7

Word-webs

— *Semantic networks* —

> Experience is never limited, and it is never complete; it is an immense sensibility, a kind of huge spider-web of the finest silken threads suspended in the chamber of consciousness, and catching every air-borne particle in its tissue.
>
> Henry James, *Partial Portraits*

Words are not assembled out of a common store of semantic primitives, we decided. So how are they are related to one another? Perhaps we should imagine them as linked together in a gigantic multi-dimensional cobweb, in which every item is attached to scores of others. Or, to use a more sophisticated image: 'Suppose the mental lexicon is a sort of connected graph, with lexical items at the nodes with paths from each item to the other' (Fodor, 1983: 80). Theories of this type are known as network theories.

A network, according to the eighteenth-century lexicographer Samuel Johnson, is 'anything reticulated or decussated at equal distances, with interstices between the intersections'. Johnson was presumably thinking of something like a fishing net, in which the intersections must be equidistant. A network in relation to the mental lexicon simply means 'an interconnected system'. Researchers mostly agree that a network of some type is inevitable, but they disagree as to how it is organized, and how to explore it.

In general, early work on the topic concentrated on finding out the strength of a link between one particular word and another. The findings laid the groundwork for later research, which has spent more time on trying to ascertain the overall structure underlying the individual connections. In this chapter, therefore, we will consider the outline conclusions of some early researchers, and then try to specify the probable overall organization more carefully.

Linguistic habits

Early work on meaning networks suggested that links between words were formed by habits: if words often cropped up together, such as *pen* and *pencil*, *envelope* and *postage stamp*, or *moon* and *stars*, then these frequently associated items were thought to develop extra-strong ties. The close links forged by these habits could be revealed quite easily, it was suggested, by means of simple word association experiments.

'Give me the first word you think of when I say "hammer"'. This, as we saw in chapter 2, is the standard procedure for word association experiments. The experimenter draws up a list of words and for each item asks a subject to name the first word which comes to mind. In such experiments, different people generally give rather similar responses. For example, out of 1,000 subjects, over half said *nail* in response to 'hammer', *low* to 'high' and *black* to 'white' (Jenkins, 1970). And for some other words the probability of a particular response was much higher: over three-quarters of the subjects responded *queen* to 'king', *girl* to 'boy' and *short* to 'long'. Moreover, in cases where there was no overwhelming single response, there were usually several very common ones: *water*, *sea*, or *blue* accounted for around two-thirds of the responses to 'ocean'. The consistency of the results suggested to psychologists that they might therefore be able to draw up a reasonably reliable 'map' of the average person's 'word-web'.

At least three important findings emerged. First, people almost always select items from the semantic 'field' of the original word. Nobody said *nail* or *poker* in response to 'needle', even though these are also thin pointed objects. The majority mentioned some aspect of sewing: *thread*, *pin(s)*, *eye* and *sew* were the words mentioned most often. Sewing items seemed to trigger one another off, suggesting that clusters of words relating to the same topic are stored together. The second finding was that people nearly always pick the partner if the item is one of a pair, as in *husband* and *wife*, or has an obvious opposite, as in *big* and *small*. The third finding (which will be discussed in a later chapter) is that adults are likely to respond with a word of the same word class: a noun tends to elicit a noun, an adjective another adjective, and so on.

Can we build up a detailed mental map from these responses? Unfortunately not, in spite of the enormous amount of information available from word association experiments (e.g. Deese, 1965; Postman and Keppel, 1970). There turn out to be a number of problems. First, thinking up an immediate response to just one word is a somewhat unnatural kind of activity, so may not reflect ordinary speech processes. Second, the standard results can be altered quite dramatically by presenting a word in a group rather than alone. People normally respond to the word 'moon' with items such as *sun*, *night* and *star*. But if 'moon' is presented alongside words such as 'elephant, hall, whale, stadium', subjects tend to reply with the word *big* (Coleman, 1964). If a word's associations can be changed so easily by the context, then it is possibly wrong to assume that we can ever lay down fixed and detailed pathways linking words in the mental lexicon.

But the most serious shortcoming of word association experiments is that they cannot tell us about the probable structure of the human word-web. This is partly because each person is asked for only one response to a particular word, and partly because the links between words are multifarious. For example, the ten most common responses to 'butter' were *bread* (the commonest), then *yellow*, *soft*, *fat*, *food*, *knife*, *eggs*, *cream*, *milk*, *cheese* (Jenkins, 1970). These responses represent several different types of link: *bread* is eaten alongside butter, *yellow* and *soft* describe 'butter', whereas *cream*, *eggs*, *milk* and *cheese* are other kinds of dairy food. One would expect the mental lexicon to treat these various connections differently from one another. Let us consider this problem more carefully.

Listing the links

The ten commonest responses in word association tests to the words *butterfly*, *hungry*, *red* and *salt* are listed in figure 7.1 (from Jenkins, 1970). As with *butter*,

	BUTTERFLY	HUNGRY	RED	SALT
1	moth	food	white	pepper
2	insect	eat	blue	sugar
3	wing(s)	thirsty	black	water
4	bird	full	green	taste
5	fly	starved	colour	sea
6	yellow	stomach	blood	bitter
7	net	tired	communist	shaker
8	pretty	dog	yellow	food
9	flower(s)	pain	flag	ocean
10	bug	man	bright	lake

Figure 7.1 Word association responses

these replies encompass a number of different types of link between the stimulus word and the response. Let us consider the four which may be the most important:

1 *Co-ordination*. The commonest response involved 'co-ordinates', words which cluster together on the same level of detail, such as *salt* and

pepper; *butterfly* and *moth*; *red*, *white*, *blue*, *black*, *green*. Opposites come into this category, as they are co-ordinates in a group consisting of only two members, as with *left* and *right*, or they are the two commonest members in a larger group, as with *hot*, *cold*, *warm*, *cool*.

2 *Collocation*. The next most common response involved a word which was likely to be 'collocated' (found together) with the stimulus in connected speech, as with *salt water*, *butterfly net*, *bright red*.

3 *Superordination*. Less often, a 'superordinate' occurred, the cover term which includes the stimulus word. For example, *insect* was elicited by 'butterfly', and *colour* was a response to 'red'.

4 *Synonymy*. Occasionally, a rough synonym of the original word was found, as with *starved* beside 'hungry'.

How, then, do all these connections (figure 7.2) intermesh in the mental lexicon? And are some links stronger or more permanent than others? Let us consider these questions by examining each kind of link in turn.

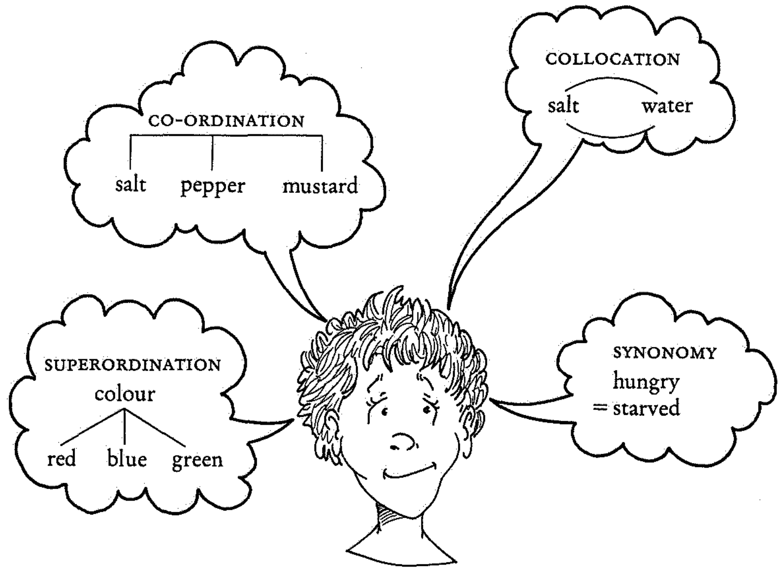
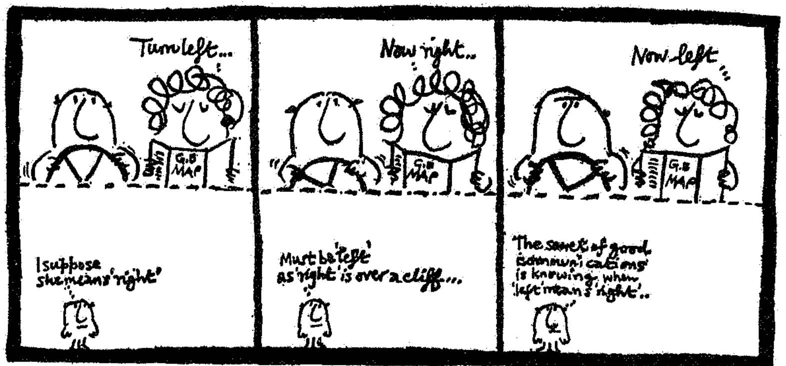


Figure 7.2 Types of link in the word-web

When left means right

The secret of good communication is to know when *left* means 'right', according to a newspaper cartoon. Muddling up *left* and *right* is possibly the



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commonest semantic tongue-slip of all, closely followed perhaps by the confusion of *yesterday*, *today* and *tomorrow*. And other similar examples can be heard daily. People say *Tuesday* when they mean 'Wednesday', *blue* instead of 'green' and *brother* in place of 'sister'.

In addition, people sometimes blend together similar words, such as:

I went to *Noshville* (Nashville + Knoxville, Tennessee towns).
I'd like some *taquua* (tequila + kahlua, Mexican drinks).
He's a born *sailure* (success + failure).

These errors confirm the results of word association experiments, that words are stored in semantic fields and that co-ordinates are closely associated. Word searches provide additional support. When looking for an elusive word, people frequently fumble around not only in the same general semantic area but often within a group of co-ordinates. Freud, when he could not remember the name 'Monaco', ran through a whole series of place-names: *Piedmont*, *Albania*, *Montevideo*, *Colico*, *Montenegro* (chapter 2; Freud, 1901/1975: 96–7). In the 'tip of the tongue' experiment (chapter 2), subjects who could not remember the word *sextant* recalled other navigational instruments, such as *compass* or *astrolabe* (Brown and McNeill, 1966).

Furthermore, aphasic patients often produce a co-ordinate or close relative of the target, as in *orange* for 'lemon', *table* for 'chair' and *diving* for 'swimming', and they may make this type of mistake in comprehension also:

Mrs P. Do you want rice crispies?
Mr P. Yes.

When the rice crispies arrived in front of him, Mr P., who had recently had a stroke, was surprised and angry, and Mrs P. became upset at his unreasonable behaviour (Butterworth *et al.*, 1984). It seems that poor Mr P. could no longer

remember which sound sequence paired with *rice crispies*, and had perhaps thought Mrs P. meant 'cornflakes'.

Such episodes suggest that some co-ordinates are so closely linked that brain-damaged people may have difficulty in distinguishing between them. A particular sound sequence may lead into the general area of the lexicon required, at which point the matching procedure needed to pinpoint the exact word fails. This was suggested by a recent experiment in which aphasics were asked to single out one item in a picture showing several objects. If the instruction was 'Point to a lemon', patients were likely to succeed if the other objects were things quite different from it such as boot, armchair, cup, pig. But many of them found it much more difficult to pick out the lemon from among other pieces of fruit (Butterworth *et al.*, 1984).

Moreover, ties between co-ordinates tend to be retained even after serious brain damage. Aphasics were asked to squeeze a rubber ball if they recognized a relationship between pairs of words which were read aloud to them (Goodglass and Baker, 1976). They responded fastest if these words were co-ordinates, and their error rate was exactly the same as that of normal subjects. In addition, work with elderly patients indicates that these connections do not deteriorate in old age (Howard *et al.*, 1981). A number of young and old subjects were presented with two simultaneous strings of letters and asked to judge whether both were words. In general, the older group, whose average age was 70, took longer to respond than the younger group, average age 28. But if the strings were both words, and these were either co-ordinates (*rain—snow*) or contained collocational links (*rain—wet*), then the responses of both groups were speeded up equally. This result suggests that the first word was linked to the second word as strongly in the old group as in the young one.

Links between co-ordinates, then, are strong. According to one researcher (Hotopf, 1980), all the examples in his collection of semantic slips fitted into three categories: contrasting co-ordinates, as with *apple* for 'pear', *red* for 'black', *Monday* for 'Tuesday'; opposites, as with *up* for 'down', *fat* for 'thin', *man* for 'woman'; and 'semantic cousins', as with *Saturday* for 'January', which are both dates but dates of a different type. This researcher may have subconsciously concentrated on certain kinds of slip, but it is unlikely that he would have missed alternative types if there had been dozens and dozens of them.

It is difficult to be precise about the detailed organization of co-ordinates within the mental lexicon, since the structure of a group is likely to depend on the type of word involved – objects, colours and actions might be treated rather differently. It seems probable, however, that for each group there is a nucleus of closely linked words, with other words attached somewhat more loosely round the edges (figure 7.3). In some cases, as with colours, the words in the nucleus may overlap to some extent, since many words have fuzzy edges which merge into one another (chapter 5).

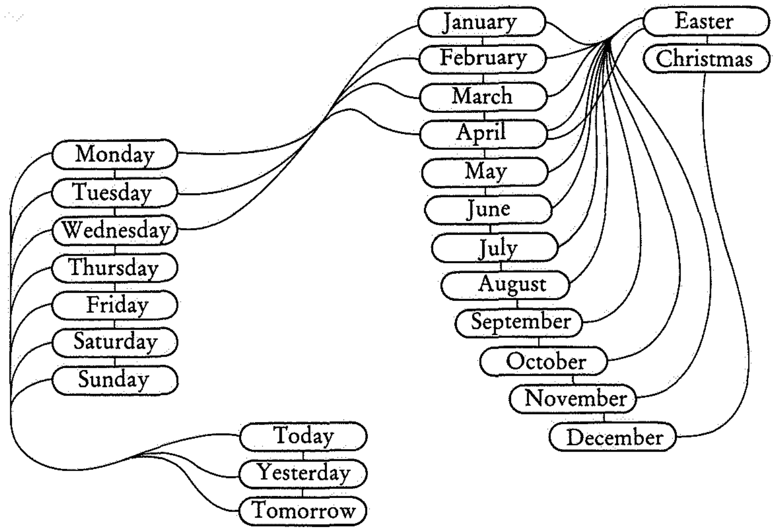

Figure 7.3 Clusters of co-ordinates

Stardust and star wars

A popular television quiz show is based on the idea that different people will come up with the same continuation for a word such as *star*: *stardust*, *starfish*, or *star wars*, perhaps. Humans seem to be fairly sensitive to collocational links of this type, as word association experiments suggested. This finding is strengthened by evidence from tongue-slips, where people sometimes start out with one phrase and then get 'derailed' on to a familiar routine, as in *Hungarian restaurant* for 'Hungarian rhapsody'. Aphasics also preserve collocational links well (Goodglass and Baker, 1976). Furthermore, the experiment involving old people mentioned earlier in this chapter showed that links such as *rain–wet* were as strong in the old subjects as the younger ones (Howard *et al.*, 1981).

These collocational links cover a wide spectrum. At one end of the range there are words which are optionally, but commonly, associated: *fresh-faced youths*, *buxom barmaids*, *rude adolescents*, *unruly hair*. These frequent associations merge into habitual connections or clichés: *agonizing decision*, *filthy lucre*, *bright and early*, *hale and hearty*. Clichés overlap with idioms, phrases whose overall meaning cannot be predicted from the sum total of the individual words: *keep tabs on*, *fall into place*, *call it a day*.

Idioms appear to be treated by humans as if they were ordinary, single lexical items (Swinney and Cutler, 1979; Cutler, 1983; Gibbs and Gonzales, 1985). They cause no special processing difficulty, even though there are thousands of them – *Longman Dictionary of English Idioms* lists over 4,500.

Collocational links, then, seem to be powerful and long-lasting. They may be as strong as connections between co-ordinates. It is not immediately clear, however, how these two different types of link intermesh, and whether one has priority over the other – though more information on this topic will crop up in the next chapter, when we consider how children acquire the meaning of words (chapter 8). Meanwhile, let us now move on to other types of links.

The old man with a beard

There was an Old Man with a beard,
Who said, 'It is just as I feared!
Two Owls and a Hen,
Four Larks and a Wren,
Have all built their nests in my beard!'

Try reading Edward Lear's limerick about the Old Man with a beard to a friend. Then ask the friend to summarize the content of the poem. The reply is likely to be something like: 'There's this old chap with a beard, and a whole lot of birds come and build nests in it.' Almost everybody uses the word *bird* in their reply, even though it is not explicitly mentioned in the original. People, then, know that *owls*, *hens*, *larks* and *wrens* are 'hyponyms' of the cover term or 'superordinate' *bird*. Does this imply that words are always kept in bundles, labelled with the superordinate term?

There are several problems with assuming that the labelling of bundles is an inevitable procedure. First, superordinate terms do not crop up very often as errors in slips of the tongue (Hotopf, 1980), although they are commoner in aphasia. It may be that such slips are not noticed: 'That wretched *animal*'s been digging up my bulbs again' sounds quite normal and would not be categorized as an error, even though the speaker might have intended to say *cat*. But the rarity of this type of error may also be because a superordinate term is not always easily available. It is often quite difficult to think up a suitable superordinate, and some of the ones that exist are quite rare. Lots of people talk about *knives* and *forks*, *cups* and *saucers*, and *brothers* and *sisters*. But not all of these talk about *cutlery*, *crockery* and *siblings*. And what about *baths* and *basins*? Are these bathroom fixtures? Or sanitary fitments? Or take the tongue-slip *tin-opener* for 'nutcrackers': are these 'kitchen gadgets for opening things which are going to be consumed'? Although people appear to link groups of items together, they may not give the resulting bundle a label.

Furthermore, not all members of a category are on an equal footing (chapter 5): it turned out to be easier to categorize a prototypical bird such as a *robin* as a 'bird' than a slightly odd one such as a *pelican*. Perhaps because of this problem, almost all experiments which have tried to find out about the relationship between hyponyms and their superordinates have been somewhat unsatisfactory. Let us consider some of these.

The process of grouping and labelling can often be repeated several times, because each item in a group can usually be subdivided. *Owls* can be split into *barn owls*, *snowy owls*, *screech owls*, and so on. And a superordinate is also likely to be included in a still higher category: *birds* form a group with *fish*, *insects*, and so on, within a category of *animal*. This progressive layering can be envisaged as a type of upside-down tree (figure 7.4).

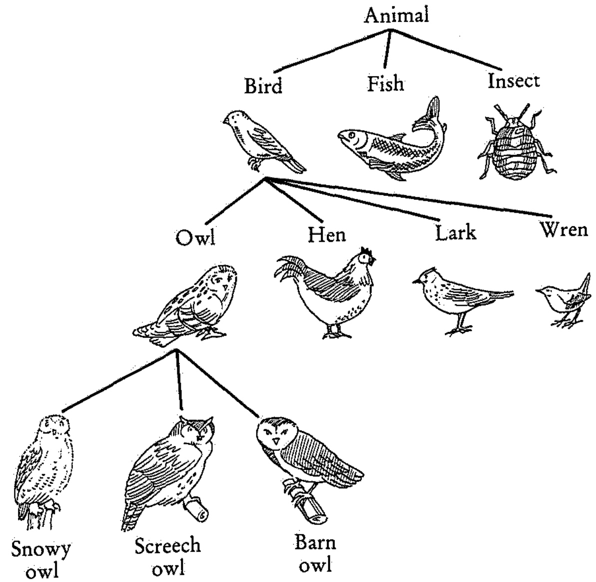

Figure 7.4 Layers of superordinates

In the late 1960s and early 1970s a number of researchers proposed that this was how the mental lexicon might be organized – in hierarchical structures of the type described above. One of the earliest papers on the topic was by Collins and Quillian (1969). They suggested that one could test this idea by asking subjects to verify sentences such as 'A canary is a canary' or 'A canary is a bird' or 'A canary is an animal', and timing how long they took to do this. They assumed that the further a person had to travel on the tree in order to verify a sentence, the longer it would take. According to this theory, 'A canary is a canary' should be verified very fast, as there is no need to travel at all. 'A canary is a bird' should take a little longer, as an adjacent node has to be reached. 'A canary is an animal' should take longest of all, since it involves travelling from *canary* to *bird*, then from *bird* to *animal* (figure 7.5).

These predictions turned out to be correct. However, their findings do not conclusively prove the existence of upside-down trees, since there are a number of other possible reasons for the result. First, *canaries* and *birds* are associated much more frequently than *canaries* and *animals*, so the effect could be caused

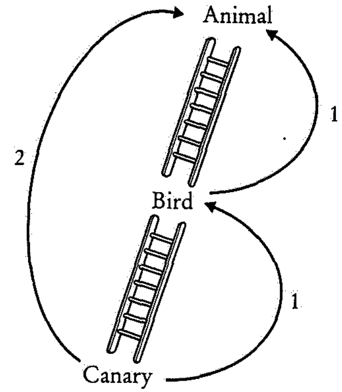

Figure 7.5 The canary—bird experiment

by a strong habitual association rather than a hierarchy. Second, there are many more possible animals than possible birds, so maybe the difficulty of assessing 'A canary is an animal' is due to the large number of items in the category *animal*. Third, the word *animal* is ambiguous: sometimes it is used in contrast to *bird*, as in 'An owl is a bird, but a dog is an animal', and at other times its includes the word *bird*, as in 'Owls and dogs are animals, but roses and oak-trees are plants'. This ambiguity might have delayed assessment time.

This last problem can be avoided by testing people on creatures which are more usually thought of as animals, such as *dogs* (Johnson-Laird, 1983: 214). The psychologists who tried this incorporated a subtle but significant difference into the task. They noted that almost all previous experimenters had contrasted the time taken to verify a link from one word to its immediate superordinate, as in 'A poodle is a dog', with the time taken to verify a link to an even higher superordinate, as in 'A poodle is an animal'. No one seemed to have checked whether 'A dog is an animal' (one step) also took less time than 'A poodle is an animal' (two steps), as the theory would predict. The researchers were unable to find any reliable difference. Subjects in general took as long to verify 'A dog is an animal' as 'A poodle is an animal'. This result suggests that even if people organize words in clumps, it is unlikely that they climb nimbly up and down lexical trees as if they were fixed scaffolding.

To summarize, superordinate labels may be easily available when the contents of a group are fairly prototypical and the label is a commonly used one. But this vertical movement, as it were, between different levels of generality seems to require somewhat more effort than horizontal movement among co-ordinates. In a number of cases, creative decision-making may have to be carried out. Faced with a question such as 'Is a tadpole an animal?', a person might well have to think this out. They might be quite sure that a *tadpole* is a small frog, and also that a *frog* is a kind of animal, but they might have to actively deduce that a tadpole is therefore an animal from these two separate pieces of knowledge.

In some cases, then, vertical links are likely to have been pre-established, and no further reasoning will be required. In other cases, humans have to make inferences on the spot. Similar active computation may also be required when one superordinate links words from different areas, such as *female*, which links *sow*, *princess*, *mare*. Humans can compare different words and decide what they have in common quite easily (to be discussed in chapter 13). However, unless the link is a commonly used one, it seems likely that humans work out the connection by performing a quick analysis rather than simply consulting a fixed chart in their mental lexicon. In brief, the treatment of superordinates suggests that firm connections, such as those between co-ordinates and those between common hyponyms and superordinates, are used in conjunction with our reasoning ability to make other temporary links as we need them.

Chasing or pursuing shadows

Humans have a pretty good idea as to which words are interchangeable. Perfect synonymy – total overlap of meaning – is somewhat rare, but many words are intermittently interchangeable. Shadows are *chased* in Matthew Arnold's poem 'The Buried Life':

> A man . . . doth forever *chase*
> That flying and elusive shadow, rest.

But they are *pursued* according to the orator Edmund Burke:

> . . . what shadows we are, what shadows we *pursue* . . .

Yet this interchangeability is not general. *Pursue* is normally preferred when the object of pursuit is desirable: we *pursue* wisdom, knowledge, 'the elusive butterfly of love', but we *chase* burglars and runaway horses. Humans control this variation in use without apparently thinking about it. How, then, does the mental lexicon cope with it?

Blends – when two words are amalgamated into one – occur most often when the words concerned mean more or less the same thing, and when either word would have been appropriate, as in:

I *climbered* (climbed + clambered) into bed.
That's *torrible* (terrible + horrible).

Words which are truly interchangeable, therefore, may well be closely connected, in the same way that co-ordinates are closely connected.

But what about words which are similar in meaning rather than interchangeable? These are sometimes found in the tongue-slips:

I don't know many *brands* (species) of tree.
These components are *extinct* (obsolete).
He has some *amending* (redeeming) features.
Facts learnt fast need to be *confirmed* (reinforced).
The *inhabitants* (occupants) of the car were unhurt.

However, this type of slip is relatively rare, according to at least one researcher (Hotopf, 1980). Why? There are two differing types of explanation. The first is that many of the near synonyms fit well into the vacant slot, so well that they are either as good as the right word or so close a fit that no one notices the error. The other is that these types of error are indeed rare, because the mental word-web deals with synonyms differently from contrasting co-ordinates, such as *black* and *white*, *robins* and *thrushes* (Hotopf, 1980). This might be because different words tend to get attached to different semantic fields: *plump* might get activated in dealing with grapes or peaches, whereas *fat*, *rotund*, or *obese* is unlikely. This point of view predicts that near synonym errors would occur mainly in word searches, as a back-up procedure when the most obvious word was temporarily unavailable.

Both points of view are possibly correct to some extent. But the lack of error involving similar meaning words in different semantic fields suggests that they are kept apart by the fact that they belong to a different semantic area. Otherwise, eggs would *curdle*, milk would *rot* and tomatoes would go *rancid* far more often than they in fact do.

Word-web conclusions

We have now considered various kinds of links found between words. Bonds between co-ordinates and collocational links were found to be particularly strong (figure 7.6), and so were links between interchangeable synonyms. Links between a word and its superordinate were firm when the superordinate was

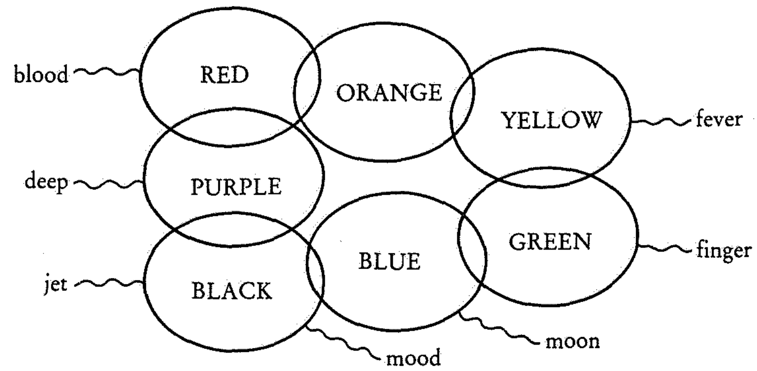

Figure 7.6 Strong links in the word-web

a frequently used term and when the words came from the same general meaning area, such as *bird* which included *robin*, *thrush*, and so on. All these findings support the suggestion that words from the same semantic field are closely linked.

In contrast, bonds between words from different semantic fields were somewhat weaker. Near synonyms from different semantic fields seem not to be particularly common in slips of the tongue, and superordinate links from different semantic fields seem to require active reasoning.

Let us now complete this chapter by considering further evidence for the weakness of links between different semantic fields.

Saucepans yes, oranges no

'I've forgotten', said an aphasic patient, when asked to define a *needle*. Asked about the word *carrot*, he said, 'I must once have known', to *mosquito* his reply was 'It sounds familiar', and to *geese*, 'An animal, I've forgotten precisely'. But the same patient defined a *pact* as 'friendly agreement', *supplication* as 'making a serious request for help' and *knowledge* as 'making oneself mentally familiar with a subject' (Warrington, 1981). He was able to cope with certain types of topic but not others.

At first sight one might suggest that he simply had a neurotic block about some kinds of word. But an ability to handle some semantic fields and not others has now been reported in quite a few patients. One of the earliest studies on the topic tested the vocabulary of 135 patients within a number of general areas, such as colours, actions, numbers (Goodglass *et al.*, 1966). The researchers found that in several of these patients the performance across these different areas was quite uneven.

One possibility is that these patients had lost the ability to deal with certain types of lexical organization: the first patient could cope with abstract words but not concrete objects; the other patients might have had difficulty with colours because of their graded nature. But this explanation cannot account for the problems of every aphasic of this type, some of whom have deficits in quite precise areas. One man knew the names of kitchen utensils but not the names of fruit. He could name items of clothing but not types of cloth. And he could name tools but not kinds of metal. Another woman was significantly better on food words than on objects (Warrington, 1981).

Fruit and vegetables were a problem for another patient (Hart *et al.*, 1985). This 34-year-old male had a stroke in 1981 which at first left him almost totally speechless. But he gradually recovered, and after 18 months appeared to be better – apart from fruit and vegetables. He 'showed a striking inability to name such common items as Peach and Orange while able to name easily less frequent items such as Abacus and Sphinx' (Hart *et al.*, 1985: 439). He was not entirely hopeless at dealing with these, and scored just over 60 per cent in

a naming test. But this was a strange contrast to everything else in his world, which he apparently coped with just about normally – including other food items.

These cases suggest that topic areas are stored to some extent independently, and that some semantic fields can be damaged without involving others, even though in normal speakers one would not expect this degree of isolation between areas.

Summary

In this chapter we have examined the human word-web – the way in which humans link words together in their minds. We noted that words seem to be organized in semantic fields, and that, within these fields, there are two types of link which seem to be particularly strong: connections between co-ordinates and collocational links.

Links between hyponyms and their superordinates are overall somewhat weaker. Some are more firmly established than others. Humans then use these firm connections in conjunction with their reasoning ability to make other, temporary links as they are needed. Connections between different topic areas may also be weak, and made on the spot by means of active matching and decision-making.

Let us now go on to consider how children cope with the meaning of words: finding out how the human word-web is acquired may also give us further clues as to its overall structure.