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Introduction

The role and neural representation of grammatical class: a special issue of the *Journal of Neurolinguistics*

What gets left of a man amounts to a part. To his spoken part. To a part of speech.
Joseph Brodsky, *Part of speech* (1975)

The vast generative potential of language is a product of rules that combine words stored in memory into sequences of words in arranged a particular order (de Saussure, 1916; Bloomfield, 1933; Jespersen, 1937; Tesnière, 1959; Chomsky, 1965). A listener, knowing both the words and the rules according to which they are combined, can deduce from this order the putative relations between the concepts to which the words refer, and hence the meaning of any given utterance. Obviously, then, in order to understand language, we must understand the basis for ordering words in speech.

A bit of introspection excludes a great number of possible dimensions along which words might, in principle, be ordered: for instance, it cannot be that words are ordered according to their sounds, length, age of acquisition, or familiarity. Variables like concreteness and semantic value may help infants to decide that in contemporary English, *doggies bark* and not **bark doggies*, according to a simple rule that says concrete objects precede actions (cf. Pinker, 1982; Grimshaw, 1981); but if this rule were retained by adults, we would presumably judge phrases like *introspection excludes* to be uninterpretable and not merely pretentious. Rather, it seems that words are ordered (and their order is decoded) in a way that relies on the property of grammatical class. Thus nouns precede verbs, determiners precede nouns, and so forth in infinite combination.

In this special issue of the *Journal of Neurolinguistics* we are concerned with understanding grammatical class and the way it is represented in the brain. What grammatical class distinctions are relevant to speakers, and how can the ability to retrieve words of different grammatical classes break down in acquired disorders of speech? How is information about grammatical class utilized in language production, and how is it stored and processed by neural circuits? The ten original papers and one review included here attempt to address these questions in various ways, and using various methodologies; the majority report neuropsychological investigations of language production in aphasic

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patients, but electrophysiological and computer modelling approaches are also represented. At first glance, the range of topics they cover may seem very broad—from the production of inflectional morphology to the comprehension of a particular class of verbs. Ultimately, however, all of these papers address the very critical question of how (and whether) different types of words are categorized and retrieved on the basis of grammatical class.

The coarsest intuitive distinction among entries in the mental lexicon separates ‘content’ words—meaningful elements like nouns, verbs, and adjectives—from ‘function’ words, like determiners, inflections and prepositions.¹ These two categories of lexical items differ in a number of ways. Content words are said to be open-class, meaning that new content words can be added freely to the lexicon (witness *modem*, *spam*, *xerox*, etc.), while function words constitute a closed class to which novel items are added only very rarely. Because function words appear to have this special status, and also appear to be relatively immune from errors in normal speech, Garrett (1975, 1980) and others have suggested that they are processed by a special encoding mechanism that enables their sounds to be retrieved in a particularly effective manner. On the other hand, function words are on average much more frequent than content words, which may account for their more accurate retrieval independently of any special status in word retrieval (Dell, 1990; but see Stemberger, 1985). Phonologically, function words tend to be shorter than content words, and are most often unstressed (Grosjean & Gee, 1987; Shattuck-Hufnagel, 1987). These factors may also help to explain processing differences between the two types of words.

A number of experimental methods have been used to determine how the cognitive and neural representations of function words and content words in the brain may differ. Among the most common and problematic findings is that the effects of lexical variables, like frequency and length, are difficult to distinguish from true effects of grammatical class. In the introduction to their paper in this issue, Osterhout, Allen, and McLaughlin very usefully précis findings from event-related brain potential (ERP) studies on differences in the neurobiological representation of function (closed-class) and content (open-class) words, and conclude that no consensus exists as to whether these categories of words can be distinguished electrophysiologically. In their own study, Osterhout and colleagues find that ERP differences between function and content words can be accounted for by differences in word length, rather than syntactic function. They correctly point out that these findings hardly exclude the possibility that syntactic category distinctions are represented in the brain; however, if they are, it is not obvious that they are reflected by scalp-recorded ERP differences that have been measured to date.

There is also evidence that content words and function words dissociate in aphasia. In particular, it has long been observed that agrammatic, or Broca’s, aphasics tend to omit

¹ Chomsky’s (1986, 1995) distinction between ‘lexical’ and ‘non-lexical’ categories, which largely parallels the distinction between content and function words, counts prepositions as lexical, like nouns and verbs. This raises the issue of a possible distinction between prepositions that have semantic content (e.g. directional and spatial prepositions), and hence may arguably be similar to content words, and those that play a purely syntactic role (like *of* in the construction *afraid of X*) and are almost certainly function words (see Friederici, 1981, 1982). Similar uncertainties attend the status of ‘light’ verbs which also occur as auxiliaries (like *do*, *get* and *have*; see Kegl, 1995). We will ignore these problems here.

function words in their spontaneous speech (Howes & Geschwind, 1964; Jones & Wepman, 1965), and sometimes also in reading (Andreewsky & Seron, 1975; Friederici & Schoenle, 1980; Caramazza, Berndt & Hart, 1981). However, the basis for this impairment is not well understood. As we have noted, function words differ from content words along many dimensions, and explanations for their loss in aphasia vary accordingly. Some researchers have proposed that agrammatism results from a disruption in knowledge of rules governing the relationships between words (Jakobson, 1956; Luria, 1970; Berndt and Caramazza, 1980). Others have suggested that the omission of functional elements reflects a selective loss of this category of words (Bradley, Garrett & Zurif, 1980), a phonological deficit (Kean, 1978), or difficulties with the motor processing of speech (Lenneberg, 1973).

One of the primary difficulties in determining the locus of function word impairments is the fact that they are most often encountered in the context of a more general breakdown of language processing, which may include deficits as diverse as severe dysarthria, dysprosody, and impaired comprehension of reversible sentences (Caramazza & Zurif, 1976). In this issue, Thompson, Fix, and Gitelman report a patient (RB) with a deficit restricted to the production of a subset of functional elements, namely, bound inflectional morphemes. RB's production of other lexical items, including nouns, verbs, and most freestanding function words, appears to be unimpaired. In contrast to agrammatic patients, RB's speech is fluent and connected. Moreover, it is not the case that RB simply omits inflectional morphemes; she also produces them inappropriately, as in the phrases *their feet too big* and *they makes her helps them*.

Thompson and colleagues suggest that RB's pattern of performance can be explained as resulting from a disruption in the cognitive processes that convert information about a word's syntactic features (e.g. [NOUN][+PLURAL]) into the corresponding morphological affixes (in this case, the ending *-s*). In other words, RB's difficulties are said to arise at the feature-morpheme interface. Although RB is not agrammatic (and her neurological impairment appears to be quite mild), it is possible that a similar mechanism lies at the root of the function word deficits exhibited by more severely impaired patients, who may fail to produce morphological material that depends on the intact ability to interpret syntactic information.

A much different interpretation of function word deficits in aphasia is offered by Bird, Howard and Franklin. Noting the relatively large difference in the amount of semantic information conveyed by function words and content words, at least on average, Bird and colleagues argue that the loss of function words can be attributed to more general difficulties with lexical items of low imageability (where imageability is taken to be a gross indicator of the number of semantic features a word carries). The authors found that when imageability was controlled across word class, the patients they studied had no more difficulty reading individual function words than content words. Moreover, accuracy in a single-word comprehension task was found to correlate with imageability, and not grammatical category, for all but one patient.

Findings such as these are valuable in that they underscore the need for caution in interpreting the performance of aphasic patients—especially on tests in which it is not clear that grammatical category plays a role, like single-word reading. At the same time, they hardly warrant the conclusion that explanations based on semantic variables (like imageability) are sufficient to account for all aspects of agrammatic production.

Imageability effects cannot explain why English-speaking agrammatics omit some function words, but overproduce others, like *no* and *and* (Menn & Obler, 1990); or why Italian-, German- and Dutch-speaking agrammatics produce infinitival verb forms more readily than finite forms (Miceli, Mazzucchi, Menn & Goodglass, 1983; Kolk & Heeschen, 1992; Bastiaanse & van Zonneveld, 1998).

Bastiaanse, Rispens, Ruigendijk, Rabadán and Thompson suggest here that some of these effects, which may vary cross-linguistically, are linked to deficits in the production of verbs and verb phrases. For example, they argue that when the production of negation words (like *not*) depends on verb movement, as in English and Spanish, agrammatic patients make errors with negative sentences; when it does not, as in Dutch and Norwegian, agrammatic patients are relatively unimpaired with sentences of this kind. Whether it is an impairment in verb movement specifically that is the cause of negation word errors, as Bastiaanse and colleagues suggest, or more general difficulties with syntactic transformations, explaining phenomena like this one seems to require a theory of function word production (and function word impairment) that looks beyond the processing of words in isolation.

Indeed, one of the most basic differences between function words and content words is in the type of information necessary to produce them. A content word base, like *chair* or *sit*, is presumably fully specified by the set of semantic properties to which it refers. It is therefore reasonable to assume that content words may be retrieved on the basis of this information alone (at least in some context)—that is, ‘nominally’, as isolated elements, and not ‘propositionally’ (Breen & Warrington, 1994). The production of a function word, by contrast, requires access primarily to syntactic features carried by other words in the same grammatical phrase, and sometimes also semantic and other types of information.

A paradigm case is the retrieval of determiners (e.g. Caramazza, Miozzo, Costa, Schiller & Alario, 2001). In a language like Italian, retrieval of the appropriate definite determiner requires not only the semantic specification of ‘definiteness’, but also access to the grammatical gender of the noun it modifies as well as to the phonology of the word it precedes: thus one says *il pesce* (the fish, masc.), *lo stivale* (the boot, masc.) and *la stazione* (the station, fem.), but *il grande stivale/pesce* (the large boot/fish) and *la grande stazione*. In German, determiner selection depends, as in Italian, on the gender of the modified noun—thus *der Pokal* (the cup, masc.) and *die Fackel* (the torch, fem.)—but not on any phonological information. However, German determiners are overtly case-marked, meaning that their form depends on case information assigned by the main verb in the clause (*der Pudel sieht Jörg*, the (nom.) poodle sees George, vs *den Pudel sieht Jörg*, George sees the (acc.) poodle). Clearly, several different kinds of features, which become available at various stages of lexical access, figure in the selection of determiner forms cross-linguistically. It follows that if access to any one of these kinds of features is blocked, this should be reflected in problems with determiner production.

As they report in this issue, Bastiaanse and colleagues investigated the production of determiners by six German-speaking agrammatic patients. Analyzing these patients’ spontaneous speech, the authors found that the presence of determiners in a given clause correlates strongly with the presence of an appropriate case-assigning verb. In more constrained sentence completion and generation tasks, in which the verb is provided, the patients produce determiners more frequently but also tend to make errors in case

assignment. Bastiaanse and colleagues focus on the first finding, arguing that determiner production (like negation word production) depends on the ability to retrieve a main verb. But the fact that these patients make errors with determiners even when a main verb is given also suggests a more subtle deficit in interpreting the syntactic features assigned by the verb—perhaps a feature-morpheme interface deficit of the kind described here by Thompson et al. In this light, it would be interesting to investigate whether such patients also have difficulty with grammatical features, like gender, that are intrinsic properties of nouns.

There is intriguing evidence which suggests that some patients may have specific difficulties with grammatical operations related to one category of content words (nouns or verbs), but not to the other. Compelling in this respect are the observations reported here by Tsapkini, Jarema and Kehayia, on the specific morphological processing deficit in a Greek-speaking aphasic patient SK. SK presented with difficulties when he was asked to produce inflected forms of verbs, though he was able to perform similarly complex morphological operations with nouns. This case nicely complements an earlier report of an English speaking patient JR (Shapiro, Shelton & Caramazza, 2000), who was impaired at producing inflected forms of nouns, and demonstrates that functional morphemes can be impaired specifically in conjunction with content words of a given category.

The discussion of these apparently selective morphological impairments alludes to a second type of dissociation that can arise in aphasia: that is, the dissociation within the category of content words between nouns and verbs. It has long been known that traumatic brain damage may selectively disrupt the production of either nouns or verbs in speech. The phenomenon was described quantitatively in a seminal paper by Goodglass, Klein, Carey and Jones (1966) and was first studied systematically by Miceli, Silveri, Villa and Caramazza (1984). Subsequent reports have described selective noun or verb deficits in a large number of patients (McCarthy & Warrington, 1985; Zingeser & Berndt, 1988, 1990; Bates, Chen, Tzeng, Li & Opie, 1991; Caramazza & Hillis, 1991; Hillis & Caramazza, 1995; De Renzi & di Pellegrino, 1995; Silveri & di Betta, 1997; Orpwood & Warrington, 1995; Berndt, Mitchum, Haendiges & Sandson, 1997; Berndt, Haendiges, Mitchum & Sandson, 1997; Rapp & Caramazza, 1998; Robinson, Rossor & Cipolotti, 1999).

In the first part of her review of the literature on noun–verb dissociations in aphasia, Druks nicely summarizes the controversies surrounding the interpretation of content word deficits. The central question here is whether apparently selective impairments of nouns and verbs can be explained as byproducts of more general semantic deficits—for instance, as impairments in retrieving names of objects or actions (McCarthy & Warrington, 1985), concrete or abstract words (Marshall, Chiat, Robson & Pring, 1996), or words of high or low imageability (Bird, Howard & Franklin, 2000). To use a term applied earlier by Bates, Chen, Tzeng, Li and Opie (1991), these accounts represent a class of ‘semantic–conceptual’ explanations for noun–verb dissociations. The alternative ‘lexical’ explanations hold that such dissociations may arise because of damage to some component of the lexicon that stores and utilizes information about grammatical class, that is, the sets of features that specify whether a given word is a noun, a verb, or something else. An inability to access this component might result not only in word retrieval difficulties, but also in difficulties with other syntactic operations that depend on knowledge of a word’s grammatical class—for instance, in the kinds of selective morphological

impairments displayed by JR (Shapiro, Shelton & Caramazza, 2000) and SK (Tsapkini, Jarema & Kehayia, this issue).

The paper in this issue by Vinson and Vigliocco, which describes an attempt to model grammatical class impairments by lesioning parts of an artificial semantic network, shows that semantic–conceptual and lexical explanations for grammatical class impairments may be difficult to disentangle in many cases. When information about the features assigned to a variety of nouns and verbs by normal subjects is used to construct a self-organizing neural network, words tend to cluster according to their semantic properties rather than by grammatical class: that is, action nouns are ‘closer’ to action verbs than they are to object nouns. Accordingly, action verbs and action nouns are spared or impaired together when the network is lesioned in various ways. As Vinson and Vigliocco write, this suggests that noun–verb and object–action distinctions are not perfectly isomorphic, and that semantic information alone cannot be used to predict grammatical class.

Unfortunately, the results do not speak to the question of whether putative noun–verb dissociations in aphasia may be attributable to impaired semantic knowledge, grammatical knowledge, both, or neither. The authors note that some particularly relevant data are lacking: how do patients with documented problems in object noun production perform with action nouns? Even if these data were available, however, it is not clear that they would be sufficient to adjudicate between semantic–conceptual and grammatical explanations of content word dissociations. Action nouns and action verbs share certain features not necessarily related to the semantic domain of actionality; for example, words of both categories (along with non-action verbs) may take grammatical arguments, an important property given that argument complexity has been shown to influence word retrieval by aphasic patients (Thompson, Lange, Schneider & Shapiro, 1997; Collina et al., 2001). It is also possible that action nouns—even those without overt derivational suffixes—have underlying verbal roots, a property that might modulate the facility with which they are produced by patients with either noun or verb deficits.

Hypothetical difficulties aside, the patterns of performance displayed by certain aphasic patients seem hard to reconcile with semantic–conceptual accounts. For patients like JR and SK, whom we have mentioned already, there is independent motivation to believe that their difficulties with nouns and verbs, respectively, may have a lexical-grammatical basis: to wit, they are impaired specifically with grammatical operations, and at least for JR there is no evidence to indicate that semantic variables influence his performance in a manner consistent with his noun production deficit. The paper by Berndt, Haendiges and Mitchum in this issue further demonstrates that variables such as concreteness and imageability are of limited utility in accounting for selective grammatical class impairments. Berndt and colleagues report the performance of several aphasic patients on a test which required them to complete sentence frames with nouns and verbs matched for this variable. Though some patients did indeed exhibit problems with low-imageability words regardless of grammatical class, others persisted in showing selective impairments for verbs relative to imageability-matched nouns. These results make a convincing case that effects of imageability and grammatical class contribute independently to word production difficulties in aphasic patients.

Among the most problematic cases from a semantic–conceptual point of view are those in which a patient is able to produce either nouns or verbs in one modality of output

(speaking or writing), but not in the other (Caramazza & Hillis, 1991; Rapp & Caramazza, 1998). The fact that these patients are impaired only in one modality strongly suggests that semantic knowledge is intact. Until now, however, modality-specific deficits in content word production have been demonstrated only for verbs, raising the possibility that this category of words may be more susceptible to impairment in the context of a very mild modality-specific deficit.

The first report of a double dissociation between noun and verb production in a single patient is presented here by Rapp and Caramazza. The patient they describe, KSR, has more difficulty producing nouns than verbs in speech, but is relatively more impaired with verbs in writing. KSR was able to produce correctly 92% of verbs but only 76% of nouns in oral naming tasks; this pattern was mirrored neatly in written naming (96% of nouns, 57% of verbs). The interaction between grammatical class and modality in this case cannot be attributed to differences in the relative difficulty of nouns and verbs, for the simple reason that the *same* items were used in speaking and writing tasks. The cases of KSR and of other patients with modality-specific grammatical class deficits, taken together with patients like SK, JR, and those reported here by Berndt and colleagues, make the argument increasingly untenable that selective impairments in the production of nouns or verbs always result from damage to the semantic system.

This is not to say that selective impairments in noun or verb production always result from damage to representations of grammatical class. Some putative cases of grammatical class specific disorders may indeed reflect basic impairments in the ability to name actions or objects (McCarthy & Warrington, 1985), abstract or concrete concepts (Breedin, Saffran & Coslett, 1994; Marshall, Chiat et al., 1996; Marshall, Pring, Chiat & Robson, 1996), or even words of low or high imageability (Bird, Howard & Franklin, 2000). It is also possible that some impairments—particularly those that compromise the production of verbs and verb-like nouns—may have their root in problems with access to information that is not directly related either to a verb's core meaning or to its grammatical class.

As Druks notes in the second part of her review, a number of investigators have suggested that impairments in verb production might be linked to either or both of two such intermediate levels of representation—namely, argument structure (which specifies the kinds of arguments a verb takes, e.g. subject and direct object) and thematic structure (which specifies certain 'semantic' properties of arguments, e.g. agent, instrument, patient, theme). Of the two, argument structure is better understood: it is clearly related to structural syntactic properties of the verb phrase, and a number of studies have shown that argument complexity plays a role in the production and comprehension performance of certain aphasic patients (Shapiro & Levine, 1990; Thompson et al., 1997; Kim & Thompson, 2000).

The nature of thematic structure is more ambiguous. There is no agreement among linguists about how many possible thematic roles exist, nor what they semantic properties they represent; some researchers have argued that the thematic roles assigned by a verb must be stored as part of that verb's lexical entry, while others have claimed that thematic structure is predictable from argument structure and other syntactic and semantic information (Zubizarreta, 1987; Pinker, 1989). One robust and controversial finding regarding thematic structure is that some aphasic patients are severely impaired in comprehending verb phrases in which the subject and direct object are both animate—like *the boy*

saw the platypus, as opposed to *the boy saw the calendar* (Caramazza & Zurif, 1976; Byng, 1988; Martin & Blossom-Stach, 1986; Caramazza & Miceli, 1991).

Failure to comprehend such phrases has traditionally been attributed to a specific deficit in mapping thematic roles onto arguments (Saffran, Schwartz & Marin, 1980; Saffran, 1982). But this deficit must be constrained to some degree by semantic factors, like knowledge about animacy and about which arguments of a verb can be animate. In this issue, Finocchiaro discusses a specific thematic property of verbs—agentivity—that discriminates between verbs that assign the thematic role of ‘agent’ to animate subjects (e.g. *to drink*; *to call*) than with verbs that do not customarily have animate subjects (*to contain*). The Italian-speaking aphasic patient she describes, CAN, was better in a variety of production and comprehension tasks with agentive than non-agentive verbs, suggesting that the organization of verb representations in the brain may be sensitive to this property.

Why might information about agentivity constitute an important dimension of verb representations? Finocchiaro raises the possibility that agentivity in verbs parallels the distinction among nouns between living and non-living items, which have been shown to dissociate in semantic–category specific disorders. But the agentive-nonagentive distinction is not as clear-cut as living-nonliving, as many verbs (like *enter* and *melt*) can take either agent or non-agent subjects. If anything, agentivity seems to be a property of verb phrases rather than a ‘core’ property of verbs themselves; consider that even characteristically non-agentive verbs like *rain* can take agents in some constructions (e.g. *he rained on my parade*). Accordingly, a deficit in producing or comprehending agentive phrases may point to an impairment in utilizing grammatical or thematic information related to verbs, not in the representation of verbs as such.

There is, however, some evidence that ‘core’ semantic properties of verbs may affect production and comprehension in aphasia. Breedin, Saffran and Schwartz (1998) showed that a group of patients were slightly worse at remembering and repeating verbs that implied changes of state (like *crushed*) compared to verbs that did not (like *pushed*), though the number of items in each category was too small to afford a strong conclusion. In this issue, Kemmerer and Wright present intriguing evidence that some aphasic patients are impaired in the ability to distinguish appropriate and inappropriate uses of the English prefix *un-* (e.g. *unhook* vs **uncrush*), which ostensibly applies only to verbs that fit narrow semantic criteria (i.e., those that imply a reversible change of state). The same patients retain the ability to make fine-grained semantic discriminations along dimensions not relevant to *un-*prefixation.

Kemmerer and Wright argue that judgments about *un-*prefixation rely on access to knowledge about grammatical semantics, a level of representation that lies between general semantics or syntactic properties per se, and conclude that the deficit in the patients they studied involves damage to this level of representation. This interpretation is, however, necessarily equivocal. They do not find patients who show the opposite dissociation, with impaired access to general semantics but spared knowledge of *un-*prefixation. Nevertheless, the notion that certain properties of verb meaning have grammatical reflexes, and are therefore represented separately from features of no syntactic consequence, is an attractive one. Perhaps even properties like thematic structure and agentivity can ultimately be accounted for under the rubric of grammatical semantics.

The proliferation of neuropsychological dissociations that are presumably based on

grammatical function—between morphologically free and bound function words, function words and content words, nouns and verbs, and so forth—suggests that knowledge of grammatical class is represented richly, and perhaps very heterogeneously, in the brain. Indeed, it would be surprising if this were not the case: as Rapp, Osterhout, and others point out here, how else could we account for the ability to generate theoretically boundless numbers of novel grammatical sentences? However, as the papers represented in this issue demonstrate, researchers face a formidable task in understanding precisely how knowledge of grammatical class is stored and utilized in the course of speech production.

The challenges are at least threefold. First, attention should be devoted to deciphering the mechanisms involved in function word production, and how this diverges from the retrieval of content words. Since Garrett's (1980) proposal that function words and content words are specified at different stages in the construction of syntactic frames, little work has been done to investigate precisely how function words are specified, and how their forms are determined (but see Friederici & Schoenle, 1980; Friederici, 1981, 1985, on prepositions; Miozzo & Caramazza, 1999; Caramazza et al., 2001, on determiners; and Stemberger, 1998, on bound morphemes). Any model of sentence production that aspires to explanatory adequacy must include a comprehensive account of function word production, taking into consideration the various kinds of information necessary to define and articulate these elements.

Second, it is beginning to become apparent how little is known about the representation of verbs in the lexicon, and what properties of verbs are important in determining their grammatical function; fortunately, this question is increasingly attracting the curiosity of researchers, as is evident from the papers in this issue. Two separate (but undoubtedly related) issues are at stake: understanding, on the one hand, the grammatical properties important in the retrieval of verbs and the generation of verb phrases, and on the other, the semantic relationships between verbs and groups of verbs (cf. Levin, 1993). A good deal has been written about the various semantic kinds or categories of nouns, and how these might be represented in the brain (see Caramazza, 1998, for a review); neuropsychology would undoubtedly profit from similar insights into the conceptual organization of verbs.

Finally, as it becomes clearer how disorders in accessing grammatical class affect speech production in aphasic patients, we can begin to formulate specific hypotheses about the neurobiological correlates of this knowledge. These in turn can be corroborated and extended by investigations in normal subjects, using ERP and functional neuroimaging techniques.

We hope that this special issue of the *Journal of Neurolinguistics* will help in some small way to stimulate interest in each of these three lines of inquiry, and more generally into the problem of how grammatical class is represented in the brain. Grammatical class, in a sense, is the key that links knowledge of stored lexical forms to the rules for combining these forms into meaningful utterances; understanding its nature is fundamental to the field of neurolinguistics, and to the study of language in general.

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