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Neurological Evidence For A Functional Basis for Lexical Categories Barbara Birch California State University-Fresno

Formal syntactic theories generally hold that lexical categories like noun or verb are marked +N or +V in the mental lexicon reflecting a semantic or inflectional basis for the distinction (Croft 1991, Chomsky, 1965). However, Hopper & Thompson (1984) argue that the nominal or verbal meaning and inflectional characteristics that any root has in a context depend on the extent to which that root fulfills nominal or verbal functions in the discourse, making the discourse function primary and the inflectional marking or nominal/verbal meaning secondary

The field of linguistics is now more open to cross-fertilization from neurology and I hope the opposite is also true. This paper is a somewhat preliminary attempt to discuss the nature of lexical categories in linguistic theory in a way that is informed by research done by neurologists with people with aphasia. It is also meant to outline what lexical categories are like so that neurologists acquire a more sophisticated view of them.

and derivative.

Aphasia research shows a very robust finding that in a number of languages, patients have differing problems with the production, but not necessarily the comprehension, of nouns and verbs both when they occur within contexts or without contexts. In general, verbs are more problematic for Broca's aphasics (McCarthy & Warrington, 1985; Miceli, Silveri, Villa, and Caramazza, 1984), and nouns cause more difficulty for Wernicke's aphasics (Caramazza & Hillis, 1991; Goodglass, et.al. 1966). There are several hypotheses to explain these findings: one is that of Miceli, et al., 1988, which we can call a Lexical Hypothesis and another is that of Bates, et al., 1991, which we can call the Semantic Hypothesis.

Lexical Hypothesis: The mental lexicon is divided into subcomponents based on lexical category. Broca's aphasics have more difficulty with verbs because there is a breakdown in the part of the lexicon where verbs are represented. Similarly, nouns are difficult for Wernicke's aphasics because they have a problem in the area where nouns are represented. Thus, dysfunction is lexical and not semantic or conceptual.

Semantic Hypothesis: Nouns and verbs differ in meaning. Noun meaning is related to object and verb meaning is

related to action. Kellogg, 1995, puts it thus: "....the anterior and posterior cortex is differentially involved in the representation and processing of action and object meanings. The cortical regions responsible for the semantic representation of actions lie near the motor cortex (commonly the site of damage for Broca's aphasics) and the cortical regions responsible for the semantic representation of object names draw input from sensory association areas, (which are areas implicated in Wernicke's aphasia)."

of these hypotheses are in accord with traditional or formal syntactic view of categories. First of all, they are distinguished from each other formally in the mental lexicon and second, the categories are meaning-based. However, as I have pointed out in previous publications, these two hypotheses about lexical categories find little support from other psycholinguistic literature (Birch, B. 1989, 1991, 1993; Cofer & Bruce, 1965; Wickens, 1970; Johnson-Laird, et.al., 1974.) In other words, the early and more recent psycholinguistic experiments provide little reason to think that the mental lexicon or semantic memory partitioned by lexical category or that words are lexical category information. 'tagged' with linguists would also argue that there is no good semantic basis for distinguishing nouns and verbs--it is too simplistic to say that nouns 'mean' things and verbs 'mean' actions. There is a third hypothesis to explain the findings from aphasia research which we will come back to shortly.

Let us return to Hopper and Thompson's theory that lexical categories are discourse or function based. Is there any support from aphasia for that view? While most aphasia studies have involved speakers of European languages like English or Italian, Bates, et al., 1991, looked at evidence from Chinese. In Chinese, nouns and verbs are not differentiated by morphological form or inflectional processes. Discourse function is indicated by word order and context. Bates found the same noun/verb dissociation in Chinese aphasics as well, indicating that it is discourse function which is the primary source of lexical category distinctions, casting doubt on claims that lexical categories are acquired primarily through evidence from morphology (Maratsos, 1982).

Bates et al. also found evidence that the noun/verb dissociation also occurs within lexicalized verbal compounds with a V-N structure, like 'look-book', meaning 'read'. If we assume that common compound words are

listed in the lexicon, and I think we should, then the distinction between noun and verb occurs somewhere other than in the lexicon. (See Birch, forthcoming, for further analysis of this finding.)

As one might expect, Bates used this evidence to argue against the Lexical Hypothesis and for her own Semantic Hypothesis, but there is some strong evidence against her hypothesis as well. Miceli, et al. (1984) found that when patients who have a deficit in verb retrieval are shown pictures of actions, they often substitute an related nominal form to describe the picture. Instead of 'cry' for example, they will say 'tears' or instead of 'swim' they will say 'flippers'. Miceli et al. argue convincingly that the problem for these patients is not in the meaning or the concept, but in the retrieval of the word class.

To summarize, there is good evidence that the noun/verb production dissociation found in aphasics is not necessarily due merely to problems in the lexicon nor to problems with conceptualizing. Bates et al. and Miceli et al. have shown each other's theories to be lacking in complexity. Also, there is evidence from Chinese that lexical categories are functionally based not formally based.

Now let me present the third hypothesis to explain the noun/verb problem in aphasics, which I call the **Cognitive Hypothesis**. Other recent evidence from neurolinguistics is consistent with the view that for English speakers at least, although there may be no difference in the lexicon or semantic memory, there is some kind of cognitive difference between nouns and verbs. Damasio & Damasio (1993) conclude the following from a study of brain damage and verbal ability in three aphasic patients:

....the systems which mediate access to concrete nouns are anatomically close to systems which support concepts for concrete entities [and]....the systems which mediate access to verbs are located elsewhere and are anatomically close to those which support concepts of movement and relationship in spacetime....It seems plausible that the systems which enact the two-way linkage between concrete entity concepts or action concepts, and the corresponding nouns or verbs, should also be relatively separate albeit interactive.

I understand this view to be that there is a dynamic lexicon which is undifferentiated with respect to noun and verb and that there are action/relation and thing concepts in a dynamic semantic memory. Mediating between the lexicon and the different types of concepts and accounting for lexical access are two different interactive systems, one which results in nouns and one which results in verbs. Deficiencies in retrieval of nouns or verbs could result from impairment in any of these three areas. Before discussing this hypothesis further, let me discuss some of Damasio & Damasio's findings.

Damasio & Damasio found that retrieval of common nouns was significantly impaired while retrieval of verbs was normal or close to normal in two of the three patients they described. However, of the common nouns, retrieval of animal and fruit/ vegetable names was much more impaired than retrieval of the names of tools/utensils:

Animals Fruits/Vegetables Tools/Utensils Verbs
Boswell 24% 25% 76% 92%
AN-1033 51% 54% 70% 96%

Although Damasio & Damasio do not tell us exactly which common nouns were used in the study, I point out that animals, fruits, and vegetables are prototypical nouns related to prototypical nominal concepts, but words for tools and utensils are frequently indeterminate in lexical category; hammer, nail, wrench, spoon, and fork can be either nouns or verbs, either related to entities or actions. I suggest that the patients with impairment in the retrieval of nouns had better success with these because they can retrieve some of them as verbs.

& Damasio argue that these neurological connections are acquired through habit and associative learning based on direct experience with words used in discourse. If, as Hopper and Thompson would have it, discourse function determines meaning and inflection, function is the primary source unconscious knowledge that we have stored about words and lexical categories. That is why we find the differential effects of names of fruits and vegetables and names of tools or utensils. The neurological findings support Hopper & Thompson's contention that lexical categories are functionally derived, but they also strongly suggest to me that function at some point becomes cognition.

The difference between nouns and verbs in English comes about because discourse function is translated through experience into cognitive pathways and connections. Now I can go back to the three level Cognitive Hypothesis as proposed by Damasio & Damasio.

Recall that there is evidence that words are not tagged with lexical category in the mental lexicon, nor does the lexicon have subgroupings based on lexical category. There is evidence that semantic memory is not subdivided in semantic fields by notions of 'action' or 'object.' Some noun/verb deficits in aphasics are not located in the lexicon. Some noun/verb deficits in aphasics are not located in the concepts in semantic memory.

So here is a slight revision of the Cognitive Hypothesis in its adaption to a linguistic theory of lexical categories: There is a mental lexicon undifferentiated with respect to lexical category. There is also a sea of concepts in semantic memory which are not organized by notions of 'action' or 'thing' but are organized into semantic fields like 'job,' 'proper name', 'fruit', 'color', etc. Ranging over these concepts are cognitive operators like NOUN and VERB, which combine with the meaning concept prior to lexical selection. These operators would be on the order of those proposed by Johnson-Laird, 1983:413.

The operators form part of Damasio & Damasio's interactive mediation systems; they are cognitive but derived from exposure to discourse. Our notion of lexical categories arises from learned preferences for certain operator/concept/word combinations stemming experience with words in various discourse functions; 'apple' generally used as a noun, 'fork' used sometimes as noun and sometimes as verb, and so on.

I suggest that some noun/verb dissociations in aphasic patients are due to impairment of either the noun or the verb operator. The verb operator is 'located' near the motor cortex and the noun operator 'draws input' (to use Kellogg's terms) from sensory association areas. Aphasics who have difficulty with the phonological or orthographic encoding of words may have deficits in the lexicon, aphasics who display marked difficulties with discrete semantic fields (like proper names) may have deficits in the concepts stored in semantic memory, and aphasics who retain knowledge of concepts but have either narrow or wide-ranging nominal difficulties may have impairment of the NOUN operator.

In conclusion, I would like to articulate two suggestions for neurologists. First, monolinguial Salish or Wakashan speakers with aphasia (if there are any) could be tested. Distinctions between noun and verb in those language families occur at the predicate level, not at the level of lexical roots. If the same noun-verb dissociation were to be found, I believe it would be evidence against the Lexical Hypothesis and the Semantic Hypothesis. It would also provide a glimpse into the interplay of the nounverb distinction, syntactic structure, and discourse, because data from those languages suggest that the NOUN and VERB operators can work at the level of predication and not roots.

Second, studies which have shown differential production of nouns and verbs in English-speaking aphasics must be replicated with test items which are more strictly controlled. Although the experimenter may say that walk or run is a verb, the linguist knows that they often occur as nouns as well. Although the experimenter may believe that hand or head are nouns, they also frequently occur as verbs. Neurologists must take into consideration that lexical categories in English and other languages are dynamic and not static, fuzzy and not discrete. These characteristics are to be expected in lexical categories that are functionally derived. More carefully crafted experiments may show that aphasia patients display a range of deficits which may indicate relative nouniness and relative verbiness of words in syntactic contexts.

Notes

¹I am grateful to a participant at the BLS Conference for pointing out the continuum of "animacy" to be found in these figures.

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