


In this chapter we explore a controversial hypothesis about the nature of the syntactic processing system. The hypothesis, roughly stated, is that some of the procedures that create grammatical patterns in sentences are in an important sense indifferent to the content of the symbols they manipulate, in somewhat the same way that the procedures for long multiplication are indifferent to the numbers involved in the computation. The purpose of this exploration is to uncover the linguistic or cognitive bases of a phenomenon noted by many, including Edward Sapir, who described it in this way:

All languages evince a curious instinct for the development of one or more particular grammatical processes at the expense of others, tending always to lose sight of any explicit functional value that the process may have had in the first instance, delighting, it would seem, in the sheer play of its means of expression . . . . This feeling for form as such, freely expanding along predetermined lines and greatly inhibited in certain directions by the lack of controlling types of patterning, should be more clearly understood than it seems to be . . . these submerged and powerfully controlling impulses to definite form operate as such, regardless of the need for expressing particular concepts or of giving consistent external shape to particular groups of concepts (1921, pp. 60–61).

Sapir’s comments were directed toward patterns of development in the history of language, rather than patterns of individual usage. We believe, however, that the seeds of the former are to be found in the latter. We will therefore spend some time sketching connections between characteristics of historical linguistic change, everyday adult speech performance, and child language acquisition that may help to explain the intransigence of form.

Our discussions of performance processes will focus on language production more than comprehension. There are two central motives behind our slant toward production in discussing the nature of the syntactic performance system. The first is that the data in hand about historical change — primarily written texts — and about developmental change — primarily children’s spoken utterances — are the products of language formulation mechanisms. The interpretation of these data

therefore hinges in part on our grasp of the processes that produced them. The second reason has to do with the relative importance to production processes of grammatical patterning. Merrill Garrett (1980) has pointed out that “The production system must get the details of form ‘right’ in every instance, whether those details are germane to sentence meaning or not” (p. 216). Unlike comprehension mechanisms, which in principle can often succeed without taking account of grammatical features, the processes of creating an utterance are inextricably bound up with them. The domain of production therefore seems a promising one for explicating the role of syntax in language use.

The plan of the paper is as follows. We begin with an overview of a communicative-function-based approach to the relationship between meaning and form that has had a major impact on research in language acquisition and adult language use over the last decade. We then review recent evidence from investigations of language change, language production, and language acquisition that suggests the need for an alternative perspective. Pursuing this, we consider some of the features of such a perspective, which emphasizes the performance problems of language use and the importance of systematic patterns in solving them. We conclude by sketching some of the basic issues related to the construal of dissociations between meaning and form in language use.

FUNCTIONALIST VIEWS OF SYNTACTIC PROCESSES

Part of the backlash against the view of language and language processing set out by Noam Chomsky in linguistics (e.g., 1957, 1965) and George Miller in psycholinguistics (e.g., 1962, 1965) was prompted by sentiments about the central importance of meaning and communication in the understanding and creating of sentences (e.g., Osgood, 1971). Issues of external linguistic form and internal linguistic structure were judged secondary. In psycholinguistics, this backlash took the form of demonstrations that people remember the meanings rather than the syntactic forms of sentences (Fillenbaum, 1966; Johnson-Laird and Stevenson, 1970; Perfetti and Garson, 1973; Sachs, 1967; Wanner, 1974), that comprehension is influenced by contextual, conceptual, and semantic factors as well as syntactic ones (Batesford, Barclay, and Franks, 1972; Slobin, 1966), and that early acquisition patterns can be described in terms of pragmatic or semantic rather than syntactic constructs (Bates, 1976; Bowerman, 1973).

Like wise, in the sentence production literature, there are strong indications that sentence form is sensitive to the discourse contexts in which utterances occur and to characteristics of the messages that they convey. For example, sentences often begin with constituents denoting things that are more animate (Clark, 1965; Clark and Begun, 1971; Harris, 1978), more concrete (Clark and Begun, 1971), more image-able (Bock and Warren, 1985; James, Thompson, and Baldwin, 1973), more definite (Grieve and Wales, 1973), more salient (Ertel, 1977; Osgood and Bock, 1977), more prototypical of their semantic category (Kelly, Bock, and Keil, 1986), given rather than new information (Bock, 1977; Carroll, 1958), the object of the speaker’s attention (Tannenbaum and Williams, 1968), and the object of the speaker’s empathy (Ertel, 1977; Kuno and Kaburaki, 1977).

The implication of these demonstrations is that syntax-based theories are not sufficient to explain language processing, since the primitives of such theories are not semantic, conceptual, or rhetorical notions, but constructs defined solely in terms of their relationship to other constructs in the syntactic system. However, an even stronger view is sometimes espoused. At its strongest, the claim is that syntactic primitives are neither sufficient nor necessary for theories of language structure and language use, and so can be eliminated from them entirely (Garcia, 1979). Respectively, these positions constitute weak and strong versions of what has been called linguistic functionalism (e.g., Bates and MacWhinney, 1982; Dik, 1978).

The varieties of linguistic functionalism are cogently laid out by Bates and MacWhinney (1982). They divide possible functionalist positions into four levels of increasing strength. The first is the level of diachronic correlation, where the claim is simply “that linguistic forms are historically associated with one or more communicative functions, in a manner that suggests a causal relationship” (p. 178). The evidence adduced for such a perspective consists of arguments about the role of adaptive utility in the evolution of different linguistic forms. For example, Slobin (1977, p. 192) suggests that “Whenever a language has gone too far from the principle of one-to-one mapping or semantic transparency in some area of its structure, the tendency to segmentalize will assert itself”. This reflects a common view in historical linguistics, where the “one form, one meaning” principle is often called upon to explain reorganizations of systems to avoid polysemy and homophony (Anttila, 1972). This is the weakest form of functionalism, in that the...
relationship between a function and a form could cease to contribute to language knowledge or use after the form is established.

The second level draws on evidence for synchronic correlations between form and function. Such evidence, typified by the above-mentioned demonstrations of contextual and conceptual effects on sentence form, shows that sentence forms continue to be associated with communicative functions in normal adult language processing. Still, as the term correlation implies, this evidence does not warrant a thoroughgoing functionalism. The link between function and form could be an indirect one, effected with the mediation of structurally-defined syntactic categories (e.g., subject, direct object), rather than being the result of an immediate translation from functions to sentence forms. As a result, various communicative functions might indeed be correlated with structural configurations, but only via syntactic categorizations. Functional categories therefore could not replace linguistic ones in explanations of language use. Nonetheless, this form of functionalist explanation goes beyond the first level, in that functional categories play an ongoing role in language use.

The third level applies to language acquisition. For linguistic functionalism to contribute to explanations of the acquisition of language, it is necessary that the link between form and function be strong enough to allow children to use meanings and communicative intentions to discover the forms with which they are paired in adult speech. Thus, children might discover the structural category of subject (whose properties include control of verb agreement, control of the nominative case for pronouns, and so on) through its association with animacy, dynamism, and topicality, provided that the association is a strong and valid one. The child would still have to learn how the subject category behaves in the language, since the functional distinctions serve only as cues to the linguistic category, but the level 3 claim would be that the correlation is strong enough to provide a bootstrap.

It is at the fourth level that abstract linguistic characterizations of sentence forms wholly give way to functional ones: "The adult competence claim is that the grammar or system of representation that mediates the interaction between form and function can be fully described in terms of natural functional categories and performance constraints" (Bates and MacWhinney, 1982, p. 187). In such a theory, a category such as that of subject would be replaced by a single functional category (e.g., attentional focus) or several functional categories with partially overlapping privileges of occurrence (topic, focus, agent, etc.).

The problems that confront this strong functionalism are substantial. Common examples of the difficulties include systems in which syntactic gender has little to do with semantic gender (as in German), the existence of verbs with similar meanings but different syntactic privileges (e.g., donate and give, let and allow), and semantically empty but required subjects (e.g., pleonastic it and there, as in It's time and There's someone here to see you in English). Bates and MacWhinney (1982) themselves concluded that this form of functionalism is unlikely to provide a full explanation for the structures and systems of most languages, though it might be useful for various portions of their grammars.

Yet it is only at this fourth level that the structural vocabulary of the language becomes transparent with respect to pragmatic functions. At each of the previous three levels, syntactic forms or relations (such as subject) enter into functionalist explanations as independent entities. Though probabilistically linked to functions, their properties cannot be completely defined in functional terms. Instead, such properties of syntactic categories as where they occur with respect to other elements or what inflectional systems they govern are explained in terms of their relationship to other linguistic categories. Thus, in these weaker forms of functionalism, function-based categories are associated with syntactic categories, and only then mapped into structural or positional configurations. A theory that instantiates this weaker functionalist view must ultimately explain both links.

Naturally, arguments for a functionalist perspective tend to emphasize function-to-form correlations, aduding level 2 and level 3 evidence. But as we have seen, this evidence does not rule out intermediate mappings from syntactic categories to surface forms. In the next section, we will pursue the implication that certain phenomena of language change, adult language use, and language acquisition can be better explained in terms of processes that manipulate syntactic categories and relations than in terms of processes that manipulate only function-based ones.

THE SHEER PLAY OF FORM

Bates and MacWhinney's (1982) analysis of linguistic functionalism laid
out four increasingly strong types of influence that communicative functions might have upon the organization of language. The links that have been empirically established at each of the first three levels are, for the most part, between functions and traditional linguistic relations such as subject and direct object. At the fourth level, representing the strongest functionalist position, such linguistic relations would give way to definitions of language structure phrased in terms of conceptual or cognitive categories. However, if the first three varieties of functionalism in fact cannot be reduced to the fourth, it should be possible to show for each one that linguistic relations influence the process or performance in question in a way that is not readily explained by contextual, pragmatic, or other communicative factors. We will discuss each of the three levels in turn.

Level 1: Language Change

Many arguments have been made about the kinds of pragmatic pressures that induce or promote language change. To the extent that all such changes can be traced to these pressures, there is support for Level 1 functionalism, or an historical association between form and function. If we can show that certain types of changes are hard to explain in pragmatic terms, but easy to explain in terms of the formal patterns that exist in a language, it would suggest that forms themselves contribute to the process of change.

Changes in language appear to spread not as a result of the abrupt reanalysis of structures (cf. Lightfoot, 1979), but as a result of gradual extension or "drift" (Sapir, 1921; see Kroch, 1982 for discussion). If drift were attributable only to a language's slow surrender to pragmatic pressures, a thoroughgoing functional explanation might be possible. However, there is evidence that something else is involved. Kroch (1982; Kroch, Myhill, and Pintzuk, 1982) has brought together several lines of evidence to show that periphrastic do (the do that supports tense in questions and negatives) evolved in English between the 13th and early 18th centuries in part to facilitate the identification of direct objects. But it also appeared in environments where it did not perform this function, and its frequency of use rose at the same rate in those environments.

To explain this trend, Kroch (1982) argued that changes in a form's rate of use are constrained by the way in which it is categorized grammatically. Its use is not simply a matter of its functional value, but of the strength of the rule or procedure that introduces it. Such a rule or procedure constitutes a classification of the pattern in terms of the syntactic contexts in which it can optionally appear, rather than in terms of its utility in communication.

Adult Language Use

Level 2 functionalism asserts that functions are linked to forms in adult language use in such a way that functional motives or demands are sufficient to cause certain forms to be used. However, if forms can operate to some extent freely of functions in adult use (i.e., if the presence of particular communicative functions is not necessary for the use of a particular form), a full reduction of form to function will be unachievable. We will examine this hypothesis with respect to language production, though a similar case could be made for language comprehension (see Ferreira and Clifton, 1986; Rayner, Carlson, and Frazier, 1983).

There are a number of observations that imply dissociations between communicative intentions and syntactic forms. One natural language phenomenon suggesting such dissociations involves the repetition of syntactic forms in speech. Weiner and Labov (1983) have shown that in sociolinguistic interviews, one of the factors that is significantly associated with the occurrence of a passive utterance is the presence of another passive somewhere in the previous five sentences. Estival (1985) found that such an effect persists even when the contributions of lexical repetition and discourse factors are statistically removed.

Levelt and Kelter (1982) have also demonstrated repetition across speakers in question answering. They cued several hundred merchants in the Netherlands and asked them the Dutch equivalents of the questions (a) At what time does your shop close? or (b) What time does your shop close? The responses to these questions varied in a very regular way: when the question contained a prepositional phrase, like (a), the answer tended to be in the form of a prepositional phrase, such as At five o'clock; simple noun phrase responses such as Five o'clock increased in frequency when the question contained a simple noun phrase, like (b).

Thus, on different occasions when communicative intentions were likely to be very similar, as in the merchants' responses to the telephone
inquiries, the syntactic forms that were used nonetheless varied. In the case of Weiner and Labov's sociolinguistic interviews, despite the likelihood of changes in the speakers' communicative intentions, the syntactic forms that were used showed some persistence. Such patterns point to the possible influence of mechanisms that influence the structure of an utterance independently of the intended message or the speaker's communicative strategies.

The significance of the syntactic repetition effect found in naturalistic situations (Levelt and Kelter, 1982; Weiner and Labov, 1983) lies in its apparent indifference to changes in or similarities between communicative intentions. It seems that the syntactic forms of sentences may be formulated in a system whose operating characteristics cannot be completely predicted from speakers' intended messages. However, the naturalistic evidence so far obtained is open to the objections that there may be unassessed persistence in communicative intentions or communicative tactics that predispose the repetition of syntactic forms (e.g., maintaining a question in working memory while formulating an answer; Malt, 1985).

To minimize the contribution of such factors, Bock (1986) carried out several experiments to investigate the persistence of syntactic forms in a controlled task environment. In these experiments the subjects first heard and then repeated aloud a priming sentence in a particular syntactic form. For example, a subject might hear and repeat the sentence *The corrupt inspector offered a deal to the bar owner.* Then a line drawing unrelated to the priming sentence was presented, such as a picture of a boy handing a Valentine to a girl, and the subject described the depicted event. What was of interest was the syntactic form of the description the subject produced. Notice that the picture might be described either as *The boy is handing a Valentine to a girl,* or *The boy is handing a girl a Valentine.* The first of these descriptions has the same syntactic form as the priming sentence, while the second is different. Other subjects received an alternative form of the priming sentence, *The corrupt inspector offered the bar owner a deal,* followed by exactly the same target picture. Two different priming sentence types were used, transitives and datives, each represented by two different forms. The transitive priming sentences included actives and full passives, and the dative priming sentences included prepositional and double-object forms.3 Examples are shown in Figure 1.

The patterns of repetition were very orderly. For datives, preposi-

![TARGET PICTURES](image)

Fig. 1. Examples of transitive and dative priming sentences and target pictures. Only one of the two alternative priming sentence forms was presented on each priming trial, followed by a target picture. Note that it is possible to describe the target pictures with either of the two primed syntactic forms, as in *Lightning is striking the church or The church is being struck by lightning* for the transitive picture, and *The man is reading a story to the boy or The man is reading the boy a story* for the dative picture.

3 Tional primes increased the frequency of prepositional utterances, and double-object primes increased the frequency of double-object utterances. Active utterances were more likely after active primes, and passives after passive primes. All of these effects were significant.
Because the only variation between conditions was a grammatical one, these results suggest that a change in the form of the priming sentence was by itself sufficient to affect the mechanisms responsible for a sentence's syntactic form.

Several simple explanations for this effect can be discounted. First, it is unlikely that the subjects consciously adjusted the forms that they used in their descriptions, since in an extensive postexperimental interview they gave no evidence of being aware of the syntactic variations in the priming sentences, of relationships between the sentences and the pictures, of the effect of the priming sentences on the way they described the pictures, or of the experiment's concern with speech production. Second, certain general patterns in the data suggested that the different priming conditions did not influence the interpretation of the events, but rather the syntactic forms of the descriptions. Third, closed-class word repetition (e.g., repetition of the to from a dative priming sentence in a subsequent picture description) does not explain the effect, since for datives also primed to datives. Finally, it does not appear that the subjects were following a tacit social convention of modelling the syntax of a conversational partner (e.g., Giles and Powesland, 1975; Putnam and Street, 1984), since a pilot study in which subjects simply read the priming sentences aloud from cards also produced a repetition effect.

These findings suggest that certain aspects of syntax can be isolated from other types of processing. However, a stronger test of the hypothesis is feasible. If the repetition effects are attributable to syntactic processing, and not conceptual processing, it should be possible to demonstrate syntactic form repetition in the face of conceptual variations.

The predicted effects on syntactic repetition of a conceptual manipulation differ on the conceptual and syntactic mapping hypotheses. According to the conceptual mapping hypothesis, there should be a strong tendency to map similar conceptual elements onto positions similar to those that occurred in priming sentences (e.g., inanimate element at the beginning of the sentence), repeating the patterns of the conceptual elements in the primes rather than the syntactic patterns. According to the syntactic mapping hypothesis, there should be some tendency to repeat the syntactic pattern or construction of the priming sentence, even when the arrangements of the conceptual elements in the pattern vary.

Two experiments that examined these contrasting predictions (Bock, 1986, Experiments 2 and 3) supported the syntactic hypothesis: Passive sentences with human agents (e.g., The floors are cleaned by a janitor daily) were as likely as passive sentences with nonhuman agents (e.g., Spring vacation was ruined by a blizzard) to prime the use of passive sentences for the description of events with nonhuman agents (e.g., The ship is being hit by a missile). In both cases these priming effects were significant. Although there were weak trends in the direction predicted by the conceptual hypothesis, these never approached reliability.

Consistent with the syntactic hypothesis, these experiments suggest that the alternative structural realizations of a constant message change in probability as a function of the prior production of similar constructions, not similar meanings. The subjects' picture descriptions varied reliably with changes in the syntax of the priming sentences, but not with changes in the conceptual characteristics of the messages conveyed by the priming sentences. This provides further support for the argument that a processing system keyed to syntactic categories and relations is heavily involved in the creation of sentences in normal adult language use.

Language Acquisition

With respect to language acquisition, the weak functionalist position (Level 3 functionalism in Bates and MacWhinney's analysis) is that the link between function and form is strong enough for the child to use pragmatic cues to induce language forms. The question to be examined here is whether these functional links are sufficient to explain how children acquire forms.

Bowerman (1985; also see Karmiloff-Smith, 1979) has argued that explanations of grammatical development that posit "predispositions or preferences for how meanings should be mapped into linguistic forms" (p. 1270) can in some cases be replaced with explanations that focus on "experience with the structural properties of the language being learned" (p. 1271). Though in 1973 Bowerman had pointed out the difficulty of showing that young children have control of something like a syntactic vocabulary — children's speech does not include many of the markers that diagnose grammatical distinctions in adult speech, providing few overt clues to the kinds of linguistic categorizations they make — there is now mounting evidence that children begin early on to
mark distinctions based on patterns in the linguistic system that are poorly correlated with functional distinctions.

One sort of evidence comes from differences in the kinds of errors made by children acquiring different languages. Bowerman (1985) notes that children learning Hebrew typically make the error of inserting subject pronouns into relative clauses, producing utterances along the lines of “the boy that he fell in the water” or “the woman that she saw the snake”. Children learning English do not make the same mistake. Bowerman argues that the most likely explanation has to do with differences between English and Hebrew relative clause formation. In most dialects of English, resumptive pronouns (pronominal proxies for relativized nouns) are rare and considered ungrammatical (though they sometimes crop up in colloquial speech). In Hebrew, on the other hand, a resumptive pronoun is required for oblique object relatives (“the boy that I gave the candies to-him”) and optional for direct object relatives (“the candies that the boy took them”), although prohibited for subject relatives. So for Hebrew children, the use of resumptive pronouns in subject relatives is a natural, albeit incorrect, extension of a characteristic pattern of the language they are learning.

There is striking experimental evidence for the early acquisition of structural categories in work on Mandarin Chinese by Chien and Lust (1985). Mandarin distinguishes between topics and subjects, giving them different syntactic privileges. If the subject category emerges from or is in part composed of a more pragmatically based, “cognitively natural” notion of topic (see, e.g., Gruber, 1969, for the former claim and Garcia, 1979, for the latter), it would be natural for children learning Mandarin to acquire subjects later than topics, to treat subjects like topics in the meantime, and so on. Chien and Lust’s data show that, from the earliest age tested onward, they did no such thing. The responses of even two-and-one-half-year-old children overwhelmingly and correctly differentiated sentence structures that were under the control of topics from superficially similar ones that were under the control of subjects.

Further tests of the role of meanings and communicative functions in the learning of grammatical form can be found in studies of the acquisition of American Sign Language (ASL). Because of the iconicity of many of its signs, ASL provides alternative bases for the development of the syntactic system: children learning new signs might induce their syntactic properties on the basis of characteristics of real world actions or referents, or on the basis of relations between categories of signs and structural paradigms (e.g., systems of verb agreement). Meier (1987) has tested competing hypotheses about the role of these factors in the acquisition of ASL. Young deaf children learning ASL as a native language were asked to imitate ASL utterances that included verbs which optionally exhibit an agreement pattern that maps iconically to the denoted action. However, the minimal or obligatory agreement pattern for these verbs disrupts their iconicity. If children prefer the iconic pattern as a basis for verb agreement, they would be expected to imitate it correctly more often than the noniconic pattern. But if they assimilate a verb to the obligatory paradigm for verbs of its type, they should more often imitate the noniconic pattern. Meier found that these children, ranging in age from 3 to 7 years, correctly imitated the noniconic pattern significantly more often than the iconic. Again, children seem to be quite adept at picking up the structural features of language, whether or not they transparently evoke the communicative context.

Finally, Pinker (1984, ch. 4) made a detailed case for syntactic characterizations of children’s earliest word combinations, providing evidence that phrase structure rules offer an account of early speech that, with respect to descriptive adequacy, is at least as good as that offered by semantic and word-bound formulae (Bowerman, 1973; Braine, 1976), and, with respect to extendability to the adult system, far better. So there are grounds for arguing that abstract pattern-based characterizations of what is produced may be appropriate throughout the course of language acquisition. Though battles still rage over the role of innate principles in guiding children’s analyses of structure, it is reasonable to suppose that “an adequate theory of language acquisition must be able to account for cases . . . where children find structure ‘because it is there’” (Bowerman, 1985, p. 1281) — wherever “there” may be.

**Summary**

In language change, adult language use, and child language acquisition, there is evidence for processes that are directly governed not by communicative functions, but by syntactic categories operating to some extent independently of those functions. The purpose of this review was not to establish that communicative functions are wholly unnecessary to
the explanation of language use, any more than Bates and MacWhinney’s (1982) aim was to establish that language forms are wholly unnecessary to such an explanation. But to whatever extent strong “level 4” linguistic functionalism glimmers and beckons on the horizon, we hope to have shown that it may be a mirage. Processing theories require something more, something that has to do with the way that relatively abstract syntactic symbols are linked to language forms and patterns.

A LEVELS-OF-INTEGRATION PERSPECTIVE ON LANGUAGE PRODUCTION

We assume that there are syntactic categories and relations — including subjects, objects, noun phrases, verb phrases, nouns, verbs, and the rest — that cannot be reduced to notional categories and relations — conceptual features, social goals, and rhetorical motives. But notional categories clearly exert a strong effect on linkages between concepts and syntactic relations: to repeat a familiar refrain, it is indisputable that the entities that serve as the subjects of sentences are more likely to be animate than inanimate, human than nonhuman, agents than patients. The question is how this state of affairs arises. It could come about because the processing system that creates sentences observes conceptual distinctions, pragmatic distinctions, and linguistic distinctions on a roughly equal basis in a highly integrated system. Alternatively, there may be mappings from conceptual distinctions to syntactic relations, with the operations that create sentence forms observing only the syntactic relations. Operations of the latter sort would constitute an isolable syntactic processing system.

An integrated system is illustrated in the competition model of MacWhinney and Bates (Bates and MacWhinney, 1982, 1987; MacWhinney, 1987; MacWhinney, Bates, and Kliegl, 1984). With respect to parsing, MacWhinney et al. (1984) have proposed that “it is possible for languages to integrate semantic contrasts on an equal footing with syntactic cues” (p. 128), so that a notional category such as animacy can be considered by the processing system at the same time and with the same weight as a structural category such as subject. In production, the analogous claim might be that syntactic and notional categories compete for assignments to surface positions. Thus, structurally defined subjects would compete with, say, animate elements for preverbal position.

Though such an approach may readily explain the predominance of communicatively important constituents early in sentences, it fares less well in accounting for some of the traditional facts about language production as they are found in speech error data. There is powerful evidence for a syntactic category constraint on a variety of error types. Word exchange errors, such as faster than the sound of speed, overwhelmingly involve words of the same grammatical category: nouns exchange with nouns, verbs with verbs, adjectives with adjectives, and so on. The same constraint shows up in word substitution errors, in which an intended word is replaced by another (e.g., I don’t know what it takes to be an editor, when author was intended, or It’s exponential, when It’s exponential was intended), and in word blends (e.g., bird sood, when either seed or food was intended). Substitutions almost always come from the same syntactic category as the intended words, and blended words also tend to be identical in their syntactic categorization. There is little evidence that this syntactic constraint can be explained in purely notional terms, since the involvement of conceptual factors is highly variable. The words that participate in word exchanges are rarely semantically or pragmatically similar; those in word substitutions and blends sometimes are (as in author/editor and seed/food), but not always (as in exponential and exponential; cf. Fay and Cutler, 1977). What is constant is the syntactic constraint, suggesting that there are basic processes of sentence production which refer not to a notional vocabulary, but to a structural one.

Models designed to account for such patterns have been proposed by Fromkin (1971) and Garrett (1975, 1976, 1980, 1982). In this approach, a nonlinguistic representation of the speaker’s communicative intention is first mapped onto a level at which syntactic relations are represented. This is then mapped onto a representation of the sentence’s surface form. As a result, there is no direct link between the nonlinguistic representation and surface positions. This type of model exemplifies Garrett’s argument that

... we should take seriously the view that most significant aspects of syntactic processing for sentences are done independently of their ultimate semantic consequence. Evidently there must be a means of insuring or determining that the forms resulting from such processing have the appropriate (i.e., speaker-intended) consequences. But that constraint in no way prejudices the possibility that syntactic form is processed autonomously both for sentence production and sentence comprehension, since semantic selection may be accomplished by means other than the importation of semantic variables into the domain of processing rules for establishing sentence form (1976, p. 232).
The emphasis is on an explanation of just those processes of utterance creation that are sensitive to linguistic categories and relations, ignoring those features of sentence form that seem to reflect conceptual, contextual, or general cognitive factors.

This approach thus accounts for the syntactic constraints on speech errors, though it has no explanation for pragmatically and conceptually conditioned variations in syntactic form. A model like that of MacWhinney and Bates readily accounts for the latter variations, but is less easily reconciled with the categorical constraints characteristic of many types of speech errors. To account for both, Bock (1987b) proposed a levels-of-integration approach to production in which features of Garrett's model are combined with competition mechanisms that help to explain pragmatic effects on syntax. Essentially, the levels-of-integration argument is that the mapping from the notional to the syntactic vocabulary is sensitive to dynamic features of information retrieval, features that in many cases reflect the types of pragmatic factors that influence syntactic form.

There are five major claims. First, assignments to surface syntactic relations (subject, direct object, and so on, defined with respect to particular verb forms; cf. Bresnan and Kaplan, 1982) are assumed to be determined in part by the accessibility of conceptual elements (which in turn may be influenced by competitions among factors such as attentional salience, concreteness, and animacy; see Bock and Warren, 1985). Second, the order of these assignments is argued to reflect a hierarchy of grammatical relations in which the subject dominates the direct object, which dominates the indirect object, which dominates various oblique objects (Keenan and Comrie, 1977). Third, after these grammatical functions are assigned, subsequent syntactic processes are hypothesized to operate in terms of linguistic categories and representations (e.g., syntactic relations, constituent structures, the phonological forms of words). Fourth, it is assumed that competition can also occur among these linguistic categories and representations as constituent structures are developed, as the phonological forms of words are retrieved, and as word forms are integrated into constituent representations (Bock, 1987a, b). Finally, the lexicon is hypothesized to mediate relatively low-level effects (e.g., phonological effects) on such high-level processes as grammatical function assignment (Bock, 1982, 1987a, b, c; Dell, 1986; Stemberger, 1985).

Unlike theories that postulate a single set of mappings from conceptual representations to utterance positions, this approach suggests that there are two tiers of processing, one concerned with mapping conceptual representations onto the syntactic vocabulary, and a second concerned with manipulating elements of the syntactic vocabulary to create utterances. And unlike theories that dismiss conceptual effects on utterance forms, this approach attempts to reconcile them with structural effects. But just like theories which argue for the autonomy of syntactic processing, this approach suggests that there are significant mechanisms of sentence production that are directly sensitive to syntactic categories or relations, and nothing else. Some of the arguments for such a system are elaborated in the next section. In order to keep claims about processing autonomy distinct from claims about formal autonomy, we will refer to autonomous processing systems as isolable, following Posner (1978).

SYNTACTIC ISOLABILITY

In developing a performance theory of syntax, it is helpful to keep questions about the nature of the grammatical vocabulary separate from questions about the processes or processing systems that manipulate the elements of that vocabulary. For some purposes, grammatical categories and relations may be usefully defined in purely formal terms, terms that make no reference to other language-relevant systems. For other purposes, this dissociation may be untenable. In the levels-of-integration approach to production, for example, grammatical relations are Janus-faced. On one hand, they are argued to enter into a set of processes that link them to conceptual elements, opening up the possibility of analyses of grammatical relations like the one of sentence subject proposed by Bates and MacWhinney (1982), where features of conceptual elements dominate the definition. On the other hand, again from the perspective of levels of integration, grammatical relations are also argued to enter into processes that map them onto surface positions. A characterization of grammatical relations that ignored either the conceptual or the structural domain would be incomplete.

However, the levels-of-integration approach also suggests that the processes that map grammatical relations onto surface positions are sensitive only to the grammatical relations themselves, being keyed to them rather than the conceptual elements to which they are linked. The processes are isolable in the sense that they themselves are blind to
conceptual features, even though their outputs are indirectly influenced by those features (via the grammatical function assignment process).

Questions about processing isolability can be set off from debates over formal autonomy (cf. Garnham, 1985), even though they are related. The issue of formal autonomy has to do with whether the explanation of some domain requires a theory to go outside a closed system of formal relations that analyze the primitives of the domain. If not, the primitives are formally autonomous. Theories of syntactic processing in language production or comprehension are unlikely to achieve autonomy in this sense. However, such theories do need to concern themselves with the decomposability of complex mental processes, and whether there are processes responsible for generation or for parsing whose interactions with semantic or inferential processes are limited. It is in these contexts that the question of isolability arises.

Over the last two decades, much of the literature devoted to questions about language use has conflated the vocabulary issue with the processing issue. In the next section we try to separate them.

Syntactic Vocabularies Versus Syntactic Processors

Vocabularies

There are two widely credited but opposing views of the nature of the grammatical vocabulary in current linguistics and psycholinguistics. The first is the basis of the functionalist position we described earlier. From this vantage point, the mapping from meaning to form is regarded as relatively transparent, with forms themselves being highly constrained by the nature of the ideas to be conveyed or the speaker's intentions in conveying them (e.g., Bolinger, 1975; Garcia, 1979). For example, prominence in thought has been argued to translate relatively straightforwardly into prominence in language, with the initial constituents of sentences tending to represent the speaker's perspective (Bates and MacWhinney, 1982; Firbas, 1966; Halliday, 1970; MacWhinney, 1977; Wundt, 1900). The general conception is that thoughts or communicative intentions map into grammatical categories in a rather direct way.

On the second view, the relationship between meaning and form is opaque. Because language knowledge is intricate, highly structured, and to a significant degree innately specified (the argument goes), there are important features of its form that have little to do with meaning or communication (e.g., Chomsky, 1968). For example, on this view the subject of a sentence can be defined purely in terms of its various structural privileges. We will refer to these two alternatives as espousing transparency versus opacity of the grammatical vocabulary.

Processors

These views of the grammatical vocabulary are logically independent of two others that concern processing in language use. The processing questions have to do with the role played by specialized procedures or cognitive architecture. The first position that might be taken is that there are no processes dedicated solely to language processing. From this perspective, the processes involved in language use are also involved in or influenced by other aspects of cognition such as thinking, remembering, attending, and so on. This is the strong interaction position.

The alternative to the strong interaction position is that there are language processors with significant and possibly unique responsibilities. Such processors might be specialized for meshing linguistic and conceptual knowledge structures with the auditory and articulatory systems in ongoing time. Because of the intricacy of these integrations, there may be little reason to expect them to be served efficiently by mechanisms that are likewise responsible for other aspects of our mental lives. Instead, certain processing systems may be dedicated to the production and comprehension of language, with heavily restricted lines of communication to the general cognitive system. This constitutes an autonomous processor.

Pairing Vocabularies and Processors

It is easier to appreciate the consequences of the processing alternatives if they are paired with different views of the grammatical vocabulary. Coupling strong interaction with grammatical transparency yields the position that language use constitutes an alloy of representations and processes drawn from the basic cognitive repertoire of human beings. For example, Anderson (1983), while acknowledging that there may be some language-specific adaptations among human cognitive abilities, argues that the more plausible view is that such adaptations are “few and minor, [and] that the language faculty is really the whole cognitive system” (p. 3).

Coupling strong interaction with grammatical opacity, it could be
argued that the formal interrelationships among elements of the grammatical vocabulary constitute the only purely linguistic constraint on language use, with their deployment handled entirely by cognitive processes that serve other, nonlinguistic functions as well. Such general processes learn to manipulate the elements of the vocabulary in accordance with the structural constraints on them, but because the same processes also perform other tasks, they can limit or deform the expression of language. The result is the various errors, dysfluencies, and other disruptions that occur in speaking and listening. This seems to be a common view of performance processes within linguistics (cf. Radford, 1981).

Combining autonomous processing with grammatical transparency, we get a linguistic processing system whose internal representations originate in general cognitive categories, though they may become increasingly dissociated from them as they are linked to specialized language processes, such as those that produce and perceive speech. Since different types of procedures would be required for production and comprehension, there need be no declarative representation of the grammatical vocabulary expressed in primitives different from those in other domains of cognition, and hence no unified representation of language knowledge independent of language use (Clark and Malt, 1984).

Combined with grammatical opacity, the autonomous processing position yields the strong view of a system whose representations are from the beginning unique to the language system, and whose processes are equally unique, tailored to the requirements of that domain. Relatively clear statements of views of this sort in the area of language processing can be found in the motor theory of speech perception (Liberman and Mattingly, 1985; Liberman, Cooper, Shankweiler, and Studdert-Kennedy, 1967), the derivational theory of complexity (Miller and Chomsky, 1963), and in recent parsing theories (Berwick and Weinberg, 1984; Marcus, 1980). From these perspectives, neither the processing systems nor the information they manipulate share significant features with other cognitive, perceptual, or motor systems.

There are, then, two different sorts of conceptions of syntactic autonomy. One emphasizes the uniqueness of the vocabularies of grammars — their fundamental differences from the vocabularies of thought, nonverbal communication, or social interaction. The other emphasizes the uniqueness of language performance, arguing that there are significant language processes that occur independently of other aspects of cognition, and, at least in mature language performance, cannot be deployed indifferently across the domains of language, memory, cognition, attention, or perception.

**Autonomy and Modularity**

This difference is related to a point of contrast between Chomsky’s conception of syntactic autonomy and Fodor’s modularity thesis. Chomsky (e.g., 1980) has long claimed that the rich intrinsic structure characteristic of language is in all probability different from the structure of knowledge in other cognitive domains. This knowledge, by hypothesis, consists of a system of rules and principles that both relate and generate various kinds of mental representations, in particular representations relating form and meaning.

Fodor (1983), however, distinguishes structural arguments of this sort from notions about the dissociability of processing systems, reserving the term “modularity” for the latter. Fodor characterizes modularity in terms of hypothesized properties of those processing systems (perception and language, to wit) that play fundamental roles in mediating between the information given to the senses and the information represented in thought. Among others, these properties include speed, rigid patterns of ontogeny and breakdown, fixed neural architecture, mandatory operation given appropriate inputs, inaccessibility of the intermediate products of processes to introspection, and informational encapsulation.

Fodor’s claims thus center on the function and structure of processing systems, while Chomsky’s arguments focus on the forms of knowledge representation across different domains. The modularity hypothesis for language, in essence, is that processing systems with significant computational responsibilities or functional roles enter into linguistic performance. The two conceptions thus have different implications for the construal of syntactic autonomy within theories of language use: questions about the nature of the grammatical vocabulary are more closely related to arguments about formal autonomy, while questions about the nature of the processing system may be better construed in terms of the issues surrounding modularity and processing isolaability.

Because the levels-of-integration approach to language generation assumes a system in which processing responsibilities are rather strictly
allocated, it is reasonable to ask whether the general features of production accord with the characteristics of an isolable processing system. We will see how production fares against the criteria established by Fodor (1983) for modularity.

**Syntactic Modularity in Sentence Production?**

Fodor's (1983) arguments about the modularity of certain components of human information processing are directed almost exclusively at input systems. In fact, he adopts rather different positions about the nature of language processing in parsing versus production. Parsing is viewed as a modular process, computationally elaborated and algorithmic. However, he excludes the mechanisms of language production from candidacy for modularity on the grounds that they cannot be domain-specific (1983, p. 102). Their domain-generality, according to him, follows from the fact that they must have access to thoughts as well as to the perceptions yielded by all of the modular input systems, if they are to convey our general cogitations and particular reflections on the world.

Garrett (1980) argues the opposite. As we have seen, he maintains that the faithfulness to form demanded by production makes it more rather than less likely to incorporate a specialized mapping process. Where comprehension mechanisms could dispense with the subtleties of structure and rely on general knowledge in the interpretation of sentences, production processes have no leeway. They exist to create structure, and can hardly ignore it.

The features that Fodor proposed to characterize a modular system provide a convenient framework for an analysis of this disagreement. The most important of these is informational encapsulation, or the relative imperviousness of the mechanisms responsible for the processing of sentence structure to the ongoing operations of other information-handling systems, including the systems responsible for thought and social interaction. The evidence that we have presented about the generation of syntactic structure, evidence which points to the dissociability of syntactic and semantic-pragmatic factors in language change, adult sentence production, and early language use, is more consistent with encapsulation than with a highly interactive approach.

Another proposed characteristic is that the operation of the system, given appropriate input, is mandatory. On the face of it, this appears to be irrelevant to production, since most of us are able to inhibit speaking. But the issue is not whether we are able to inhibit speech. Rather, it is whether we are able to inhibit the formulation of syntactically-structured English (or French, or Albanian, or whatever) given an appropriate initial representation. It is much less obviously true that we can inhibit these processes; their involuntariness may even be responsible for the widespread impression that thinking without language is impossible.

Another characteristic suggested by Fodor is that there is limited conscious access to processing within a modular system. This is clearly true in production; we are typically oblivious to the development of the syntax of a sentence, in the same way that we are oblivious to the retrieval of words. We seem to be consciously aware only of the output, or of the absence of output. The clearest cases of awareness of failures of the system arise during tip-of-the-tongue experiences (Brown and McNeill, 1966), and in the detection and correction of errors (Levelt, 1983).

Closely related to the preceding two characteristics is the property of speed. Is syntactic processing in production fast? This is a difficult question to answer with any confidence. Some data that are relevant to this issue come from experiments performed by Lindsley (1975), who found that roughly three-quarters of a second separated the exposure of a very simple to-be-described picture from the initiation of a descriptive utterance. Cooper, Soares, and Reagan (1985) reported times in the neighborhood of seven to nine seconds for initiating descriptions of more complex pictures. This is not fast. However, these times necessarily include picture comprehension and motor programming times, as well as lexical and syntactic processing times, and are therefore overestimates. Assessing syntactic processing speed will require factoring out ancillary operations, and this cannot be done easily for a process that is extended in time. The phenomenology is equally uninformative: it is difficult to decide through introspection when one has achieved a sufficient syntactic analysis to support the beginnings of a sentence. It is at least reassuringly common that speech follows promptly upon the heels of the decision to communicate a thought.

A fourth property, one that is connected to the issue of informational encapsulation, concerns the depth of elaboration of the output of a modular system. Fodor argues that modular systems have "shallow" outputs, by which he appears to mean that the output of a module such as one responsible for parsing does not reflect inferences that might be drawn on the basis of contextual information. This follows from the
absence of any interaction between higher-level comprehension processes and parsing. In production, going from meaning to sound, the analogous claim would be that the output of the syntactic module is insensitive to and does not reflect the phonetic or phonological characteristics of the eventual utterance. This is an issue that is under some dispute: Garrett (1975, 1980) has argued that speech errors that implicate syntactic processes do not reflect the phonological characteristics of utterances, although Dell and Reich (1981) were able to show that phonological similarities are found in such errors more often than would be expected by chance. In a similar vein, Bock (1987a) found that the phonological priming of words influenced the syntax of sentences in which these words occurred. One possible resolution of these conflicting claims is in terms of interactions between the outputs of separate syntactic and lexical processing systems: if the outputs of two parallel modules, a syntactic module and a lexical module, are integrated at some point in processing, the phonological characteristics of words may operate indirectly at that point to modify sentence form.

Two other characteristics concern the neurophysiological substrates of modularity. According to Fodor, modular systems are associated with fixed neural architecture and exhibit characteristic and specific patterns of breakdown. Some current interpretations of aphasic syndromes are at least consistent with such an argument for production. Schwartz (1984, 1987) presents a clear case for classification in aphasia in terms of difficulties in recruiting certain syntactic resources of the language versus difficulties in retrieving and using certain lexical resources (also see Bradley, Garrett, and Zurif, 1980; Caramazza and Berndt, 1978; Saffran, Schwartz, and Marin, 1980).

Finally, Fodor hypothesizes that modular systems exhibit a developmental course that is characteristic of maturational systems. Since most of the claims for maturational progression in language acquisition (cf. Gleitman, 1984) are based on evidence from children's speech production, the evaluation of the degree to which the development of syntactic production processes meets this criterion will depend in part on the evidence given to this data. Current research is far from conclusive about whether or to what degree the production of syntax is governed from the beginning by a system that is restricted to this role, or emerges from the constrained development of a system whose components are rapidly dedicated to distinct linguistic functions. However, as we noted earlier, existing data are at least consistent with the former possibility (Pinker, 1984).

To the extent that Fodor's criteria for modularity in language processing are reasonable ones, then, there are grounds for arguing that various components of production are in these senses isolable. However, modularity may hold in a relatively weak way for sentence production processes. Tanenhaus, Carlson, and Seidenberg (1985) layout alternative versions of the modularity hypothesis that describe increasingly limited domains for a modular language processing system. In one, the whole linguistic system operates as a module. This is improbable in both production and comprehension because of the wide array of evidence which argues for dependencies across different kinds of information in language processing (for reviews see Bock, 1982; Tanenhaus et al., 1985). In a different, weaker version of the modularity position, the linguistic system is comprised of sets of modules (e.g., a syntactic module, a lexical module), each of which sends its outputs to, or receives its inputs from, a general cognitive processing system. Within the framework we are assuming, language formulation interacts strongly with the general cognitive system up to the point that basic syntactic functions are assigned; only after this, during the elaboration of constituent phrases, does it appear reasonable to argue that generation becomes largely impenetrable to and dissociable from other cognitive processes. This is at best a very circumscribed sort of modularity, since it takes in only part of what can legitimately be regarded as the syntactic processes of sentence production.

Summary

There are two different ways to construe issues of autonomy in language. One of these involves what Garnham (1985) has called formal autonomy, or a structural system that is closed or complete without reference to constructs outside itself. The second is processing autonomy, which implies information processing in a system whose lines of communication are heavily restricted. It is the second of these that is most clearly relevant to theories of language use.

In terms of one set of characteristics for an autonomous or isolable processing system, Fodor's features of modularity (1983), there are interesting ways in which language production constitutes such a system. Determining whether these features are anything more than incidental will require more detailed knowledge of the way information develops and is deployed during the creation of utterances. A central
issue is whether there is a uniform set of syntactic relations which could serve as the input to such an isolable system. Though there is evidence that syntactic categories and relations play an important role in the creation of sentences, it remains to be shown whether such categories operate in any integrated way.

THE IMPORTANCE OF SYSTEMATIC PATTERNS IN HUMAN PERFORMANCE

The usual terms of the psycholinguistic debate over the autonomy issue have led to the relative neglect of processing demands as forces in the shaping of language. These usual terms, as we have noted, center more on the issues surrounding formal autonomy, with some parties to the debate emphasizing the grounding of language in meaning, communication, and human interaction (Bates, 1976; Osgood, 1971, 1980; Rommetveit, 1968), and others stressing the complexity, variety, and semantic neutrality of language structures (Chomsky, 1968). Implicit in this debate over functional-semantic versus formal-syntactic explanations of language knowledge are rather different presuppositions about the nature of the selective pressures on the mapping function: on the one hand, that its form is crucially determined by the demand for faithfulness or clarity in expression; on the other, that its form is crucially determined by an innate set of abstract principles that make languages learnable.

Neither of these perspectives takes serious account of the need for what Slobin (1977) called "processibility in ongoing time". However, from the standpoint of processing there is a different sort of utility argument to be made for the existence of an abstract structural vocabulary — a vocabulary that serves to represent information in the kind of isolable system we have just described.

This argument has nothing to say about the ontology and ontogeny of language forms. All of the competing positions on these issues can perhaps lay claim to some piece of the truth. There may be communicative-function-based forms in language, there may be forms that are rooted, specifically or generally, in learnability (Pinker, 1984; Slobin, 1977), some that satisfy the human desire to master problems (Bever, 1986), others that owe their existence to processing efficiency (Berwick and Weinberg, 1984; Slobin, 1977), and yet others that are in fact wholly arbitrary. However, all the forms of a language, regardless of their nature, must work together in day-to-day language performance.

In this section we will examine how a separation between the primitives of syntactic patterns, whatever their origins, and the meanings and motives that languages express could help to make languages more tractable for their users. Although this is a species of the processing-efficiency argument, the point we wish to make is a more general and less tendentious one: that mechanisms keyed to abstract structural features may serve to make language processes more fluent than mechanisms rooted directly in the details of content and communicative intentions.

We will first briefly examine a classic phenomenon of problem solving in which separations between pattern and content lead to less differentiated but more facile performance, and then consider the implications of a similar phenomenon in syntactic processing.

Set

One of the staple demonstrations of the problem solving literature involves the emergence across successive problem solutions of what the Würzburg psychologists (see Humphrey, 1963) called *Einstellung*, more commonly known in American psychology as set. The development of set can be illustrated with Luchins' (1942) water jar problem. Imagine that you have two jars, A and B, whose capacities are 29 cc and 3 cc respectively. Problem #1 is to use these two jars to measure 20 cc of water. For each successive problem you are given three new jars with different capacities, A, B, and C (as indicated below), and instructed to measure out the required amount of water (again as indicated). The amount of water available is unlimited (this form of the problem is adapted from Glucksberg, 1966, p. 18):

<table>
<thead>
<tr>
<th>Problem #</th>
<th>Jar A</th>
<th>Capacity of Jar B</th>
<th>Jar C</th>
<th>Required amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29</td>
<td>3</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>3</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>16.3</td>
<td>25</td>
<td>99</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>43</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>42</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>59</td>
<td>4</td>
<td>31</td>
</tr>
<tr>
<td>7</td>
<td>23</td>
<td>49</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>15</td>
<td>39</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>9</td>
<td>18</td>
<td>48</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>10</td>
<td>14</td>
<td>36</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>
A typical approach to solving these problems involves the discovery, beginning with Problem 2, that jar B poured once into jar A and twice into jar C yields the required amount. This same solution works for all of the succeeding problems, and the amount of time required to find solutions for problems 3 through 10 decreases accordingly.

The reduction in the amount of time spent looking for a solution procedure, and the persistent use of the same procedure, are characteristic features of the development of a specific set. The problem solver induces a particular pattern or rule defined over constant elements of the problem domain (jars, rather than quantities of liquid) and applies it repeatedly. When the procedure in fact yields the correct answer, the advantages are obvious: the amount of time invested in searching for a solution will be greatly reduced relative to a series in which a different solution is required for each problem.

But there are disadvantages to sets, too. One arises in problems 7 through 10. Although all of these can be solved with the B—A—2C rule, there are simpler solutions for them, solutions involving just two of the jars. Fewer steps are needed to carry them out. However, many problem solvers completely fail to notice the easier approach, and persist in using the B—A—2C rule.

Whether this is ultimately deleterious depends on what takes time, or money, or more abstract resources in the performance of a particular task. If the costs in solving a particular type of problem are mostly incurred during the application of the solution procedure (because the application is a lengthy, costly, or effortful one), the development of sets can impair performance. Clearly, the disadvantage of developing a set in the water jar problem is greater if one is measuring real water with clumsy jars than if one simply has to indicate the algebraic form of a solution. On the other hand, if the costs of solving a problem are incurred primarily during the formulation of or search for a procedure for solving it, sets can be advantageous. As a result, in domains that permit similar solution procedures for a wide array of different problems, the development of sets can produce very efficient performance as long as the procedures can be applied relatively effortlessly.

Pattern Repetition and Syntactic Processing

The increasing speed with which problems are solved as a set develops argues that processing can become more efficient when representations of the elements of a problem are abstracted away from situated details. There is evidence for similar set-like effects in language performance, evidence which suggests that highly schematic syntactic structures are used in solving the unique problems involved in creating and comprehending language.

Several instances of syntactic repetition effects were mentioned earlier, both in unconstrained conversation (Schenkein, 1980; Weiner and Labov, 1983) and in controlled experiments (Bock, 1986; Levelt and Kelter, 1982). There is other evidence for processing facilitation due to syntactic repetition in studies of sentence comprehension in adults and children, and in observations of grammaticality judgments. In comprehension, Frazier, Taft, Roepen, Clifton, and Ehrlich (1984) have shown that repetition of structural features across two successive clauses reduces reading times for the second clause, relative to matched controls. A related effect has been found with young children: Whitehurst, Ironsmith, and Goldstein (1974) reported that a group of four- and five-year-olds who heard adults describe pictures using passive sentences were less likely to make mistakes in comprehending passives (and more likely to produce them) than another group that did not receive this type of exposure (also see deVilliers, 1980). In judgments of grammaticality, Matthews (1979) claimed that sentences such as (a) The canoe floated down the river sunk change in classification (as grammatical or ungrammatical) as a function of their position in a list with respect to sentences such as (b) The man that was thrown down the stairs died. If (a) follows (b), it is more likely to be judged grammatical than if it precedes.

An incidental finding from a production priming experiment suggests that effects such as these may be relatively robust. The design and procedure of this study were in most details the same as Bock's (1986) syntactic priming experiments, in which the subjects tended to describe the pictures using sentences whose syntax matched that of the priming sentence. In addition, however, participants in this experiment adventitiously received two very similar dative priming trials (these will be called the initial and final trials) at widely separated locations in a test list. These bracketed four other dative trials (the middle trials) in which the priming sentences were always in a different form, the alternative to the form used on the initial and final trials. Thus, if the primes were in the prepositional form on the initial and final trials, they were in the double-object form on the middle trials, and vice-versa. The
amount of priming on the initial and final trials can be compared in
order to assess the effect of the four repetitions of the alternative
syntactic structure during the middle trials.

This comparison is shown in Table I. On the initial trial, there was a
reasonably large effect of the syntactic form of the priming sentence.
But on the final trial, any effect of the priming sentence was neutralized
by the impact of four predecessors in a competing form. This change in
the priming pattern affected both sentence forms: Prepositional datives
became more frequent and double-object datives less frequent after
repeated exposure to prepositional datives, while double-object datives
became more frequent and prepositional datives less frequent after
repeated exposure to double-object datives. These changes have nothing
at all obvious to do with content changes, since the pictures were
always the same. Thus, despite their very abstract connections to the
content of the message, these sentence schemas appear to become the
most accessible solutions to utterance creation problems.

It is unlikely that these were errors arising from unusual speech
strategies induced by an artificial situation. The priming trials in
question did not occur consecutively: The subjects produced 85
utterances of other types between the initial trial and the final trial, and
the final trial occurred following 12 intervening utterances of other
syntactic types. Evidently, the repetition of structures or mapping
procedures promotes the subsequent use of the same structures or
procedures, and does so for a surprisingly long time. This is buttressed
by studies of structural repetition in natural speech (Estival, 1985;
Weiner and Labov, 1983). What appears in the laboratory also appears
in everyday discourse.

So, scattered through studies of production, comprehension, and
acquisition, there is evidence that the repetition of abstract patterns
plays a part in language performance. Though it is notoriously hard to
pin down what is repeated when the relevant level of analysis is
sentence form, speakers do seem to have a predisposition to repeat
structures somewhat independently of content, a predisposition that is
doubtless related to the drift of syntactic forms to new environments
(Kroch, 1982), to the pervasive and mysterious force often called
analogy (Paul, 1886), and to the “feeling for form as such” described by
 Sapir (1921, p. 61).

Such dissociations of content and form are sometimes attributed to
the emergence in language processing of automaticity, a mode of skilled
performance that has received a great deal of recent attention in other
domains of cognition (Hasher and Zacks, 1979; Logan, 1978, 1979,
1980, 1985; Posner and Snyder, 1975; Schneider and Shiffrin, 1977;
Shiffrin and Schneider, 1977). Though definitions and operationaliza-
tions of automaticity vary, some of the properties commonly ascribed
to it are that it occurs without awareness or intention, does not interfere
with other processes, resists modification, and is highly efficient (cf.

It is undeniable that much of language performance is automatic in
these senses, since it is in much the same senses that we have charac-
terized isolability. However, the construct of automaticity will not by
itself explain how forms break free from communicative functions. One
problem is that the sine qua non for the development of automaticity
appears to be consistent mapping. Consistent mapping involves the
repetition of an invariant relationship between one code or representa-
tion and another, or between stimuli and responses (Schneider and
Fisk, 1982; Schneider and Shiffrin, 1977; Shiffrin and Schneider, 1977).

<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect of syntactic priming on the production of two dative utterance forms before and after a series of competing-form primes.</td>
</tr>
<tr>
<td>Priming condition</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Prepositional</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Double object</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Note. The table entries represent the percentages of subjects (N = 24 in each of the two priming conditions) who used the utterance form indicated at the head of the column. The distribution of responses for the initial item was marginally significant ($\chi^2 [2] = 4.72, p < 0.10$); the distribution for the final item was not ($\chi^2 [2] = 0.59, p > 0.80$).
many, and automaticity does not develop. The importance of consistent mapping suggests that the emergence of automaticity in language use should be accompanied by tighter rather than looser links between functions and forms.

A second problem arises from the construal of consistent mapping itself. Duncan (1986) makes the telling point that the notion of consistent mapping falls prey to the classic problem of stimulus definition (Chomsky, 1959): it is unclear for most real-world cases what constitutes an appropriate class of stimuli over which to define the mapping function. Another way of saying this is that one needs to know what the categorizations of patterns are before the mapping to performance processes can be said to be consistent or not. Together, these problems suggest that automaticity cannot be a sufficient explanation for what we have termed the isolability of a processing system. It is likely to be easier for automaticity to develop when the initial representations for parts of the syntactic system are more abstract with respect to cognition and more specific with respect to language structure itself than those assumed in a pragmatically- or semantically-based model. The disputed issue is not automaticity, but the nature of the mappings that are instantiated in performance.

Summary

Systematic patterns for mapping from one representation to another are critically important in many facets of human cognition, including the solution of problems and the use of language. Efficient mapping in problem solving appears to involve the use of a set of relations that preserve information in highly schematic ways and are broadly applicable. The repeated use of such abstract mappings can dramatically increase the ease and speed with which they are deployed.

Assuming analogous operating characteristics in language use, considerable benefits may accrue if the primitives of language processing are abstracted away from the details of messages and communicative intentions. From the perspective of performance, it may be less beneficial to link procedures directly to messages through features of context and meaning than indirectly through a more abstract relational representation system. Consistent with the latter arrangement, language performance reveals a robust tendency toward form repetition that does not seem to be tightly linked to pragmatic or semantic features.

CONCLUSION

Our goal in this chapter was to subvert a seductive picture of language performance. That picture emerges from the seeming invisibility of the abstract categories and relations of a language to its native speakers, and can be rationalized in any number of ways, including the usual ease with which one proceeds from the sound to the meaning in comprehension, or from the meaning to the sound in production. A simplistic explanation for this effortlessness is that there is truly very little in between — that the link between communicative intentions and surface forms in an immediate one. Coupled with evidence suggesting that certain contextual and semantic variations in messages are indeed reflected in systematic variations in form, it is tempting to conclude that there is a direct mapping from meaning to surface positions.

But there are several types of evidence which suggest that the link is not direct. This evidence comes from patterns of language change, from the early speech of language-learning children, from errors in adult production, and from dissociations between meaning variations and form variations in language use. Such evidence points to a relatively elaborate processing system whose operations are keyed not to meanings directly, but to abstract structural or syntactic categories. The rudiments of these categories may be part of the child’s natural endowment, or they may emerge very rapidly during development, but they play a clear role in adult performance.

To reconcile these two perspectives on language use, a processing theory is needed that accounts on the one hand for the apparent effortlessness of creating sentence form, and on the other for the apparent complexity of the internal system that creates it. We have suggested that the best candidate for such a theory is one that explains how and when during processing a communicative intention is given over to a system that is sensitive only to very abstract structural features.

There is perhaps some uniform level of representation at which this occurs in the course of generating an utterance, or it may occur at different levels for different types of structural mappings. Either way, the main points are the same. First, to repeat, the association between meanings and surface forms in language use is not a direct one. Instead, meanings seem to be linked to forms through more abstract categories and relations that control the elaboration of sentence structure. Second,
there is more to explaining language generation than accounting for the meaning-to-syntactic-relation linkage. The generation of forms from syntactic relations is a complex and interesting process in its own right, one that may be responsible for many of the intriguing errors of speech, but also for much of its usual efficiency.

ACKNOWLEDGEMENTS

Preparation of this paper was partially supported by a Biomedical Research Support Grant from Michigan State University and NSF grant BNS-8617659 to the first author. Figure 1 was reprinted with the permission of Academic Press.

Michigan State University and University of Pennsylvania

NOTES

1 Following their proponents, we will refer to these views as functionalist approaches to language, or grammatical functionalism. They are not to be equated with the broader functionalism of philosophy or psychology (Block, 1980), which encompass both linguistic functionalism and the alternative to it that we will endorse.

2 The priming trials were embedded in a recognition memory test that made speaking appear incidental to the purpose of the experiment. This test format also permitted priming trials to be camouflaged by a large number of filler items that obscured relationships between sentences and pictures. The test picture descriptions were scored for syntactic form, with descriptions of pictures from the transitive priming trials scored as active or full passive, and descriptions of pictures from the dative trials as prepositional or double-object (descriptions not meeting the criteria for inclusion in these categories were discarded).

3 In light of the consistent evidence for the syntactic hypothesis, the most viable explanation for these weak conceptual effects involves the syntactic role assignment process. There may still be a tendency to repeat the pattern of syntactic role assignments across sentences, linking elements with similar conceptual characteristics to the same syntactic roles. However, there is clearly an additional force at work, one which biases the repetition of the same sentence form — the same mapping from syntactic relations to surface positions.

4 The priming sentences on the initial and final trials were both benefactive (the prepositional forms were: The governor made a pot of tea for the princess and The secretary baked a cake for her boss), their syntactic forms were identical for each subject, and the priming pictures that they preceded were also closely related (the initial trial picture showed a girl giving flowers to her teacher, and the final trial picture, two children giving flowers to a man).

REFERENCES

aphasia’. In D. Caplan (Ed.), Biological Studies of Mental Processes. Cambridge, MA: MIT Press.


Language disorders resulting from brain damage provide a unique perspective on language processing in the normal case. In this paper, I wish to argue that language pathology may provide considerable support for one set of claims about language processing: the thesis of linguistic modularity. In particular, I will review the neuropsychological evidence that bears most directly upon the claim that syntactic structure is computed by an autonomous processing module.

The discussion is organized as follows. The preliminary remarks in Section 1 address the nature (and limitations) of neuropsychological evidence generally, and clarify the notion of autonomous syntactic processing to be investigated below. In the following sections, the neuropsychological case for modularity is developed in connection with a variety of language disorders. Section 2 concerns the striking preservation of syntactic capacities in patients with severe lexical impairments and, in some cases, general cognitive deterioration; this dissociation appears to provide very strong support for the view that syntactic processing must be psychologically distinguished both from lexical processing and from general cognitive processing. Section 3 concerns the implications of agrammatic Broca's aphasia, which has been invoked as an argument for modularity on the grounds that it represents a selective loss of syntactic capacity. The argument put forth in this section, by contrast, is that receptive language processing in agrammatism provides evidence for the distinctness of parsing and semantic interpretation, and hence for modularity, because certain agrammatic patients appear to be capable of computing syntactic structures which they are unable to interpret. Finally, Section 4 details some recent investigations of sentence processing in agrammatism which, I believe, provide support for a modular, two-stage model of language processing.