CHAPTER 15

The Shadows of Lexical Meaning in Patients with Semantic Impairments

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Central in the processing of words is the retrieval of their meaning. Neurological diseases can affect the processing of lexical meaning in a number of ways. First, various examples of semantic impairments are discussed, including semantic paraphasias, deep dyslexic reading errors, and category-general and category-specific impairments in the semantics of concrete nouns. Next a number of theoretically relevant issues in studies on semantic impairments are discussed: (a) the concreteness effect, (b) impairments of perceptual versus functional information, (c) amodal versus multiple semantic systems, and (d) access impairments versus storage deficits. On the basis of a review of the neuropsychological evidence, it is proposed that the representation of lexical meaning consists of conceptual structures tied to models that are tailored to the requirements of the different sensory systems and the motor system.

A central notion in all models of language production and language comprehension is the mental lexicon. The mental lexicon refers to the knowledge of the language user about the words of his/her language(s). This knowledge specifies not only the

sound pattern and the orthography of words, but also their grammatical properties (e.g., word class, gender), their morphological structure, and their meaning. Both neuropsychological evidence and recent brain-imaging studies have shown that these different types of word knowledge are represented in widely distributed areas of the brain.

The role of the mental lexicon in language processing is to mediate between different representational domains, including form (sound, orthography) and meaning. To do this effectively, the mental lexicon has to contain information about a large number of words. For instance, an adult speaker of English has an estimated passive vocabulary of at least 40,000 words (Nagy & Herman, 1987). On the basis of the spoken or written input, the best matching word form in the mental lexicon is selected. As a result, the adult speaker of English gains access to all the information associated with this particular word form. For instance, he or she knows that it is a noun or a verb, that it refers to an animal that flies, or to the act of flying, and so forth.

This chapter focuses on the processing of a central aspect of words, namely, lexical meaning. Although there is some disagreement about whether the meaning of words should be treated as lexical knowledge per se, there is no disagreement about the centrality of meaning in word processing. The centrality of meaning is further supported by the neurolinguistic literature, which provides ample evidence that brain damage can affect the ability to select (in speaking and writing) and recognize (in listening and reading) the appropriate lexical-semantic representations.

15-1. SEMANTIC IMPAIRMENTS

Ideally, a neurolinguistic theory of semantic impairments is based on an explicit account of how lexical meaning is represented in the unaffected language system. However, surprisingly enough, the nature of meaning representations has not played a major role in studies of semantic impairments. In these studies, the two central themes of the last decade are (a) category and modality specificity of semantic impairments and semantic representations, and (b) degraded representations versus access impairments. Often these issues are addressed without clear statements about the notion of meaning representation that underlies the interpretation of the results. However, it is not at all clear that satisfying answers to the questions involved can be given in the absence of an explicit account of meaning representations.

To set the stage for discussing a number of theoretically relevant issues in the semantic impairment literature, I will first describe a few symptoms and syndromes associated with impairments at the level of lexical-semantic processing.

15-1.1. Semantic Paraphasias

A common symptom in patients with a Wernicke-type aphasia are so-called semantic paraphasias. In this type of paraphasia, a word is produced that deviates in meaning from the intended word (Poeck, 1982). The actually produced word very often has some semantic similarity to the intended word. For instance, an aphasic patient whom

I asked to describe a picture of a man reading a newspaper replied, "The man reads the radio." Another aphasic patient said in an interview about his disease that he "became deaf in his eye." When tested in a word–picture-matching task, such patients regularly correctly match words like *newspaper* and *radio* to the relevant picture, indicating that the semantic specifications of the intended words are still largely intact. The observation that semantic paraphasias are often in the same semantic field as the intended word (e.g., *radio–newspaper, deaf–blind*) suggest that they are not unlike a particular type of speech error in normal speech, namely, word substitutions (cf. Levelt, 1989).

15-1.2. Deep Dyslexia

Word substitutions on the basis of sensory instead of conceptual input are found in patients with deep dyslexia. Deep dyslexia is an acquired reading disorder with semantic errors as its most striking symptom. A patient with deep dyslexia might, for instance, read the orthographic string RIVER as "ocean." However, the actual error pattern is complicated by the presence of a number of co-occurring symptoms. These include visual errors (SCANDAL read as "sandals"), morphological errors (SELL read as "sold"), and a better performance for concrete than for abstract words. Different explanations have been given for this clustering of symptoms. One possibility is that in fact we are faced with a number of independent deficits that co-occur for anatomical reasons. The brain damage happened to affect anatomically proximal areas subserving independent language functions. However, no evidence has been obtained in direct support of this hypothesis.

An interesting attempt to explain the co-occurrence of semantic and visual errors as well as the concreteness effect is found in a connectionist model of acquired dyslexia (Hinton & Shallice, 1991; see Plaut & Shallice, 1993a, for a detailed account of the model). In this model, patterns of activation in the layer of orthographic units are converted into associated patterns of activity in the layers representing the semantic space. If the initial pattern of activation within the semantic space falls within the region of a particular meaning, the pattern of activation converges on the pattern of activation representing that meaning (see Figure 1). These regions of convergence are called the basins of attraction.

In the model, the basins of attraction for words with similar meanings tend to be in close proximity. In addition, the attractor basins for similarly spelled words tend to be close to each other. Similarly spelled words are thus mapped onto nearby points in semantic space (see Figure 1). Damage to this network (e.g., removal of subsets of the nodes or connections, or addition of noise to the weights on the connections) can change the boundaries of the basins of attraction. As a result, the initial pattern of activation in semantic space might fall into an incorrect basin of attraction. Because both semantically and orthographically related words are likely to have nearby basins of attraction, when the initial pattern of semantic activation falls into the incorrect basin, either a semantic (CAT read as "dog"), a visual (CAT read as "can") or a mixed error (CAT read as "rat") might result.
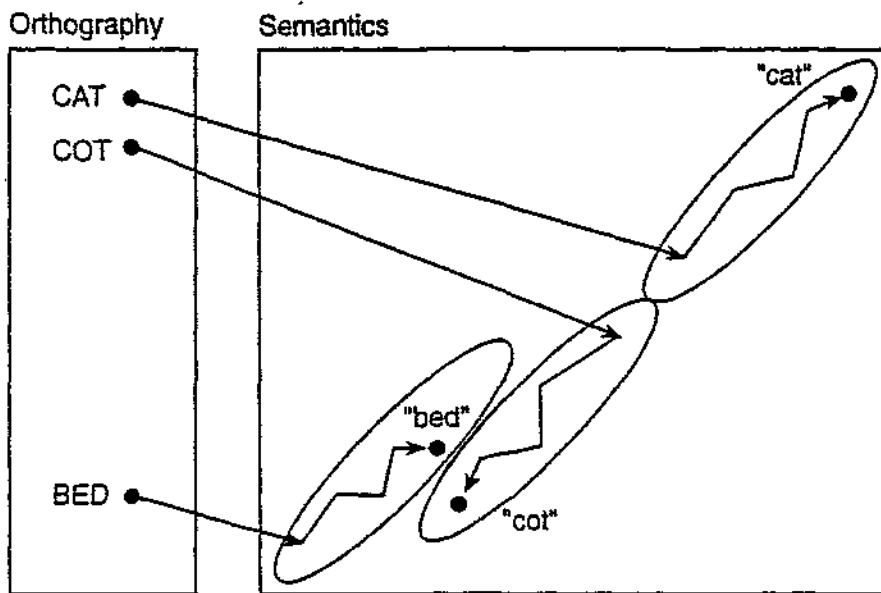
Orthography   Semantics

FIGURE 1   A representation of the basins of attraction at the semantic level of the attractor network for reading (after Plaut & Shallice, 1993). The solid ovals depict the basins of attraction. Information is converted from the orthographic layer (CAT) to a position somewhere in semantic space. As a result of activity in an additional layer of the network (i.e., the cleanup layer), this position is drawn to the point corresponding to the closest meaning ("cat"). Whenever the network's initial semantic output appears within a basin of attraction, the network's state will inexorably be drawn to one position within the region. This position is the point in semantic space that represents the meaning (e.g., "cat") that is associated with the orthographic input (e.g., CAT). However, a lesion in the network can change the boundaries of the basins of attraction. As a result, CAT might fall into the basin of attraction of "cot."

Although this connectionist model nicely accounts for the clustering of errors in deep dyslexia, there is very little independent evidence to date for a nonarbitrary mapping between orthographic and semantic representations (Rueckl & Dror, 1994).

15-1.3. Semantic Dementia

In recent years, an increasing number of patients have been reported with a progressive, degenerative brain disease that initially shows up as a selective semantic impairment. This disorder is known as semantic dementia (Hodges, Graham, & Patterson, 1995; Hodges, Patterson, Oxbury, & Funnell, 1992; Snowden, Goulding, & Neary, 1989). Brain-imaging data indicate that temporal lobe damage, predominantly in the left hemisphere, is crucially involved in the disease process. Semantic dementia should be distinguished from a syndrome called primary progressive aphasia (PPA; Mesulam, 1982). PPA is also a progressive, degenerative brain disease. However, in this case the impairment of the phonological and syntactic aspects of language is most prominent, whereas comprehension is relatively preserved.

Patients with semantic dementia can often only produce the category name when confronted with a picture or a name (e.g., *geese*—"an animal, but I've forgotten precisely"). On the whole, these patients show a fairly consistent pattern of breakdown, with loss of knowledge about semantic attributes, but relatively long-term preservation of superordinate category information. Hodges et al. (1995) tested patients with semantic dementia longitudinally during their progressive disease on a series of semantic tests, including naming of the Snodgrass pictures. A characteristic longitudinal performance pattern is illustrated by patient J.L., who responded as follows to the picture of an *elephant* in four different sessions over a 1.5-year period: (1) "elephant," (2) "horse," (3) "horse," (4) "animal." There is a clear progression from the specific, correct response to a prototypical instance of large animals ("horse") to the generic "animal" response. Semantic dementia patients usually show a parallel decline in tests of comprehension and production. This parallel decline suggests that a central semantic deficit underlies the semantic impairments observed in different language modalities.

I have given a few examples of neurological syndromes with semantic impairment as one of their most salient characteristics. In the remainder of this chapter, I will focus on a few theoretically interesting aspects of the reported semantic impairment symptomatology (for an excellent review, see Saffran & Schwartz, 1994). These are *(a)* the concreteness effect, *(b)* impairments of perceptual versus functional information, *(c)* amodal versus multiple semantic systems, and *(d)* access impairments versus degraded representations.

15-2. THE CONCRETENESS EFFECT

Brain-damaged subjects often show a better performance in the production and comprehension of concrete words than abstract words. Normal subjects also show a processing advantage for concrete words, but this effect is strongly amplified in patients. It has been known for a long time that, in general, aphasic patients are more impaired in retrieving abstract words than concrete words. The same holds for patients with reading disorders such as deep dyslexia.

One can find at least three different accounts of this concreteness effect in the literature (Breedin, Saffran, & Coslett, 1994). According to Paivio (1991), the advantage for concrete words is due to the existence of a dual code for this class of words, one verbal and the other nonverbal (imaginable). Abstract words, in contrast, only activate a verbal code.

The context availability account of Schwanenflugel (1991) explains the effect by assuming that concrete words are embedded in a larger body of associated contextual-perceptual information in memory than are abstract words.

Finally, a third possibility is that concrete words are represented by a larger set of semantic features than abstract words (Plaut & Shallice, 1993a). When there is an impairment of the mapping of orthography onto semantics in the Hinton and Shallice model of acquired dyslexia (Hinton & Shallice, 1991), the reading of abstract words

is more affected than the reading of concrete words; that is, lesioning the network has the strongest consequences for words with a relatively sparse semantic representation.

All three accounts thus assume that concrete words activate a richer representational structure in memory than do abstract words. In general, this makes concrete words easier to access and remember, and less vulnerable to brain damage. However, this shared feature of the accounts of the concreteness effect cannot easily explain the cases of patients who are better at retrieving abstract than concrete word information. At least five such cases have been reported in the neuropsychological literature (Breedin et al., 1994). This reversal of the concreteness effect has potential implications for our understanding of the nature of semantic or conceptual representations.

Breedin et al. (1994) argue that a crucial difference between concrete and abstract words resides in the sensorimotor (including perceptual) attributes of the former. On this account, attributes of perception and action are part of the representations of concrete but not of abstract words. Selective impairment of these sensorimotor attributes might be a core aspect of the semantic disorder of patients with a reversed concreteness effect. The observed double dissociation between impairments of concrete and abstract words implies that there is more than just a quantitative difference in their representational structure. To account for the full set of patient data, it seems necessary to assume and specify qualitative rather than only quantitative representational differences between concrete and abstract words.

15-3. IMPAIRMENTS OF PERCEPTUAL VERSUS FUNCTIONAL INFORMATION

Further evidence for the importance of sensorimotor attributes in the representation of concrete nouns comes from patients with category-specific deficits. Elizabeth Warrington and her colleagues especially (for an overview, see McKenna & Warrington, 1993) have reported a number of single cases in which semantic knowledge of either objects of nature (e.g., animals, fruits, vegetables) or man-made artifacts (e.g., tools, furniture, kitchen utensils) was selectively impaired. So far, more cases have been reported with a loss of knowledge of living things than of artifacts. However, generally the number of cases is too limited to determine whether this distributional difference is meaningful.

Patients with category-specific deficits show, among other things, striking differences in the adequacy and specificity of their definitions for words from the two classes. One patient (J.B.R.), for instance, described a *briefcase* as a "a small case held by students to carry papers," but when asked to define *daffodil*, J.B.R. could only come up with "plant." Although it has been suggested that these category-specific deficits can be attributed to a lack of control over differences in the familiarity and visual aspects of the stimuli, it is unlikely that one can attribute all the reported cases to imperfect testing procedures (Saffran & Schwartz, 1994).

A theoretically important issue raised by the reports of these category-specific deficits is to determine the precise nature of the semantic dimension that cuts the semantic impairment pie into living and nonliving things. The best candidate seems

to be the distinction between perceptual and functional attributes. Warrington and Shallice (1984) suggested that sensory attributes are very salient features for the identification of living things such as animals or fruits. In contrast, functional attributes are probably more important than perceptual characteristics for the identification of artifacts such as tools. Recent empirical evidence supports the claim that visual features are more salient in definitions of living things than of artifacts (Farah & McClelland, 1991).

In a further refinement of this account, Warrington and McCarthy (1987; McCarthy & Warrington, 1990b) have proposed that the contributions of sensory (perceptual) and motor (functional) channels are differentially weighted not only between but also within categories. For instance, within the category of artifacts, small manipulable tools are associated with a repertoire of skilled movements, and hence rely more heavily on motor channels than do large man-made objects such as airplanes. Airplanes are probably not too different from birds in their reliance on sensory channels for identification and categorization.

15-3.1. Evidence from Brain-Imaging Studies

Supportive evidence that there is a relation between conceptual knowledge and brain systems for perception and action comes from a PET study by Martin, Wiggs, Ungerleider, and Haxby (1996). In this study, subjects were asked to name pictures of animals and of tools. For pictures of both kinds, bilateral activation was obtained in ventral regions of the temporal lobes. The naming of animals resulted in additional activation in the left medial occipital lobe, an area involved in visual processing. In contrast, the naming of tools led to additional activation in the left premotor area and an area in the left middle temporal gyrus. These areas are close to cortical tissue that is active when using objects and perceiving motion. The authors conclude that the brain circuitry underlying the conceptual representation of objects includes regions that are particularly well suited for the processing of their most salient meaning aspects (perceptual, functional).

This evidence is largely compatible with an analysis of the lesion data of patients with disorders in the identification of living things versus man-made artifacts. On the basis of a review of the lesion data of the known cases, Gainotti, Silveri, Daniele, and Giustolisi (1995) conclude that the lesion distribution of these two patient types suggests a dominance of areas for visual object processing (living things) versus areas that are especially important for somatosensory and motor functions (man-made artifacts).

In conclusion, the neurological evidence seems to be compatible with the distinction between perceptual and functional attributes as an important metric for semantic categorization.

15-3.2. Implications for Lexical Semantics

Although the category-specific deficit data support the importance of a distinction between perceptual and functional attributes for concept retrieval, their full interpretation with respect to the processing of lexical meaning is dependent on one's theory

of semantics. For instance, one influential theory of semantics makes a distinction between the core of a concept and nondefining features that are usually used for a quick identification of the concept (Armstrong, Gleitman, & Gleitman, 1983; Osherson & Smith, 1981). Neither the patient data nor the PET results allow one to determine whether it is the core aspects of meaning that are represented in the area of lesion or activation. The alternative option is that the identification procedures are localized in the visual and sensorimotor areas, whereas the core meaning aspects are represented in other brain areas. The lack of an explicit account of meaning in many neuropsychological studies of semantic impairments certainly adds to the confusion about the interpretation of the results. The same holds for recent brain-imaging studies in the area of semantics (Caramazza, 1996; Damasio, Grabowski, Tranel, Hichwa, & Damasio, 1996; Martin, Haxby, Lalonde, Wiggs, & Ungerleider, 1995; Martin et al., 1996; Ungerleider, 1995).

Jackendoff's account of conceptual-semantic structure might be of help here. Jackendoff (1987) argues that the representation of a word in long-term memory includes not only a description in a propositional format, but also an abstract visual-geometric description (a 3-D model, in Marr's terminology). This claim "reflects the intuition that knowing the meaning of a word that denotes a physical object involves in part knowing what such an object looks like" (p. 104). A similar idea is present in some instances of prototype theory in which word-meaning representations contain an image of a stereotypical instance. But the proposed 3-D model is a more abstract representation in which objects are spatially decomposed into parts and subparts in a viewer-independent orientation.

The neuropsychological data and the results from brain-imaging studies, however, indicate that Jackendoff's theory of lexical semantics needs further extension. Not only is a 3-D model part of word knowledge in semantic memory, but, for certain classes of words, the functionally relevant motor aspects might be represented as well. According to Jackendoff (1987), these functional aspects can be dealt with in the 3-D model too. However, the empirical data indicate that functional aspects might actually need to be specified in a structural description of another kind, more tailored to the properties of the motor system. Crucially, Jackendoff's account points toward ways of enriching the lexical-semantic representations of concrete nouns with specifications of their perception and action attributes in terms of their respective formats.

15-4. MULTIPLE SEMANTIC SYSTEMS?

An issue that has led to considerable controversy in the last decade is whether there is one amodal semantic system, or different, independent, and modality-specific semantic representations. The empirical evidence for this latter option consists largely of semantic impairments that only occur in one input modality (for relevant ERP data, see Ganis, Kutas, & Sereno, 1996). McCarthy and Warrington (1988) reported a patient (T.O.B.) with a selective impairment for animals. However, this impairment was only observed when animal names were presented verbally, but not when presented

as pictures. For example, T.O.B. gave as definition for the spoken word *rhinoceros:* "Animal, can't give you any further function." However, when shown a picture of a rhinoceros, he gave a much more specific description: "Enormous, weighs over one ton, lives in Africa." Warrington and McCarthy (1994) have reported a patient with a category-specific deficit for common objects such as knives, cups, and so forth, but only when visually presented. On the basis of these case reports, Warrington and McCarthy (1994; see also Shallice, 1993) hypothesize that there are modality-specific meaning systems (e.g., visual semantics and verbal semantics). On the basis of the occurrence of similar category-specific deficits in the verbal and the visual semantic systems they claim that the organizational principles (e.g., sensory versus functional core aspects) are the same in these two modality-specific semantic systems.

The notion of multiple modality-specific semantic systems has been strongly criticized (e.g., Caplan, 1992; Caramazza, Hillis, Rapp, & Romani, 1990; Rapp, Hillis, & Caramazza, 1993; Saffran & Schwartz, 1994). A major problem is that no specification of visual semantics is given. Is it something like Marr's 3-D model? Jackendoff (1987) has convincingly shown that a 3-D model alone is insufficient as a conceptual representation of objects. In the absence of an articulated account of visual semantics, it is unclear what the notion of visual semantics will do for us. In addition, the data clearly do not exclude the possibility that it is modality-specific access (or identification) procedures that are impaired rather than modality-specific conceptual knowledge itself.

Since this chapter is about lexical meaning, the focus is on semantic representations that are tailored to the verbal system. Therefore, it is sufficient to conclude that, intriguing as these modality-specific semantic impairments are, the implications for representational and processing accounts of lexical meaning are far from clear.

15-5. IMPAIRED ACCESS VERSUS LOSS OF SEMANTIC KNOWLEDGE

So far in my discussion of the different semantic impairments there has often been the implicit assumption that these impairments impact the lexical-semantic representations, whatever their characterization. However, this is not the only possibility. It might well be that the brain damage affects the access or retrieval operations rather than the representational structures themselves. Therefore, it is important to determine whether an observed semantic deficit is due to the loss or degradation of word-meaning representations (a storage deficit), or to a failure in the routine procedures called upon to access and exploit these representations in real time (an access deficit).

It is not easy to formulate criteria that allow an unambiguous distinction between these two general options (for an in-depth treatment, see Shallice, 1988). One reason for this is that the nature of neither lexical-semantic representations nor access operations is sufficiently specified (cf. Rapp & Caramazza, 1993). Nevertheless, a number of criteria have been defined to distinguish between impaired access and loss of

semantic knowledge (e.g., Shallice, 1988; Warrington & Shallice, 1979; for criticism of these criteria, see Caplan, 1992; Rapp & Caramazza, 1993).

15-5.1. Consistency in Performance

One important criterion for distinguishing between impaired access and loss of semantic knowledge is item consistency in performance. In the case of degraded semantic representations, it is predicted that the inability to identify or name an item should be consistent over time and across tests. In contrast, an access impairment is associated with performance variability across time and tests for the same item. For patients with dementia of the Alzheimer type (DAT), consistency in performance has been reported in a number of cases. The same names they failed to produce in a picture-naming task were the ones they failed to recognize in a word-to-picture-matching test (Chertkow & Bub, 1990; Huff, Corkin. & Growdon, 1986). In addition, Chertkow and Bub (1990) reported that on a retest, a group of 10 DAT patients failed to name 92.5% of the items that they were unable to name during an earlier testing session. This consistency in performance across tests and over time is in marked contrast with the absence of consistency across a range of semantic tests in a group of aphasic patients with impaired language comprehension (Butterworth. Howard, & McLoughlin, 1984).

Consistency measures suggest that in Alzheimer patients we see a real breakdown of semantic representations, whereas in aphasic patients an access impairment is more likely than a semantic breakdown. However. since only a limited number of studies have explicitly tested item consistency, these effects need replication. In addition. more stringent tests are required to unambiguously determine the locus of the knowledge degradation. For instance, the inability to name a picture might be due to a loss of the word concept. but it could also arise from an impairment at the level of word-form representations.

15-5.2. Semantic Priming

In the last decade or so, most studies that have addressed the issue of impaired access versus degraded representation have used the semantic priming technique. Since the early seventies (Meyer & Schvaneveldt, 1971), it has been a well-known and robust phenomenon in psycholinguistics that the processing of a word benefits from the presence of a preceding word to which it is related in meaning. For instance. subjects name the word *dog* faster when they have just seen (or heard) the word *cat* than when they have seen (or heard) the word *bar*. This processing advantage of the primed word *(dog)* is often attributed to the increase in activation that its concept node inherits from the related prime *(cat)*.

In the influential model of Collins and Loftus (1975; see Figure 2), lexical meanings are thought to be organized as a network of concept nodes, with the network's wiring diagram determined by semantic similarity: there are stronger and more direct connections for semantically related nodes than for unrelated nodes. Upon reading or
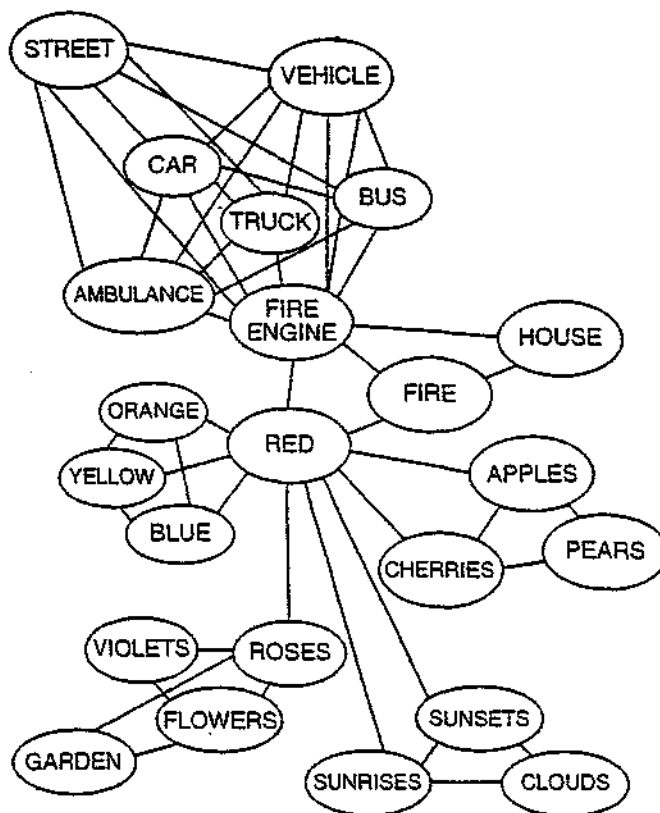
FIGURE 2 A nondecompositional model of word-meaning representations (after Collins & Loftus. 1975). Each node represents one concept. The wiring of the network is determined by semantic similarity. The links between the nodes represent the meaning relations between the concepts. The strongest semantic relations exist between concepts with short and direct links. Activation can spread from one concept to another via the links. The more direct a link between nodes, the more activation is received from a node related in meaning.

hearing the prime, its concept node gets activated and spreads parts of its activation to nearby nodes in the network. In this way, related words increase their levels of activation and require less processing time when these words are subsequently read or heard. This effect is very short-lasting, probably not longer than about 400 msec (Neely, 1977).

In recent years, an increasing number of neurolinguistic priming studies have appeared in the literature. In these studies, either aphasic patients with impaired comprehension or DAT patients were tested. These patients often show marked impairments when they are required to perform semantic judgments or other forms of explicit semantic evaluation. In marked contrast to their performance in explicit semantic tasks, a substantial number of studies report priming effects in such patients. In general, these priming effects have been taken as evidence that in many aphasic patients with semantic impairments, lexical-semantic representations are largely unaffected, but that

they have a problem in accessing these representations (see Hagoort, 1993, for an overview). For DAT patients the results of priming studies are less clear-cut, but the overall conclusion has been the same as for the aphasic patients (see Chenery, 1996, for an overview). However, for DAT patients the interpretation of the priming results is in contrast to conclusions based on their consistency scores (see Section 15-5.3).

Overall, the results of priming studies with aphasic and DAT patients suggest that an access impairment underlies their semantic deficits. However, some caution is warranted with respect to the conclusions of these priming studies, since significant priming effects as such are not necessarily clear evidence for an access deficit (cf. Moss & Tyler, 1995). I will discuss two concerns about the interpretation of priming effects.

The first concern is related to the locus of the observed priming effects. Most patient studies used words that were related either associatively (e.g., *bread–butter*) or both associatively and semantically (e.g., *dog–cat*). These associations might be due to frequencies of co-occurrence in the language input, so it cannot be excluded that links between associatively related words exist at the level of word forms. In the absence of firm evidence that the priming effects actually arise at the concept level, significant priming effects in patients are insufficient evidence for the integrity of lexical-semantic (concept) representations. In a few studies, priming in purely semantically related word pairs (e.g., *church–villa*) was compared to priming in associatively related pairs (Hagoort, Brown, & Swaab, 1996; Ostrin & Tyler, 1993). The comforting outcome of these studies is that the aphasic patients showed the same pattern of results for both types of relations.

A second concern is related to the priming mechanisms involved. Priming effects can be caused by quite different underlying processes (see for an overview, Neely, 1991). The automatic spreading of activation between concept nodes in semantic memory is one of the contributing mechanisms. But there are others, such as a postlexical matching of the prime and target for semantic overlap. This latter mechanism can easily explain priming under conditions of degraded representations. As has been observed by Warrington and others, in the absence of detailed semantic knowledge about a particular concept, patients still are often able to produce the category name (e.g., *animal*). It is exactly this kind of generic information that might be left intact in the case of a degraded semantic representation. Clearly, for pairs such as *dog–cat* a postlexical matching would still detect the category overlap, even in the absence of a more specific lexical-semantic structure. This illustrates the importance of testing priming under conditions that mainly or exclusively tap the spreading of activation through the lexical-semantic network itself (Hagoort, 1989, 1993). These conditions are realized by having very short time intervals between primes and targets, by presenting only relatively few related word pairs, and by avoiding as much as possible task components over and above the natural ones of listening or reading (Hagoort et al., 1996; Hagoort & Kutas, 1995). Priming that is obtained under these circumstances can be relatively safely interpreted as indicating intact lexical-semantic knowledge.

Priming studies can substantially contribute to our understanding of the nature of the semantic impairment. One major advantage of the priming technique is the implicit nature of the task. What subjects are required to do (e.g., lexical decision, or, in the

case of recording event-related brain potentials [ERP], just listening or reading) is in no way related to the actual question at stake, for example, whether or not patients are sensitive to the semantic relations between primes and targets. Sensitivity to or lack of sensitivity to these relations cannot easily be explained by reference to specific aspects of the task. However, priming studies will only contribute further to our understanding of the nature of semantic deficits if an attempt is made to tap the full richness of lexical-semantic structure by testing a whole range of semantic relations (e.g., antonyms, category-member, co-hyponyms, and so forth) for concrete as well as abstract words.

15-5.3. Consistency versus Priming

The complexities of determining whether the impairment is due to an access problem or to degraded representations become especially clear in the case of Alzheimer patients. On the basis of item consistency in their performance, it has been claimed that these patients suffer from a loss of semantic knowledge. However, the significant priming effects in most studies with DAT patients are taken as evidence for an access impairment (Chenery, 1996). Possible reasons for this inconsistency of results are that most priming studies with DAT patients have used only associatively related word pairs, that the presentation conditions of some studies have been insufficient to guarantee the contribution of automatic spreading of activation to the priming effects, and that still other studies have found excessively large priming effects (hyperpriming). Hyperpriming is indicative of a representational deficit under the assumption that degraded representations benefit more from spreading activation provided by the prime than unaffected semantic representations (Chertkow, Bub, & Seidenberg, 1989). However, Chenery (1996) has argued in her review that even when these factors are taken into consideration, the weight of evidence still favors an account in terms of an access impairment. Additional, finer-grained studies are needed to resolve the remaining inconsistencies and to determine the functional locus of semantic impairments in DAT patients.

15-6. CONCLUDING REMARKS

The literature on semantic impairments indicates that theories of lexical-semantic representations of nouns should be able to account for the qualitative differences in the semantics of abstract and concrete words, and for the perceptual versus functional attributes of different categories of concrete nouns.

To date, most accounts of semantic impairments suffer from vagueness about the presupposed nature of lexical-semantic representations and lexical-semantic processing. Warrington and Cipolotti (1996) define semantic memory as "a system which processes, stores and retrieves information about the meaning of words, objects, facts and concepts" (p. 611). However, nothing is said about the nature of the semantic representations for words, objects, concepts, and facts. What are the differences and

commonalties'between the semantic representations of these seemingly different memory items? These are issues that need to be addressed as well. It is, however, an unfortunate aspect of the semantic memory tradition that the fractionation of semantic memory into different components has received more attention than the representational structure of its content. Unless more explicit accounts of (lexical) semantics are given, it will remain difficult to decide whether patient data support explanations of semantic impairments in terms of multiple versus central semantic systems, in terms of access versus storage deficits, and so forth.

With respect to impairments in the processing of lexical meaning, we also need a better understanding of what exactly our task configurations tap. One thing that has become clear in recent years from brain-imaging studies on language is that seemingly subtle task differences have overriding consequences on the patterns of brain activation obtained (e.g., Price et al., 1994). This should make us realize that for answering questions about the underlying nature of semantic impairments, we need to be more explicit about the requirements for performing the task at hand over and above accessing lexical meaning. In essence, we often ask patients to solve a problem imposed by the experimenter, such as to match a word to a picture, to give a verbal definition on the basis of a picture or word input, or to pantomime a concept. Too often the peculiarities of these task requirements are not taken into consideration enough in the interpretation of the results.

Finally, I have suggested that a revised version of Jackendoff's theory of lexical semantics (Jackendoff, 1983, 1987, 1992) might be able to account for most of the empirical data. According to Jackendoff, word meanings are decomposed into a restricted set of primitive conceptual features, paired with an abstract visual description (a 3-D model). I have proposed extending this account with other matched pairs of conceptual structure and nonvisual sensory models, and models of action specified in a format that is tailored to the requirements of the motor system.

In my view, the major challenge of the coming years will be to close the gap between the intriguing findings in studies of different types of semantic impairment, the more recent brain-imaging data on semantic processing, psycholinguistic data on real-time processing of word meaning, and theories of word meaning. Only then will we begin to see the contours of a neurosemantic theory.

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