatively intact, but, like E.M. and A.B. described above, his comprehension vocabulary

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

appeared to be impoverished and degraded. (For a full description see Warrington & Shallice (1981).)

J.B.R. attempted to define a large subset of Brown & Ure words. The percentage correct, for two levels of frequency and two levels of concreteness, is given in table 8. Although no significant difference between his levels of performance on concrete and abstract words was found, it was noted that certain classes of words within the 'concrete' category were particularly impaired. It appeared that plants and animals were abolished, whereas objects were intact. We attempted to document these observations by using word definition tasks.

TABLE 8. CONCRETE–ABSTRACT WORD DEFINITIONS (J.B.R.): PERCENTAGE OF WORDS CORRECTLY DEFINED FOR EACH LEVEL OF CONCRETENESS AND EACH LEVEL OF FREQUENCY

(Modified from Warrington & Shallice (1981).)

word frequency	concrete words ($C > 4.47$)	abstract words ($C < 4.47$)	total
AA & A ($n = 132$)	87	90	89
1–50	60	71	66

TABLE 9. LIVING–OBJECT WORD DEFINITIONS (J.B.R.): PERCENTAGE OF WORDS CORRECTLY DEFINED FOR EACH CATEGORY

(Modified from Warrington & Shallice (1981).)

		living	object
test 1	observed score ($n = 40$)	18	76
	expected score	61	57
test 2	observed score ($n = 40$)	25	83
	expected score	55	58

Test 1

The test stimuli comprised names of 40 objects and 40 living things. His performance in terms of percentage correct definition (a very lenient scoring criterion was adopted) is given in table 9, together with an 'expected' score derived from his performance of a full range of concrete–abstract words matched for frequency. There was a significant deficit in his comprehension of living things and significant preservation of his comprehension of objects.

Test 2

We attempted to replicate the findings of test 1 by testing J.B.R. with a non-overlapping set of test stimuli from the same two categories, 40 objects and 40 living things. The percentage of correct definitions for each category of words, together with the expected score (derived as above) is given in table 9. Again there was a significant deficit for living things and a significant preservation for objects.

Test 3

In view of this striking dissociation it seemed appropriate to explore other concrete categories. J.B.R. attempted to define 20 animal names, 20 plant names and 20 food names. His percentage correct score for each category, together with his expected score (derived as above) is given in table 10. There was a significant deficit on all three categories of words.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Test 4

A wider range of categories was sampled by selecting 12 words from each of 27 of the Battig & Montague categories. His performance on a subset of 8 categories selected to highlight certain dissociations is given in table 11. He appeared to know kitchen utensils but not fruit; items of clothing but not kinds of cloth; tools but not kinds of metal; and occupations but not specific sciences.

TABLE 10. WORD DEFINITION FOR DIFFERENT CATEGORIES (J.B.R.): PERCENTAGE OF WORDS CORRECTLY DEFINED FOR EACH CATEGORY

(Modified from Warrington & Shallice (1981).)

	animals	plants	foods
observed score ($n = 20$)	10	0	0
expected score	60	55	42

TABLE 11. SELECTIVITY OF CATEGORY DEFICITS: PERCENTAGE OF WORDS CORRECTLY DEFINED FROM EACH CATEGORY

(Modified from Warrington & Shallice (1981).)

categories preserved		categories impaired	
kitchen utensils	83	fruit	0
tools	75	metal	17
clothing	83	cloth	8
occupations	67	science	8

J.B.R. provides evidence of a fine-grained categorical organization of verbal concepts. Any explanation in terms of individual differences would be highly improbable. In particular the dissociation between tools and metals, or clothing and cloth, or objects and food can hardly be attributed to differences in the past experience of an individual. Similarly, these category-specific deficits cannot be reduced to word frequency effects. But perhaps more compelling is that the converse dissociation has now been observed. This occurred in a patient in whom the category of objects was impaired and the category of living things was preserved; foods, too, were reversed and they now joined the preserved categories.

THE SELECTIVE IMPAIRMENT OF OBJECT NAMES

McCarthy and I investigated a patient with a grave global dysphasia. V.E.R., a 62 year old housewife, who previously was a domestic worker, had sustained a major left hemisphere stroke. On admission six months after the stroke, the CAT scan showed evidence of an infarction involving the front-temporo-parietal region of the left hemisphere; her right hemisphere appeared to be normal. Initially our interest lay in putting on record a remarkably dense spoken word comprehension deficit in a patient with a unilateral left hemisphere lesion. V.E.R. was unable to carry out the simplest instruction (e.g. 'close your eyes'). She was unable to point reliably to one of a pair of common objects.

Her expressive speech functions were very markedly impaired, such that she had virtually no capacity for propositional speech (for a full case report see Warrington & McCarthy (1981)).

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

She was therefore tested throughout by using matching-to-sample techniques. In the first test we attempted to establish that her comprehension deficit was principally in the auditory verbal domain.

Test 1

The test stimuli comprised a set of five objects and five photographs of different objects with the same name, selected so that there were two visually dissimilar versions of each (e.g. two differently shaped tin openers, glasses, watches, etc.). V.E.R. was asked to match either a spoken name or a photograph to one of an array of five real objects. She was tested in blocks of 20 trials by using an ABBA design. This procedure was repeated four times with a different set of five objects for each replication. The percentage correct scores for the picture–object match and the spoken word–object match are given in table 12. Her scores on both conditions were significantly above chance and the difference between her level of performance on the auditory condition and the visual condition is statistically reliable. It is clear that picture–object matching tasks cannot be achieved entirely by physical matching, and it is known that a deficit of picture–object matching is lateralized to the left hemisphere (De Renzi *et al.* 1969). It therefore seems reasonable to assume that this task demands object recognition at a semantic level. This auditory–visual discrepancy indicates that her impairment on spoken word–object matching tests cannot be accounted for by a failure to recognize the visual object and it therefore follows that V.E.R.'s deficit on spoken word–object matching tests lies in the comprehension of the spoken word.

TABLE 12. VISUAL AND VERBAL OBJECT MATCHING (V.E.R.): PERCENTAGE CORRECT ON MATCHING FOR EACH CONDITION (CHANCE = 20%)

(Modified from Warrington & McCarthy (1981).)

	visual picture/object	auditory word/object
score ($n = 160$)	87	43

Test 2

It was established in test 1 that V.E.R.'s level of performance in comprehending spoken object names is very poor indeed. However, in the course of our assessments, we observed that her comprehension of animal and plant names was considerably better than for object names; these we attempted to document. The test stimuli comprised three pairs of object names, plant names and animal names. V.E.R. attempted a two-choice spoken word–picture matching task for each of the nine pairs. The three stimulus categories were tested in a latin square design, with 20 trials per stimulus pair. The percentage correct score for each category is given in table 13. There was an overall significant effect of category. Her performance on the word–object matching condition was not significantly above chance. There was no significant difference between her performance on the word–plant and word–animal matching conditions, but both these conditions were significantly better than the word–object matching condition. It should be noted that the object stimuli were mostly common household objects, which in terms of her own experience must have been relatively high-frequency items.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

Test 3

In view of the findings obtained for J.B.R. (see above), for whom comprehension of object names was superior to his comprehension of food names, a task was devised to compare V.E.R.'s comprehension of these two categories. The test stimuli comprised food names and object names. A spoken word–picture matching test was attempted, with a two-choice array and a five-choice array. V.E.R. was tested in a block of 20 trials with a double ABBA design. Her score on each condition expressed as a percentage is given in table 14. Her performance on the word–object matching conditions was significantly worse than her performance on the word–food matching conditions for both sizes of array. This result, together with that of test 2 above, when compared with the performance of J.B.R., provides evidence of a double dissociation of deficits in the comprehension of objects compared with food, animals and plants.

TABLE 13. WORD–PICTURE MATCHING FOR DIFFERENT CATEGORIES (V.E.R.): PERCENTAGE CORRECT OF WORDS CORRECTLY MATCHED FOR EACH CLASS OF VISUAL STIMULI (CHANCE = 50%)

(Modified from Warrington & McCarthy (1981).)

	objects (mop/steps)	animals (wasp/ladybird)	flowers (daffodil/thistle)
score ($n = 60$)	63	83	96

TABLE 14. WORD–PICTURE MATCHING FOR OBJECTS AND FOODS (V.E.R.): PERCENTAGE OF WORDS CORRECTLY MATCHED FOR EACH CLASS OF VISUAL STIMULI FOR EACH ARRAY SIZE (CHANCE = 50% AND 20% RESPECTIVELY)

(Modified from Warrington & McCarthy (1981).)

array size	objects	foods
2 ($n = 80$)	76	92
5 ($n = 80$)	58	88

If one accepts the evidence of category specificity, the significance of these unexpected dissociations within the broad domain of concrete words is of some theoretical interest. They are unlikely to be arbitrary. Their occurrence leads one once again to infer not only that the neural substrates of these categories are different, but that they are required to be different for efficient access to their semantic representations. Living things and man-made objects are alike in so far as both are tangible things that can be allocated to a hierarchy of superordinate categories but they differ in so far as living things are comprehended in terms of attributes or distinguishing features that differentiate them from other similar members of the same class. Perhaps this applies to foods as well. On the other hand, objects are comprehended not only in terms of physical properties but also in terms of *function*. I would speculate that it is the paramount importance of function, as compared with physical attributes, which require separate mechanisms to achieve their respective semantic representations.

To recapitulate, I have argued that the verbal semantic systems are categorical in

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

organization and that the categorical specificity of these systems may be much more fine-grained than has been hitherto supposed. In putting such an argument are we rejecting any alternative model of semantic organization? Yes, I think so. Such a formulation is almost certainly incompatible with notions that consider verbal semantic organization necessarily to be in the form of a network of words related by associations, i.e. words related by association that share a semantic field. To be more concrete: lion/danger or horseshoe/luck would be close in an associative network organization but distant in a categorical organization such as I have described. Similarly whisk/cream or barn/cow would be close in an associative network but more distant in terms of the living–non-living dichotomy that we have documented. Such a suggestion should not be taken to deny the possibility that associative networks are available for many high-level cognitive processes, such as recall or problem solving, or that these may be selectively impaired. However, I would hold that the cerebral systems subserving the attainment of meaning from a percept are categorical in organization.

To summarize, a series of analytical studies has been reviewed of individual patients with deficits of either spoken word comprehension or written word comprehension. Word frequency is a major determinant of spoken word and written word comprehension. The failure of comprehension for individual words, whether spoken or written, is not necessarily absolute; there is evidence of partial comprehension such that superordinate information is less vulnerable than subordinate information. Category-specific deficits of spoken and written word comprehension are observed. In particular a double dissociation of deficits 'concrete–abstract and living–object' categories is documented. These studies suggest that the semantic representation of verbal concepts are structured in a definitive order or hierarchy and it would appear that our verbal thesaurus is categorical in organization.

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