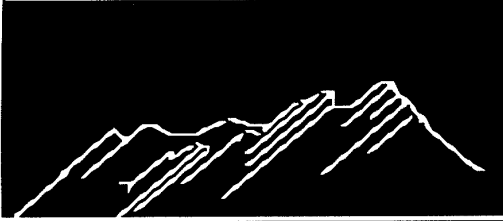


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Toward a Theory of Grammatical Encoding in Speech Production: Evidence from Speech Errors

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ABSTRACT

Human language production is a complex cognitive skill that maps thought to speech. A subgoal of production is grammatical encoding, in which the functional relations and structural constituents of an utterance are computed. This study focuses on the stage of encoding that establishes functional relations, the *functional processing* stage. During functional processing, production units corresponding to message components are assigned to a set of grammatical functions, like subject and object, that forms the *functional frame* of a clause. Functional processing also assigns elements to functional relations within domains smaller than the clause, such as phrasal head. Functional representations are precursors to constituent assembly.

The empirical domain of investigation is a corpus of speech errors. Speech errors have been instrumental in the development of production architectures, and one contention of the study is that errors continue to be valuable probes into production processes. The results based on analyses of error data, as well as proposals for future directions in encoding research using speech errors, validate this approach.

The error data are used to explore three currently unsettled questions about functional processing: (1) How is the functional frame of a clause computed? (2) When is the information available to compute a clause's functional frame? and (3) What elements undergo function assignment to the grammatical functions of a frame, both at the clause level and below? The errors patterning of an error subtype, *sentence pattern errors*, is used to argue that functional frames are production units that compete for selection and are not necessarily computed incrementally. Crucial to the argument is the *Processing Uniformity Hypothesis*, which states that a single processing vocabulary applies to production units of all types. The properties of sentence pattern errors also argue that functional frames may be computed from semantic, thematic, and discourse-pragmatic information before lemma selection makes the syntactic properties of words available, making lexical guidance in frame computation nonobligatory. Properties of a second error subtype, *noncontextual displacements*, are best explained in a model in which the elements that undergo function assignment at all levels are not lemmas or phrasal constituents, but some pre-lexical grammatical element. The result is compatible with a production architecture is that in which lexical meaning contains a non-decomposed stratum of concept nodes that form the domain of function assignment. The properties of noncontextual errors also support a model with inhibitory connections between concepts and binding of functions to a functional frame by timing.

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TABLES

3.1 Error sources and counts	37
3.2 Numbers of lexical errors by unit type.....	40
3.3 Numbers of lexical errors by distribution type	40
3.4 Numbers of lexical errors by distribution type and unit type	41
4.1 Numbers of repetition and noncontextual displacements exhibiting accommodation, stranding, and preservation of grammatical class	54
4.2 Numbers of anticipations and perseverations by error subtype and relation to source..	56
4.3 Numbers of repetitions and noncontextual displacements by form similarity to source.....	57
4.4 Error-source pair examples of six semantic relations from each semantic subclass	58
4.5 Distribution of errors in three semantic subtypes by contextually appropriate and inappropriate semantic relation categories	60
4.6 Numbers of errors in three semantic subtypes by error-target form similarity	60
5.1 Numbers of error-target pairs of the same and different grammatical class for two replacement subtypes	73
5.2 Numbers of word error-target pairs of the same and different grammatical class in two replacement subtypes.....	74
5.3 Numbers of combined form error-target pairs of the same and different grammatical class in two replacement subtypes	74
5.4 Numbers of simple displacements with error-source matches by replacement subtype.....	75
5.5 Numbers of errors and targets in verb substitutions compatible with the error frame...	79
5.6 Number of sentence pattern errors by error and target word class	81
5.7 Number of sentence pattern errors by correction method and identifiability of target from speaker restarts	83
5.8 Number of sentence pattern errors by compatibility of error predicate with error frame and identifiability of target	83
5.9 Encoding of three participant categories in error and target frames	85
5.10 Valences of error and target frames	86

FIGURES

2.1 Garrett's (1984) model of language production	36
2.2 Message representation for "The child gave the mother the cat" (from Levelt 1989)	46
2.3 Part of the lemma for the verb 'give' (from Levelt 1989).....	48
4.1 Distribution of semantic relations for three semantic subtypes	95
5.1 Distribution of semantic relations for four semantic subtypes	136

INTRODUCTION

The goal of this study is to contribute to an understanding of the processes of speech production that accomplish grammatical encoding. Grammatical encoding is that component of the human language production system that transforms a speaker's message into an ordered set of lexical items that are suitable for conveying the intended message and that meet the semantic and syntactic constraints of the encoding language. Encoding follows the conceptualization process, which breaks a speaker's message down into conceptual chunks that can be verbalized by the speaker's language. It is intimately related to the lexicalization process, during which the words that will express concepts are chosen. Grammatical encoding itself is a collection of subprocesses. I will largely be concerned with the early stages of encoding, often referred to as functional processing and not the later stages that involve constituent assembly. The output of grammatical encoding is a syntactic structure that serves as input to phonological encoding and articulation.

A study of encoding necessarily contributes to a psychological theory of language production, as distinct from syntactic theories, which are concerned with explaining language competence (Chomsky 1965). However, the two approaches are related. A theory of production encompasses the architecture of a complex cognitive skill. It seeks to explain at a symbolic level how speakers generate utterances. Under ideal circumstances, an utterance generated by a speaker will be grammatically well formed, and the constraints on well-formedness are the domain of theories of syntax.

At this time, most of what theories of production have to say about the encoding process is non-specific and speculative. The difficulties in developing a theory of production are well known (see Bock 1996). Language use is a largely automatic and unconscious process, as are many human cognitive skills. One approach taken by production researchers since the inception of the field is to consider observational data, primarily unintended errors in production (Butterworth 1982; Cutler 1982; Dell 1984, 1986; Dell & O'Sheaghda 1992; Dell & Reich 1981; Fay & Cutler 1977; Fromkin 1971, 1980; Garrett 1975, 1976, 1980a, 1980b, 1982; Harley 1984; Jescheniak & Levelt 1994; Shattuck-Hufnagel 1979, 1983; Stemberger 1982, 1983, 1985, 1989). Errors occur in spontaneous speech because even well practiced, unconscious cognitive skills are not immune to failure.

I will employ a corpus of speech error data in this study, identifying for analysis error subtypes that will shed light on aspects of functional processing. The errors in the corpus can, with very few exceptions, be characterized as lexical errors, that is, errors that can be described in terms of words. Among the more well-studied subtypes of lexical errors are form blends of pairs of words (*feeling sadry for herself*, for *sad* and *sorry*), substitutions of unplanned words for intended ones (*when do you have to type - teach?*), and displacements of the planned words of an utterance (*deafness is no acquisition - no handicap for the acquisition of language*). Word errors impose constraints on the way in which production processes can be modeled.

Previous work on the lexical and the phonological components of a production system forms a basis for the analysis. Lexical and phonological errors have been extensively employed in production research and have contributed to an understanding of grammatical encoding and the production system in general. Lexical errors bear directly on the questions of lexical

organization, lexical access, and processes of grammatical encoding, to the extent that encoding is lexically driven. Analyses of the production of words and sounds establishes a methodology by which to proceed, and provide insights into the forms and mechanisms of production that I will extend to a study of grammatical encoding. Experimentation (Bock 1987a; Bock & Loebell 1990; Bock & Warren 1985; Levelt, Schriefers, Meyer, Pechmann, Vorberg, & Havinga 1991; Meyer 1990, 1991, 1992, 1994; Meyer & Schriefers 1991; Roelofs 1993; Roelofs & Meyer 1993; Schriefers, Meyer, & Levelt 1990; Shattuck-Hufnagel 1992; Wheeldon & Levelt 1995) and computational modeling (Dell 1984, 1986, Dell, Burger, & Svec 1997; Dell & Reich 1981; Dell, Chang, & Griffin 1999; de Smedt 1996; Harley & MacAndrew 1995; Kempen & Hoenkamp 1987; McClelland & Rumelhart 1981; Roelofs 1992, 1993, 1997) have also contributed to solving the production problem. Conclusions from error analysis, experimentation, and modeling will all be taken as a foundation for the current study and brought to bear on the arguments where appropriate.

While speech errors have been widely used in the development of production architectures, the appropriateness of error data as an empirical domain is not universally recognized. Some researchers maintain that the primary domain of production research should be the normal processes of speaking, examined primarily through latency data in naming experiments, and not speech errors (Levelt 1989; Levelt et al. 1999; Meyer 1992). Regardless of whether speech errors are the primary domain of investigation, they must be accounted for in a model of human language production. One contention of this study, however, is that error data can be a continuing source of useful insights and cannot be ignored in the development of a production model.

The study focuses on an aspect of grammatical encoding referred to as functional processing. Functional processing in the clause can itself be further broken down into two subgoals (Bock & Levelt 1994). One subgoal, *frame computation*, establishes a set of functional roles that structure the relations between the conceptual participants of a situation. The functional roles will be considered to correspond to traditional grammatical relations, like subject and object. The question of the exact nature of the roles in production will not be taken up in this study. In addition to encoding functional relations, frame computation must respect functional dependencies between the frame roles and the clause's predicate. The second subgoal of functional processing, *function assignment*, involves mapping elements corresponding to conceptual participants to the functional roles of the frame. Frame computation and function assignment result in a functional representation that forms the basis for constituent assembly. A functional representation thus manifests itself as a sentence pattern configuration (Levin 1993).

Some basic theoretical questions about the functional processing will be touched on using error evidence, and three will be directly addressed. First, it is not known when frames are computed. One theory, *lexical guidance*, takes a strongly lexicalist approach to encoding by proposing that frame computation can only occur after lemma access. On this view, lemmas are central to the mapping from concepts to functional representations. In contrast, *conceptual guidance* allows frame computation to precede lexicalization. Second, how functional frames are computed remains to be determined. A frame may be created *incrementally*, one function at a time, or it may be computed as a unit. On the latter view, frames would be production units that are selected *competitively*. Third, we do not know what elements undergo function assignment. Most models assume that lemmas corresponding to phrasal heads are assigned to functional roles. However, an alternative view is that function assignment can occur before lexicalization and is performed on some other element type.

Two analytic approaches are pursued in the study. First, I will revisit traditional classifications of lexical errors and identify a subtype of errors, *noncontextual displacements*, with properties that can be used to probe functional processing. An analysis of lexical error data involves examining the properties of errors across a variety of structural and functional parameters, comparing properties among error subtypes both qualitatively and quantitatively, and noticing what logically possible error types do not occur in the corpus. In a study of functional processing, the properties of most interest are those that involve the functional dependencies of words. The second analytic approach is to reconsider the errors in the corpus as requiring for their description and explanation something other than lexical interaction. I will identify a subtype of errors in the corpus, *sentence pattern errors*, whose behavior can be captured by recognizing the existence of complex units of production other than words. As in an analysis of lexical errors, the characteristics of this subtype that make it appropriate in a study of functional processing involve functional dependencies among words.

I will show that error data will lead to progress toward understanding functional processing by providing answers to the three questions addressed in the study. First, I will argue that the elements assigned to the relations in a functional plan at all functional levels are not phrases or word lemmas, but concepts. The evidence comes from error data that reveal the representational types that are active during functional processing. The conclusion entails a non-decompositional level of semantic representation in the lexicon, but avoids stipulating strict modularity of level processing, although the conclusion holds in a modular model as well. Second, the data suggest that the computation of a functional plan for a clause does not entail predicate lemma access. I propose that the basis for frame computation is, in some cases, the conceptual, semantic, and discourse-pragmatic information available before predicate lexicalization. Finally, error data is consistent with a view of functional frames as units of computation within the production system, although this issue is not settled by the results. The units I will identify are functional plans at the clause level, corresponding roughly to the notions of argument structure or of sentence patterns in syntactic theory. These functional units are identified by applying the *Processing Uniformity Hypothesis*, which claims that the computational primitives of the production process are independent of processing level, and consequently error profiles for units at any level will be identical if they are subject to the same processing vocabulary. In general, the results argue for the option of conceptual guidance and competitive selection of functional frames in functional processing, which corroborates the intuition that parallel processing allows greater speed and flexibility for speakers in utterance creation.

Error analysis certainly will not completely solve the production problem for grammatical encoding; some questions cannot be answered by using observational data of this kind. This limitation on the use of error data holds for each of the areas stated above. For example, we will almost certainly not be able to predict how a functional frame is computed in any given instance. We will also not be able to learn anything quantitative about the absolute timing that production requires. But where questions remain, error analysis can suggest alternatives that may be differentiated using a complementary approach, like experimentation or computational modeling. Error analysis has already sharpened understanding of lexical and phonological processing to the point that questions can be framed for experimental research in those areas. Error data are also the source of indispensable benchmarks for computational simulations of lexical and phonological production. Knowledge gained from these approaches has fed back into the study of speech errors, which continue to be part of the cycle of

investigation. An important claim of this work is that error data continues to provide useful insights into the nature of production.

This paper is organized as follows. In §1.1, I briefly state the guiding assumptions of the research program of which this study is a part. The empirical domain of the study is speech errors, and §1.2 argues for their appropriateness in production research. I look at the successes and limitations of some earlier applications of error data to encoding research in §1.3. The major theoretical questions in developing a model of encoding are presented in §1.4.

Chapter 2 provides an overview of the current state of production theory by reviewing its historical development using speech error data and, more recently, experimentation and computational modeling. The historical presentation serves to elucidate the methodology of speech error research and its interaction with other methodologies used in production research.

Chapter 3 discusses some of the problems of gathering speech error data for a study of grammatical encoding in §3.1, and then presents the data by surveying the corpus I will use in §3.2. The chapter ends with a discussion in §3.3 of the analytic approaches I will take in the studies of the subsequent chapters.

Chapters 4, 5, and 6 each address a specific question about the domain of functional processing. In chapter 4, I investigate a subtype of lexical errors, noncontextual displacements, in relation to other lexical displacement types. The data are used to investigate what elements in the domain of functional processing undergo function assignment. Chapter 5 identifies and analyzes the sentence pattern errors, which are a subtype of errors that exhibit failures to meet the functional dependencies of words in the utterance, although proper semantics and participant configurations are maintained. The analysis of sentence pattern errors provides an answer for when it is, relative to other functional processing events, that frame computation occurs. Chapter 6 argues that the functional frames are complex units manipulated by the production system during functional processing. The paper ends with a summary of the results and their model implications in chapter 7, together with some directions for future research on encoding using speech error data.

CHAPTER 1 THE PRODUCTION PROBLEM

1.1 SOME GUIDING ASSUMPTIONS FOR PRODUCTION RESEARCH.

In exploring the processes of grammatical encoding, this study is intended to contribute to solving the production problem. It shares this goal with other production research, and with them works within a shared paradigm of research. A research program develops theory under a set of high level guiding assumptions that are more wide-ranging in their application than any particular theory that is explicated within their bounds (Laudan et al. 1986). Guiding assumptions are not always explicitly stated by researchers when expounding a local theory, although the assumptions will determine the empirical phenomena examined and the methodologies by which they are analyzed. Dialog within a community of researchers obviates continued explicit statement of assumptions. For purposes of completeness in this study, I will briefly state the set of assumptions I take to hold in studying grammatical encoding, and that are shared by most researchers in production modeling in general.

The production theories developed in this study are psychological theories developed to explain a complex cognitive skill, the use of language. The family of cognitive theories to which the production theories are related are symbolic systems that involve the manipulation of mental objects. Developing a theory in terms of symbolic manipulations does not mean the theory cannot be algorithmically implemented using non-symbolic mechanisms, such as the connectionist models that have become commonplace in cognitive science. Metaphors from connectionist models and their implementations, including the notions of network and spreading activation, can be imported into a symbolic theory, where they increase the descriptive power of the theory without changing its symbolic basis.

In the current approach, language processing can be studied separately from other cognitive processes. It interfaces with other cognitive systems, but otherwise is not influenced by them in its internal manipulations. Language production is initiated within the language processing system under intentional control, but the inner workings of the system are carried out largely automatically, and they are opaque to conscious control or perusal. Opacity and automaticity also characterize other domains of mental processing.

The goal of the production process is to turn the intention to communicate into speech. Speech production processes achieve the linearization of a multidimensional cognitive representation of an intended communication, a message, as a string of symbols, the utterance. The process is deterministic, in the sense that a single output is computed for any message (Kempen 1999, Levelt 1989). The production process must also allow for the generation of an unbounded number of novel, well-formed strings in real time. Generativity permits the design of a single universal system whose architecture can explain production in any language.

1.2 SPEECH ERRORS: A WINDOW INTO PRODUCTION.

Exploration of production processes requires identification of an empirical domain of investigation that is appropriate for the area. A premise of this study is that speech error data is such a domain. In this section, I argue why this is so, and what advantages a study of speech

errors has over other approaches. While error data is argued to be valuable, some limitations and problems it brings with it must also be recognized.

Among the candidates as a tool for production research is linguistic theory. Linguistic theories of syntax are meant to capture the structure of the grammatical utterances of a language. Although utterance structure cannot be read directly from the string of sounds of which an utterance is composed, techniques have been developed for probing constituency. By comparing grammatical utterances that differ minimally, or by comparing grammatical utterances to minimally different ungrammatical ones, it is possible to develop a theory of what the pieces of an acceptable utterance are and how they must fit together. However, in use, utterances are not static entities; they are produced in finite real time by speakers as the realization of an intention to communicate meaning. Knowing the internal structure of a completed utterance does not tell us how that utterance was formulated. More explicitly, we cannot know from the surface form of an utterance what mental objects form the basis for its generation, how these objects are accessed, in what sequence and under what constraints they combine, or what intermediary forms may be created on the path to an utterance's externalized form, which, under normal circumstances, is the only evidence we have of the production event. What this knowledge would require is a window into the production process. To this end, introspective evaluation of distributional data is largely useless.

It is the case, however, that syntactic theories—some more so than others—can be construed as high level architectures of language production, in that they encompass the interaction of the various representational modules posited to explain the grammar. In this regard theories can provide insight into representational forms and suggest necessary interactions. However, syntactic theories are not principally concerned with providing a procedural account of production, and so details of access and integration are largely left unspecified. From the standpoint of syntactic theory, then, the production problem remains unsolved, since these temporally underconstrained components are open to multiple interpretations when viewed from the perspective of real-time processing. What is more, there is no reason to assume that syntactic theories are necessarily helpful in solving the production problem, because their metaphors are generally not intended to be psychologically real. If they are so intended, the relation can in actuality only be speculative, if not merely coincidental.

Since a theory of production is a psychological theory, we might turn to the experimental methodology widely used in psycholinguistic research to investigate the production process. This has proved a difficult approach, since as Bock argues,

It is hard to control the input to language production processes in the way that the input to language comprehension can be controlled and, in the face of the diversity of the output, even harder to develop a defensible set of response measurements. (1996:395)

In other words, in order to exploit the experimental approach it is necessary to develop tasks in which a number of speakers are induced to produce utterances that reflect precisely the same communicative intent, but without specifying that intent to them in words. Then, when the outputs vary, as they will, it must be verifiable that observed variation is a function of the production system, and not a reflection of differing intentions. This is not to say that no experimental paradigms have been developed that help to investigate the production process, especially at lower levels of representation, but also at the level of syntax. We will make use of

experimental paradigms have been developed that help to investigate the production process, especially at lower levels of representation, but also at the level of syntax. We will make use of some successes in this sphere.

If production is automatic, it is certainly not the case that its execution is carried out seamlessly. Rarely, in spontaneous, unpracticed speech, is any reasonably long sequence of utterances produced fluently. The reality of the production process is generally something like the exchange in 1.1 (from the Switchboard corpus of recorded telephone conversations, Godfrey et al, 1992).

(1.1) A: Uh, mansard roofs are, are in bond building, I guess, are, they do a lot of that, I understand, by laminating the series of, of beams of planks together and, and with,

B: Yeah tha-, that's done some where they're actually create a, a single piece that is the truss.

These observational data tell us that the output of speech is frequently interrupted by hesitations and repetitions, or is even sometimes abandoned before completion. Dysfluencies suggest that construction of the output string and its execution go on simultaneously. This fact we can corroborate by introspection, because as speakers we know that we may be thinking about saying one thing while uttering another. Garrett 1982 attributes dysfluencies to three factors based on output facts like those seen in 1.1. The factors are variation in processing load, planning delays, and retrieval difficulties. Most of the attention to dysfluency data has focused on issues of planning domains and their relation to constituency, or to theories of self-editing, which taken together are only a small part of the production system.

There is a way the sealed production mechanism reveals its processes to us, and that is through the relatively rare, spontaneous production by speakers of utterances that do not correctly represent the intentions of the speaker (1.2).¹

- (1.2) a. my whole body felt – fit in one leg of his pants
b. What he was saying was kind of implied - was implying...

Notice that the unintended productions in 1.2 are followed by dysfluencies, and this is often the case. In 1.2, self-editing results in restarts that correct the errors. The restarts in 1.2 provide enough context to identify the preceding utterance fragments as errors, although it would have been even more evident if the larger discourse context were available (as it was when the utterances were recorded by the author). Preceding contexts would unequivocally identify the utterances in 1.2 as errors even without the corrections, and the restart phenomenon can be separated from the error itself in an analysis of error data.

From the point of view of the psychological paradigm assumed in this study, errors in spontaneous speech are a result of failures that occasionally occur in the unconscious

¹ Examples without a cited source are part of the corpus used in this study. The ultimate source for corpus errors is cited only when the error is provided to illustrate reported arguments from other studies. The corpus is described in chapter 3. Error sources for all errors are found in the Appendix..

manipulation of mental objects. Failures in processing can be revelatory about underlying mechanisms. Each interruption acts as a probe into processing. That a range of probes covering different aspects of processing exists can be seen by inspecting the variety of errors to be found in any of the relatively large error corpora. The challenge is to recognize patterns in the outputs and from these to induce constraints and units for a production architecture that gives a principled account for both error phenomena and fluent speech. That this approach can be successful is evidenced by the advances that studies of error data have contributed to solving the production problem

There are caveats that need to be mentioned in the use of error data. In a way, the window on production that an error provides is indirect. Our view of the production process relies on interpreting what the speaker intended to say and how that might have been said if the error had not occurred. Even if the speaker self-corrects, as in 1.2, the problem still exists, because we recognize that other acceptable alternatives were possible, like *what he was saying kind of implied...*, that may quite plausibly have been the intended target at the time of utterance, or may have interacted with the target in creating the error. Our window on production may also be distorted through observational biases and limitations (see Cutler 1981, Meyer 1992). Collection bias makes statistical analysis of errors problematic in some cases. Some of problems may be overcome, or minimized, by collecting large corpora. In its failings, error data is no different from other types of data employed in linguistic analysis, in that it requires the analyst to take into account general linguistic knowledge, and to know what it means to be a speaker.

1.3 PREVIOUS ERROR ANALYSES: LIMITS AND STARTING POINTS.

Lexical error data have provided insights into production constraints and have led to some partial understanding of the processing of sounds and words, and, to a lesser extent, grammatical encoding. For probing the encoding process, however, error usefulness has not been exhausted. Error analysis has been limited primarily because previous analyses of errors that consider them in the light of grammatical encoding are few in number. Some influential studies point the way to continued research, but they are limited in the error subtypes that were examined (Garrett 1980a, *inter alia*), by having assumed a specific syntactic theoretic perspective (Fay 1980a), because subtypes were not adequately explored (Stemberger 1982, 1985), or because they considered error evidence only post hoc as a check on model adequacy (Levelt 1989). As a result, error analyses only just outline a high level solution to the problem of encoding at this time, but they also suggest approaches for continued research.

Previous error studies have largely failed to include some error subtypes, either explicitly, from a desire to limit the scope of analysis, or implicitly, because their occurrence was not recognized. Fromkin 1971 and Garrett 1976 include examples of lexical exchanges in their corpora like the errors in 1.3 (from the MIT corpus, Garrett 1976).

- (1.3) a. The whole country will be covered to a *foot* of one *depth* with dung beetles. (for 'depth of one foot')
- b. We tried it *máking* - *máking* it with gravy.

However, both Garrett and Fromkin (and also Dell 1986, 1997; Dell & Reich 1981; Harley & MacAndrew 1995; Stemberger 1983; del Viso et al. 1991; and Fay & Cutler 1977) limited themselves to lexical exchanges, as well as displacements, involving "planned" words. Planned

elements are defined as elements that are part of what is construed as the speaker's intended utterance. Earlier studies also included errors involving unplanned words. These *noncontextual* errors were of two types, substitutions (1.4a) or blends (1.4b). In both substitutions and blends, the unplanned intrusion into the speaker's plan is most closely related, in some salient way, to the target it replaces.

- (1.4) a. an Easter outfit for a *newlywed* – newborn
 b. the compost is worked into the *topper* part – the top part of the soil ('top' and 'upper')

Other types of errors are logically possible: misplacements of unplanned words (i.e., substitution at a location different from the error source, e.g., 1.5a, from Stemberger 1985) or substitutions and blends of planned words (15b). Only a handful of studies have considered errors of these types.

- (1.5) a. I knit my *sweater* Michelle a scarf (for 'sister')
 b. part and *parcible* (for 'part and parcel responsible')

Stemberger uses errors like 1.5a to point out similarities between the processes responsible for substitution and movement. By comparing the grammatical behavior of errors like the one in 1.5a to substitutions and movements, he argues that word access and word placement are phenomena that originate during the same stage of processing. I will take up the investigation of these errors to see what they reveal about the differences between substitution and movement and how this knowledge can be used to model functional processing.

Previous studies have occasionally reconsidered lexical errors from the viewpoint of syntactic theory. Fay 1980a uses types of errors not considered in earlier studies, but selects and analyzes them for the express purpose of finding evidence for one syntactic theory, Transformational Grammar (as proposed in Chomsky 1965). As an example, Fay used errors such as the information questions in 1.6 (from Fay 1980a) to argue for the psychological reality of proposed subject-auxiliary inversion transformations. Fay suggests that in 4a the inversion transformation applies where it should not, and in 1.6b it does not apply where it should. Similar logic is brought to bear on a range of errors to demonstrate that surface errors reflect deep structure configurations.

- (1.6) a. Why do you be an oaf sometimes?
 b. What she could do?

The limitation of Fay's approach is that the data have been selected to support syntactic theoretical claims. As Stemberger 1982 points out, it is not difficult to find errors that cannot be explained as transformational errors, such as those in 1.7 (Stemberger 1982), where no transformation could relate the surface form to a proposed underlying form.

- (1.7) a. That would fill me too up.
 b. It wouldn't take much time to him.
 c. They take a long time to dry, but they should be it now.

Fay (1980a) himself points out that many of the errors he attributes to transformation failures could be explained in other ways, such as simple lexical misorderings or insertions, that do not appeal to the mechanism of transformation. Stemberger (1982) adds that if non-transformational mechanisms can explain many errors, then "there is no reason to assume that transformations are involved in other errors that are at least superficially similar" (p. 331). A parsimonious account of production would thus eliminate transformations in favor of processes of greater simplicity and with broader explanatory power.

Stemberger's (1982) own analysis of errors takes an approach in many ways similar to one approach pursued here in that he classifies syntactic errors based on categories from the typology used to classify errors at the levels of words and segments. He recognizes that many errors can be explained by assuming the manipulation of supra-word level syntactic objects. He proposes that these structures are phrase structures in a single level syntax. Phrase structures are selected "directly on the basis of semantic structures" (p. 321), although the significant features are not identified. Errors then occur as the result of misselection of a semantically related or contextually appropriate structure. Consider his examples repeated in 1.8.

- (1.8) a. I can't be done that to! (for 'You can't do that to me!')
 b. These definitely haven't finished sorting (for 'haven't finished being sorted')
 c. They said that was the best way, wasn't it?

Stemberger claims that in 1.8a a passive structure is selected in lieu of the correct active one, and an inchoative instead of the correct passive in 1.8b. In 1.8c a tag structure is incorrectly selected to agree with the subject of an embedded clause, instead of the subject of the main clause, as required.

The notion that competition for selection of units can be the source of errors has been proposed to explain some errors at other levels, and it will be pursued in this study as well. An interesting observation can be made about the error in 1.8a. Passivization of the theme argument of a preposition dative construction is not allowed in English. Theme arguments of ditransitive verbs can only be passivized in the double object construction, as the active-passive in 1.9 show.

- (1.9) a. She gave me the present ~ I was given the present.
 b. She gave the present to me ~ *I was given the present to.

Thus, the verb cannot be the source of the passive sentence pattern in 1.8a in a standard grammar, although the utterance is contextually appropriate (i.e., in its passive form, according to Stemberger's report). Stemberger's explanation is that data like 1.8a "...illustrate the extension of passive just beyond the bounds of the grammatical" (p. 324). He implies that passive structures are to some degree independent of the words used to encode them.

Incompatibility between the verb and its syntactic context is also the source of the errors in 1.8b and 1.8c, as the parallel sentences in 1.11a,b demonstrate, with appropriate lexical substitutions.

- (1.11) a. These definitely haven't finished washing
 b. I guess that was the best way, wasn't it?

The errors in 1.8 thus suggest that the production of grammatical utterances must entail dependencies between the lexicon and syntactic structure. Stemberger also discerns that this is the case, but only goes so far as to list subcategorization phenomena as examples of lexical-structural dependencies. He does not consider that the sentence pattern and the verb selected for an utterance must also be, independently, functionally compatible in order to correctly generate an utterance. Recent advances in syntactic theory provide a vocabulary for discussing this further requirement. Something like the theoretical notion of lexical argument structure is needed to encode functional relationships among lexical items, and a theoretical mechanism like unification or merger would achieve lexical-structural compatibility. In hindsight, the evidence is there in these error data, but it has not been exploited. I will pursue the issue in this study to determine how functional dependencies are met.

Finally, Levelt's 1989 comprehensive model of speech production posits algorithmically defined mechanisms for syntactic encoding. The model draws extensively on a syntactic theory, Lexical Functional Grammar (LFG; Bresnan 1982), in modeling the details of syntactic encoding.

Although Levelt does not take error data as direct evidence for model processing, his model does incorporate insights from previous models that are based on error analysis (like the models in Garrett 1976, 1980 and Dell 1986). Levelt's model is, as a result, capable of accommodating a variety of error phenomena post hoc, largely those errors that were explicable in the earlier models. However, Levelt admits that the algorithms implementing his model only receive "...varying but encouraging degrees of support from the error data" (p. 282).

For example, errors involving a reordering of planned phrasal constituents in an utterance, like the error in 1.12a (Fromkin 1973), are readily explained using the mechanisms he proposes for lexical selection and integration into a syntactic plan. In the Levelt (1989) model, the error in 1.12a would arise through the misassignment to the wrong functional slots of the two NPs *a cigarette* and *my coffee*. However, I will argue in §4.1 that phrasal exchanges are rare, making it unlikely that lexical and phrasal exchanges have the same explanation.

- (1.12) a. I have to smoke *my coffee* with *a cigarette* (for 'a cigarette with my coffee')
 b. Linda, do you talk on the telephone *with which ear?* (for 'with your right ear?',
 with the appropriate intonation for a yes/no question)

Errors like the one in 1.12b (Fromkin 1973) do not as a class have a uniform explanation in the Levelt (1989) model. His proposal for 1.12b (following Cutler 1980) is, reminiscent of a competing plan account, that they be explained as conceptual errors; the speaker in 1.12b "changed his mind" part way through the utterance. As a result, "a different sentence-initial PP (*with which ear*) was then erroneously accepted as a sentence-final complement of the running sentence" (p. 255). This explanation appeals to a glitch in the same integration mechanism whose failure is claimed to be responsible for the error in 1.12a and once again assumes that constituents are manipulated during production. However, it misses a generalization about this type of error, namely that the latter part of the utterance is also part of a well-formed sentence. It is an in situ information question, which, with the rising intonation of a yes/no question (that it is reported to have had by the observer), is an echo question: *you talk on the telephone with which*

ear?

The same pattern of overlapping constructions is seen in many errors, like the one in 1.13 not involving questions.

(1.13) In some sense that's what we're all would like to find.

In this case, the competing plans implicated in the error are ...*we're all hoping to find* and ...*we all would like to find*. But in 1.13, the erroneous constituent *would like to find* (erroneous, that is, from the perspective of the initial fragment, *In some sense that's what we're all...*) cannot have been accepted for integration into a slot in the utterance projected from the beginning of the sentence because auxiliaries and modals cannot co-occur in any sentence in English. The process of constituent integration proposed by Levelt cannot explain this sequence.

This review invites several conclusions. First, there seem to be patterns in error data that have not been carefully explored. They may be sources of additional constraints on production models. Second, advances in both syntactic theory and production modeling can suggest new ways of viewing error phenomena. Finally, using error evidence as a check can identify problems in the adequacy of algorithmic implementations of production and lead to a more complete solution of the production problem.

1.4 OPEN QUESTIONS IN ENCODING RESEARCH.

The stage of production with which this study will be dealing in detail is grammatical encoding. At this time, the production problem for grammatical encoding translates into a collection of directed questions the answers to which have implications for the modeling of grammatical encoding. In this section I present the issues and alternative proposals for their explanation. The three questions addressed in this study in chapters 4, 5, and 6 are taken from the issues outlined in this section. Although not all aspects of encoding are examined in the study, many more of them may be approached using error data. Some suggestions for how this may be accomplished are presented in chapter 7.

We can divide the domain of investigation into three broad areas: (1) the inputs to the process of grammatical encoding; (2) the processing mechanisms that the mapping entails; and (3) the outputs that processing produces. The three areas are each discussed below.

1.4.1 QUESTIONS ABOUT INPUTS. What information is used to perform grammatical encoding? In other words, what is the domain of encoding? Encoding is ultimately based on conceptual representation, and conceptual structure and content may be the immediate domain of encoding, a proposal that has been called *conceptual guidance* (see de Smedt 1996). Conceptual guidance entails that encoding can be initiated using the content and structure of a message before lexicalization. Conceptual guidance of encoding receives support from evidence for a correspondence between verb meaning and verb subcategorization requirements (Fisher, Gleitman, & Gleitman 1991; Levin 1993; Pinker 1989). If verb meaning can predict syntactic form, then it should be possible to compute a frame for the clause before accessing a verb's lemma, where information specifying the verb's syntactic dependencies is stored. Conceptual content and relations would seem to be necessary in determining structure in some cases, because speakers are capable of associating words with frames in novel ways for conveying meaning.

An alternative proposal for the source of input to encoding, *lexical guidance*, recognizes the central role of the lexicon in encoding. Lexicalist theories can account for the fact that subcategorization requirements of verbs are sometimes idiosyncratic and hence unpredictable from meaning. In idiosyncratic mappings, encoding would seem to require that verb access occurs before encoding can begin. After lexicalization, the syntactic information that is accessed from word *lemmas* (Kempen & Huijbers 1983) is available to guide encoding. At the clause level, lexical guidance predicts selection of a predicate lemma before the computation of a frame that encodes the clause argument structure can begin. Supporting the need for lexical guidance, sentence form is to some extent a function of the accessibility of concepts and the words used to encode them (Bock 1987a; Bock & Warren 1985; Levelt 1989). Because of the possibly unpredictable mappings of words to their syntactic requirements, lexical guidance would seem a necessary option in the encoding process. A more difficult question to answer is whether conceptual guidance is required as an alternative method of encoding. Models allowing for either lexical or conceptual input to encoding have been proposed, such as the *dual route* model of Schriefers et al. 1998 (cf. also Stemberger 1985).

What objects in the input domain are relevant to encoding processes? The answer to this question depends to some degree on the domain of encoding. If the domain is lexical, then domain content is a question of what information is associated with word lemmas and the form it takes (Jeschaniak & Levelt 1994; Pickering & Branigan 1998; Vigliocco et al. 1997). Lemma content in current models incorporates word category information, grammatically relevant features (such as number, tense, and gender), and combinatorial information that constrains the way in which lemmas combine with other lemmas and larger structure. There are several suggestions for the form that combinatorial information may take. It could be that lemmas contain subcategorization information, either in the form of syntactic structures or substructures that are unified during encoding, or in the form of production rules for frame creation. Lemmas may also provide access to representations constraining functional combinations of lemmas. For predicate lexemes, the lemma might then, for example, contain some representation of argument structure.

If the domain of encoding is conceptual, questions about domain objects depend on the solution of the lexicalization problem. Theories of lexicalization can be divided into two classes, *decompositional* theories and *non-decompositional* theories (see Roelofs 1992). In decompositional theories, word access is accomplished directly by matching conceptual structure with the semantic forms of lexical items that are based on semantic specification in terms of primitives (Collins & Loftus 1975; Dell 1986; Dell & Reich 1981; Stemberger 1985). In conceptually driven encoding, semantic primitives may serve as inputs to the generation of syntactic structure as well. In non-decompositional theories, on the other hand, lexical access is preceded by conceptual chunking of the message format, consisting of perceptual and other cognitive information (Fodor 1975; Garrett 1975, 1976). In a theory involving conceptual guidance, concept nodes and their relationships (such as proposed in Jackendoff 1983, 1997a; and Kempen 1999) may then serve as input to processes of grammatical encoding.

One strong argument in favor of non-decompositional theories is their success in solving a class of convergence problems in lexicalization. In naming a concept, a word lemma exactly matching the concept should be selected; decompositional theories allow selection of more general words containing the meaning of the appropriate word, such as hypernyms (see the discussion in Roelofs 1992, and the "hypernym problem" in Levelt 1989). Concept nodes also allow a ready explanation for word-phrase synonymy. However, proposals for handling these

issues have also been provided in compositional approaches (Bierwisch & Schreuder 1992; Levelt 1989).

1.4.2 QUESTIONS ABOUT ENCODING PROCESSES. Is encoding a multistage process? Garrett 1975 proposes that encoding is accomplished in two stages, a functional stage, which establishes function relations between lexicalized concepts, and a positional stage, in which serial ordering of words is established. His model is based on the differing patterns of functional elements (closed-class function words, inflection, and stress) and content words in lexical and phonological errors. The model assumption of two distinct stages in the encoding process has been widely adopted (Bock & Levelt 1994; Levelt 1989; Kempen 1999). However, Stemmer 1985 argues that two stages of grammatical processing are unnecessary. He argues that the differing behavior of functional elements and content words might be explained by differences between the two classes in frequency and syntactic constraints and that error classes are thus not qualitatively different.

What are the processes by which inputs are mapped to outputs? We can first ask, What is the size of the *advance planning unit* on which grammatical encoding is carried out (see Dell & O'Seaghdha 1992)? A message chunk corresponding to a clause is generally agreed to provide an upper bound on the chunk size used in encoding (Garrett 1980). The clause (or proposition) thus defines a domain of computational simultaneity in which objects undergoing processing are concurrently available. The proposal finds support in speech error evidence (Garrett 1976), hesitation patterns (Ford 1982; Ford & Holmes 1978), and experimentation (Kempen & Huijbers 1983).

To what degree is encoding accomplished incrementally? Within the computational domain, it is not known whether encoding occurs top down by selecting one of a set of competing plans, or bottom up by constructing plans piecemeal from smaller units. There is some evidence that production is incremental at the clause level (Ferreira 1996), and incremental production is an assumption of many implementations of model architecture at all levels of structure (de Smedt 1996; Kempen & Hoenkamp 1987). However, in many cases syntactic form is determined by idiomatic semantics (Jackendoff 1997b) or pragmatic requirements of the utterance as a whole (Michaelis & Lambrecht 1998), making it incompatible with strict incremental production. In these cases, grammatical encoding might be guided by direct access of objects larger than words, which may be idioms, preassembled templates, or constructions (Goldberg 1994).

1.4.3 QUESTIONS ABOUT OUTPUTS. What representations are created during grammatical encoding? Two-stage models of encoding assume the creation of an intermediate representation during functional processing that specifies functional roles. In these models, the functional representation then serves as the input to syntactic frame creation. Two issues must be settled in understanding functional encoding. First, What elements undergo function assignment? Second, What are the functions to which elements are assigned? The elements assigned to functional roles may be constituents, lemmas, or concepts. The functional roles at the clause level are grammatical functions, like subject and object (or nominative and accusative, etc.; see Bock & Levelt 1994). Below the level of the clause it is less clear how to identify the functional roles used in production.

Do functional representations encode any ordering information? It is widely assumed that they do not, and that word order is only established using the frame during positional processing (Bock & Levelt 1994). The dissociation between word order and grammatical function is clearer

in languages with relatively freer word order than English. However, there is a strong correspondence between the grammatical function assigned to an argument and its "conceptual accessibility" (Bock & Warren 1985). More conceptually accessible arguments, as measured using various parameters of saliency (including topichood, agentivity, and imageability), tend to be encoded as higher grammatical functions. But languages also provide means of encoding highly salient referents early in a sentence without making use of prominent grammatical roles, such as topic fronting, or the early positioning of focused participants in clefts. If elements are ordered at the functional stage, it may be an order based on accessibility and not grammatical role.

The output of grammatical encoding is a syntactic frame used to guide the sequencing of word forms. A number of models assume a frame-and-slot approach to encoding (Bock 1982; Dell 1986; Garrett 1975). Dell 1997 argues that only a model incorporating frames separate from the objects they serve to order can explain the error types observed. However, what is the form and content of the frame created by grammatical encoding? Garrett's two-stage model was derived under the assumption that the frame contains functional elements prior to the incorporation of content words. Stemberger's 1985 evidence that function words differ only quantitatively from content words in their error behavior is one argument against treating function words as part of the syntactic frame. Other evidence against a special status for function words comes from experimentation. Bock 1989 found that structural repetition effects did not depend on the presence of specific closed class words, but only structural similarity between sentences. In response, an analysis of disturbed language prompted Lapointe and Dell 1989 to introduce a mixed model, in which function words are associated with the frame like content words, but inflections are part of the frame.

Aside from the issue of functional elements in frames, what form does the frame take? Bock & Loebell 1990 (and Bock 1986) provide evidence that frames probably do not contain metrical, semantic, or conceptual information. The alternative is that frames reflect syntactic relationships (see Bock & Levelt 1994). Syntactic frames may be hierarchical structures encoding syntactic constituency, perhaps phrase structure as described in syntactic theory, the assumption made in some models (Levelt 1989; Stemberger 1985). There is evidence against multiple levels of syntactic structure linked by transformations (Bock, Loebell, & Morey 1992). However, the output of the encoding process may be a (relatively) flat structure that does not contain all of the constituent relationships that are usually assumed.

CHAPTER 2

PREVIOUS RESEARCH: A HISTORY OF PRODUCTION THEORY

All currently influential models of production share a common history that began with the examination of speech errors. The models encapsulate basic theoretical notions and are each capable of explaining many production phenomena. However, no model proposed to date is a detailed model of all the processes of production, in that it is able to account for the complete range of empirical facts. This is particularly true in the domain of grammatical encoding, which is only beginning to be explored in detail. Major issues that remain to be resolved in understanding encoding were outlined in chapter 1.

The chapter begins with a review of the ways in which errors have contributed to production modeling in general by presenting the observations that researchers have made about error data and their theoretical implications, especially for the processes of grammatical encoding. In addition to error data, experimental and computational studies have also informed model design. Modeling contributions from these areas are also presented to complete the picture of what we know about encoding processes.

The chapter continues with a detailed description of one encoding algorithm from the model of production proposed in Levelt 1989. The model provides one solution to the production problem for grammatical encoding. The three unresolved issues presented in the introduction that are the focus of the study are recapitulated at the end of the chapter in the light of the Levelt model. These three issues are addressed in the analyses in chapters 4, 5, and 6. The result of this chapter is a background against which a study of these issues can be placed.

2.1 SPEECH ERRORS AND EARLY PRODUCTION RESEARCH.

"Slips of the tongue" have long been noted and studied by psychologists (Meringer and Mayer 1895), but interest in them by linguists is more recent. Their emergence as an important source of data corresponds to a nascent interest in production modeling. In an early seminal work, Fromkin 1971 reviews speech error data and recognizes that the errors they contain are patterned, not random. As Fromkin put it, "it is not true that ... errors are totally random and unexplainable" (Fromkin 1971, p. 48). The explanation of errors was naturally inferred to lie in production processing (Boomer & Laver 1968, Nooteboom 1967). Recognizing regularities, Fromkin suggested that errors provide evidence for linguistic structure and impose constraints on a model of language production. Patterns that she and others observed derive not only from categorization of extant errors, but also from the recognition that some logically possible errors do not occur. Speech errors thus "provide information about speech performance which non-deviant speech obscures" (Fromkin 1971, p. 48).

Strikingly, despite the continuous nature of the speech stream, Fromkin noted that speech errors involve discrete units, including at least words and sounds. That errors involve units argues for the psychological reality of words, sounds, and any other units of language that are involved in speech errors. Symbolic models of production manipulate the units involved in errors in explaining how processing proceeds, and how it may fail.

Errors involve the interaction of units. Fromkin and others (Garrett 1976, *inter alia*) noted that units interactions are limited to units of the same type. For example, segments interact

with segments, and words with words. A single error is never observed to involve the interaction of a segment and a word or syllable. Words and segments are universally accepted as processing unit types, but there is no agreement on what other types are involved at any level. The type constraint on interaction has led to the modeling of production as a series of processing stages that produce a hierarchically structured representation. Processing at each stage performs computations on a unique level of representation involving a single type of unit. Processing in each stage occurs more or less independently from processing at other stages. There is disagreement about the degree to which processes or representations at one level may affect processing at other levels.

The units that interact in an error may be entirely elements that are part of the presumed utterance plan. In this case, the errors are referred to as plan-internal errors (see Butterworth 1982), or contextual errors (see Dell 1986). Errors may also involve the intrusion of a unit from some other source. The non-plan-internal errors attest to the influence of alternative formulations of the same message (the "alternative plan errors" of Butterworth 1982), of related but unplanned units (noncontextual errors), or of "environmental contamination" from the physical or discourse context (Garrett 1980a). Environmental and alternative plan intrusions suggest a model that must "explicate high level processes such that more than one message can be constructed at any one time, and so that it is possible to plan the content of the intended message in more than one way (Harley 1984, p. 214).

Interacting units are presumably processed concurrently at some stage of processing. Observing the span to which contextual unit interactions are confined permits identification of the planning units, or domains of "computational simultaneity" (Garrett 1975, 1976), of each stage. Word interaction is limited to a clause or two; sound interaction is much more local, rarely involving more than a few words.

There is a good deal of evidence that errors reveal similar patterns of interaction at each level. Sounds and words, and perhaps segmental features, morphemes, and even phrases, can all be exchanged with or replaced by units of the same type, inserted, and deleted. We can account for this consistency in a production model by proposing that similar error types at each stage result from the failure of computational primitives that apply independent of unit type. I propose that, even more strongly, a *Principle of Processing Uniformity* holds in production that says that one set of primitive computations is necessary and sufficient at each level to achieve encoding. Processing uniformity predicts that the same error types will be observed for each unit on which computations are performed, and no error type will be observed at one level without an analog at all others. The distribution of error types at each level may differ, however. The extent to which error profiles at each level differ is a function of differences in the form and distributional characteristics of the units at each level of processing. We must also note that the set of processing levels, as defined by unit types, does not necessarily conform to the set of linguistic units (Garrett 1975).

Errors involving replacement at all levels preserve the structural relationships of the affected unit(s). In sound errors, for example (2.1; Fromkin 1973), the perseveration, anticipation, or exchange of initial segments of words has as a counterpart at the level of word processing an error in which words functioning as heads of phrases are exchanged (2.2). In both cases, a functional relationship including the interacting units (word, or syllable, onset for the sound exchange, and head of phrase function for the word exchange) is preserved. The preservation of structure in replacement errors is explained in models in which the method by

which elements are ordered is independent of the units being ordered. In other words, production results in the creation of frames at each level to which content is associated (see Dell et al. 1997).

- (2.1) a. to equip their luxury *lot* (for 'yacht')
 b. *ples* the stress (for 'place')
 c. the *nipper* is *zarrow* (for 'zipper is narrow')
- (2.2) a. You can move any old *focus* (.) into the matrix focus
 (for 'into the matrix position')
 b. I don't have time to *work* -- watch television [because I have to work.]
 c. there aren't as many *weeks* in the *day* as I need (for 'days in the week')

Words associate sound and meaning in language; as a consequence, word errors reflect the semantic and formal properties of words. Word substitution errors group into two types: those in which the intruding error word is a semantic associate of the target, and those in which the primary relationship is phonological (Fay & Cutler 1977, Fromkin 1971, Garrett 1980, Raymond & Bell 1998). In 2.3 (Bell & Raymond 1997), the relationship of the error word to the target word lies in the similarity in form between *apartment* and *appointment*. The error and target words in 2.3 are typical of form-based substitutions in that they share a range of formal features. They share the same number of syllables, the same stress pattern, begin with the same sequence of sounds, and are both morphologically complex (and moreover, contain the same derivational morphology).

- (2.3) He has to move our *apartment* – appointment.

The second type of relationship observed in substitution errors is semantic association or similarity between error and target. In 2.4 (Bell & Raymond 1997), there is no strong similarity of form between error and target, but they are close semantic associates. Hotopf 1980 observes that most semantic substitutions involve antonyms (or other types of semantic opposition, like in 2.4a) or co-hyponyms (i.e., words that share a superordinate, e.g., 'leafy vegetable' in 2.4b).

- (2.4) a. I'm fighting to stay *asleep* – I mean, to stay awake
 b. the *lettuce* leaves are just beginning to peek out (for 'spinach')

The existence of form and semantic substitution errors points to a separation of representations into a lexical semantic network and a word form network. Corroboration for the separation of levels comes from the Tip-of-the-Tongue (TOT) phenomenon (Kohn et al., 1987). Semantic specification of a lexical item leads to selection of a word's *lemma* through the mechanism of spreading activation (after Kempen and Huijbers 1983). A lemma associates meaning with formal content, represented in a word's *lexeme*.

There is evidence from experimental work and other speech error data that semantic processing and form processing within these networks are ordered, with selection based on word meaning occurring earlier than word form access. Schriefers et al. 1990 use a picture interference paradigm in which subjects are asked to name pictures of objects. A distractor word is presented auditorily 150 ms before, at the same time, or 150 ms after the picture is presented. The distractors can be related to the pictured objects either semantically or phonologically (with initial segments the same). An effect is found for semantically related words in the early

presentation condition (specifically, it is an inhibitory effect), but not in the simultaneous or late presentations. An effect (in this case facilitatory) was found for phonologically related words in the simultaneous and later condition, but not the early condition. The results indicate that semantic processing occurs before word form processing.

An unsettled question about model architecture regards whether processing at different levels of representation is strictly modular and sequential, or if processing is largely ordered, but processing at a lower level can influence processing to some degree at a generally earlier stage of production. Arguments against strict modularity hinge on evidence from a class of bias phenomena. A tendency for sound errors to produce lexical items has been found in some error corpora (e.g., Dell & Reich 1981) and is observed experimentally (Barrs et al. 1975). However, other investigators have found no lexical bias in speech error data (e.g., Garrett 1976; del Viso et al. 1991). The claim that there is a tendency for the semantically related words that interact in semantic substitutions to have phonological similarity, the so-called "mixed errors," seems firmly established (Dell 1986). Bell & Raymond 1997 have found a tendency for semantic substitutions to be form related.

Many models incorporate a strict modularity of level processing (Garrett 1975, 1976, 1980a; Levelt 1989; Levelt et al. 1999; inter alia). Other models allow interaction between levels or processing units to accommodate bias phenomena (Dell 1986; Stemberger 1985; Bock 1982, 1987b; Harley and MacAndrew 1995). Bias effects at all levels can be accounted for in a loosely modular architecture in which feedback from one level can influence selection of representations on the previous level. Levelt et al. 1991 review experiments that fail to find evidence for feedback from lower to higher levels. They report on experiments using picture naming that found no effect of "mediated" priming. In mediated priming, the prime for a target (*sheep*) is a word (e.g., *goal*) that is phonologically related to a semantic associate of the target (in this case, the associate *goat*). In a response, Dell and O'Seaghdha 1991 reconcile feedback and modularity by proposing "globally modular control structures and an interactive network" (Dell & O'Seaghdha 1991, p. 613). What they call global modularity is a rough sequencing of level activation imposed on the interactive representational system by external activation of unit nodes at each level that is provided by linguistic "rules" (i.e., ordering frames) in the level above. Feedback between levels is motivated, they suggest, if the production system is the same as the speech comprehension system, requiring that processing be bidirectional (cf. Kempen 1999). Levelt et al. 1999 report that it is possible to model the overrepresentation of mixed errors in a modular computational model, making feedback unnecessary in a model architecture.

2.2 SPEECH ERRORS AND MODELS OF ENCODING.

So far, little has been said about grammatical encoding in a production model. Fromkin 1971 suggested that constituents above the level of the word may constitute a unit class that is manipulated in a syntactic processing stage in ways that are similar to the manipulation of words, sounds, and units at any other representational level. Substantial evidence for this position is not abundant or unequivocal in the error data that most corpora contain. Subsequent to Fromkin's 1971 study, work on the production of syntax took one of two approaches. One approach, initiated by Fromkin, was to seek out error evidence that validates assumptions about syntactic units and the computations performed on them. This was the approach taken by Fay (1980a, 1980b), who attempted to provide error evidence for transformations of phrase structure as a processing mechanism. Stemberger (1982, 1985) also pursues this course by collecting errors

that seem best to be explained as failures in the deployment of phrase structure in a monostratal syntax. The second approach, taken by Garrett (1975, 1976, 1980a, 1980b, 1982), is not to look for supra-word level structure, but to analyze the relatively frequent word and sound errors to determine how they might constrain grammatical encoding. Only the latter approach has led to widely accepted conclusions about encoding processes.

Garrett, building on work by Fromkin 1971, proposed an abstract model of production consisting of a *functional stage*, a *positional stage*, and a *phonological stage*. Each stage implicitly takes as input one level of a hierarchical representation and produces as output another. The stages are serially ordered; processing at each stage must be completed before processing at the next stage can begin. The model is depicted in Figure 2.1 (modified from Fromkin 1993).

In the model, utterance generation begins with a message source (cf. Fromkin 1971). A message receives an intuitive definition as the conceptual content to be conveyed by the speaker. Grammatical encoding encompasses the functional processing and positional processing stages. Phonological processing is not part of encoding, although sound errors played a role in developing the model. Phonological encoding is followed by articulation, not elaborated in the model.

During the functional stage, the message guides identification of concepts representing message chunks. Concepts select lexical items, making the lexicalization process in the model non-decompositional. The determination of functional roles is based on syntactic factors. Lexical items are assigned to functional roles and they are subsequently serially ordered in a syntactic frame.

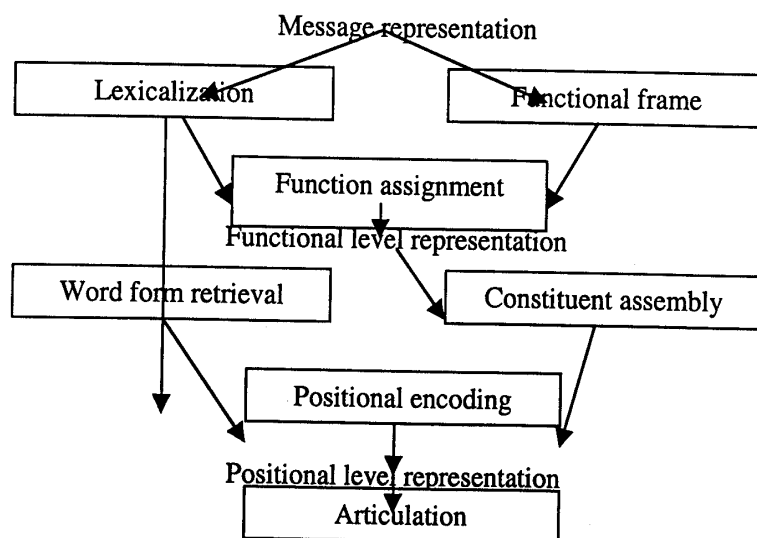


FIGURE 2.1. Garrett's (1984) model of language production.

Garrett investigated the domain of encoding by examining errors in how planned words interact. He observed that in errors in which planned words exchange places, the interacting words normally involve words in the same clause or adjacent clauses, as in 2.5.

- (2.5) a. If you *break* it it'll *drop*.
 b. You just count *wheels* on a *light*. (Stemberger 1985)
 c. Some *small*s are *twelve* -- twelves are smaller than others.

Garrett concluded from the displacement characteristics of contextual errors involving an exchange of words that a unit approximately the size of a clause is the domain over which computational simultaneity should be defined for words. This observation seems largely to hold in anticipations and perseverations of planned words as well. The conclusion that the clause is the planning domain of grammatical encoding is supported by experimental evidence (Bock & Cutter 1992; Ford 1982; Ford & Holmes 1978).

Garrett proposed separate functional and positional stages in encoding based on the differing behaviors of two classes of lexical exchange errors, "whole word" exchanges (2.6) and "combined form" exchange errors (2.7). Whole word exchanges are those in which whole words change places, even if they are morphologically complex (e.g., 2.6a); combined form errors involve the exchange of stems, with associated "syntactically active affixes" (Garrett 1975, p. 158), usually inflectional morphology, being stranded at the source site.

- (2.6) a. we'll drop them *bosses* while we bomb their *leaflets*
 b. used the *door* to open the *key*
- (2.7) a. she's already *trunked* two *packs*
 b. I'm not in the *read* for *mooding*

Garrett (1975, 1976) observed that whole word exchanges and combined form exchanges differ in the following ways: (1) whole word exchanges usually involve words of the same grammatical class (90% of the whole word exchange errors in Garrett's corpus are from the same grammatical class; Garrett 1976), but combined form errors are usually of different classes (70% of the combined form errors in Garrett's corpus are from different grammatical classes); (2) the words involved in whole word exchanges are on average farther apart than those participating in combined form errors (they are significantly farther apart in average number of words, and are more likely to be from different phrases, although about 80% of both are members of the same clause); and (3) the words involved in whole word exchanges are more likely to play similar structural roles in their phrases (as heads) and clauses (as arguments) than the words involved in combined form errors.

Combined form errors are not sensitive to grammatical class, so they occur at a time when functionally determined class is not relevant. Combined form errors occur when functionally defined elements, particularly syntactically active pieces of morphology, are integrated. That combined form errors have, on average, a smaller span than whole word exchanges, suggests that they occur later in processing, when the planning domain has been narrowed. In addition, combined form errors behave like sound errors in being insensitive to the functional roles of the words involved and having a disregard for their functional roles, which make reference to syntactic features. The similarity of combined form errors to sound errors also argues that combined form errors, like sound errors, occur at a level AFTER whole word

exchanges. The phenomena are modeled in a level of processing that accomplishes the serial ordering of word forms with a syntactic frame, that is, a positional processing level.

The fact that word form integration is independent of syntactically active morphology in combined form errors suggests that inflectional morphology is a part of the syntactic frame, that is, that the morphology is in place in the frame before word forms are incorporated into it. The fact that combined form errors involve words that are close together and NOT of the same grammatical class suggests that they are sensitive to serial position and not to functional relations. Combined form errors will be unlikely to involve words that are very far apart if we model frame integration as an ordering operation that occurs serially and left-to-right. Since grammatical class is largely functionally determined and independent of serial position, combined form errors are not bound by the class constraint if they occur at a level of positional processing.

Exchange errors originate at a point in production that can be characterized as "...a level of processing for which functional relations are the determinant of 'computational simultaneity'" (Garrett 1976: 241). By functional relations Garrett presumably intends at least whatever relationships determine surface grammatical class, since exchanges, which preserve form class, identify this level. For example, the functional relations would include phrasal head, in cases of noun exchange, and the role of predicate (or head) in verb exchanges. In some noun phrase exchanges (2.8a,b) and pronoun exchanges (2.8c,d), the exchanged items are clausal arguments. Functional processing is also sensitive to argument status, since exchanged arguments accommodate to the grammatical function of the target argument, as indicated by the case assignments of the pronouns in 2.8c,d.

- (2.8) a. a difference in *gerunds* of the *syntactic behavior* (for 'a difference in the syntactic behavior of gerunds') (UCLA)
 b. I've got to get some *kids* for the *macadamia nuts*. (for 'I've got to get some macadamia nuts for the kids') (Fromkin 1971)
 c. *He* smooshed *her* (for 'she smooshed him') (VW)
 d. they didn't want to get *their* blood all over *him* (for 'they didn't want to get his blood all over them')

Functional processing would involve the simultaneous processing of a larger planning chunk than positional processing, so whole word exchanges will be farther apart than combined form errors. Confusion will be independent of serial position, but sensitive to functional role, creating the similarity in grammatical class and structural role in these errors. Functional specifications will precede frame creation, so morphology is unavailable to interact in functional errors. The processes accomplishing computation of the syntactic frame remain unspecified in Garrett's model.

We must make guesses about how to interpret some aspects of Garrett's proposal, since he persistently rejected reference to linguistic constructs in building a production model, claiming that his stages can only be equated with general levels of linguistic representation. He therefore did not refer to theory-specific structural units, such as phrase structure. This approach has been criticized as lacking sufficient detail to provide insight into production processes as distinct from representational levels (Stemberger 1985; LaPointe and Dell 1989). Nevertheless, he established the division of encoding into functional and positional processing stages that persists as a high level architectural feature in all more recent encoding models.

2.3 NETWORK MODELS OF PRODUCTION.

In addition to its vagueness about processing units, Garret's architecture of production includes no mechanisms by which the processes in each proposed stage can be carried out. A mechanism is provided in network models of production that incorporate the notion of spreading activation. Network models have their source in psychological models of priming (e.g., Collins & Loftus 1975). Priming involves facilitation or inhibition in an experimental language task through prior exposure to an item related to a task's target in some influential way. In a network model, activation spreads from any unit of representation to all units connected to it. Units may be any symbolic element of production, and the connection between units may represent any number of relational parameters. Retrieval of a unit involves activation above some threshold level.

Spreading activation models of production readily explain many speech error phenomena (Dell 1986; Dell & Reich 1981; Stemmer 1985). In a network model, the misplacement or misselection of units is the accidental selection of unintended units activated above threshold level through network connections during processing. The relations between errors and targets in substitutions are the types of relationships that produce priming effects in naming and decision tasks. Lexical anticipations (2.2b) and perseverations (2.2a) can be compared to repetition priming; a planned word is repeated before or after its intended location. Formal and semantic relationships, like the ones that exist between errors and targets 2.3 and 2.4, are also factors that have been shown to produce priming effects.

Spreading activation in a network of production units is not adequate by itself for solving the linear ordering problem of language production. Dell et al. 1997 argue that ordering requires the existence of a plan that can order the production units that have been selected. Experimental evidence has supplemented error evidence to give a more detailed picture of the phonological encoding process. Experimentation has elucidated how the segmental content of selected lexical items, available in the word lexemes, is integrated into slots in a prosodic frame needed to sequence the segments (Meyer 1990, 1991; Roelofs & Meyer 1997). Segmental information is integrated from left to right, and syllabic structure is derived as encoding proceeds, either by rule or by lookup in a syllabary. Whether syllable structure is accessed, constructed via rule, or looked up in a stored syllabary has not been definitively settled. It has been suggested (Shattuck-Hufnagel 1993; Dell 1986) that syllable position is retrieved along with segmental information and then associated to ordered positions in the frame. However, Roelofs and Meyer 1997, in the most recent and detailed examination of this question, point persuasively to separate access of segmental and prosodic tiers that are then linked using language-specific syllabification rules.

It is not clear at this time whether syllabification "rules" are processes or the access of stored syllabic representations. Syllabic structure may be stored in the lexemes of words. However, a syllabary is a feasible alternative; syllable structure may be computed from a listing of possible language-specific structures using the segmental information available in a word's lexeme. Matching segmental content with syllabic structure by lookup would make storage of syllabic structure with each word unnecessary. Whether prosodic structure is stored or generated on-line, segmental content would be associated with the prosodic frame as the last step of phonological encoding. There is evidence that the association occurs from left to right (Meyer & Schrieffer 1991). The nature of the input source for computation of a prosodic frame is an important issue for phonological encoding and has implications for grammatical encoding as

well. The same issues of lookup or construction must be reexamined to understand how functional and syntactic frames are computed.

Stemberger (1982, 1985) proposed an interactive parallel processing model using as a selection mechanism the connectionist paradigm of spreading activation across networks of representation. The model contains modules representing meaning, words, syntax, and phonology. In the model, syntactic structures are selected from conceptual input, and they are computed in the form in which they appear in the final utterance. Selection of lexical items may partially determine the syntactic form chosen to express them. The syntax is represented in terms of phrase structures. Phrase structures are the form that frames take to guide the sequencing of lexical items. There is a single level of syntactic processing, and no strict modularity between any processing levels. With these assumptions, Stemberger argued that the simultaneous processing of lexical and syntactic elements explains the observational data, making unnecessary a two-level syntax divided between functional and surface representations.

In support of this proposal, Stemberger 1985 reviewed error data to argue that differences between the functional and positional levels of processing can be explained by spreading activation in a single level. Garrett's (1976) argument for separate levels rested on recognizing different behavior for open-class words and for closed-class elements (function words and inflections). According to Stemberger, differences between these classes disappear if we take into account the relatively higher frequency of closed-class elements. If error behavior is a function of frequency, then we should see graded error effects, and not categorical ones, as Garrett claimed. Stemberger provided some evidence that this is the case, though his evidence was far from unproblematic. His analysis controls frequency solely by comparing a class of high frequency closed-class words to a class of lower frequency open-class words. This approach does not allow evaluation of his claim for graded effects, as distinct from Garrett's claim that open and closed class elements are processed differently. Stemberger's conclusion that only a single stage of processing is necessary is rejected by most subsequent models, and will not be taken up in this study.

2.4 AN OVERVIEW OF THE ENCODING PROCESS.

The basic outlines of a production architecture have now been sketched, and the role of speech errors in the development of production models has been reviewed. Production models can be algorithmically implemented by incorporating a storage and retrieval mechanism taken from the connectionist paradigm. This section discusses the sequence of processes that achieve encoding, as well as the processes of conceptualization and lexicalization with which it interfaces. Some current controversies that are introduced in this section are addressed in this study. The Levelt (1989) model of grammatical encoding is considered in detail by following an example of sentence encoding from message to syntactic frame. Some of the assumptions exemplified by the Levelt model are revisited in this study.

2.4.1 MESSAGE STRUCTURE. Following Garrett, Levelt and other modelers (Stemberger 1985; Bock 1987b, 1996; Bock and Levelt 1994) agree with researchers studying the language-cognition interface (Pinker 1989, 1994; Jackendoff 1997a) that an utterance begins with a message. A message is a planning unit containing the propositional, thematic, semantic, and information-theoretic content of a to-be-produced utterance. It is derived through inferential processes applied to other cognitive systems in the mind, such as the visual and motor systems

(Garrett 1975, 1976, 1982; Jackendoff 1983; Lakoff 1987) that result in a specifically linguistic (but not necessarily language specific) representation.

One specific proposal for message structure format that is adopted in some models of production, such as Levelt's (1989) model, is taken from Jackendoff (see 1997a). Messages are composed of syntactically relevant semantic primitives such as EVENT, STATE, CAUSE, GO, PERSON, THING, PATH, etc. Some of these are basic ontological categories (THING, PATH) and some are often-used complexes composed of basic categories (EVENT = THING GO on PATH). Primitives can further combine in hierarchical structures through a variety of functional relationships to create a message. The same format that is used for the intermediate messages can also be used in the stored semantic representations of lexical items (as in Bierwisch & Schreuder 1992). In this way, a message structure can select a lexical item if (and only if) a fragment of the message matches the semantic representation of a word.

2.4.2 FROM CONCEPTS TO WORDS. The first step in the mapping of messages to words is *conceptualization*. Message content must be chunked into schematized events containing the necessary information regarding predications and participants (Chafe 1977) that correspond to the lexical items of the production language.

There is some debate about the output of conceptualization (see Roelofs 1992). Decompositional theories posit the existence of a separate conceptual level of representation consisting of concept nodes. In non-decompositional theories, there are no concept nodes. Lexical semantics is distributed, and conceptualization results directly in word selection. Bierwisch and Schreuder 1992 propose a composite model in which both concepts and lexical items are structured in terms of more basic components.

Word selection, or *lexicalization*, requires the identification of words that can be used to express the conceptual chunks resulting from conceptualization (Levelt et al. 1999). Production requires that messages be chunked "...to identify those conceptual configurations that are available for lexicalization." (Bierwisch & Schreuder 1992, p. 56). Lexicalization involves the selection of word *lemmas* (Kempen & Hoemkamp 1987). Word lemmas contain the grammatical properties of words that specify encoding requirements of a lexical item. Some models (Levelt 1989, Levelt et al. 1999) maintain that encoding is achieved through *lexical guidance*. That is, encoding can only proceed after lemma access has made available the grammatical information stored in a word's lemma. An alternative view, *conceptual guidance*, proposes that encoding can proceed without accessing word lemmas by using conceptual information alone.

2.4.3 AN ALGORITHMIC ACCOUNT OF GRAMMATICAL ENCODING. The Levelt 1989 model of speech production incorporates an algorithmic account of grammatical encoding. It allows only lexical guidance in frame computation. That is, in the model inputs to encoding are only available after lexicalization and lemma access. Units and procedures of encoding are taken from Lexical Functional Grammar (LFG, Bresnan 1982). The resulting assumptions about the forms of inputs and outputs and the details of processing are irrelevant for the current discussion.

In the Levelt model, the encoding process is controlled by a *formulator*. The formulator employs combinatorial information in lexical entries to call corresponding categorial routines controlling the generation of phrase structure components, such as NP and VP. A lemma's combinatorial information captures how the word combines with phrase structure components and other lexical items. The categorial routines build the phrase structure fragments and then call the appropriate functional routines to establish functional relations between components. The functional routines create slots for items that will satisfy functional relationships, such as head,

subject, unit, etc.

In the Levelt model, the frame includes diacritic features specifying bound inflection and closed-class morphemes (such as [+PAST] for Tense and [+ACCESSIBLE] for Det), though not the closed-class forms themselves. Functional slots are filled in the phrase structure via default rules that relate the constituents formed from other phrase structure fragments to the structural slots representing functional positions. Frames guide the ordering of words in positional processing to complete sequential encoding.

To follow the operation of this model in the construction of a syntactic frame, consider the message structure in Figure 2.2 (adapted from Levelt 1989, p. 237), representing the sentence *The child gave the mother the cat*, a ditransitive dative sentence. (Only relevant aspects of the processing of this message will be discussed; for more detail, see Levelt 1989, Kempen and Hoenkamp 1987.) Message generation can be initiated by the matching of any fragment of the message structure with the semantic representation of a lexical entry. For example, the entry for *child* will contain in its lemma the semantic representation [PERSON, CHILD], which matches a subtree of the message (to which the bracket convention is notationally equivalent). The dominating node in this fragment represents the ontological category of this element (see Jackendoff 1983, p. 41ff). The subordinate node CHILD is an abbreviation for an

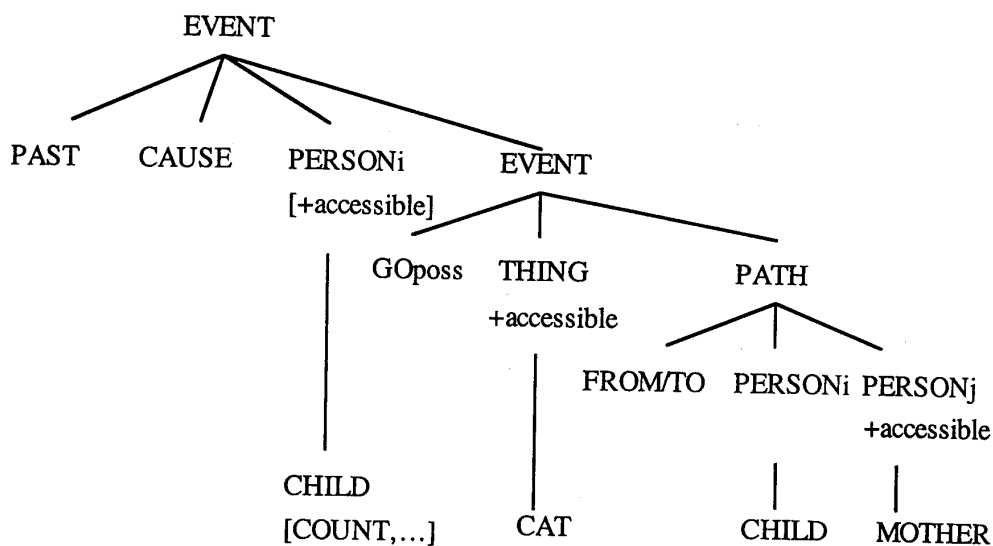


FIGURE 2.2. Message representation for "The child gave the mother the cat"
(from Levelt 1989).

array of the syntactically relevant semantic features of this example of a PERSON, such as COUNT, as well as its lexical semantic content (cf. Jackendoff 1997a, p. 86). Note that nodes can have diacritic features associated with them, indicating values of grammaticalized categories of information structure ([+ACCESSIBLE]), tense ([+PAST]), number, etc., that may later be used to select, or construct (see Jaeger et al. 1996; Stemberger & MacWhinney 1988), morphological variants of word forms.

Activating the *child* lemma will cause the categorial routine for this item's phrasal category to be called (accessible in the lemma), in this case NP. The categorial procedure NP

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will elaborate the internal structure of the noun phrase. In this example NP will call the functional routine DET, which will use the accessibility of the referent of [PERSON, CHILD] to create the NP *the child*. The NP *the child* can be associated with the subject function of the sentence after the categorial routine S has been called, which builds a structure requiring a subject and so calls a functional routine SUBJ to find one. If the lemma for *child* creates the first NP, it can become the subject by default and subsequently initiate a call to S.

Much of the structure of a sentence will be determined by the lemma for its verb, since the verb dictates the argument structure to be represented in a clause. The verb lemma will contain syntactic information about the subcategorization frame of the verb and how the conceptual arguments of the verb's semantic representation are mapped to the grammatical relations in its subcategorization frame. We can picture the syntactic representation for *give* and its linking specifications as being something like Figure 2.3. The representation differs from the message format in Figure 2.2 in that it contains three conceptual argument slots X, Y, and Z instead of specific instantiations of the ontological categories PERSON_{i,j} and THING, and contains no diacritic features, such as [+ACCESSIBLE] and [PAST]. When *give* lemma is selected, it initiates a call to categorial procedure VP, which then will call the function procedures for the grammatical relations SUBJ, DO, and IO.

Procedure calls translate each fragment of the message into a phrasal constituent that goes into a developing unified syntactic structure reflecting the entire message. The result of the process is a string of terminal nodes that was created incrementally and mediated lexically. Each node is an abstract representation of a word and each is a site at which phonological encoding can begin. The phrase structure also forms the basis for the generation of sentence prosody that together with message content will determine the pitch accent and intonation contour of the utterance.

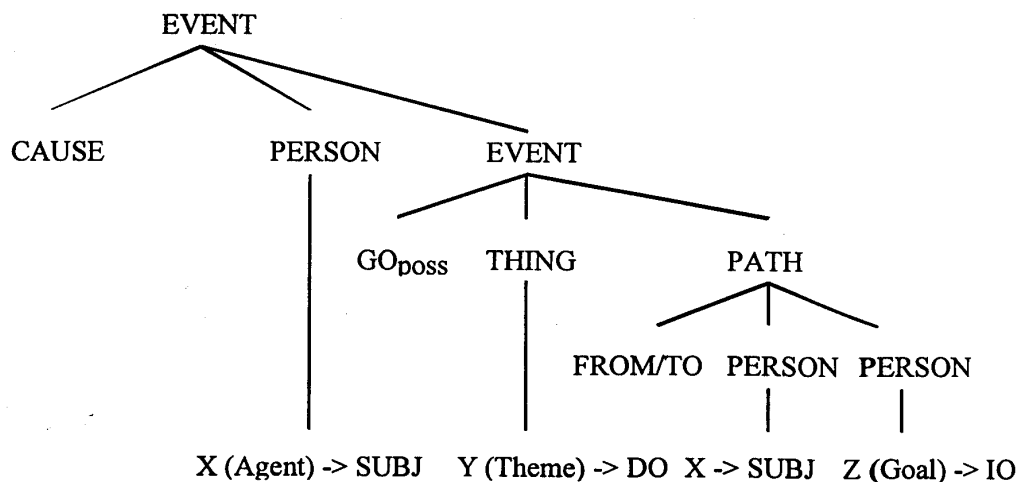


FIGURE 2.3. Part of the lemma for the verb 'give' (from Levelt 1989).

In general, syntactic encoding proceeds from left to right, but other factors may influence the order of lexical access and, consequently, the form of the utterance. For example, the lemma for *mother* may be activated before that for *child* or *give*, because of its discourse salience or ease

of activation. As a consequence, its NP may have been linked to the SUBJ function. The phrase [*mother*]_{NP} as subject would be incompatible with the subcategorization frame for *give*. The consequence might be that the speaker relexicalizes the message structure “on the fly,” as Levelt says (1989, p. 245), by selecting a verb allowing the same participants, but compatible with a Goal subject, such as *receive* or *get*. Alternatively, a mapping could have been achieved using *give* but with a passive voice. The semantics of the passive are related to the semantic representation for active, ditransitive *give* in Figure 2.3 by a lexical rule, as in LFG (Bresnan 1982). On this account, the lemma for *give* includes the lexical rule to derive a passive mapping. A lexical rule would also exist in the *give* lemma that creates the dative alternation between an internal (or double unit) dative sentence, represented in Figure 2.3, and an external (or prepositional) dative sentence. The prepositional dative mapping applied to the same conceptual arguments would result in the sentence *the child gave the cat to the mother*. The encoding of the prepositional dative could result if activation of the *cat* lemma occurs before the activation of the *mother* lemma (but after the activation of the *child* lemma), according to Levelt. The possibility of creating a prepositional dative frame depends on activation of the lemma for *give* (in this case), from which both argument linkings are available.

2.5 FOCAL ENCODING ISSUES FOR THE STUDY.

The Levelt (1989) account of grammatical encoding illustrates how one model answers the three questions about encoding processes that are the focus of this study, although it is not the only possible solution to the encoding problem. The issues this study will focus on are: when functional frames are computed, how they are computed, and what elements undergo function assignment to a functional frame.

The answer to what elements undergo function assignment depends on assumptions about lexical representation, since representational elements are available for operations like function assignment. The Levelt (1989) model assumes that lexical semantics is compositional (cf. also Bock & Levelt 1994). That is, lexicalization is achieved by matching a conceptual chunk of a message representation to the semantics of a lexical item. Matching is facilitated by allowing lexical semantic representation in the lemma and conceptual representation to have the same format. In later work Levelt (Levelt et al. 1999) opts for a non-compositional model of the lexicon, containing a separate level of concept nodes based on the work of Roelofs 1997. A non-compositional semantics makes concept nodes available for function assignment, while a compositional semantics does not. The issue of which conceptual representation best models error phenomena is taken up in chapter 4 in an investigation of the process of function assignment.

Function assignment in the Levelt (1989) model is accomplished over phrasal categories. In the encoding example described previously, it is the NP *the child* that is assigned to the subject function of the sentence. There is error evidence, already mentioned (§1.3) and that will be considered in more detail in chapter 4, that this is probably not correct. Thus, a second issue probed in chapter 4 is what elements undergo function assignment. In a compositional model, if phrase structure is eliminated as the domain of function assignment, then the only elements that can be assigned to functional roles are lemmas. In a non-compositional model, concepts or lemmas may be the domain of function assignment.

Grammatical encoding in the Levelt (1989) model is exclusively lexically guided. Lexical guidance is a property of many current production models (e.g., Kempen 1999; Bock et al.,

1992). Function assignment and the elaboration of phrase structure can only proceed in these models after lemma access has made the grammatical properties of words available to the formulator. An alternative is that conceptual information available before lemma access can be used to compute a functional frame. The assumption of exclusive lexical guidance is examined in chapter 5 and evaluated using the error evidence.

The Levelt (1989) model achieves strict incrementality by alternating structural and functional procedures. An alternative to obligatory incremental production is competitive selection of structure. The possibility that structures may be accessed as complex production units and compete for selection during encoding is explored in chapter 6.

CHAPTER 3

DATA AND METHODS OF ANALYSIS

The data analyzed in this study comprise a corpus of speech errors collected by the author and culled from other published and unpublished sources. For the most part, the errors in the corpus can be viewed as lexical errors of some type. A lexical error is a deviation from the intended utterance that can be described in terms of lexical differences between the target utterance and the utterance produced by the speaker. The properties of lexical errors have been used to constrain models of grammatical processing (see chapter 2), and continue to illuminate production processes in this study. However, considering production errors just as lexical errors, or considering only errors that can be construed as lexical, misses generalizations that can shed light on encoding processes. Consequently, the errors in the corpus are also viewed as encoding errors that are described in terms of (non-lexical) structural and functional parameters. Generalizing over the structural and functional properties of errors, which are the domain of grammatical encoding, also allows the error data to address questions about encoding processes.

Some issues that are important in selecting errors appropriate for a study of encoding are considered in §3.1. Parameters of speaker competence must be separated from speaker performance, and this task is more controversial at levels above the word. Making valid judgments about speaker intentions becomes more difficult at the grammatical level as well. There is also uncertainty, in coding processing errors, in deciding on the proper generalizations over the data, which factors to include and which to exclude. The process is not complete at this time, but the analytic approaches have been established.

The corpus is described in §3.2. After describing error sources and collection methods, §3.2.1 defines the parameters used to code the data as lexical errors and gives examples of each of the error subtypes that the parameters create. Parameters that were used to code the data as error of encoding involving complex structure other than words are defined in §3.2.2, and I will show how the error data can be categorized using these parameters.

After describing the corpus, I will outline the analytic approaches taken in the study in §3.3. Both of the basic approaches employed in past studies to explore encoding are pursued in this study as well. The first approach is to examine the properties of lexical error subtypes in order to extract constraints on encoding models that they may impose. The study extends the previously defined parameters of lexical error classification and revisits some claims made by earlier researchers about properties of lexical errors. The second approach to exploring encoding considers production errors as processing failures that occur during the manipulation of structural units other than words. Error subtypes defined using constituent and functional criteria will be used in this approach. The study pursues analyses using both approaches to address questions about functional processing. Other possible analyses that use error data not examined in detail in the study are outlined for future work on different aspects of grammatical encoding.

3.1 ON IDENTIFYING ENCODING ERRORS.

We can be sure that errors in encoding exist. Just as it has been possible to identify a class of segment or lexical errors that reflect failures in lexical selection or phonological spell-

out, it should be possible to find errors that occur during grammatical encoding. There is no reason to suppose that encoding is immune from processing failure. In fact, many lexical errors are encoding errors in that they can be used to probe encoding processes. Beyond these errors, since utterances are composed of words, a failure in structural encoding will have a direct effect on the words of the utterance and may also be interpreted as a lexical error.

Above the level of the word, identifying processing failure may be difficult for two reasons. First, processing errors that result in a failure to create proper grammatical form may be less frequent than errors involving smaller units because their larger size would make it easier for monitoring processes to catch them before much of the error is produced. Second, errors of grammatical form need to be distinguished from performance dysfluencies, from dialectal or idiolectal grammatical performance, and from intended usages that are novel and not licensed within the larger speech community. Examples of possible pitfalls in identifying encoding errors are discussed below.

Dysfluency. There are many instances in which performance results in what we might classify, after a superficial examination, as non-grammatical utterances, because they are composed of fragments of complete units that result from dysfluent production. Speech is full of dysfluencies like the ones in 3.1 (from Switchboard, Godfrey et al. 1992). Dysfluencies can be described in a theory of performance, or even subsumed into a theory of competence, by extending the notion of a grammar to include situational performance in a discourse context. To this end, one taxonomy categorizes dysfluencies into hesitations (silent pauses), filled pauses (containing fillers like *uh* and *um* and editing terms, such as *you know*), false starts (perhaps followed by a restart), and repetitions (MacClay & Osgood 1959).

- (3.1) a. He, he almost wishes that, that he could have gone home.
 b. (hesitation)
 c. ...and while I'm glad that they -, I -, it was important to demilitarize that area...
 d. I guess from what I understand the thing could just -- it could just, they could take off at any moment.

Dysfluencies in production may be interpreted as involuntary deviations in production in the sense that they may be failures to produce fluent speech when uncertainties or distractions delay or inhibit access of words or syntax. Dysfluencies are generally recognizable in the context of speech as incomplete subparts of a projected, well-formed syntactic utterance. They arise during the formulation or execution of an intended utterance, but they do not represent ungrammatical utterances once the discontinuities have been accounted for. In this way we can distinguish dysfluencies from errors, in form and in etiology. Although these performance phenomena will not be classed as errors, they nonetheless can be used as evidence of production processes as an additional type of observational data (and they have been: hesitations, Garrett 1982, Meyer 1994; filled pauses, Smith and Clark 1993, Garrett 1982; false starts, Jasperson 1998). These observational data do not constitute part of the corpus used in this study.

Note that production errors often result in production dysfluencies themselves, with the intended form being produced in a restart with repair, perhaps also with a filled pause (3.2).

- (3.2) a. ...get on their *live* /laiv/ - with their lives.
 b. do my *compute*, or my commute in log time

- c. these *words* have not exceeded nine words in length – uh, these slides have not exceeded nine words in length.

Repair is a consequence of self-monitoring. Self-monitoring that results from the realization that an error is being produced often means that an error is not completed and a dysfluency is created. Self-correction is evidence that a deviation from intended performance occurred, and hence as evidence that an error occurred. However, it is often the case that no self-correction is performed on the part of the speaker in these situations (or, more rarely, the hearer; Schegloff et al. 1977), and the error and the intended utterance must be inferred from the speech context. While this may at times present uncertainties in the collection of errors, in most cases the distinction between dysfluencies resulting from execution or planning difficulties and those resulting from the need to correct an unplanned utterance is clear.

Variation in Competence. Utterances that appear to be failures of encoding may actually be intended utterances by speakers of nonstandard dialects, or utterances by speakers of the standard dialect containing constructions that are marginal or idiolectal. Here we are concerned with the range of variation that can be displayed across grammars at the levels of the individual and of speech communities, and the extent to which individuals can intentionally stretch the envelope of grammatical usage or simply fail to be competent. Knowledge of this variation is crucial to identifying the boundary between these forms and performance errors, which we have defined as unintended deviations from the speaker's plan. A parallel situation exists at other levels of production (see Zwicky 1989 on classical malapropisms).

Speakers sometimes make errors because of a too tenuous grasp of the syntax involved. At the word level, an analogous competence failure can result in a classical malapropism, which may be confused with a form-based substitution without any additional information about speaker competence. Failures involving syntactic competence will be excluded from consideration as syntactic errors of production just as classical malapropisms have been from the study of the lexicalization process. (Though note that similarities between malapropisms and form-based substitution errors are striking and the underlying mechanisms may be related.)

- (3.3) My father has been my dentist since my first tooth has come in. (TV commercial)

The use of the perfect aspect in the subordinate clause of 3.3 is perhaps to be analyzed as a hypercorrection by the speaker of a dialect lacking the perfect/nonperfect distinction, as is true of many speakers of American English, the dialect of 3.3's speaker. However, it may be that 3.3 is a true error involving what might be called aspectual perseveration from the main to the subordinate clause. There is some evidence that this is a possible error type from errors such as 3.4a, arguably caused by a perseveration of the tense marker; 3.4b, an anticipation of the perfect aspect marker; and 3.4c, an aspectual and tense substitution. Examples are excluded when there is reason to suspect, as in 3.3, that the utterance is idiolectal, but not otherwise, leaving the examples in 3.4 as errors.

- (3.4) a. maybe I'll ask you next time I'll see you.
 b. before we've had a chance to respond it's robbed us of our resources.
 c. a university that is celebrating its 50th anniversary a couple of years ago (for 'celebrated')

It is more difficult to distinguish between errors of production and the use of constructions that are apparently part of the grammar of at least some speakers (or dialects), such as those in 3.5.

- (3.5) a. There was a ball of fire shot up through the seats in front of me.
 (Lambrecht 1988, p. 319)
 b. The problem is is that this is my only car.
 c. the man, who I didn't know who he, was.
 d. I decided how would I fix the rake. (Stemberger 1982, p. 322).

In each example in 3.5 the utterance is marginal or unacceptable from the point of view of a standard grammar, but the construction involved is used by some speakers of standard American English, at least in informal registers. I will consider each utterance in (3.5) in its relation to performance.

Lambrecht 1988 argues that a class of presentational amalgams, of which the presentational relative in 3.5a is one type, are used regularly by many speakers of standard American English. Lambrecht notes that speakers use amalgams whether or not they are aware of this fact or judge such constructions to be "grammatical" when they are asked. Lambrecht claims that the purpose of the presentational amalgam construction is to introduce an instance of a type-identifiable referent (here, *a ball of fire*) and use it as a topic about which a comment is made (*the ball of fire shot up through the seats in front of me*). The discourse motivation of the presentational relative is "...to combine referent introduction and predication in one grammatical unit" (p. 336). These goals are accomplished through the grammaticalization of an amalgam resulting from structural reanalysis. Examples of the grammaticalized presentational amalgam will not be considered as error data.

The source of the presentational amalgams is the broader phenomenon of amalgamation, exemplified in 3.6. This broader phenomenon, while sharing some of the motivational source with presentational amalgams, includes instances that are not grammaticalized for a specific discourse function. Instances of non-presentational amalgams are included in the corpus.

- (3.6) a. I guess that was a difference between me and you was that I always thought
 with
 Sylvia it would be over at some time. (Lambrecht 1988, p. 337).
 b. I think that's actually their main office is in Duane.

The construction in 3.5b is an example of a phenomenon we can call *copula doubling*. The standard form of this construction would have only one occurrence of *is*, but the doubled *is* is almost ubiquitous in contemporary speech. The motivation for this construction may be formal, in parallel with the pseudocleft, in 3.7. Note that pseudoclefts also occur with doubled copulas (McConvell 1989). The widespread use of the double copula does not allow us to consider it an error, although its formal motivation may be explained by examining the processes of syntactic encoding. In any event, instances of copula doubling are not included in the error corpus.

- (3.7) what it is is a problem.

Relativizations with resumptive pronouns are another example of a frequent usage that is disallowed by grammars of competence in English. The example in 3.5c shows the relativization of the subject of a *wh*-complement. Resumptive pronouns are widely employed by speakers of the standard American English dialect only when syntactic constraints prevent gapping (as in 3.5c), which is the usual strategy in English relative clauses. However, there are dialects (or speakers) that use resumptive pronouns where the standard language allows a gap, as in 3.8a (which the speaker intended). The alternative strategy, gapping in situations where structural constraints prohibit it, almost never occurs. Speakers prefer resumptives over gaps when gaps are disallowed, although they may have a sense that resumptive constructions are not well-formed. Evidence for awareness of a hierarchy of ill-formedness comes from repair examples like 3.8b.

- (3.8) a. I just saw [this friend of mine]_i today that he_i has to go to Ft. Collins to get...
 b. [NP_i] that I doubt I even know what \emptyset_i is - what it_i is.

The patterned use of resumptive pronouns in extractions clearly indicates that these constructions are not errors. The need of speakers to use them may arise during encoding when there is a failure to plan around the lacunae in English grammar created by gapping constraints (whether language-specific or universal), and in this sense they may provide information about encoding processes. However, these errors will not be considered in this study.

Finally, the auxiliary inversion in the embedded question in 3.5d is an example of a type of error often reported (cf. the discussion of Fay 1980a in §3.2 below). Stemberger 1982 reports that he collected this utterance as an example of this type of error, only later realizing it was a dialectal variant in the speaker who uttered it. Only familiarity with the speaker can prevent false error reports of this kind, which is not always possible in casual error collecting. Some false errors must inevitably creep into a corpus, although care has been taken to exclude ideolectal forms by asking speakers about their errors whenever possible.

Novel usages. Related to these last examples, and perhaps most difficult to distinguish from errors without knowledge of speakers' intentions, are novel uses of syntax that are plausible extensions of standard uses. Goldberg 1995 and Pinker 1989 both discuss intentional novel uses of verbs in nominally unacceptable frames (see Talmy 1985). Goldberg cites examples like 3.9 (p. 55) to support a constructional approach to syntax, as discussed in §2.2.1. In Goldberg's version of Construction Grammar, constructional meaning can override lexical meaning.

- (3.9) a. He sneezed the napkin off the table.
 b. My father frowned away the compliment and the insult.

Pinker draws on examples collected by himself and by Bowerman 1982 to support the existence of broad-range lexical rules, including causativization, as in 3.10 (Pinker 1989, p. 153). Pinker proposes that broad-range rules can be extended, when motivated, to verbs whose narrow-range rules do not license their use.

- (3.10) a. The relatively steep nose-up attitude after takeoff climbs the airplane quickly to decrease noise on the ground.
 b. Zia conforms Pakistan law with Islam.

Very similar examples exist that ARE apparently syntactic errors, judging from repair phenomena or interpretation of intent (3.11).

- (3.11) a. y'know I think Dykstra fin- they finished the d- Dykstra (.) in ninety-one or so
and that was the last dorm they finished.
b. when the skillet was washing (for 'when the skillet was being washed')

The examples in 3.11 will be considered errors. In the same way that the utterances in 3.10 are evidence for syntactic representations (although the interpretation of the facts differs), the utterances in 3.11 will be analyzed to explore the processes of grammatical encoding.

3.2 THE ERROR CORPUS.

The error corpus consists of 699 errors that were collected by the author (or associates and friends) in natural conversations or culled by the author from published and unpublished corpora of speech errors over a period of six years. A summary of the collections, sources, and the numbers of errors taken from each collection is found in Table 1.

A small number of the errors in the corpus have been taken from the corpus of semantic and form substitutions used in the analyses in Bell & Raymond 1997 (referred to henceforth as BR97). The semantic errors taken from BR97 have properties that place them in one of the important subtypes described in this chapter. These data are attributed in Table 3.1 to A. Bell, A. Cutler, D. Fay, and W. Raymond, and the UCLA corpus, although not all the errors attributed to these sources are also in the BR97 corpus. The majority of the lexical substitution errors in the BR97 corpus have not been incorporated into the current corpus. The BR97 corpus is used in this study in conjunction with the corpus described herein whenever the form and semantic substitutions it contains provide a useful comparison to the errors of the present corpus, and then only when noted. The BR97 corpus and the corpus detailed here also include errors from the collection of L. Menn (from BR97), and errors reported to the author by L. Michaelis and M. Gregory, which are not separately listed in Table 3.1, but are included under W. Raymond. The Switchboard corpus (Godfrey et al. 1992) is a corpus of recorded telephone conversations from which the author extracted a small number of errors and their contexts.

The errors of the corpus include lexical, morphological, and other non-phonological errors that cannot be classified as lexical or morphological. Lexical errors involving form substitution were not included because they are unlikely to provide evidence that bears directly on grammatical encoding.² Phonological errors were also explicitly excluded from the corpus because they are errors occurring at a stage in production after grammatical encoding. All errors of the target types were recorded whenever they were encountered (in conversation or in another corpus or publication), if this was possible. An attempt was made to collect as wide a variety of lexical and morphological errors as possible. Non-phonological errors that could not be classified as lexical or morphological were also collected whenever possible. The non-phonological errors in the corpus can generally be construed as phrasal errors that are parallel in their relational and distributional types (v.i., §3.2.1) to lexical cases. During the collection process, particular

² The BR97 corpus includes an extensive collection of form substitutions that was available as a data source.

attention was paid to finding examples of all error subtypes that can be theoretically predicted using combinations of the parameters that will be defined in §3.2.1. Many of these subtypes are only sparsely represented in existing corpora, perhaps because of collection bias.

The database includes the errors in the context recorded by the collector and the collector's estimation of the utterance intended by the speaker. These raw data were then coded in two ways. Errors were first considered as *lexical errors*, that is, deviations from a speaker's intended output that could be described in terms of words (626 errors) or morphological units (37 errors) (i.e., roots, stems, and affixes; cf. del Viso et al. 1991). A few errors (32 errors) were not strictly lexical errors by these criteria, but could be described using the system of lexical codes defined below but applied to combinations of a few words. The residue (four errors) could not readily be interpreted as lexical errors in any way. The errors were coded for two classes of factors for lexical coding: (1) the error type; and (2) descriptive characteristics of the distribution of error elements in the utterance.

After coding the errors in the corpus as lexical errors, all corpus errors were reanalyzed as errors that depended for their description on units other than words in ways that followed from an interpretation of the errors as *encoding errors*. Encoding errors are described in terms of functional or constituency structures, which are created during grammatical encoding. There are 403 errors (58% of the corpus) that were reclassified as encoding errors using the second schema. The two classificatory systems are discussed in §3.2.1 and §3.2.2.

TABLE 3.1. Error sources and counts.

Collector	Source	Number of errors
A. Bell	AB, BR97	3
A. Cutler	Personal collection (AC)	5
D. Fay	Personal collection (DF)	7
V. Fromkin	Fromkin 1973 (VF)	2
M. Garrett	Garrett 1975, 1976 (MIT)	61
T. Harley	Harley 1984 (TH)	7
W. Raymond	Personal collection (WDR), BR97	297
J. Stemberger	Stemberger 1982, 1985 (JS)	40
Switchboard corpus	Godfrey et al. 1992 (SWBD)	9
UCLA corpus	UCLA corpus (UCLA)	253
V. Wallace	Personal collection (VW)	15
TOTAL		699

An issue that must be dealt with in describing errors using any schema, and ultimately explaining errors, is establishing what a speaker intended to say when an error is committed. In this study, the speaker's intended *target* was reconstructed for errors in the WDR collection by the author based on intuition. The same methodology has been applied in the creation of other error corpora, whenever the issue is mentioned at all (e.g., Garrett 1975). Collector intuition about speaker targets can be corroborated in three ways: (1) by the semantics or syntax of the error utterance and its wider context; (2) through speaker interviews; and (3) from speaker self-corrections.

Generally, an error constrains possible target variation through its semantics or its syntax. In 3.12a, an exchange of *neck* and *back* is strongly suggested because a meronymy of *back* does not include a subpart *neck*. However, *the back of your neck* is meaningful. This conclusion is suggested both by the limited context recorded for this error (repeated in 3.12a) and by the more extended context in which the error was encountered by the author. In 3.12b, the singular *experiment* is syntactically inappropriate for the utterance context. The utterance context suggests that the speaker's target was *one of Walter's experiments*, using the plural *experiments*. However, in it is also possible that the speaker had intended to say *with Walter's experiment*, in which case it would have been the partitive *one of* that constituted the deviation from the speaker's target, and not *experiment*.

- (3.12) a. ...the hair raises on the neck of your back
b. ...with one of Walter's experiment

The syntax of the error in 3.12b constrains the possible targets, but does not identify a unique target. Similar situations arise when semantic criteria are employed to determine speaker intentions. It seems to hold for the most part in errors that where there is target ambiguity there are *two* possible alternative target utterances, and no more. We will return to this fact in §3.2.2 in establishing criteria for coding errors of grammatical encoding. For lexical coding, the alternative was chosen that had the least difference in number of words between error utterance and target utterance and that allowed the error to be classified with other errors of the same description. For 3.12b, this algorithm selects *with one of Walter's experiments* as the target.

Is there any way to confirm that intuitions based on semantics and syntax, as well as the algorithm used to select between alternative utterances, comports with speaker intentions? One way is through speaker interviews immediately after a possible error has been detected. Speaker interviews are only feasible in a very limited number of situations, and interviewing was employed infrequently by the author. In collecting errors, I most often questioned speakers when I was in doubt whether an utterance was an error or intended. Instances in which I questioned speakers about utterances that were errors corroborate my judgments of speaker intentions in those cases. However, speaker interviewing was not applied in a controlled way, and the conclusions can only remain impressionistic.

Another indicator of speaker intentions, speaker self-corrections, can be quantified and examined in the data. Of the 699 errors, 176 (a proportion of .25) are recorded with speaker self-corrections as part of the error utterance context. The error subtypes defined in the following sections all have representative errors with self-corrections, suggesting that the error parameters used to define the error subtypes capture significant aspects of the errors. The self-corrected errors also argue that the targets of other errors that are similar to them, but for which the target has been identified by collector intuition, generally reflect speaker intentions. However, for

coding errors of encoding in §3.2.2, speaker self-corrections are used to identify errors that behave differently from lexical errors that they superficially resemble.

It is very often possible to identify some element or elements of the target context that have a salient relationship to the error site. We can assume that the relationship is not coincidental if a particular type of relationship is a persistent pattern in the error data. The relationship may involve meaning, form, or location of the element with respect to the error. When a related element is identified, we conclude that it is implicated in the error process and is at least a part of the error's *source*. The identification of a source element does not exclude the influence of other elements of the utterance context, however; the source of an error may be a combination of many factors. For example, Raymond and Bell 1998 (Bell & Raymond 1997; Raymond & Bell 1993) use regression analysis to explore a number of independent predictors for one type of lexical error, noncontextual substitutions. They found that a number of relational characteristics are significantly correlated in error-target pairs, including meaning, form (both segmental and prosodic), use frequency, and morphological makeup. The number and variety of similarities between errors and targets in substitution errors is consistent with a network model of lexical representation and access.

3.2.1 CLASSIFYING LEXICAL ERRORS. Established parameters used to categorize errors were used to create a classification system for the 695 lexical errors (including the morphological and phrasal errors that can be interpreted using lexical parameters) in the database. The parameters can be grouped into two classes, factors describing *error types* and factors describing *relational types*. Error types categorize errors by structural criteria in the surface form of the utterance. Relational types capture the important relation between elements in the intended and actual utterances. Some *complex errors* involving multiple error types and multiple relational types are also found in the database.

Error type. Error types are defined by two parameters: (1) *unit type* and (2) *distribution type*. Unit type is defined in terms of the linguistic object by which an error deviates from the speaker's intended utterance. The database contains errors of three unit types: bound morphemes, words (and word stems), and phrases. A few errors are classified as complex because they can only be described by referring to multiple units of a single type (not including exchanges) or to units of more than one different type. A summary of the numbers of lexical errors is found in Table 3.2.

Deviations from a speaker's target plan can be viewed as resulting from five distribution types. A unit may be omitted (*deletion*), a unit may be replaced with some other unit of the same type (*replacement*), a unit may be added to the utterance (*insertion*), two units may be reordered (*movement*), or two units may be merged (*blend*).

Replacements are a large subtype of errors. The proportion of replacements in the corpus is .73 (504 errors). The other distributional types range in proportion from .04 to .10. A summary of the numbers and proportions of errors in the corpus by distribution type is given in Table 3.3.

TABLE 3.2. Numbers of lexical errors by unit type.

Unit type	Number of errors
Morphemes	25
Words, Stems	629
Phrases	32
Complex	9
TOTAL	695

TABLE 3.3. Numbers of lexical errors by distribution type.

Distribution type	Number of errors	Proportion of errors
Replacement	494	.71
Insertions	43	.06
Deletions	30	.04
Movements	48	.07
Blends	71	.10
Complex	9	.01
TOTAL	695	1.00

An error type can theoretically be any combination of unit level and distribution type. Crossing the 3 unit levels and 5 distribution types defines 15 error subtypes. For example, the corpus contains examples from the subtypes of lexical blends (3.13a), lexical deletions (3.13b), morphological insertions (3.13c), and phrasal replacements (3.13d).

- (3.13) a. he's a *grancestor* of yours ('grandparent' and 'ancestor')
 b. one might want have – want to have
 c. it turned-*ed* out – it turned out to be very tender
 d. water *over the dam* – uh, over the bridge – I mean, under the bridge

The numbers of errors in each of the 15 error subtypes is summarized in Table 3.4.

Relational types. The relational types encode the relations between the error unit and other elements in the error context. Three relation types were coded in the database: (1) the *location* of the error unit relative to a unit that is construed as the error's *source* (2) the *representational manner* in which the error is related to source and target; and (3) the relation of *grammatical properties* of the error to those of the source and target.

TABLE 3.4. Numbers of errors by distribution type and unit type.

Distribution type	Unit type		
	Morphemes	Words	Phrases
Replacement	2	467	25
Insertions	4	35	4
Deletions	5	24	1
Movements	14	32	2
Blends	0	71	0
Complex	3	2	4
TOTAL	28	631	36

Error location is defined as *displacement* relative to an error source. Displacement is measured as the number of words from error unit to source unit. Subtypes of errors are referred to using names that designate general categories of error displacement. If the error and source units are at the same location, so that the separation between them is zero, the error is referred to as a *substitution* (3.14a). If the error linearly precedes the source, it is called an *anticipation* (3.14b), and if it follows the source, it is a *perseveration* (3.14c). Anticipations and perseverations are jointly referred to as *displacements*.

- (3.14) a. this was the first in my *occasion* (error: *occasion*; target: *experience*; source: *experience*; displacement: 0)
 b. many *players* think – many people think he's the most underrated player (error: *players*; target: *people*; source: *player*; displacement: 6)
 c. a branch falling on the *tree* (error: *tree*; target: *roof*; source: *branch*; displacement: 4)

The relations of errors to source and target may involve the context of the utterance or the words' lexical properties. Contextual relations between errors and sources can be characterized as *planned*, i.e., part of the speaker's target utterance, or as *unplanned*. Unplanned units may be further subcategorized as *alternative plan* errors or *competing plan* errors (Butterworth 1982; Harley 1984). Alternative plan errors "...are caused by interference from an alternative formulation of the intended thought," while competing plan errors, also called "situational" errors (Garrett 1976) or environmental contaminants, "...are caused by interference from an unintended thought" (Harley 1984, p. 192). Competing plan errors are not included in the error corpus and are not considered in this study.³ A planned unit will be referred to as *contextual*; an unplanned alternative plan intrusion into the target utterance will be referred to as *noncontextual*.

³ Competing plan errors are not INTENTIONALLY included in the noncontextual errors of the corpus. See Garrett 1976 for a discussion of the implications of their a priori exclusion.

The relational parameter contextual-noncontextual is logically independent of distribution type. On the definitions assumed, the error in 3.14a is a noncontextual substitution, the error in 3.14b is a contextual anticipation, and the error in 3.14c is a noncontextual perseveration. The contextual anticipation in 3.14b is a member of a broader class of contextual, or *repetition*, displacements. The noncontextual perseveration in 3.14c is an example of the subtype of noncontextual displacements.

If an error is noncontextual, the relation between the error unit and the source and target units can be characterized in terms of the representational system in which the units are similar. Pairs are coded as the identity relation, a relation of form, a relation of meaning, an inflectionally related form, or a derivationally related form. A basic distinction can be made between relations of form and semantics. However, these relations overlap in morphologically related words, since morphologically related words have formal and semantic similarities. In addition, morphological processes are intimately related to syntax. The overlap of meaning and form and the interconnection between morphology and syntax motivate recognition of the two morphological relation types. Pairs were judged as form related or semantically related by the author. While it is recognized that all the representational manners are correlated, no attempt was made to quantify the relations for each error pair (cf. Bell & Raymond 1997, Raymond & Bell 1998 for an approach to this problem). Subjective, categorial judgments were considered sufficient for the preliminary analyses of this study.

A third relation type coded in the corpus capture the grammatical properties of errors, targets, and sources. The grammatical class of error units, target units, and source units are coded for all errors. Class was coded as noun, pronoun, verb, auxiliary, adjective, quantifier (numbers, *all*, *every*, etc.), adverb, preposition, particle (in idiomatic combination with a verb, as in *take off*), negation (*not*), subordinator (complementizers, such as *that* or *wh*-words, or correlatives, such as *as* and *so*), and determiner (*the* and *a/an*). Grammatical class of the error, target, and source words in errors was determined by the author based on the context of use in the error utterance. Grammatical class can also be compared for error-source, error-target, and target-source pairs to create a binary variable for each pair encoding whether the grammatical class of the words in the pair is *same* or *different*.

When a source or target site includes a word with inflectional or derivational morphology, the morphology may behave differently in an error than the stem to which it is attached. Inflectional morphology on a source word is often *stranded* at the source, and is not carried over to the error site. In the identity anticipation in 3.14a, the plural suffix on *points* is stranded at the source and does not appear on the error unit *point*. Derivational morphology is less likely to be stranded, but does sometimes occur. In the anticipation in 3.15b, the nominalizing suffix *-er* is stranded and does not appear on the error unit *fold*. Conversely, inflectional morphology on the target often appears on the error, which *accommodates* to the target's morphology (with or without allomorphic variation). In 3.15c, a contextual lexical blend accommodates to the past tense morphology *-ed* of the target site. Replacement errors may exhibit both stranding and accommodation. In the contextual anticipation in 3.15d, the contextual anticipation strands the past participle inflectional morphology *-ed*, and accommodates to the morphology of the target, the nominalizing suffix *-or* and the plural inflection *-s*. Note that 3.15d argues that there is a class of *stem* displacements exhibiting stranding, and that these errors do not simply involve form structure, such as the syllable, which could be argued from examples like 3.15b.

- (3.15) a. I'm going to mainly *point* about – to talk about three main points
 b. I didn't *fold* out – throw out any folders
 c. have 'Love Boat' *tackled* – tattooed on his knuckles
 d. I want to get my feature *locators* – detectors located.

Stranding of morphology at the source site and accommodation of morphology by the error at the target site are coded for each error in which the units are morphologically complex. Stranding and accommodation are common phenomena in all subtypes of lexical errors. The proportion of all errors that exhibit stranding or accommodation of either derivational or inflectional morphology is .20 (143 errors). Only five errors clearly fail to strand source inflectional morphology or accommodate to target inflectional morphology.⁴

Complex errors. Three categories of complex errors are coded in the data. Errors that involve the same or different error types at more than one location in an utterance are referred to as *multiple site* errors. Errors with a single locus, but in which the error unit has relations to more than one source unit are referred to as *multiple source* errors. Finally, utterances in which more than one error has occurred are referred to as *sequential* errors.

Multiple site errors involve deviations from the speaker's intention at more than one location in a single utterance. The multiple site errors in the database include the theoretically important subtype of *exchanges*. Contextual exchanges involve a switch in location of two planned elements (3.16a,b). The proportion of errors in the database that involve exchanges is .24 (162 errors).

- (3.16) a. I'll *tell*, I can *say* that
 b. it just *sounded* to *start*

Exchange errors can be considered as combining an anticipation error with a perseveration error. In 3.16a, there is an identity anticipation of *tell*, replacing *say*, and an identity perseveration of *say*, replacing *tell*. As discussed in §2.2, exchanges that involve either stranding of morphology or accommodation of morphology (e.g., 3.16b) are labeled "combined form" errors by Garrett (1975), and are contrasted to the "whole word" exchanges, where no morphology is disassociated from one of the displaced words, usually because the words involved are monomorphemic (e.g., 3.16a).

Multiple site errors can also involve noncontextual relations. The example in 3.17 combines a contextual anticipation (of *Iowa*, replacing *basketball*) and a noncontextual semantic substitution (of *Indiana* for *Iowa*). There are two examples of this error type in the corpus (but see Stemberger 1985 for a discussion of these as "bumper car errors", p. 171).

- (3.17) *Iowa's* very important in *Indiana* (for 'basketball's very important in Iowa')

⁴ Determining when stranding or accommodation MIGHT have occurred in all cases is complicated by two factors. First, errors involving morphologically related forms clearly violate accommodation or stranding, but these errors do not involve different stems, so the morphology itself is at issue in these errors. Second, it is not clear what should count as "active" derivational morphology, that is, what morphology would be susceptible to failures in production processes.

Multiple site errors can also be found in which there are two different error types. The example in 3.18 is categorized as a lexical movement of *two* and as a morphological movement of the plural inflection *-s*.

(3.18) in linguistics there are kind of *two* people-*s* (for 'two kind-s of people')

In multiple source errors, a salient relation exists between the error unit and more than one source unit in the utterance. In these cases, all sources and source types are coded. In 3.19a, the noncontextual error word *eat* is semantically related to two words of the context (*food* and *mouth*). In 3.19b, the error *sweater* is both a noncontextual semantic anticipation (from *scarf*) and a noncontextual form substitution (for *sister*).

(3.19) a. you have to *eat* with food in your mouth – talk with food in your mouth
b. I knit my *sweater* Michelle a scarf (for 'sister')

Finally, sequential errors are found in utterances in which an error is followed by a self-correction that itself contains an error. The second error in sequential errors is related to the initial error. In 3.20a, a semantic substitution (*shit* for *dog*) is followed by a second semantic substitution (*dog* for *shit*), before it is corrected (see 3.13d as an example of the same type). A similar sequence of errors occurs in the blends in 3.20b.

(3.20) a. put someone in the *shit* house – no, the dog *list* – I mean, the dog house
b. my data consists *monly* – *maistly* (for 'mostly' and 'mainly')

3.2.2 CLASSIFYING ERRORS OF ENCODING. While it is almost always possible to code errors using the system of lexical codes defined in §3.2.1, this view of the data is not wholly adequate for capturing regularities in the data. In order to use the data as evidence for constraints on the processes of grammatical encoding, the data were reconsidered in an effort to described them in terms of parameters that make direct reference to grammatical structure. The approach taken was to retain the same system of five distribution types used in the coding of errors as lexical errors in §3.2.1 (deletion, insertion, replacement, movement, and blend), but to look for other unit types to which they may applied as descriptors.

Previous studies have also pursued a strategy of identifying errors involving units larger than words, but they have limited the class of unit types to constituent structures, such as NPs or PPs. I did not exclude constituency as a source of unit types, but I also looked for structures reflecting functional relations that were maintained in errors, since the base model assumed in the study includes both functional and structural processing levels.

The first step was to identify errors that could be construed as involving the interaction of two different utterances, plans, or structural elements, where the differences were sequences of more than a single word. As noted above, errors often implicate two possible targets, which can be construed as interacting plans. For example, the error in 3.21a is classified in the lexical schema as a movement error in which *three* shifts two words to the left (an anticipatory movement with a displacement of 2 words). As a lexical error, the speaker's target may be reconstructed as 3.21b, since this target is the minimum deviation from the error utterance.

- (3.21) a. for each *three* of those
 b. for each of those three
 c. for all three of those

However, 3.21a may also have been caused by the interaction of the two alternative utterance plans in 3.21b and 3.21c, both of which are contextually appropriate given the discourse context of the utterance. Under this construal, 3.21a can be described as a replacement of *all* (in 3.21c) by *each* (from 3.21b). These errors as a class are called *frame* errors, making the minimal assumption that the units interacting in the error are of an abstract type *frame*, which may involve word order, constituency, or functional relations. In 3.21a, one way to define the unit interacting in the alternative frames (3.21b,c) is that they are both NP constituents. The type of frame involved in each encoding error is coded for each of the frame errors identified in the database that involves constituent units. This coding provides one way to subcategorize frame errors.

The analysis of alternative plan interaction is corroborated by speaker self-corrections. In 3.22a, the error *no useful* is corrected first by use of the alternative frame given in 3.22b before it is corrected a second time in a manner that allows the original utterance to be interpreted as a lexical substitution.

- (3.22) a. the existing space is *no useful* – is not use – is no use
 b. the existing space is not useful
 c. the existing space is no use

The errors in 3.23 are also all corrected by changing the frame in the utterance and not by a lexical change, although each could be construed as a lexical substitution without the corrections. A further indication that these errors are quite likely not simply lexical errors that can be described as failures of the same mechanisms that are used to explain other superficially similar errors is that a possible target is sometimes difficult to identify. In 3.23b, a verb such as *went up* may be substituted for *finished*, although there is nothing in the context that suggests this was the speaker target. In fact, the self-correction is an indication that the speaker indeed intended to use *finish*.

- (3.23) a. it's important that the prosecution come back and put on more *case* – more of a case
 b. y'know I think Dykstra fin [-ished] – they *finished* the Dykstra in ninety-one or so
 c. but I tell you he's not *crazy* – I mean, he's insane [=crazy]

The proportion of errors in the corpus that can be reclassified as interactions of alternative frames was .58 (408 errors). The errors in 3.21a, 3.22a, and 3.23 are categorized as a *frame substitution error* (cf. the "substitution blends" in Fay 1982). For example, the frame for *all* in 3.21c is intended, but the quantifier *three*, requiring an alternative frame, is used with it. Under the hypothesis of Processing Uniformity, one approach to establishing the meaningfulness of the frame as a unit is to identify frame errors of all distribution types that occur with some other production unit with internal structure, such as words. In addition to substitutions, this would require finding frame displacements, insertions, deletions, movements, and blends. A

subtype of errors that can be construed as *frame blends* is identified in the corpus. The error in 3.24a is interpreted as a blend of the plans in 3.24b and 3.24c. The constituents interacting in 3.24a are clauses, sentences, or perhaps idiom chunks.

- (3.24) a. where does it buy me
 b. / *where* does it / get me
 c. *what* / does it buy me /

In 3.24a, the alternative frames overlap in the utterance produced by the speaker.⁵ The situation is parallel to the overlap of words in most lexical blends (cf. 3.13a). However, some frame blends do not involve an overlap of the alternative frames (3.25a). This phenomenon is again mirrored in some lexical blends. In 3.25a, the interacting frames are verbal idioms.

- (3.25) a. there was one thing we didn't deal *about* - with
 b. / *deal* / with
 c. talk / *about* /

In 3.24a and 3.25a, the interacting frames can be described as being the same constituent type, even if we are not sure what the type is. However, this is not always true of frame blends. In 3.26a, the error *that I'm not conscious of it* is a blend of the relative clause in 3.26b and the conjoined VP in 3.26c. An interaction of constituents cannot describe the error in 3.26a. However, the frames in 3.26b and 3.26c are functionally equivalent in the context. This suggests that the production units interacting in frame errors are not constituents, but functional structures.

- (3.26) a. to what extent am I responding to errors that I'm not conscious of it?
 b. / *that I'm not conscious* / of
 c. and / *not conscious of it* /

The conclusion that functional structures are involved in frame interactions is the basis for identifying an important subtype of frame error, the *sentence pattern errors*, which involve sentence- (or clause-) level frames. These errors can be construed as involving the interaction of functional frames that can be characterized in terms of argument configurations, as in 3.27a. The error in 3.27a involves an interaction of the functional frames of two different verbs, *learn* and *teach*. The verbs have different functional requirements, reflected in different constituency environments in the alternative plans in 3.27b and 3.27c. However, the verbs encode the same argument configuration, and the argument structure can capture the similarity between the interacting structures. Note that the speaker self-correction in 3.27a indicates that the error should not be described as simply a lexical substitution, just like the errors in 3.23.

- (3.27) a. these types of research should learn us – should allow us to learn...
 b. these types of research should teach us
 c. these types of research should allow us to learn

⁵ Slashes demarcate linear spans of frame overlap, with italics indicating the words in the speaker's utterance.

The sentence pattern error in 3.27a is a (functional) frame substitution. Functional frame blends have also been identified in the corpus (3.28a). The alternative plans in 3.28a and 3.28b overlap, like lexical blends, are both contextually appropriate, and involve the interaction of functional plans from two predicates that require different mappings from arguments to functional roles.

- (3.28) a. you'd be easier to heat it up all at once
 b. / *you'd be* / better off to heat it up all at once
 c. it'd / *be easier to heat it up all at once* /

There are 71 sentence pattern substitutions and 7 sentence pattern blends in the corpus. These subtypes of frame error are investigated in the analyses in chapters 5 and 6 in the investigation of frame encoding.

The frame substitutions in 3.21a, 3.22a, and 3.23 and the frame blends in 3.24a, 3.25a, and 3.26a are noncontextual errors in which the interacting frames are both semantically appropriate in the context of the error. Only one of the alternative frames could be produced, and the other is, by definition in these cases, unplanned. Contextual relation types should also apply to frame errors. The example in 3.29a shows a contextual blend of two successive structures, both planned by the speaker. The error subtype of contextual frame blend is structurally similar to the grammaticalized amalgams discussed in §3.1.

- (3.29) a. it's a relatively small number of schools are involved
 b. *it's* / a relatively small number of schools /
 c. / a relatively small number of schools / *are involved*

The blend in 3.29a is parallel to examples of contextual lexical blends (3.30a,b).

- (3.30) a. is there enough money to *reser-* to restore and preserve the wall?
 b. have Love Boat *tackled* – tattooed on my knuckles

The identification of units more specific than the generic category of "frame" for all errors is incomplete at this time.

3.3 METHODS OF ANALYSIS.

Two analytic approaches are pursued in the study. The alternate approaches, introduced in §2.2, have been taken by other researchers of encoding processes. One approach is to examine subtypes of lexical errors and interpret their properties as constraints on the production system. The analysis of word exchange errors performed by Garrett (1975, 1976) is of this type. His analysis led Garrett to propose a level of functional processing distinct from the level of positional processing during grammatical encoding. The lexical subtypes defined using the parameters of §3.2.1 are candidates for a continuation of this analytic approach in that they include and extend the subtypes employed by Garrett. The second method of analysis appropriate for an investigation of encoding processes is to view errors as involving structure other than words or their components. The coding scheme outlined in §3.2.2, which makes reference to

grammatical structure involving functional or constituency relations, defines the dataset for this approach, the sentence pattern errors.

Achieving useful results using either analytic approach requires matching appropriate data to specific questions about grammatical encoding. Because the study focuses on functional processing, error subtypes defined in terms of functional dependencies are clearly pertinent. Sentence pattern errors are defined in terms of functional frames, and thus may be useful in exploring the process of frame computation. Other frame errors implicate constituent structure as components of production. The frame errors identifiable of substitutions, blends, or other distributional subtypes of grammatical errors can be examined when asking questions about constituent assembly and frame content. Lexical error subtypes also provide opportunities to ask questions about functional processing and constituent assembly. For example, noncontextual displacements involve noncontextual substitution that are displaced from their source. As a consequence, they allow us to look at the interaction of the processes of lexical selection and lexical integration within the planning domain of encoding. Contextual blends are errors of positional processing. Movement errors also appear to occur during positional processing, and may be used to explore the ways in which the serial positions in an utterance may be functionally constrained.

Not all of the potential analyses suggested in the previous paragraph are pursued in the study. The data and the questions have been narrowed. An analysis of lexical errors, focusing on noncontextual displacements, is conducted in chapter 4 to compare theories of semantic representation and implications for function assignment. Analyses of sentence pattern errors are performed in chapters 5 and 6 to explore the relative timing and inputs to the computation of functional frames. Some speculations regarding analyses of other error subtypes are discussed as future work in §7.2.

CHAPTER 4

THE INPUT TO FUNCTION ASSIGNMENT

One of the subgoals of functional processing is function assignment. That is, elements corresponding to conceptual chunks of the message must be uniquely associated with functional roles encoding their conceptual relations. In the clause, the roles can be characterized as grammatical functions, such as subject or object. However, other relations, such as head or modifier, can be defined at other levels of a hierarchical frame. For any functional relation, it is not known what elements undergo function assignment, to what roles they are assigned, how the set of roles is computed for a message, or when during encoding function assignment takes place. This chapter addresses the first question concerning what elements undergo function assignment to functional relations of any kind. Are the elements that are assigned to functional roles concepts, lemmas, or categories of phrase structure?

The question is addressed by investigating a class of errors defined using the error parameters of chapter 3, noncontextual displacement errors. Three properties of noncontextual displacements are examined: (1) grammatical constraints on the errors; (2) their displacement characteristics; and (3) the relation types characterizing error-source pairs. We will see that the grammatical properties of the words involved in noncontextual displacements suggest that they are, like words that undergo contextual displacement, active during functional processing. However, their displacement characteristics distinguish them from contextual displacements. In particular, perseverations predominate in noncontextual displacements, but anticipations are more frequent in contextual displacements. Noncontextual displacement distances are also shorter than contextual displacement distances. In addition, the semantic relations between errors and sources in noncontextual displacements have the same distribution of semantic relations as those found in noncontextual blends, and they are different from the semantic relations most common in semantic substitutions. The results allow us to use noncontextual displacements to probe the process of function assignment.

It will be argued in this chapter that the properties of form displacements in the data can best be explained in a non-decompositional model of word meaning. In a non-decompositional lexicon, words are selected directly from unanalyzable concepts. Each concept stands in a one-to-one relation with a lemma, or a set of lemmas, lexicalizing its meaning. A non-decompositional model can predict the behavior of noncontextual displacements without requiring strict modularity of functional and positional processing levels if we allow concepts to be the elements that undergo function assignment. However, non-decompositionality also seems to be required in a strictly modular model in order to relate the behavior of noncontextual displacements to the properties of noncontextual substitutions and contextual displacements. On the modular view, concepts undergo function assignment if substitutions are failures of lemmatization, since failures of function assignment must occur at a different point during encoding.

A further model characteristic supported by the noncontextual displacement data is the inhibition of lemmas after their incorporation into a syntactic plan. Inhibition is a feature of so-called *binding-by-timing* models, such as the model proposed in Dell 1986. In a binding-by-timing model, lemmas are associated to functional slots based on activation levels. In binding-

by-checking models, functional slots may access the concept corresponding to a lemma in order to ensure that it is appropriate for the function to which it is being assigned.

A discussion of the issues of functional assignment are reviewed in §4.1. In §4.2, a method for identifying the class of noncontextual displacements is provided, along with a discussion of other relationship types that are seen in the class. Procedures for investigating the properties of noncontextual displacements are proposed in §4.3, and the results are presented. The implications for models of functional processing are discussed in §4.4. A summary of the conclusions is provided in §4.5.

4.1 THEORIES OF FUNCTION ASSIGNMENT.

Proposals regarding the domain of function assignment span a variety of production units. In the Levelt (1989) model, major category elements, such as nouns, are identified as category heads from lemma information and become expanded into phrasal constituents by specialized phrase building processes. In the model, it is phrases, like NPs, that are assigned to functional roles in the clause, in a theoretical approach that follows Lexical Functional Grammar (Bresnan 1982), on which the model's grammatical encoding processes are based (see chapter 2).

That phrase structures are the elements that undergo grammatical function assignment seems unlikely given error data. Garrett's (1975, 1976) original observation leading to the proposal of a two-stage model was that whole word exchanges respected functional relations, either in terms of grammatical form classes or in terms of grammatical relations in the clause (or both). However, exchanges of phrases are extremely rare as errors. There are only 7 examples (out of 162 exchanges of all types in the data) in which one or more of the exchanged phrases involves at least a modifier or a determiner together with the head, a proportion of .04. In only 2 cases are both a determiner and a modifier moved with one of the heads (e.g., 'a difference in *gerunds of the syntactic behavior*'). Even if we focus on assignment of grammatical functions, the proportion is .21 in the exchanges involving heads of different nominal or adjunct phrases (7 out of 34 cases). The proportion is still only .27 if we further limit the exchanges to the 26 cases in which the phrasal structures differ (including 'I have to fill up [the_{Det} gas_N]_{NP} with [car_N]_{NP}' but not 'used [the_{Det} door_N]_{NP} to open [the_{Det} key_N]_{NP}'), allowing us to distinguish between phrasal and word exchanges.

The failure of phrasal constituents to participate at any level in function misassignment on any significant scale points to some element closer to the word level, such as lemmas or some earlier representational category, as the input domain to function assignment in the majority of instances. Other proposals for what these elements are have focused on the smaller units, either lemmas or the concepts that select them, although which of the two units undergoes assignment has not been determined. Bock & Levelt 1992 suggest that concepts or lemmas are assigned to syntactic functions. Roelofs's (1992) spreading activation model accounts for exchanges as occurring "when two to-be-verbalized concepts in the message simultaneously retrieve their lemma nodes, and the nodes get erroneously linked to each other's syntactic slot" (1992, p. 129), suggesting that lemmas undergo assignment.

Lexical representation remains a modeling issue, and which elements are candidates for function assignment is related to theories of the lexicon and of the lexicalization process, or how conceptual chunks are mapped to words. A contention among competing theories of the lexicon concerns whether the representation from which lemmas are selected is distributed, in a network of semantic primitives, or non-distributed, in a network of concept nodes (see Roelofs 1992,

Bierwisch & Schreuder 1992). Models opting for a distributed representation of lexical meaning are classified as *decompositional* (Dell 1986; Dell & Reich 1981; Stemberger 1985). In a decompositional model, lexicalization is equivalent to the problem of conceptual chunking. Models that include a level of abstract concept representations are called *non-decompositional* (Garrett 1975, 1976, 1982).

Non-decompositional theories have a long tradition in connectionist modeling (Collins & Loftus 1975) and formal semantics (Fodor 1975). In a non-decompositional model, conceptual chunking leads to the selection of concept nodes. Concepts are the non-distributed meaning units of words. The process of lexicalization in a non-decompositional model is then a trivial mapping from concept to lemma. In a non-decompositional model then, the domain of function assignment may be concept nodes or word lemmas. However, in decompositional models, lemmas are the only available candidates for function assignment between semantic primitives and phrase structure.

4.2 IDENTIFYING NONCONTEXTUAL DISPLACEMENTS.

The properties of displacements are central to issues of functional processing. The level of functional processing was proposed by Garrett (1975, 1976) based on a tendency for exchanged whole words, a type of multiple displacement, to be of the same grammatical class and to play similar functional roles in the clause. The details of his argument were reviewed in §2.2. Displacements are thus a type of error that constrains function assignment. A subtype of displacements, the noncontextual displacements, was identified in §3.2.2 and is considered more carefully in this section. The class will form the basis for an analysis of the domain of function assignment. At this point, no distinction will be made between functional processing that is constrained by grammatical class or grammatical functions. Errors that are more specifically failures to preserve grammatical functional dependencies will be used in the analyses in chapters 5 and 6.

For the most part, the literature on lexical "movement" errors (cf. Dell et al. 1997) has only dealt in a detailed way with contextual anticipatory and perseveratory displacements, that is, with displacements in which the error's domain is the target context. However, it is logically possible that an error word's domain and its displacement are independent, and this possibility can be used to define the class of noncontextual (anticipatory or perseveratory) displacements, as was noted in §3.2.1. A noncontextual displacement is an error in which the error word is not a repetition of another word of the target context and is most saliently related to a word in the target utterance OTHER than the word it replaces. Noncontextual displacements thus involve a noncontextual substitution and a displacement. Errors that can be characterized as noncontextual displacements have been noted and briefly discussed by a handful of researchers before (Harley 1984, Hillert & Gupta 1994; Levelt 1989, Stemberger 1985).

The errors in 4.1 are examples of noncontextual displacements from the corpus. The error words in these utterances do not appear to be related semantically or in form to the targets they replace (i.e., *fault* to *side*, and *novel* to *class*). A strong relation of the error to some other planned word (underscored in the examples) suggests that selection of the error word depends to some degree on the presence of the other word in the utterance plan, which is considered the utterance source.

- (4.1) a. That was a mistake on Tony's *fault* -- on Tony's side.
 b. ...which we're not reading in this *novel* (for 'in this class')

The errors in 4.1a,b are perseveratory noncontextual displacements, in which the source precedes the error, but anticipatory noncontextual displacements can also be identified (4.2).

- (4.2) put your *ax* to the grindstone (for 'put your nose to the grindstone')

While there are no examples of displacements that exhibit ONLY a strong form relation to a word in the utterance from which they are displaced, the errors in noncontextual displacements can be similar in form to the words they replace, as in 4.3.

- (4.3) a. do my *compute* – my commute in log time
 b. even computers don't do anything like this for very large *programs* – for very large problems
 c. We found out that there weren't bridges over the *roads*. (for 'over the rivers')
 d. ...Keenan's category of *subtype* - uh, subject.

A few noncontextual displacements occur in the corpus that can be interpreted as errors with multiple discrete sources (3 examples). Example 4.4a shows an anticipatory relationship between an error word and two subsequent words in the utterance (and also perhaps to the target); 4.4b shows an error with an anticipatory (form based) and a perseveratory (semantic) relation in the utterance.

- (4.4) a. you have to *eat* with food in your mouth – have to talk with food in your mouth
 b. I don't feel competent to *qualify*]- to comment on this quality.

The examples presented above indicate that a range of noncontextual displacements occurs. The following section investigates in more detail what properties noncontextual errors share with other related subtypes, and some important ways in which they differ from related types.

4.3 PROPERTIES OF NONCONTEXTUAL DISPLACEMENTS.

Relational properties of the noncontextual displacement errors were investigated. The properties examined were: (1) grammatical relations between errors, targets, and sources; (2) error displacement from source; and (3) representational and structural relations of error-source pairs. The noncontextual displacement errors can be better understood by comparing the results of the analyses to the same properties of the more well-studied contextual (repetition) displacements and noncontextual errors with zero displacement, i.e., noncontextual substitutions and semantic blends. Substitution data used in the analyses were taken from the BR97 corpus. The results of the analyses are summarized in this section.

4.3.1 GRAMMATICAL PROPERTIES. Three grammatical phenomena characterize displacements: a strong tendency for displaced errors to accommodate to target morphology

(e.g., the accommodation of *player* to plural *people* in *many players think – many people think he's the most underrated player*), a tendency for errors to strand inflectional morphology at the source site (e.g., the stranding of the plural of *points* in *I'm going to mainly point about – talk about three main points*), and the tendency for errors and targets to be of the same grammatical class. The numbers of noncontextual errors and repetition displacements exhibiting each of these properties were determined. The results are summarized in Table 4.1.

The proportion of repetition displacements that accommodate to the inflectional morphology of the target (when it differs from that of the source) is .71 (5 out of the 7 cases in which morphology is present on the target). The proportion for noncontextual displacements is .50 (2 out of only 4 cases), a difference which for this small sample is not significant.

TABLE 4.1. Numbers of repetition and noncontextual displacements exhibiting accommodation, stranding, and preservation of grammatical class.

Grammatical property		Error type	
		Noncontextual Displacements	Repetition Displacements
Accommodation	Yes	2	5
	No	2	2
Stranding	Yes	7	4
	No	2	1
Error-Target Grammatical Class	Same	40	30
	Different	7	9

The proportion of repetition displacements that strand inflectional morphology of the source (when it differs from that of the target) is .80 (4 out of 5 cases in which morphology is present on the source). The proportion for noncontextual displacements is .78 (7 out of 9 cases). The two subtypes are not different in this small sample in the degree to which they strand inflection.

The proportion of noncontextual displacements sharing the grammatical class of the target is .85, compared to .77 for repetition displacements. A comparison of noncontextual displacements to repetitions displacements is consistent with the hypothesis that the two subtypes do not differ in the tendency of errors and targets to be of the same grammatical class ($\chi^2(1, N=86) = .943, p = .33$).

Although the amount of data is small, the results of the analyses corroborate the intuitive observation that noncontextual displacements maintain the functional requirements of the utterance to the same degree as repetition displacements.

4.3.2 ERROR DISPLACEMENT. Table 4.2 summarizes the average displacements of errors (in words) from their sources for the (contextual) repetition displacements and the noncontextual displacements.

TABLE 4.2. Average displacement in words for two error subtypes by displacement direction.

Displacement direction	Error type	
	Repetition displacements	Noncontextual displacements
Anticipations	3.8	2.4
Perseveration	6.6	3.6
ALL DISPLACEMENTS	4.5	3.3

An analysis of variance was performed on the displacements of anticipations and perseverations across the two error subtypes. Overall, perseverations were displaced a greater number of words than anticipations ($F(1,69) = 10.4$, $MS_e = 56.3$, $p = .002$). There was also a significant effect of error type, with repetition displacements being displaced farther than noncontextual displacements ($F(1,69) = 12.7$, $MS_e = 69.1$, $p = .0007$). There was no significant interaction of error type and displacement direction.

The results suggest that noncontextual displacements behave differently from (contextual) repetition displacements with respect to the distance an error is displaced from its source. Noncontextual displacement errors are separated from their source by fewer words than the repetition displacements. Perseverations are displaced a greater distance on average than anticipations for both error subtypes, and there is no difference in the degree of displacement for the two subtypes.

4.3.3 ERROR-SOURCE AND ERROR-TARGET RELATIONS. Table 4.3 summarizes the numbers of repetition and noncontextual displacements that are anticipations and perseverations, and the numbers of noncontextual anticipations and perseverations exhibiting semantic and form similarity to their sources.

The proportion of repetition anticipations is .74, while the proportion of noncontextual anticipations is only .28. A comparison of noncontextual errors and repetition displacements with respect to displacement direction reveals that there are significantly more repetition anticipations and more noncontextual perseverations ($\chi^2(1, N=72) = 16.8$, $p < .001$).

One striking fact is that there is only one noncontextual displacement with a form relation to a source word in the utterance. However, this one example of form anticipation is in fact also a semantic perseveration (the example in 4.4b). In other words, all noncontextual displacements are semantic displacements and there are no noncontextual displacements that are ONLY related in form to a source word in the utterance.

TABLE 4.3. Numbers of anticipations and perseverations by error subtype and relation to source.

	Error type		
	Repetition displacements	Noncontextual displacements	
		Semantic similarity	Form Similarity
Anticipations	23	11	1
Perseveration	8	29	0
TOTAL	31	40	1

There are, however, many semantic displacements with some degree of form similarity to the target (e.g., the errors in 4.3). The number of repetition and noncontextual semantic displacements with and without form similarity to the target is summarized in Table 4.4. Errors and targets were considered to be similar in form if they share at least their first segment. The proportion of semantic displacements with an additional form similarity to the target is .57. Stemberger 1985 noted that in errors semantically related to a word other than the target in his corpus an additional phonological relationship with the target occurs in just under half of the errors of this type (1985, p. 172). The proportion of repetition displacements with form similarity to the target is .26.

TABLE 4.4. Numbers of repetition and noncontextual displacements by form similarity to source.

Form similarity with target	Error type	
	Repetition displacements	Noncontextual displacements
Yes	8	23
No	23	17
TOTAL	31	40

A comparison of the numbers of each error subtype that do and do not have an additional form similarity to their target reveals that noncontextual displacements are significantly more likely to exhibit form similarity to their targets than repetition displacements ($\chi^2(1, N=71) = 7.13, p = .008$). Within the noncontextual displacements, there is no evidence that form similarity to targets differs in anticipations and perseverations. The proportion of semantic anticipations with form similarity to the target is .45 (5 out of 11) for anticipations, but the proportion is .62 (18 out of 29) for perseverations. A comparison of the numbers of anticipations and perseverations with form similarity and without is consistent with the hypothesis that there is no difference by displacement direction ($\chi^2(1, N=40) = .901, p = .34$).

The results show that while noncontextual displacements have four logically possible source relational types (anticipatory or perseveratory relation to source crossed with semantic or form relation to source), only two types, semantic anticipations and perseverations, occur in the corpus. However, the noncontextual displacements are more likely to be related in form to their targets than are the repetition displacements. In addition, the noncontextual displacement errors are different from repetition displacement errors in the degree to which they are anticipatory.

4.3.4 SEMANTIC CHARACTERISTICS OF THREE ERROR SUBTYPES. The noncontextual displacements in the corpus all involve a semantic relation between error and source words. They can thus be considered a subtype of semantic error and compared with two other semantic error subtypes, semantic substitutions and semantic blends. Substitutions and blends are not well understood. Bock & Levelt (1994) note that blends are "something of a puzzle" (p. 956). However, what is known about these classes provides a point of departure for understanding noncontextual displacements.

In order to examine the origins of noncontextual displacements, which are all of a subtype we may call *semantic displacements*, the types of semantic relationships exhibited in these errors were compared with the semantic relationships seen in semantic blends and whole-word semantic substitutions. Semantic blends used in the comparison consisted of the 56 semantic blends contained in the corpus. To complete the three-way comparison, 50 semantic substitutions were selected from the BR97 corpus.⁶

Previous studies have noted that the kinds of semantic relations characterizing blends and substitutions differ (Hotopf 1980; Levelt 1989). Blends are "roughly equivalent in meaning in the context of the message as a whole" (Levelt 1989, p. 216). They are characterized by a predominance in error corpora of contextual synonyms (e.g., *close* and *near*) and closely related co-hyponyms (e.g., *butter* and *oil*, which are both subordinates of *fats*). Substitutions, however, are most often close semantic associates, words produced by subjects in experiments in which they are asked to produce words related to or associated with a stimulus word. Substitutions are thus more likely than blends to involve antonyms (e.g., *fresh* and *stale*), which differ in only a single semantic feature, and coordinate members of different semantic fields (e.g., *slow* and *short*). Substitutions may also involve co-hyponyms, which are not contextually equivalent (e.g., *fingers* and *toes*).

Six semantic relations were selected for the categorization comparison: (1) synonymy; (2) oppositeness; (3) dominance; (4) co-hyponymy; (5) domain coordinates; and (6) syntagmatic relatives. Oppositeness includes antonymy, but also other semantic subclasses generally considered to be opposed in some way (see Cruse 1986). The dominance category subsumes taxonomic dominance and part-whole (meronymic) relations. The category of syntagmatic relatives contains word pairs that can be related by simultaneous use in a single (non-coordination) structure. Error-source pairs from different grammatical classes are often best categorized with this relation (e.g., 'to fly with wings' or 'reading a novel'). The category was suggested by the large number of such pairs in the noncontextual displacements that could not readily be fitted into one of the other categories.

⁶ A block of 50 consecutive errors from the BR97 database was arbitrarily selected for the comparison. No attempt was made to make the selected subset random. However, the database is organized in no particular order, and the subset contains errors from a variety of sources.

Using the six categories, the three semantic error subsets were categorized by the author and a second judge (M. Gregory). Examples were discussed to resolve conflicts until an agreement was reached for each pair. All subtypes contained examples of each semantic relation. Examples of errors and sources from each subtype exhibiting relations in each semantic category, as determined by the procedure described, are given in Table 4.5.

The proportions of the three error subtypes in each of the six relational categories are shown in Figure 4.1. Except for the category of syntagmatic relatives, the profiles of noncontextual displacements and blends are quite similar. The distribution of relation types for substitutions, however, appears different. As claimed in earlier studies, synonyms predominate in blends; the proportion of synonym blends was .59. The proportion of substitutions involving the hierarchical relationships of dominance and co-hyponymy was .60, while the proportion for blends was only .31.

TABLE 4.5. Errors-source pair examples from each semantic subclass of six semantic relations.

Semantic relation	Error type					
	Substitutions		Blends		Displacements	
	<i>error</i>	<i>source</i>	<i>error</i>	<i>source</i>	<i>error</i>	<i>source</i>
SYNONYMS	produce	present	talk	speak	fault	mistake
Opposites	adequate	inadequate	released	withheld	always	never
Dominance	word	verb	grandparent	ancestor	language	German
Co-hyponyms	silk	wool	ferns	palms	sweater	scarf
Coordinates	young	shortish	best	most	qualify	competent
Syntagms	speech	speaker	redistribute	redistribution	compute	log (logarithm)

The numbers of examples in several of the semantic categories are too small to be used separately in a statistical comparison of the semantic blends and semantic displacements. However, a comparison of syntagmatic relatives to a conflation of the other five categories reveals that blends and semantic displacements do differ on this category ($\chi^2(1, N=94) = 13.2$, $p < .0003$). The reason for this difference can be explained by noting that the category of syntagmatic relatives is more likely to apply to the displacements, because in these errors, error and source are separated and thus occupy different grammatical slots. As a consequence, errors and source in displacements are more likely to be from different grammatical classes.⁷ Since traditional semantic categories apply to words of the same grammatical class, pairs of words from different grammatical classes can only be assigned to the syntagmatic relatives category.

⁷ In fact, there are no semantic blends of differing grammatical class except for two examples of blends of derivationally related words (cf. *redistribute* and *redistribution* in Table 4.5).

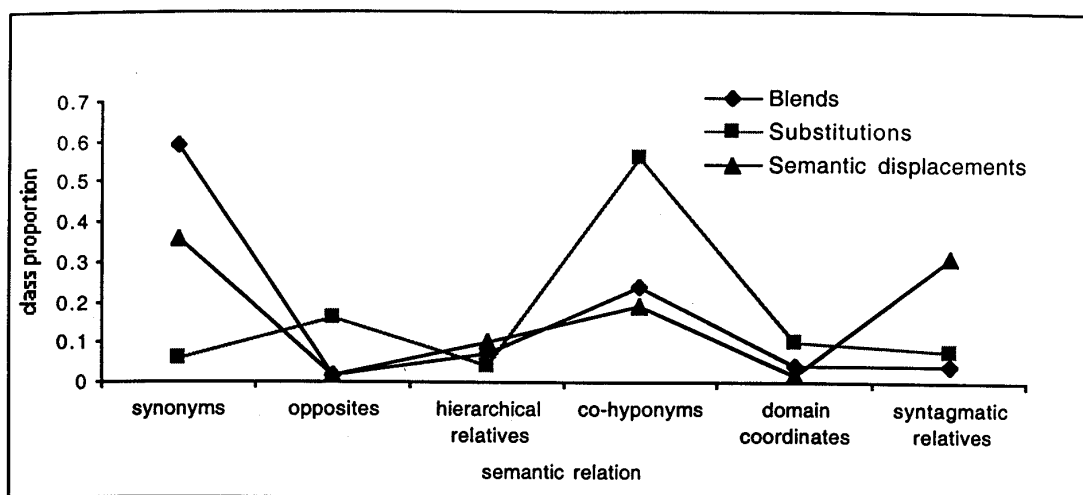


FIGURE 4.1. Distribution of semantic relations for three semantic subtypes.

The six semantic categories defined above can be viewed in another way that sheds light on the differences between the error subtypes. Can words related in each of the six ways both be appropriate for the utterance produced, or do some types of relationships necessarily exclude appropriateness? The answer would seem to be that most synonyms, many hierarchical relatives, and perhaps syntagmatic relatives could replace or supplement the source, while most opposites, all co-hyponyms, and all members of coordinate domains are by definition inappropriate. If we divide the categories in this way into appropriate and inappropriate groups, we find that the proportion of blends that belong to possibly appropriate categories is .67, and the proportion of possibly appropriate semantic displacements is .78. However, the proportion of substitutions from the possibly appropriate categories is only .18. The data are summarized in Table 4.6.

A comparison of the distribution of errors in the two semantic categories (formed by grouping contextually appropriate and inappropriate relational types) by error subtype indicates that semantic displacements are semantically different from semantic substitutions ($\chi^2(1, N=90) = 43.3, p < .001$), but is consistent with the hypothesis that semantic displacements have the same semantic distribution as semantic blends ($\chi^2(1, N=94) = .616, p = .30$).

TABLE 4.6. Distribution of errors in three semantic subtypes by contextually appropriate and inappropriate semantic relation categories.

Category type	Error type		
	Semantic blends	Semantic displacements	Semantic substitutions
Semantically appropriate categories	38	31	9
Semantically inappropriate categories	16	9	41

The results of the semantic relatedness comparison indicate that the types of semantic relations characterizing blends and semantic displacements are the same, but differ from the relationships characterizing semantic substitutions. Blends and semantic displacements involve errors that are appropriate for the utterance context. One apparent difference between blends and displacements is in the proportions of syntagmatic relatives. Semantic displacement errors have more syntagmatic relative pairs than do semantic blends.

A final comparison among the three semantic subtypes can be made with respect to the frequency of form similarity in error-target pairs in each class. The data are summarized in Table 4.7. The proportion of error-target pairs in the semantic displacements exhibiting initial form similarity (i.e., sharing at least the initial segment) is .57. The proportion of blending pairs from the corpus exhibiting an initial form similarity is .30. These proportions can be compared to the proportion of semantic blends that have initial form similarity, which is only .12 for the sample of 50 errors selected for comparison from the BR97 corpus.

TABLE 4.7. Numbers of errors in three semantic subtypes by error-target form similarity.

Error-target pair form similarity	Error type		
	Semantic blends	Semantic displacements	Semantic substitutions
No initial form similarity	18	17	6
Initial form similarity	48	23	44

A comparison of semantic displacements and semantic substitutions indicates that they differ with respect to the degree to which error-target pairs exhibit form similarity ($\chi^2(1, N=90) = 8.78, p = .003$). Similarly, a comparison of semantic blends and semantic substitutions indicates that they differ with respect to the degree to which error-target pairs exhibit form similarity ($\chi^2(1, N=116) = 9.60, p = .002$). However, a comparison of semantic displacements and semantic blends is consistent with the hypothesis that they do not differ with respect to the tendency of error-target pairs to have initial form similarity ($\chi^2(1, N=106) = 2.60, p = .10$).

The results of the comparison indicate that semantic blends and semantic displacements are the same with respect to the frequency of form similarity in error-target pairs, and that blends and displacements differ from semantic substitutions in this regard.

4.4 ANALYSIS AND MODEL IMPLICATIONS.

The results of the analyses reveal four properties of noncontextual displacements that must be accounted for by a model of grammatical encoding. The properties of noncontextual displacements place them in relation to the error subtypes of semantic blends, semantic substitutions, and repetition displacements. First, noncontextual displacements are subject to the grammatical class constraint to the same degree as repetition displacements, suggesting that they are errors of functional processing and do not occur during positional processing. However, the average displacement of noncontextual displacements is less than that of repetition displacements. In addition, form displacements do not occur in noncontextual displacement

errors, contrary to what is observed in substitutions, in which the error word may be related semantically or in form to the source. In this respect noncontextual displacements resemble noncontextual blends, which are also limited to pairs of semantically related words. However, there is a high incidence of form similarity in the noncontextual displacement subtype between errors and their targets. Finally, the semantic profile of the error-source pairs in noncontextual displacements is also like that of blends, and unlike the semantic relations found in the error-source pairs in semantic substitution. These four properties of noncontextual displacements have implications for the process of function assignment that will be drawn in this section.

4.4.1 NONCONTEXTUAL DISPLACEMENTS IN A TWO-STAGE NON-DECOMPOSITIONAL MODEL.

The occurrence of semantic noncontextual displacements provides evidence that, during production, lexical word meaning can have an effect at a distance in a developing plan. This appears not to be the case for the phonological form of words, however. The error data show that the form of a target word cannot by itself be the source of an error for any word in the utterance other than the target. These facts have a natural interpretation in a two-stage production architecture. Two-stage models propose that repetition displacement errors occur during function assignment when an element in the planning domain is associated with a function other than the one appropriate to convey the message.

In a two-stage model, the semantic form of all elements in the planning domain is active throughout at least some part of functional processing, but phonological information is accessed only later during positional processing, at the time lexemes are being sequenced by the syntactic frame. As a consequence, noncontextual substitutions or displacements that are semantically related to a planned word are, in a two-stage model, predicted to be possible during functional processing. However, noncontextual replacements that are related solely in form to a word in the utterance plan resulting in form substitutions, should only occur during positional processing. Form replacements cannot occur during functional processing without substantial feedback to the lemma level from the form level during functional processing.

The absence of form displacement argues that feedback from lexemes to lemmas during functional processing does not occur. However, the high proportion of semantic noncontextual displacements in which there are also form similarities between errors and targets might be evidence of feedback, although explaining the form similarity as a consequence of feedback would not seem to explain why form similarity is limited to errors and targets. The strong tendency for errors and targets to be form related (occurring in almost 50% of the noncontextual displacement errors) is perhaps better explained as a form bias introduced during positional processing. The bias may exist because form similarity substantially increases the likelihood of a replacement by an activated semantic competitor. In addition, dissimilarity may increase the likelihood of detection through self-monitoring before the plan has been articulated.

How can a two-stage model explain the lack of evidence for feedback, in particular, the absence of form-based noncontextual displacements in the data? There are two possible explanations. The first is strict modularity of processing within the stages. However, we have noted that strict modularity does not appear to be compatible with some bias phenomena and is rejected as a model characteristic. A second explanation has implications for the source domain of function assignment and is related to the question of the nature of semantic representation in the lexicon. We can compare the predictions of decompositional and non-decompositional models of semantics for function assignment.

A distributed model of lexicalization would entail that the input to function assignment is the set of lemmas in the planning domain, since lemmas are the only elements corresponding to words in the model that are available for assignment. Planned lemmas are active throughout function assignment, so that the corresponding lexemes have time to become activated during functional processing as well. In the globally interactive architecture we are assuming, lemma activation would lead to some degree of lexeme activation. Activated lexemes in the form network could cause activation to spread back to a lemma related to a planned lemma only in form. The feedback could cause the unplanned lemma to be incorporated into the developing functional plan in place of its form-based relative, or perhaps even at some location other than the target site of the form related word.

An alternative domain for function assignment is available in a non-decompositional model of lexical representation. In a non-decompositional model, the planning domain for function assignment may be defined over concept nodes. During function assignment in a non-distributed model, active concepts in the planning domain may be the source of activation for other concept nodes that are semantic relatives of a planned concept. The related concepts may also receive activation from an alternative formulation of the message. Activation of a semantic relative could sometimes result in the integration of its lemma into the developing functional plan during function assignment to the function appropriate for some unrelated concept, resulting in a semantic displacement. Concept nodes have no direct connection to lexemes in a non-decompositional model, so the activation level of any form related lemma will not be greatly increased. A non-decompositional model in an interactive architecture thus predicts semantic displacement, but can also explain the lack of form displacement.

4.4.2 THE ORIGINS OF SEMANTIC ERRORS. In a model architecture with strict sequentiality of lemma and lexeme processing, a non-decompositional semantics allows the same explanation of the properties of form similarity in noncontextual displacements just described using loosely yoked modularity. However, could the facts be explained by allowing modularity and decompositional semantics? Sequentiality of level processing in a modular architecture prevents feedback from lexemes to lemmas. The possibility of a decompositional semantics afforded by a modular system may be eliminated by considering the properties of the three semantic subtypes analyzed in this section.

The results of the semantic comparison indicate that semantic displacements and semantic blends have the same distribution of semantic relations in error-source pairs when the relations are grouped according to their contextual appropriateness. Semantic blends and semantic displacements are alike in another way as well. The proportion of error-target pairs in the semantic displacements exhibiting initial form similarity is high; the word pairs involved in semantic blends are also very likely to be related in form. Taken together, the similarities suggest that semantic displacements and semantic blends are aspects of the same failure type. On the other hand, semantic displacements and semantic substitutions have different relational distributions and differ in the degree to which their error-target pairs exhibit initial form similarity. The differences in this situation suggest that semantic blends and semantic substitutions have different origins during production, a conclusion reached in Levelt 1989 as well. Where should the two failure types be placed in a model of encoding?

The production of two fused lexemes in semantic blends has been explained by assuming that blends occur when two more or less equally appropriate lemmas are selected to lexicalize the same message component (Bock & Levelt 1994; Levelt 1989). (Recall that in the models of

Bock & Levelt 1994 and Levelt 1989, lexical semantics is non-decompositional, so that lemmas are the product of conceptualization.) The blending words are elements of "alternative plans" both developed to convey the same message component (cf. Butterworth 1982). The realization of two lexemes in a single syntactic slot in blends entails that function assignment in these errors resulted in an association between the blending words and a single position, that is, a single grammatical function at some functional level. Semantic blends are thus failures of function assignment through a violation of the criterion that functions be assigned unique elements.

The hypothesis that semantic displacements have the same origin as semantic blends implies that both error subtypes involve correctly lexicalized elements from the utterance planning domain and an alternative plan that fail to be assigned to the correct function. This conclusion is supported by the grammatical similarity of semantic displacements to repetition displacements, which also involve the misassignment of correctly lexicalized words. The error and source lemmas in semantic blends and displacements fail to be associated to a functional role either *uniquely* (in the case of blends) or *properly* (in the case of displacements), making them both failures of function assignment at some level.

Substitutions, on the other hand, are inferred from the results of the analyses to be failures that originate at a different point during functional processing. Recall that the error words in semantic substitutions are generally not contextually appropriate. It has been suggested that substitutions may originate after lemma access through connections among lemma nodes that reflect semantic association (Levelt 1989). Thus substitutions involve the incorporation of an erroneous lemma to the syntactic slot intended for a related lemma and they are failures of lemmatization. However, placing the origin of substitutions at the lemma level does not seem to differentiate them from semantic blends, which also occur at the lemma level in a decompositional model. In a non-decompositional model, the intuition that blends and semantic displacements involve alternative conceptualizations can be maintained if these errors originate at the concept level, which is the domain of function assignment. Semantic substitutions, on the other hand, remain failures that originate at the lemma level. The concept selecting the erroneous lemma in a substitution would have already been assigned to the correct functional slot. Semantic substitutions are then analogous to form substitutions, in which an erroneous lexeme is incorporated at the position intended for the target lemma's lexeme because of form relations among lexemes, although their lemmas are correctly assigned. On this view, substitutions occur AFTER function assignment and are not failures of function assignment.

4.4.3 DISPLACEMENT DIRECTION AND SEMANTIC INHIBITION. The results show a greater proportion of perseveratory noncontextual displacements than anticipatory noncontextual displacements in the data. We might expect the error profile of noncontextual displacements to be the same as the profile of repetition displacements. However, in error corpora collected from non-special populations (i.e., adults without language impairment), like the one from which these data are drawn, the proportion of anticipatory repetition displacements is expected to be greater than the proportion of perseverations (Dell et al. 1997). In explaining the differing distributional profiles of repetition displacements and noncontextual displacements, recall the difference between noncontextual displacements and repetition displacements: the noncontextual displacements are unplanned words that are semantically related to planned words, while the repetition displacements are themselves planned for some other location.

The interaction of displacement direction and error subtype can be explained in a model in which ordering of a set of selected lemmas that lexicalize the message is accomplished by

association of lemmas with the syntactic frame as they become activated, referred to as *binding-by-timing* (see, e.g., Dell 1986 and the response to by Dell et al. in Levelt et al. 1999). On a model employing association by activation timing, ordering during positional processing requires association of an activated lemma with the current frame position and inhibition of lemmas already associated with the frame. Activated semantically related lemmas receive activation from each other before integration. An alternative proposal, *binding-by-checking*, lemma association with the frame when there is a match between a lemma and the slot to which it is assigned (e.g., Levelt et al. 1999). On such a model, there are no inhibitory connections.

On a binding-by-timing model, a lemma is not inhibited when its relative is integrated. Its activation levels will continue to rise after association of the relative to the frame, though at a slower rate than before because an important source of activation has been eliminated. Higher activation levels after integration of its relative than before increases the likelihood of perseveration over anticipation. Planned nodes, on the other hand, ARE inhibited after frame integration, regardless of whether they are integrated with the frame in the correct slot or not. As a result, their activation levels are lower immediately after selection, and are less likely to perseverate. Post-integration inhibition thus explains the lower proportion of contextual perseverations relative to contextual anticipations as well as the higher proportion of noncontextual perseverations relative to noncontextual anticipations. There does not seem to be a way to explain the differing displacement biases in repetition displacements and noncontextual displacements in a binding-by-checking model.

Dell et al. 1997 present a general computational model of serial order in language production that can predict the relative frequencies of anticipatory and perseveratory lexical repetition displacements in any sufficiently large corpus. The anticipatory proportion (AP) of all anticipatory and perseveratory repetition errors combined in a corpus is a function of a number of parameters that predict the ratio of anticipatory to perseveratory errors. The parameters include the activation weights between a sequencing frame and the units already integrated into the frame, the unit currently being integrated, and the units remaining to be integrated with the frame. The three activation weight values model the sequencing of past, present, and future words in the utterance plan. In the model, the activation weight w of a planned unit affects the rate of perseveration P , but not the rate of anticipation A . As w decreases, P increases, and AP becomes lower.

The relationship between w and AP explains a variety of phenomena, including the anticipatory practice effect, in which practice saying a phrase increases the proportion of anticipations by strengthening connection weights w_i to the words in the planned utterance. It may also explain the lower AP of children, who tend to produce more perseveratory errors than adults. In children, w is presumably lower because they have had less experience with production in general. To model non-special language, model parameters can be selected to simulate the advantage of anticipatory to perseveratory repetition displacements.

The Dell et al. (1997) model is compatible with the explanation proposed here for noncontextual displacements. Because they are related to planned words, noncontextual displacements receive an initial activation which is some fraction of the activation of the target. Because they are unplanned themselves, their activation is never inhibited. The model assumes that the activation level of planned words is inhibited after the planned word is selected. Consequently, the activation level of a semantically related word always continues to rise, though perhaps more slowly after selection of its planned relative, since it will no longer receive activation from the associate. Activation levels of semantic relatives are thus necessarily higher

after one has been incorporated into the functional plan, making perseveration of the relative more likely than anticipation.

4.4.4 DISPLACEMENT MAGNITUDE AND ACTIVATION LEVELS. The average noncontextual displacement is less than the average repetition displacement. Range of interaction is one property that distinguishes whole word exchanges from combined form exchanges and argues for the interacting elements of the two subtypes being active in different processing domains. However, the two exchange subtypes were also qualitatively different with respect to grammatical properties. In the case of displacements, only the quantitative difference in displacement magnitude is observed, suggesting a continuous variable is the source of the difference and not a difference in processing vocabularies.

The magnitude difference may simply be due to the lower initial activation of semantic relatives because of their competition as alternative plan elements. The consequence is that more time is required for semantic relatives to reach an activation level high enough to cause them to be selected, and less time for their activation level to decay to a low level once again once their major source of activation, their semantic associate, is integrated and inhibited. Lower initial activation levels thus mean a narrower window of possible plan incorporation, reflected in a limited displacement range for noncontextual displacements compared with repetition displacements.

4.5 SUMMARY OF CONCLUSIONS.

Noncontextual displacements are a subtype of replacement errors that have not previously been carefully investigated. They combine two features that make the subtype a useful probe into function assignment. First, there is evidence that noncontextual displacements undergo function assignment. They surface in a syntactic slot compatible, in general, with the grammatical properties of the target in the same way that repetition displacements do. However, unlike repetition displacements, which have an anticipatory bias in corpora of non-special language, noncontextual displacements have a perseveratory bias.

The fact that noncontextual displacements have the grammatical characteristics of repetition displacements indicates that they originate during functional processing. The similarity in semantic relations between error and source in noncontextual displacements to the semantic relations of the words involved in semantic blends suggests that the noncontextual displacements are failure of the same type as blends. Blends are cases of appropriate conceptualization coupled with a failure of unique function assignment, which argues that noncontextual displacements are also correctly conceptualized elements that fail to be properly assigned to their intended function. The differing displacement biases of repetition displacements and noncontextual displacements can be explained by recalling the difference between the two subtypes that repetitions are planned elements of the utterance frame, but noncontextual displacements are not. A model in which planned elements are inhibited after function assignment explains the bias difference. However, a model without inhibition does not seem to have an explanation for this phenomenon.

A second feature of noncontextual displacements is that they have as their source related words, and the parameters relating errors and sources delimit the domain of function assignment in a way that repetition displacements cannot. Noncontextual displacements are limited to semantic relatives of planned words and cannot be related solely in form to a word in the context.

Consequently, the domain of elements that serve as input to function assignment cannot have access to word forms.

What elements, then, undergo function assignment? A solution to the problem was found by electing a model with non-decompositional concept nodes that directly select lemmas. Concept nodes can be activated through the semantic network connecting word lemmas, but receive little activation from lexemes. These properties can explain the behavior of noncontextual displacements if we propose that concept nodes are the domain of function assignment. This conclusion turns out to be independent of assumptions about the modularity of the model given the fact that semantic substitutions appear to be failures of lemmatization, making the function assignment errors, the semantic blends and displacements, computational failures over concepts.

CHAPTER 5

THE COMPUTATION OF A FUNCTIONAL FRAME

Function assignment maps elements onto functional roles. At the sentence level, the functions to which elements are assigned are assumed to be grammatical functions, including subject and various object types. The set of grammatical functions needed to express a message is a reflection of the number and kinds of conceptual participants in the message, but is constrained by the words chosen to lexicalize the message. At what point does the processing system have the information available to compute the proper set of grammatical functions needed for function assignment in the clause, the clause's *functional frame*?

Two theories have been proposed to answer this question. The theory of *lexical guidance* asserts that a functional frame can be computed only after lexical access can provide grammatical information associated with word lemmas. For the sentence or clause, the verb is central to the grammatical encoding of participants. On the theory, a verb or other predicate lemma must be accessed for frame construction because only the predicate lemma can provide the information needed to map conceptual participants onto grammatical functions. An alternative theory, *conceptual guidance*, proposes that the functional frame for a sentence may be computed on the basis of conceptual, semantic, thematic, and discourse-pragmatic factors, and before verb lemma access.

Pivotal to the controversy over the input to frame computation is the role played by words, and lexical errors may be used to test the competing theories. Previous analyses of lexical errors have led to two-level models based on observations that a subtype of lexical exchange errors ("whole word" exchanges) is sensitive to the grammatical class of the interacting words and another subtype ("combined form" exchanges) is not. Errors sensitive to grammatical class occur during a stage when the processing vocabulary is sensitive to functional roles, the level of functional processing.

The grammatical class constraint is modeled as a constituency requirement imposed by the syntactic frame at lemma integration, and is observed not just in whole word exchanges, but in displacements and substitutions as well. An analysis analogous to the grammatical class analysis can be applied to errors of functional processing by asking if reference to grammatical class is sufficient to describe the error phenomena in this type. The answer is no. Some errors of functional processing require reference not to constraints on form classes imposed by constituent slots, but to constraints on functional roles imposed by the functional dependencies of words in a clause.

A crucial subtype of lexical errors, referred to as *sentence pattern errors*, is analyzed in this chapter. In these errors, the functional frame of a clause is incompatible with the verb or other predicate lexeme produced in the clause. As an example, consider the error in 5.1, in which the set of functional roles comprising the functional frame in the sentence cannot properly be used with the verb *remind* as it is encoded with an extraposed clause and a Goal object introduced by the preposition *to*.

- (5.1) it was *reminded* to Caliban that he must do what Prospero says (for 'it was suggested to Caliban CP' or 'Caliban was reminded CP')

If lexical guidance is obligatory to the computation of the functional frame, then the type of incompatibility in 5.1 between frame and the verb *remind* implies the access of some other lemma that serves as the frame source. In addition, lexical guidance entails the access of the lemma of the predicate lexeme, *remind*. The pattern in 5.1 is compatible with a semantically related verb, *suggest*, which may have been the speaker's target, although there is no evidence other than the frame that it was. The verb *suggest* could thus have been the source of information by which the functional frame in 5.1 was computed. When a target for the error can be identified, as in 5.1, the error is easily explained as resulting from the access of two verb lemmas: one lemma provides the input to frame computation, while the other is the source of the lexeme produced in the utterance. Multiple lemma access for a single functional role is a type of processing failure that has already been argued to be the source of blends and semantic displacements. Verbs may also be associated with more than one functional frame, as evidenced by sentence pattern alternations. A single verb lemma could then be the source of two functional frames, and a sentence pattern error could result if the wrong frame is paired with the intended participant configuration. On the other hand, if lexical guidance is not required to compute functional frames, then there will be sentence pattern errors in which the frame was not computed after lemma, but from information accessed at some earlier point during production.

The data presented in this chapter provide evidence against the necessity of lexical guidance in computing a functional frame. The main results are as follows. Although many sentence pattern errors can be viewed as lexical substitutions involving words that take arguments, many cannot because no "target" word can be identified and the "error" word was presumably intended. The errors are better viewed as resulting from the creation of a frame that is incompatible with the predicate lemma. The predicate that is produced in errors with no identifiable target may itself be the source of the inappropriate frame in some of these errors, because predicates are often compatible with more than one functional frame. However, in a subset of the errors, not even the error word could be the source of the incompatible frame. In this subset, there is no predicate lemma that can serve as input to frame computation. Sentence pattern errors also point to specific non-lexical factors that may alternatively be used in computing a functional frame. There is evidence that discourse salience and preferred discourse-pragmatic mappings of participant sets influence frame computation. Their influence is independent of the lexicalized predicate.

Lexical guidance is not eliminated as a means of functional frame computation by the evidence. Support for lexical guidance comes from comparing the semantics of the interacting elements in lexical blends and displacements with the semantics of errors and targets in sentence pattern errors. The results are compatible with a dual-route model in which functional frames can be lexically or conceptually guided. The data also argue for a separation between the processing of functional dependencies and the processing of syntactic constituency.

In §5.1, I review some correlates of functional mappings and describe the two competing models of frame computation. Section 5.2 contains a discussion of how grammatical constraints on errors are manifested and how this can help to identify errors that may involve failures of frame computation. In §5.3, I identify the subtype of sentence pattern errors, starting from a core subset of semantic substitutions of verbs. The properties of the sentence pattern errors are explored in §5.4, and model implications of the results are presented in §5.5. A summary of the conclusions is found in §5.6.

5.1 THEORIES OF FRAME COMPUTATION.

Grammatical functions play a fundamental role in the organization of information in the clause. The set of relations used in a sentence is correlated with a variety of structural, thematic, semantic, cognitive, or discourse-pragmatic factors. In English, almost all sentence types are required to have a subject, although imperatives are not. Subjects may also be absent if a clause is the second member of a coordinate structure, if the clause is one of various types of subordinate clauses, or even in main clauses of certain discourse styles (e.g., *Come here often?*). Subjects are correlated with actors in events, or to other thematically prominent situation participants if there is no actor. There is experimental evidence that words with referents that are more animate or more concrete tend to be encoded earlier, as subjects (Bock & Warren 1985). Subjects also normally encode active, accessible, "old," or "given" elements of the discourse, with the result that there is a close relationship between grammatical encoding and the information structure of a sentence. Factors from the same categories can also predict other grammatical relations to varying extents. In contrast to subjects, direct objects are correlated with new or focal information, and often encode an undergoer participant in a situation.

Because of the strong correlations between non-lexical factors and grammatical functions, the set of functions in a clause is to some extent independent of the words used to encode a message. In 5.2, two different sentences convey roughly the same information using different verbs. The functional frame of both includes a subject (*the Senate*), a direct object (*the budget bill*), and a prepositional object (*the House*). The configuration is predictably appropriate from the presence of a conceptual actor, undergoer, and theme as participants in the situation being described (where the thematic terms are used simply as convenient labels for collections of participant properties).

- (5.2) a. The Senate sent the budget bill to the House.
b. The Senate referred the budget bill to the House.

Languages allow a degree of flexibility in encoding participants, and the event expressed in 5.2 can alternatively be encoded expressing the participants using a different set of grammatical functions. In 5.3a, the set of grammatical functions consists of a subject and two objects. This option is possible because the predicate is lexicalized using the verb *send*. The same option is not allowed when the event is encoded using the verb *refer*.

- (5.3) a. The Senate sent the House the budget bill.
b. *The Senate referred the House the budget bill.

Thus, while there are strong correlations between non-lexical factors and grammatical functions, a particular lexicalization will sometimes impose idiosyncratic constraints on the availability of particular grammatical functions. The ungrammaticality of 5.3b reflects that fact that *refer* is incompatible with a functional frame encoding two situation participants, the Recipient and the Theme, as (non-prepositional) objects. However, it may be that even the restriction preventing 5.3b may be predicted from the semantic representational features of *refer*. The issue is a matter of current theoretical debate (Fisher et al. 1991; Levin 1993, Levin & Rappaport Hovav 1996, Pinker 1989, Goldberg 1995, Grimshaw 1990, Michaelis & Lambrecht 1996).

On the basis of observations like the preceding, two theories have been proposed to explain at what point functional frame computation can be initiated. The observation that lexical choice may idiosyncratically control the content of a functional frame is the basis for the lexicalist approach to frame computation. *Lexical guidance* provides for functional frame computation from the syntactic information in the lemma of the phrasal head, which controls the phrase frame's functional dependencies (cf. deSmedt 1996). The Levelt 1989 model of grammatical encoding assumes that the computation of a functional frame is always lexically guided. In the model, the verb is central to processing at the clause level, in that "...the verb dictates what arguments have to be checked in the message, and which grammatical functions will be assigned to them" (Levelt 1989, p. 244). In other words, the verb dictates the functional frame of the clause, and the mapping from arguments to grammatical relations. The lemma is the site of other idiosyncratic grammatical information about words, such as the gender of nouns in languages with gender distinctions (e.g., Italian; see Vigliocco et al. 1997).

An alternative to lexical guidance is that computation of a functional frame may be *conceptually* guided. Conceptual guidance allows computation of a functional frame from the conceptual content of a message before access of the lemma that lexicalizes the head controlling the frame's functional dependencies. At the clause level, this means function assignment, either of message components identified as conceptual arguments or of the lemmas selected to encode them, that is independent of verb lemma selection. For the clause, this proposal is consistent with recent syntactic research indicating that argument taking properties of verbs (including subcategorization frames and argument structure) are largely, if not completely, derivable from verb meaning (Levin 1993; Pinker 1989).

There is some experimental evidence that lexical guidance is not obligatory for German speakers. Schriefers et al. (1998) use a picture-word interference task in German in which subjects were asked to describe pictured events that involve two participants, an Actor and an Undergoer (e.g., a picture that can be described by saying 'a man is filling a bucket'). The descriptions thus required production of transitive clauses. Subjects produced clauses as completions of lead-in fragments that either required responses to be verb second word order (VSO) or that induced verb final (i.e., subordinate clause) word order (SOV). Before picture presentation, subjects saw words semantically related or unrelated to the verb describing the pictured event. Semantically related words should cause onset latencies for sentences if the initiation of sentence articulation must be preceded by verb lemma access, a semantic interference effect (Roelofs 1993). Schriefers et al. found semantic interference when the verb was initial in the clause, but no interference effect when the verb was final in the clause. The lack of an interference effect in SOV clauses suggests that German speakers can begin clause articulation before the verb's lemma has been accessed, and hence the verb is not obligatorily a part of advanced planning at the clause level. On the basis of these results, Schriefers et al. propose a *dual route* model allowing either conceptual (pre-lexical) information or lexical information to serve as input to frame computation.

Lexically guided models are sufficient to account for sentence-level functional frame construction and function assignment, but are the assumptions of lexical guidance necessary? Specifically, is there error evidence that lemma access must always precede frame creation or, alternatively, is there evidence that frame creation may sometimes be possible before lemma access, as in a dual route model? Identifying errors that result from failures of proper frame computation can be guided by an examination of the relationship between the grammatical class of an error word and the class of the target word (and source word) in lexical errors. The

similarity in grammatical class, together with the tendency for errors to accommodate to the grammatical environment of their locus, is often stated in terms of a constraint

5.2 GRAMMATICAL CONSTRAINTS AND FUNCTIONAL PROCESSING.

The computation of a functional frame is accomplished during functional processing. A functional level of processing was proposed based on the strong tendency for exchanged whole words to have similar functional roles in the utterance. That is, the functional roles of exchanged whole words tend to be of the same grammatical class and play similar roles in a phrase or clause, in particular as heads of arguments or adjuncts (Garrett 1975, 1976). Because interaction of words in exchanges involves functional relations, these errors implicate processing that is sensitive to functional roles. The observation that the grammatical class of the target and error words involved in exchanges are predominantly the same has also been made for the errors and targets in form substitutions (Fay & Cutler 1977), for form and semantic substitutions (Bell & Raymond 1997; Raymond & Bell 1998), and for blends (Stemberger 1985). In chapter 4, we saw that errors and targets tend to be of the same class in semantic displacements as well. All of these error subtypes, then, can be inferred to be errors that occur no later than the functional processing stage.

Garrett points out that the one subtype in which lexical errors are NOT predominantly of the same grammatical class is the combined form errors. The difference between combined form errors and whole word exchanges is one property that prompted Garrett to propose a positional processing level distinct from the functional level. Combined form errors are explained as failures in positional processing, when functional relations are no longer at issue.

Most models assume that the origin of the grammatical class constraint on replacements is imposed at lemma integration by the syntactic frame. Stemberger 1985 proposes that "a useful way to account for the syntactic category constraint is to posit the existence of syntactic conditions on the slots of the sentence." (p. 161). Levelt 1989 similarly speculates that a match in grammatical class between error and target "...is what one would expect if the insertion of the lemma in the developing surface structure were to require a fitting syntactic category" (p. 222). In other words, the grammatical class constraint is imposed by the syntactic frame at a late stage in functional processing when lemmas are integrated with slots in the syntactic frame.

Given the disjunctive characterization of functional role in terms of grammatical class or phrasal role, an extension of Garrett's method of identifying error subtypes with processing stages will be pursued. A deeper understanding of the grammatical class constraint can help in this regard by identifying where Garrett's observation about the grammatical class constraint holds, and where a more restricted constraint on functional dependencies is observed.

5.2.1 EXPLORING GRAMMATICAL CONSTRAINTS. The relationships that hold in the data between the grammatical properties of error words in replacements and the grammatical properties their targets and sources were examined. Three questions were pursued: (1) Over what subtypes of errors can a grammatical class constraint can be generalized? (2) Does the constraint holds between errors and targets, errors and sources, or both? and (3) Is the grammatical class constraint sufficient for describing error phenomena, or can it be made more specific by extending it to a constraint on grammatical subclasses defined by the functional dependencies of words, as reflected in their subcategorization requirements? The results of the analyses are presented in this section.

The grammatical constraint in lexical replacements. Errors and targets are very likely to be of the same grammatical class for replacements.⁸ The proportion of error-target pairs of the same grammatical class in all replacements (i.e., displacements and substitutions) is .80. Errors and targets are also likely to be of the same class in the major replacement subtypes of simple (anticipatory or perseveratory) displacements, exchanges (i.e., complex displacements), and substitutions. Table 5.1 summarizes the numbers of error-target pairs in which the grammatical class of error and target are the same and different by replacement subtype.

TABLE 5.1. Numbers of error-target pairs of the same and different grammatical class for three replacement subtypes.

Error-target	Replacement subtype		
	Simple displacements	Exchanges (complex displacements)	Substitutions
Same class	70	54	184
Different class	15	21	34
TOTAL	85	75	218

The numbers reported in Table 5.1 combine the numbers for whole word and combined form replacements. Recall that combined form errors involve accommodation of errors to target morphology (e.g., "that's why they sell the *cheaps drink*"). Table 5.2 summarizes the numbers of error-target pairs in which the grammatical class of error and target are the same and different by replacement subtype for whole word replacements only.

TABLE 5.2. Numbers of whole word error-target pairs of the same and different grammatical class in two replacement subtypes.

Error-target	Replacement subtype	
	Simple displacements	Exchanges (complex displacements)
Same class	56	45
Different class	11	6
TOTAL	67	51

The proportion of whole word repetition exchanges of the same class (.88) is close to the proportion reported by Garrett 1975 for whole word (repetition) exchanges (reported as .90; Garrett 1975, p. 149, Table III). As in the Garrett study, the numbers reported for exchanges

⁸ I am assuming at this time that there is an independent effect of grammatical class similarity that is not explained by semantic relatedness. Note that the constraint on grammatical class holds in form substitutions and contextual displacements, in which there is little semantic similarity between errors and their targets.

include only the exchanges in which error and target are separated by more than one word because of the ambiguity between exchange and movement when the interacting words are adjacent.

There is only one subtype in which form class similarity does not predominate, and it is, as in Garrett's data, the combined form exchanges. Table 5.3 summarizes the numbers of error-target pairs in which the grammatical class is the same and different for combined form exchanges in each subtype. The proportion of error-target pairs of the same class in combined form exchanges is only .38. A comparison of combined form exchanges and whole word exchanges indicates that they differ with respect to the grammatical class constraint ($\chi^2(1, N=75) = 20.83, p < .001$).

TABLE 5.3. Numbers of combined form error-target pairs of the same and different grammatical class in two replacement subtypes.

Error-target	Replacement subtype	
	Simple displacements	Exchanges (complex displacements)
Same class	14	9
Different class	4	15
Total	18	24

However, combined form displacements involving only one error site (anticipations and perseverations together) do tend to be of the same class. The proportion of the single error displacements in which targets and errors are the same class is .76. A comparison of combined form anticipations and perseverations to whole word anticipations and perseverations is consistent with the hypothesis that the two subtypes do not differ with respect to the grammatical class constraint ($\chi^2(1, N=84) = .428, p = .49$).

The results show that the grammatical class of error words and their targets tend to be the same in replacements overall, as well as in the subtypes of substitutions, combined form and whole word displacements, and whole word exchanges. Only combined form exchanges show a tendency for errors and targets to be of different grammatical classes, as noted by Garrett (1975, 1976).

Errors, targets, and sources. We can compare the relative contributions of target and source to the grammatical class of the error by looking at the grammatical classes of error-source pairs in simple displacements, and by considering accommodation and stranding facts for these errors.⁹ Table 5.4 summarizes the numbers of error-source matches in grammatical class by displacement subtype.

⁹ For these comparisons, exchanges and substitutions are not considered because of overlaps in these errors of targets and sources.

TABLE 5.4. Numbers of simple displacements with error-source matches by replacement subtype.

Error-source	Simple displacement subtypes	
	Repetition displacements	Noncontextual displacements
Same class	34	25
Different class	5	22
TOTAL	39	47

For displacements as a whole (both simple displacements and exchanges), in which by definition target and source are separate elements, the proportion of errors and targets that are of the same grammatical class is .75 (cf. Table 5.1). For all displacements, the proportion of errors and sources that are from the same class is .87. However, the subtype of all displacements includes repetition displacements, in which the error and source are the same stem, and so very likely of the same class (unless the stem accommodates to the derivational morphology of the target, which does sometimes happen, e.g., *I didn't fold out – throw out any folders*). Indeed, error-source pairs in repetition displacements do tend to be of the same grammatical class, and the proportions of error-target and error-source matches are similar for repetition displacements (.77 for error-target matches and .87 for error-source matches). A comparison of error-target and error-source match for repetition displacements is consistent with the hypothesis that repetition displacements are not different in their behavior with respect to the tendencies of error-source pairs and error-target pairs to be the same ($\chi^2(1, N=78) = 1.39, p>.20$).

Considering noncontextual displacements allows us to separate the class of the source from the class of the error. In the noncontextual displacements, the proportion of error-target matches is .85, while the proportion of error-source matches is reduced to .53, even though morphological accommodation is possible in these errors as well as in repetition displacements. We saw in chapter 4 that noncontextual displacements do not differ from repetition displacements with respect to the tendency for errors and targets to be of the same grammatical class. A comparison of error-source pair matches in repetition and noncontextual displacements show that they do differ in their tendency for errors and sources to be of the same grammatical class, reflecting fewer matches in the noncontextual displacements ($\chi^2(1, N=86) = 11.3, p<.001$).

The inflectional morphology of the target in displacements is almost always maintained, and morphology is rarely carried over from the source, even if the grammatical class of error and target differ. There are 13 cases of stranding or accommodation of morphology, and four cases in which there is either a failure to accommodate to the morphology of the target or failure to strand morphology of the source when morphology is present on target or source. The difference is significant by a sign test ($p=.018$).

The results show that for all displacements as well as for simple repetition displacements the grammatical class of errors and their sources tend to be the same. Only noncontextual displacements do not exhibit a tendency for errors and sources to be of the same grammatical class. Also, displacements are more likely to exhibit stranding of source morphology and accommodation to target morphology than not to strand or accommodate.

Grammatical class and functional dependencies. In pursuing a differential effect of grammatical class and functional dependencies in errors, we can ask whether errors in which the functional dependencies of error words are violated, or in which the error word is incompatible with the error frame, behave differently than errors in which the functional dependencies of the error word are met and the error word is compatible with the error frame. Since there is a difference in the strength of the grammatical class constraint in error-source pairs and error-target pairs, we control for the difference by considering only substitutions, in which source and target are the same word. Substitution errors are taken from the corpus and BR97 (Bell & Raymond 1997). Because the similarity in grammatical class of the error word and the target word is a strong indication that the error originated during functional processing, we consider only substitutions in which the grammatical class of error and target are the same. Finally, to limit attention to functional dependencies in the clause, we consider only verb substitutions.

If functional dependencies play a role in some subset of the substitutions, then we would expect a difference in compatibility with the functional dependencies of the clause between errors and their targets. How do we identify targets in error utterances? In 5.1, it was possible to propose a "target" word that is compatible with the error frame (*suggest*). However, there is no evidence, other than the compatibility and an inexact semantic appropriateness, that the target was intended by the speaker. We noted in chapter 3 that one indicator of the speaker's intention is found in speaker corrections. If we limit the analysis only to substitutions with speaker self-corrections, we may take the "target" to be the verb produced in the correction.

There are two ways in which speakers may self-correct. Corrections may contain either a repetition of the error verb, with a concomitant change in the utterance's functional frame, or they may contain some different verb. Compatibility of the error with the frame is logically independent of the correction method. For example, in 5.4a, the error *write* is compatible with the error frame, and the correction changes the verb to *read*. In 5.4b, an error that is incompatible with its frame, *die*, is corrected by changing the verb to *kill*. In 5.4c, an error containing the predicate *learn* is corrected by changing the frame. The predicate in the correction, *learn*, is of course still incompatible with the error frame. There are no examples of errors in the corpus or BR97 in which the error is compatible with the error frame and a correction involves changing the frame, although this type is possible. However, errors like the one in 5.4d may be candidates for this type of correction, in 5.4d by changing the frame to *not to encourage*.

- (5.4) a. it's not as though I haven't writ-[ten] – read lots of English stuff
 b. up to six men may have been died – killed
 c. these types of research should learn us – should allow us to learn...
 d. to encourage – discourage hate speech (cf. 'not to encourage')

A comparison was made of the compatibility of error frames in verb substitutions with the error predicate and with the speaker target, as identified in speaker corrections. Only semantic verb substitutions for which a speaker correction was recorded are included in the comparison. The data consisted of all semantic verb substitutions in the corpus and BR97. A summary of the numbers of corrections compatible with the error frame by numbers of error verbs compatible with error frames is found in Table 5.5. A comparison of the compatibility of errors and targets in the error frame reveals that the two subtypes differ with respect to frame compatibility ($\chi^2(1, N=45) = 19.9, p < .001$).

TABLE 5.5. Numbers of errors and targets in verb substitutions compatible with the error frame.

Target compatibility with frame	Error compatibility with frame	
	Compatible	Incompatible
Compatible	23	9
Incompatible	0	13
TOTAL	23	21

The results show that the compatibility of errors and targets in verb substitutions is correlated, allowing us to identify two subtypes of verb substitutions. Error verbs incompatible with their error frame are correlated with a change of frame in speaker self-corrections; error verbs compatible with their frames are correlated with a verb change in speaker self-corrections.

5.2.2 DISCUSSION: GRAMMATICAL DEPENDENCIES. A functional level of processing was proposed by Garrett (1976) based on a stronger tendency for the words involved in whole word exchanges to be of the same grammatical class than the words involved in combined form errors. A difference between combined form and whole word exchanges is found in this corpus as well, with combined form errors violating the grammatical class constraint between errors and targets that is largely observed by other displacement subtypes. Combined form errors can thus be eliminated as a source of data appropriate for an investigation of frame computation.

Two results argue that the grammatical class of the target imposes a greater influence on the grammatical class of an error than does the grammatical class of the source in displacement errors. First, there is a strong similarity in grammatical class between errors and their targets, regardless of the error subtype. The correspondence in class between errors and sources is weaker than between errors and targets when targets and sources are not the same word, in the noncontextual displacements. Second, there is a preference for accommodation of an error to the morphology of its target, and carrying over the morphology of the source is rare. The conclusion that the grammatical class of the target makes a stronger contribution to the grammatical class of the error than the grammatical class of the source supports the notion that the grammatical class of the error is imposed in some way by the syntactic frame, and is not as strongly determined by the domain of the source word.

Within a subtype of substitutions with errors, target, and sources of the same grammatical class, so that frame requirements have been met, there are two subtypes that behave differently with respect to speaker corrections. Errors incompatible with their functional frames behave differently with respect to correction than do errors compatible with their frames. The implication is that there are two subtypes of errors, one occurring at a later stage of processing during lemma integration and sensitive only to the grammatical class constraint, and another occurring earlier during the establishment of the functional frame and sensitive, as a consequence, to functional dependencies in the clause. The errors with incompatible frames are members of the subtype of sentence pattern errors identified in §3.2.2. We now turn to a clarification of this subtype.

5.3 IDENTIFYING SENTENCE PATTERN ERRORS.

Error data in which frame computation has failed could be used to investigate the processes of frame computation, if such data could be found. Logically, a failure of frame computation that does not involve the failure of any other functional process would result in the production of an impossible combination of functions, or in a possible function set that cannot be used to correctly encode the message as lexicalized. Error data of the second kind, in which a legal combination of functions is incompatible with the constituents computed to convey the message, are identified in this section.

The prototypical members of the subtype were discussed in the previous section. They are verb substitutions involving violations of functional dependencies of the verb in a clause. Criteria for identifying sentence frame computation failures of this kind will be developed. This subset will be recognized to crosscut substitutions and other lexical error subclasses.

5.3.1 GRAMMATICAL AND CONTEXTUAL CRITERIA. Limiting ourselves to a survey of substitution errors, can we be more specific about what properties are shared by the error word and the target it replaces and what properties are not shared? The substitutions in 5.5, 5.6, and 5.7 all observe the grammatical class constraint between error and target. However, if we compare the errors in 5.5 to the errors in 5.6 and 5.7, we see that the substitutions in 5.5 maintain the syntactic integrity of the utterance, rendering it only semantically inappropriate to convey the intended message. That is, all lexical dependencies between the error word and its context in 5.5 are satisfied because the error and target words only differ in their lexical semantics in aspects that are not syntactically relevant, although they are very relevant to utterance meaning. Syntactic appropriateness holds in the substitutions in 5.5 independent of whether error and source (the target word, in these substitutions) have a semantic relation (5.5,d) or form relation (5.5,b). Lexical semantic association or similarity in lexical form between error and target captures the error domain in the errors in 5.5. Thus the traditional characterization of these errors as lexical replacements is appropriate.

- (5.5) a. *type* it on the book (for 'tape it on the book')
- b. that would *prevent* – present a lot of problems
- c. I would have *gone* (for 'I would have come')
- d. a complete new *library* – not library, what do you call it? A wardrobe

On the other hand, the substitutions in 5.6 and 5.7 are contextually appropriate for the utterance (based on the recorded context and corroborated by the larger discourse context in which the errors occurred, when that is known), but they result in an utterance that is syntactically ill-formed for various reasons to be discussed. Conceptual appropriateness does not translate into the clear types of semantic association that characterize semantic substitutions, like those in 5.5. In addition, unlike the apparent independence in the lexical substitution errors in 5.5 of syntactic appropriateness and error-source relational type, none of the errors in 5.6 and 5.7 can be categorized as solely form-based. This observation holds for all of the errors of this type in the corpus, although it is the case that some of them have form-based similarities with their targets in addition to being contextually appropriate (5.6a,b).

- (5.6) a. a comet *hitting* for Earth (for 'a comet heading for Earth')
 b. you are *committed* of a murder (for 'you are convicted of a murder')
- (5.7) a. when did we have *chance*? (for 'when did we have time')
 b. they *devoted* their entire lives *on* something (for 'they devoted their entire lives to something' or 'they spent their entire lives on something')

There is an important difference between the errors in 5.6 and the errors in 5.7 that can be made explicit by considering how the errors in 5.6 and 5.7 are syntactically ill-formed. Syntactic ill-formedness in the errors in 5.6 can be defined in terms of the encoding of intended functional relations in the message using grammatical relations that are inappropriate in combination with the error lexeme. In 5.6a, the utterance's intended Patient argument *Earth* is obliquely encoded in a PP headed by *for*, and not as a direct object, as required by the subcategorization frame of *hit*. Similarly, in 5.6b, the Theme argument *a murder* is encoded in a PP headed by *of*, and not as a direct object, as required by *commit*. The encoding requirement for a Theme participant holds regardless of whether *commit* is used in a passive construction (as in 5.6b) or an active construction. However, the intended Agent argument *you* cannot appear as the subject of the passive, as it does in 5.6b.

Syntactic ill-formedness in the errors in 5.7 occurs as the result of violations of wholly formal encoding requirements. The grammatical relations and functional roles in these errors are correct. In 5.7a, the singular count noun *chance* is correctly the head of its NP, but it must occur with an article. That is, the definiteness of the error *chance* must be explicitly encoded. In 5.7b, the Recipient argument something is obliquely encoded, but the PP is introduced by *on* rather than *to*, as required by *devote*. In both cases, the functional relation of the error word to the utterance does not depend on the encoding failure.

In what sense can we say that the substitutions in 5.6 and 5.7 are contextually appropriate? In each case in 5.6, the functional content of the intended message can be conveyed using the error word but changing the functional plan to be appropriate for grammatical encoding of the arguments. The participants denoted in 5.6a,b could appear as thematic arguments of the error verbs by changing the sentence frame produced, as the rephrasings in 5.8a,b show. The substitution in 5.7a would be appropriate in the context if an NP frame appropriate for a singular count noun were used, such as *chance* (5.9a). The substitution in 5.7b would be appropriate if *on* were changed to *to* (5.9b). Contextual appropriateness of the error word can thus be defined as the ability to use the error word in an utterance reformulated to encode the same message (or a closely allied message, as determined by the utterance context) using a different functional plan.

- (5.8) a. a comet hitting the Earth
 b. you are convicted of a murder

- (5.9) a. when did we have a chance?
 b. they devoted their entire lives to something

5.3.2 EXTENDING THE CLASS. The criteria of contextual appropriateness without semantic association and of functional inappropriateness allow us to define a subset of lexical substitutions involving verbs. The errors in 5.6 and 5.7 are examples of this subset. Other examples are not

unusual among substitutions, although corpora do not normally contain many, probably because of collection bias toward recognized subtypes. The verb substitution errors in this subset will be referred to as sentence pattern errors. The subtype can be extended from this core set.

It is not necessary to limit sentence pattern errors to verb substitutions. Errors that can be classified as lexical substitutions of other argument-taking words may also be errors in which there is a mismatch between a word and the functional plan used to encode its arguments. The examples in 5.10 are adjective substitutions resulting in a functional mismatch.

- (5.10) a. it's not *sure* to me - clear to me... (or 'I'm not sure...')
 b. whatever you like is *best* with me (for 'best' or 'fine with me')

Noun phrases with arguments are less common, but the corpus contains one example of a sentence pattern error involving a noun and its arguments in the NP (5.11).

- (5.11) but Faulkner's *perception* in Britain... (for 'the perception of Faulkner (by people) in Britain', not 'the perception by Faulkner (of X) in Britain')

The example in 5.11 poses a problem for an explanation of sentence pattern errors as lexical substitutions. There is no easily identifiable alternative target for this error. That is, no word that is a semantic relative of *perception* could be substituted for it in this utterance with the result that the utterance would be syntactically correct and convey the speaker's intended meaning. In fact, *perception*, appears to be the only possible argument taking word semantically appropriate for the context.

Example 5.11 is not an isolated instance of this phenomenon. Examples that involve verbs can be found in the corpus. In 5.12a, *finish* is used inchoatively, although this construction is not possible with a non-process subject. To convey the meaning of 5.12a, a passive construction could have been used (*I think Dykstra was finished...*), so that the lemma of *finish* may have been the source of the frame produced. Alternatively, another verb like *went up* is compatible with this context, although there is no indication from the speaker or the broader context of the error that this verb was intended or active.

- (5.12) a. I think Dykstra *fin*-[ished] - they finished the Dykstra in ninety-one or so
 b. that guy got over to *pass* me (for 'that guy got over to let me pass')

Finally, there are examples in which different argument configurations require derivationally related forms of the same stem, e.g., the errors in 5.13. While the error in 5.13a could be an error of stress as the result of two related forms, this begs the question of why the alternate forms were activated.

- (100) a. it isn't that she *súspect*s us - suspects us (or 'that we're *súspect*')
 b. for a president, there are *limited* - there are limits to the... (or 'a president is limited to...')

What the errors in 5.11, 5.12, and 5.13 have in common with the sentence pattern errors identifiable as substitutions is that the locus of the error is a word. However, an important generalization can be made over the errors in 5.6 and 5.10-13: an argument taking word in each

error appears in a functional frame that is incompatible with its constituency requirements. The errors in 5.12 suggest that the incompatibility is not the result of a lexicalization failure that resulted in the substitution of an unintended word for the intended one. In all of the errors in 5.6 and 5.10-5.13, lexicalization of the arguments and the predicate appear to be semantically and pragmatically appropriate for conveying the intended message.

The properties of the errors cited suggest that sentence pattern errors are failures to compute a functional frame that can correctly encode the predicate and its arguments as they have been lexicalized. Properties of this subtype were explored to provide evidence for an analysis of the source of input to frame computation.

5.4 PROPERTIES OF SENTENCE PATTERN ERRORS.

The corpus contains 71 errors that have been classified as sentence pattern errors using the criteria defined in the preceding section. Table 5.6 summarizes numbers of sentence pattern errors by grammatical class of error and target.

The proportion of sentence pattern errors in which the error and target are both verbs is .82, accounting for the vast majority of the errors in sentence frame computation in the corpus. The proportion of errors in which error and target are adjectives is .10. Only one error in the corpus involved the incompatibility of a noun with its arguments (see 5.11).

TABLE 5.6. Numbers of sentence pattern errors by error and target word class.

Target class	Error Class		
	Verb	Adjective	Noun
Verb	58	1	1
Adjective		7	
Noun	2	1	1
TOTAL	60	9	2

In a small proportion of sentence pattern errors (.05), the grammatical class of the error word was different from the grammatical class of the target word (e.g., 5.14). In comparison, there is a larger proportion (.16) of substitutions in which the error and target are of different grammatical class. The difference does not reach significance, however ($\chi^2(1, N=289) = 3.36$, $p = .067$).

(5.14) he gave a *speak* for his foundation ('was asked to speak' or 'gave a speech')

The sentence pattern errors will be the subject of two investigations. The first investigation looks for evidence bearing on the question of lemma access in frame computation. Lexical guidance entails that for all errors a lexical source should be identifiable as the source of the error frame. Three properties of sentence pattern errors were examined to test this hypothesis: (1) the pattern of speaker corrections in restarts; (2) contextually identifiable lemma sources for

the functional frame produced; and (3) the distribution of semantic relations between errors and contextually identifiable targets.

The second investigation looks for evidence that some non-lexical information may be used to compute functional frames. Conceptual guidance, the alternative to lexical guidance, proposes that frames can be created using conceptual information in the message. If the frames produced in sentence pattern errors are created using conceptual guidance, then error frames should show the influence of semantic, thematic, cognitive, or discourse-pragmatic factors that are independent of specific lexical items. The effect of these factors should be greater on the frames produced in the errors than on frames compatible with the error predicates. To test this hypothesis, three properties of participant encoding in sentence pattern error frames were investigated: (1) the encoding of underspecified or contextually predictable participants; (2) the encoding of cognitively accessible participants; and (3) participant encoding as a function of animacy. A further test of the effect of conceptual properties on frame computations involves the investigation of the valences of error and target frames.

5.4.1 SPEAKER RESTARTS. The proportion of sentence pattern errors for which restarts containing error corrections have been recorded is .31 (22/71). Error restarts can correct sentence frame errors in two ways: (1) a restart can reuse the original predicate, changing the frame in which it is used to be compatible with it; or (2) a restart can substitute another predicate for the original predicate, leaving the functional frame unchanged. When an error does not contain a restart with a change of predicate, it may or may not have a contextually identifiable target to which the predicate could be changed to effect a correction. The results of a comparison of correction method by target identifiability are summarized in Table 5.7.

The proportion of restarts in which the speaker changes the functional frame to accommodate the predicate of the error is .59. This proportion is not substantially different from the proportion of errors in which the restart changes the predicate (.41). The numbers of restarts changing frame and changing predicate are not significantly different by a sign test ($p=.12$; a difference of 6 and 16 would be needed for significance). In five errors, a restart changed the frame to accommodate the predicate of the errors and there is no target that can be identified from the context to which the predicate could have been changed.

TABLE 5.7. Number of sentence pattern errors
by correction method and identifiability of target from speaker restarts.

Indentifiability of target	Correction method	
	Restart changes frame	Restart changes predicate
Identifiable	8	9
Not identifiable	5	0
TOTAL	13	9

The results show that speakers are as likely to change the frame of a sentence pattern error as they are to change the predicate in self-corrections.

5.4.2 LEMMA SOURCES OF FRAME COMPUTATION. Two lemmas are possible frame sources in sentence pattern errors, the error predicate and a contextually identifiable target. A lemma may

be the source of a frame if it is functionally compatible with the frame. Targets will, by definition, be compatible with the error frame when they can be identified. Table 5.8 summarizes the number of error frames compatible with error predicate by identifiability of a target predicate in sentence pattern errors.

A large number of sentence pattern errors have target predicates that are identifiable using the criteria used to establish targets in lexical substitutions (see §3.2 for a discussion of this issue). Unlike in §5.4.1, targets were not identified only from speaker self-corrections. The proportion of sentence pattern errors with an identifiable target is .72 (52/71). About half of the error frames are compatible with the error predicate. The proportion of sentence pattern errors in which the functional frame is compatible with the error predicate is .42 (30/71). The proportion of sentence pattern errors in which the error predicate is compatible with the error frame and there is also an identifiable target is .25. In a small portion of the errors, there is no identifiable frame source. The proportion of sentence pattern errors in which the frame is not compatible with the error predicate and there is no identifiable target that could serve as frame source is .10.

TABLE 5.8. Number of sentence pattern errors by compatibility of error predicate with error frame and identifiability of target.

Identifiability of target predicate	Compatibility of error predicate with error frame	
	Compatible	Incompatible
Identifiable	18	34
Not identifiable	12	7
TOTAL	30	41

A comparison of frame compatibility to identifiability of a target predicate shows that error predicate incompatible with their frames are more likely to have an identifiable target than error predicates that are compatible with their frames ($\chi^2(1, N=71) = 4.64, p=.031$).

The results suggest that the error word and an identifiable target word together can account for most of the error frames. However, in a small proportion of the cases, neither the error predicate or an identifiable target predicate can be the source of the error frame.

5.4.3 SEMANTIC RELATIONS. The predicates produced in sentence pattern errors are all contextually appropriate, by definition of the subtype. We can characterize the semantic relation between the predicate produced in an error and the target predicate in the subset of 46 sentence pattern errors for which identification of a target predicate is possible from the context. The six semantic relations used to compare semantic displacements, semantic blends, and semantic substitutions in chapter 4 were used to compare semantic relations between errors and targets in sentence pattern errors following the same procedure used in chapter 4.

The results of the semantic analysis are shown in Figure 5.1. Sentence pattern errors are characterized by a large proportion of synonyms (.48), hierarchical relatives (.22), and co-hyponyms (.17). There were no errors and targets that were domain coordinates. The proportions of opposites (.09) and syntagmatic relatives (.04) were low. The profile of sentence pattern errors is different from the profiles of the errors of lemmatization (substitutions) and similar to the errors of function assignment (semantic blends and displacements).

As in the comparisons of semantic displacements, semantic blends, and semantic substitutions in chapter 4, the numbers of examples in several of the categories are too small to allow a comparison of the profiles. As in §4.3.4, a comparison of syntagmatic relatives to a conflation of the other five categories reveals that blends and sentence pattern errors do differ on this category. The explanation for this result is most likely again that the semantic displacements occupy different frame slots and are their errors and targets are more likely to be of different grammatical classes, increasing the number of syntagmatic relatives, which is the most appropriate category for semantically related words from different grammatical categories.

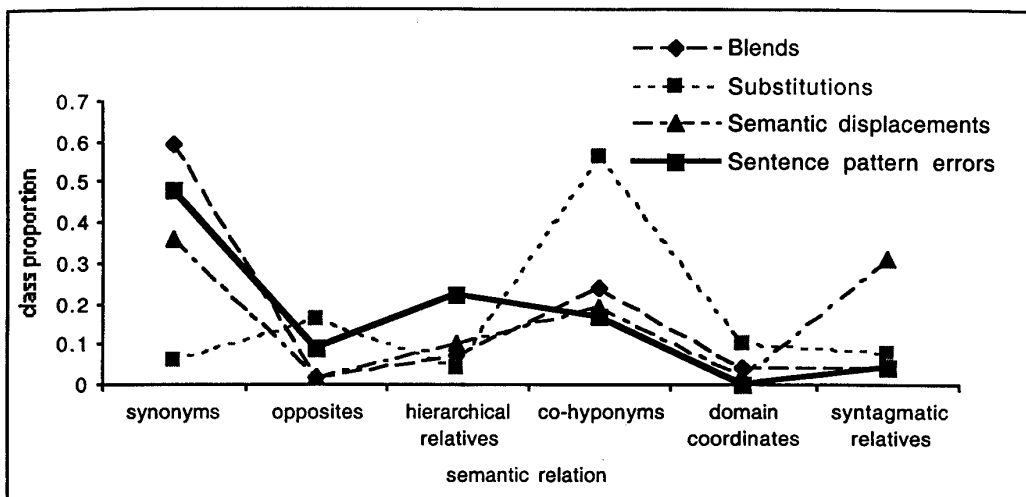


FIGURE 5.1. Distribution of semantic relations for four semantic subtypes.

We can once again conflate synonyms, dominance relations, and syntagms in one group (of generally contextually appropriate relations) and opposites, co-hyponyms, and domain coordinates in another (of generally contextually inappropriate relations) for comparison. A comparison of sentence pattern errors with semantic substitutions shows that these error subtypes are significantly different ($\chi^2(1, N=84) = 28.84, p=.001$). A comparison of sentence pattern errors with semantic displacements is consistent with the hypothesis that the subtypes do not differ in their semantic profiles. ($\chi^2(1, N=84) = .065, p>.70$).

The results show that sentence pattern errors do not pattern with semantic substitutions with respect to the semantic relations between error words and target words. However, the semantic relations seen in sentence pattern error target-error pairs are the same as the relations found in semantic displacements, and hence the same as in semantic blends.

5.4.4 PARTICIPANT ENCODING. Table 5.9 summarizes the results of the comparisons of participant encodings in error and target frames. The target frames were identified from contextual cues, and not necessarily from speaker self-corrections.

Situation participants that are underspecified (e.g., the indefinite pronoun *something* in 5.15a) or predictable (e.g., the first person pronoun *I* in 5.15b) tend not to be encoded in error frames. Considering only the error-target frame pairs in which participant sets differ, the

proportion of error frames that fail to encode a predictable or underspecified participant is .75. The difference is significant by a sign test ($p=.05$).

TABLE 5.9. Encoding of three participant categories in error and target frames.

Participant category	Frame		
	Error frame only	Target frame only	No difference
Suppression of predictable participants	12	4	55
Promotion of accessible participants	26	29	16
Promotion of more animate participants	11	5	55

- (5.15) a. I want to *say* to you about X (cf. 'I want to *say* [something] to you about X')
 b. it's *glad* that you've marshalled your evidence (cf. *I'm glad...*)

Error frames also tend to promote more animate participants to higher grammatical functions than less animate participants in the same frame (e.g., *I* over *Fishman's definitions* in 5.16). Animacy is ranked by encoding form and class of referent (1st, 2nd person pronouns > 3rd person pronouns > human referring expressions > non-human animate referring expressions > inanimate referring expressions). The proportion of error frames in which a more animate participant is encoded with a higher grammatical function than a less animate participant is .69. This factor is not significant by a sign test, however.

- (5.16) *I'm very strange* about Fishman's definitions (cf. 'Fishman's definitions are very *strange* [to me]')

There does not appear to be any difference between error frames and target frames in the encoding of accessible participants.

The results indicate that error frames are likely to suppress the encoding of predictable participants. We can tentitively conclude from the numbers that errors tend to promote more animate participants to higher grammatical functions in the clause with respect to their target frames, although confirmation from additional examples is desirable. There is no indication of a difference between sentence pattern error frames and their target frames in the encoding of accessible participants.

5.4.5 FRAME VALENCES. The valences of error frames and target frames were compared. The results are summarized in Table 5.10. Frame valence is defined as the number of argument participants encoded in the frame. Intransitive verbs and passive frames have valence 1. A transitive verb, with subject and object expressed, has valence 2. The proportion of the valences of error frames that are less than or equal to the valence of the target frame is .82.

TABLE 5.10. Valences of error and target frames.

	Relation of error valence to target valence		
	Error < Target	Error > Target	Error = Target
Number of errors	39	12	16

The results indicate that error frames tend to be of a valence lower than or equal to the valence of their targets.

5.5 ANALYSIS AND MODEL IMPLICATIONS.

Sentence pattern errors provide evidence that allows us to compare the explanatory adequacy of two competing theories of frame computation, lexical guidance and conceptual guidance. It is assumed that lexical guidance of sentence frame computation is possible. At issue is whether conceptual guidance is an alternative method by which a sentence frame may be computed. If lexical guidance is obligatory, then frame computation in sentence pattern errors entails multiple lemma access or multiple frame access from a single lemma. If it is not obligatory, then there should be evidence for frame computation without lemma access. Complementing this, if conceptual guidance is an alternative method of frame computation, then it should be possible to identify a potential input to frame computation in the conceptual domain.

5.5.1 THE CASE AGAINST OBLIGATORY LEXICAL GUIDANCE. Self-corrections in restarts following sentence pattern errors provide evidence that the speaker was no more likely to correct a sentence pattern error by changing the predicate (5.17a) than by changing the functional frame (5.17b). However, in a proportion of cases involving frame changes (.38), there is no identifiable target (5.18), suggesting that only the error predicate's lemma was selected. Taken together, the corrections give evidence for multiple lemma access in under half of the sentence pattern errors in which a restart is recorded. In other words, in over half of the errors with corrections, there is no explicit evidence for multiple lemma access, and in a proportion of these errors there is implicit evidence that only the error predicate was selected.

- (5.17) a. it's not *sure* to me – clear to me
 b. these types of research should *learn* us – should allow us to learn

- (5.18) I think Dykstra *fin-* [ished] - they finished the Dykstra in ninety-one or so

If a frame is computed on the basis of lemma access, then there are two clear candidates in sentence pattern errors for what predicate lemma serves as the source of the information used to compute the error frame. The first possibility is that the frame was computed from some contextually appropriate predicate that can be reconstructed as the target of a lexical substitution. However, there may be no identifiable target for the error. The second possibility is that the frame was computed from the lemma of the predicate produced in the error, although that frame is inappropriate for conveying the intended message. However, the frame produced may never be compatible with the error predicate. In a small proportion of cases (.10), there is no identifiable source for the error frame (5.19).

- (5.19) a. that guy got over to *pass* me (for 'that guy got over to let me pass')
 b. I can't be *done* that to (for 'NP can't do that to me')

The semantic profile of the relations between errors and targets in the sentence pattern errors indicates that these errors are like semantic blends and displacements. This similarity suggests that sentence pattern errors are, as a class, instances of multiple lemma access. The conclusion is compatible with a model in which lexical guidance is a possible, perhaps the usual method of frame computation, and in which lexical guidance accounts for most of the errors in which a predicate is paired with an incompatible functional frame. However, in a proportion of the data there is no explicit evidence of multiple predicate lemma access, and in another proportion of the data there is no evidence for access of any predicate lemma that could be the frame source. Taken together, the findings are compatible with lexical guidance, but argue against the necessity of predicate lemma access in frame guidance, supporting a dual route encoding model.

5.5.2 EVIDENCE OF CONCEPTUAL GUIDANCE. Several lines of evidence converge to suggest that functional frames may be computed using pre-lexical information. First, the sentence patterns produced in errors are semantically and pragmatically appropriate to convey the intended message. Second, the encoding of arguments in the errors reflects general discourse-pragmatic tendencies not specific to the lexicalized predicates. In particular, encoding patterns in error frames tend to suppress underspecified or predictable participants, and more animate participants tend to be encoded using higher grammatical functions than less animate participants. Finally, syntactic properties of the error frames suggest that they are computed by minimizing encoding requirements, resulting in the production of error frames with reduced valence compared to frames compatible with the error predicate.

5.6 SUMMARY OF CONCLUSIONS.

The approach taken in this analysis was to look for evidence in the error data for the effects of a processing vocabulary involving functional dependencies that could be separated from processing sensitive to form class. A class of errors was identified, the sentence pattern errors, that have the desired property. Sentence pattern errors involve a mismatch between argument taking words and the constituent patterns that encode their functional plans, described in terms of grammatical relations. These errors exhibit a strong tendency for speakers to self-correct by changing the functional frame of the utterance. This property distinguishes them from substitutions, in which speakers tend to self-correct with a lexical change of the error predicate.

An analysis of sentence pattern errors revealed that the functional frames in many of these errors cannot be viewed as having been projected from some predicate compatible with the frame. There are sentence pattern errors that do not appear to involve a predicate that can serve as the source of the information used to compute the error frame. Under lexical guidance, lemma access is necessary for the computation of a frame. Sentence pattern errors thus argue against the necessity of lexical guidance. However, there is no strong evidence that these errors never involve lemma access in frame creation.

On the other hand, the frames produced in sentence pattern errors are well formed, semantically appropriate for the intended message, and compatible with general discourse-

pragmatic tendencies of argument expression. The functional frames produced reveal a goal on the part of the speaker to minimize the structural content of an utterance. These tendencies suggest that conceptual information available before lemma access can be the basis for frame computation. Taken together, evidence against the necessity of lexical guidance and for the sufficiency of pre-lexical information in establishing a function frame argue for a dual route model of frame computation in which frame computation may be either lexically or conceptually guided.

CHAPTER 6

FUNCTIONAL FRAMES AS PRODUCTION UNITS

How are functional frames computed during functional processing? The question is orthogonal to the issue of when frames are computed, the issue addressed in chapter 5. There we saw some evidence for a dual route model of frame computation at the clause level, meaning that computation of a functional frame may be based either on grammatical information accessed in predicate lemmas or on conceptual information available before lemma access. This chapter considers the type of information that serves as input to computation and the manner in which that information is used in the computation of a frame.

In exploring the manner of frame computation, two views can be contrasted, *incremental* computation and *competitive* selection (see Ferreira 1996). In an incremental model of frame computation, conceptual arguments are identified and assigned to grammatical functions individually, based on a variety of conceptual factors as they become available (Bock 1986, 1987). Function assignment is complete when all conceptual arguments have been functionally encoded. The encoding of a grammatical function is constrained by combinatorial requirements on functional sets and by compatibility of a function set with an argument-taking predicate, but the frame is not determined before assignment begins. In a competitive model, grammatical relations are selected together as a set. On this model, functional plans are production units that can compete for selection. It is also possible that functional frames can be computed both incrementally and non-incrementally, allowing greater production flexibility.

Determining the manner of frame computation rests on the status of functional frames as production units. The principle of Processing Uniformity predicts that when computations are performed on units of any type during the production process, the units are susceptible to failures that characterize other unit types. Consequently, if functional frames are units, they should exhibit a profile of error types that parallels the error profile of other, uncontroversial production units, such as words. If functional frames are not production units but incrementally produced, then production failures in frame computation should reflect a different processing vocabulary, one that applies to the creation of structure at other levels, such as syllabic constituency.

The data examined in this chapter are compatible with the theory that functional frames compete for selection. This conclusion is reached by noting that functional configurations at the sentence level participate in the types of distributional errors that are predicted by processing uniformity to characterize production units, such as words. In particular, the subtype of sentence pattern errors behave like frame substitutions. The conclusion is based on the observation that almost all of the sentence pattern errors are wholly appropriate for at least one argument-taking word in English. It also appears to be possible to identify frame errors in which the interacting units are related in form, and others in which there is a semantic relation between error frame and target frame. In addition, blends of functional frames also occur that are composed of frame fragments consistent with overlapping alternative utterance plans. The overlapping portions are not necessarily phrasal constituents. Finally, there are no examples in the corpus of errors consisting of incoherent collections of grammatical functions. Even sentence pattern errors that are not compatible with any argument-taking word are denotationally appropriate for the context.

In §6.1, I review theoretical views on how speakers generate sentences, and describe two competing models of frame computation. In §6.2, I return to sentence pattern errors and argue

that the error profile of these errors is like the profile found for lexical errors, an uncontroversial production unit. A summary of the conclusions is presented in §6.3.

6.1 SENTENCE GENERATION AND THEORIES OF FRAME COMPUTATION.

Syntactic theories can often be construed as production architectures. One area in which syntactic theory provides alternatives for a theory of production regards which formal objects are taken to be primitives in the grammar and which objects are generated by rule application. Lexical theories of syntax maintain that syntactic structures are generated through projection of the structural requirements of words. Structural generation may be incremental (Bresnan 1982; Chomsky 1981, 1993) or competitive. Constructional approaches to syntax see structure elements as selected from "an inventory of form-meaning-function complexes, in which words are distinguished from grammatical constructions only with regard to their internal complexity" (Michaelis & Lambrecht 1996, p. 216). In constructional accounts then, syntactic structure may be accessed directly from meaning and function, without mediation by lexical items. However, in constructional accounts as well there is variability between theories proposing that functional structures are accessed as wholes (Goldberg 1995) or as smaller units (Kay & Fillmore 1999).

Reflecting the contention among syntactic theories, two alternative theories of frame computation in grammatical encoding have been proposed, an *incremental* model, and a *competitive* model (see Ferreira 1996). The theories as tested in Ferreira 1996 are concerned with the elaboration of syntactic constituency. However, his terminology can be extended to apply to the manner in which functional frames are computed because of the correlation between functional dependencies and constituency.

Many production models have included the notion that encoding is performed incrementally (de Smedt 1996; Kempen & Hoenkamp 1987; Lapointe & Dell 1989). Incremental production can explain the relative fluency with which speakers produce language. It has been observed that fluency is achieved despite the fact that speakers can begin utterances without necessarily knowing how they will end. An incremental production architecture ensures fluency by allowing phrasal constituents to be constructed as the lemmas and function assignments to which they are matched become available (Bock & Levelt 1994).

Some network models allow syntactic structure to be activated much like words and segments (Dell & O'Seaghdha 1994; Stemberger 1985). On these competitive models, structures receive activation from word nodes. Like words, and other production units in the model, grammatical structures are part of the network of stored elements. They are selected when activation reaches a threshold level.

The different proposals about the nature of the information used to compute a set of grammatical relations make different predictions about how the production process may fail. In an incremental model, each functional relation is computed individually. Relation combinations are constrained by mutual compatibility of the functions and their compatibility with a predicate lexeme. Given this process, failure to combine functions correctly may occasionally lead to utterances in which the set of grammatical functions are incompatible with each other. In a competitive model, functional relations are computed as sets. On this model, sets may be incompatible with the lemmas assigned to each function, or they may be incompatible with the predicate. However, the sets should be coherent and mutually compatible.

Ferreira 1996 examines the issue of frame computation in an experimental task. He hypothesizes that frame competition should slow production and increase the likelihood of

errors, while incremental production should facilitate production. On a competitive model of frame computation, the constituent structure needed to encode the arguments of a clause (e.g., NP V NP₁ NP₂ or NP V NP₂ to NP₁ for a di-transitive clause) are selected together as wholes. In incremental production, each constituent is selected as needed when the lemma of its functional head is activated. He found that encoding flexibility decreased production latencies and decreased the likelihood of errors, arguing for incremental production of constituent configurations.

While Ferreira provides evidence for incremental production in an experimental task, it may still be possible that frames are alternatively produced competitively in normal discourse. Evidence may be found in errors involving failures of frame computation, the sentence pattern errors.

6.2 SENTENCE PATTERNS AS PRODUCTION UNITS.

The clearest examples of internally complex production units are words. Lexical errors show how failures to properly access words in production are reflected in production. Failures in lexical processing can produce lexical movement, substitution, and blending. Lexical error profiles, then, can serve as a diagnostic for identifying other production units. Internally complex production units should thus participate in, among other errors, substitutions, displacements, and blends involving structures of the same type to which they are related semantically or formally.

One general approach researchers employing error data have taken in attempting to understand encoding processes has been to look for evidence that supra-word level units are manipulated during production. Efforts to identify production units isomorphic with phrase structure using error data have met with limited success. For example, we found little evidence that phrases undergo function assignment in chapter 4. Fay 1982 analyzes sentence blends (cf. Fromkin 1971). He recognized "substitution blends," equivalent to the *frame substitution errors* identified in the corpus (6.1a), and "splice blends," called *frame blends* in this study (6.1b) (see §3.2.2). Recall that in frame substitutions, like the one in 6.1a, a word from an alternative plan (*each in each of those three*) is substituted for a word in the utterance plan (*all in all three of those*). In frame blends, two contextually equivalent utterances are merged sequentially, like in 6.1b (*they seem to know where the problem is and it seems they know where the problem is*).

- (6.1) a. for each three of those
b. they seem they know where the problem is

Fay 1982 notes that blending sentences of either type generally "...have the same meaning" (p. 163) and involve the interaction of equivalent utterance plans, and this also holds in the corpus used in this study. In his corpus, the interacting plans seem to mainly be of the same structural type, such as NPs, PPs, declarative sentences, or Wh-questions. However, there are examples in Fay's corpus, and in this corpus as well, of interacting utterances of different structural types (6.2). The error in 6.2a involves the blending of a relative clause (*that I'm not conscious of*) and a conjoined VP (*and not conscious of it*). The error in 6.2b is a frame substitution of an adverb (*ready*) and a reduced relative complement VP (*put together*). Examples of this type suggest that frame blends and substitutions do not exclusively involve the interaction of what can be identified as structural constituents, but may also result from the interaction of functional plans.

- (6.2) a. to what extent am I responding to errors that I'm not conscious of it?
 b. Bill's trying to get another abstract ready together

The limited success of finding errors involving syntactic structures makes phrase structure similar to syllabic structure, for which examples of substitutions, blends, and movement are rare. There is abundant evidence for the structural domains of both syntax and syllabic constituency from formal linguistic analysis, and yet both fail to participate in the distributional error types that characterize failures of unit manipulation.

The explanation for the gap in the error evidence may be that syntactic structure is created in the encoding process using lexical and functional information in a way that is parallel to the construction of syllabic frames from segmental and metrical information, as proposed in recent models (cf. Levelt et al. 1999). If this is true, then the processes of constituent and syllabic construction are accomplished using a processing vocabulary that is different from the vocabulary that accomplishes the processes of unit selection, access, and integration with a frame, although processing uniformity still holds in both processing domains.

What evidence is there that functional frames are production units? In chapter 5, I argued that sentence pattern errors should be viewed as failures in the computation of a functional frame, rather than lexical substitutions of the predicate. Evidence came from two sources, the compatibility of the frame with the context and a tendency of speakers to change frames rather than predicates in restarts. If functional frames are production units, then sentence pattern errors should be a specific type of frame computation failure, a failure of frame access. A failure of frame access would result in frame substitutions and blends involving functionally equivalent frames, parallel to the errors that result from word access failures. To find support for this hypothesis, the properties of sentence pattern errors are examined in this section.

6.2.1 FRAME SUBSTITUTIONS. All of the 71 sentence pattern errors involve possible sentence patterns in the sense that their frames are wholly appropriate for SOME predicate in English, even if there is no identifiable "target" predicate. In all sentence pattern errors, the frames are coherent wholes for a target verb, and perhaps overlap with a frame compatible with error verb on the left (as in 6.3a) or the right (as in 6.3b).¹⁰ In some errors, there is no overlap with a frame compatible with the error predicate (e.g., 6.3c). It is sometimes possible to categorize the overlap in more than one way because of uncertainty about the target. However, in these cases the alternative target frames are all compatible with some predicate and fall into one of the three categories described.

- (6.3) a. they tried to *convict* a murder on him ('/ they tried to pin / a murder on him',
 '/they tried to convict / him of a murder')
 b. what would it *do* to keep you in Austin? ('what would it / take to keep you in
 Austin /', 'what could we / do to keep you in Austin /')
 c. ...they were *insisted upon* to do everything ('they were required/relied on to do
 everything'. 'XP insisted upon their doing everything')

¹⁰ Slashes indicate the area of frame overlap.

With respect to error-target similarity, sentence pattern errors in which there is an overlap with a target frame at one end or the other resemble lexical form substitutions. In form substitutions, the error word and target word almost always share one or more initial or final segments. However, there is no obvious form similarity in cases in which the frame configurations do not overlap (e.g., 6.3c). In these cases, the similarity is semantic, involving argument structure alternations that do not apply to the error verb. These errors can be viewed as similar to lexical semantic substitutions.

6.2.2 FRAME BLENDS. The corpus contains 6 examples of errors with frames that are not compatible with a single predicate, but can be viewed as blends of two functional frames compatible with different predicates. The error in 6.4a combines frames compatible with the idiomatic predicates *be good for* (6.4b) and *mean to do X with* (6.4c).

- (6.4) a. what's it meant to be done with it?
 b. what's it good for
 c. what's meant to be done with it

The example in 6.4a also indicates that blending is not prohibited because of a constraint against encoding a participant twice.

The error in 6.5a combines two different frames of *seem*.

- (6.5) a. there already seems there are one too many cars in Colorado
 b. it already seems there are one too many cars in Colorado
 c. there already seem to be one too many cars in Colorado

Notice that in 6.4a and 6.5a the error predicate is compatible with the following context. This is the case for all of the frame blend errors identified in the corpus.

6.3 SUMMARY OF CONCLUSIONS.

Utterances in the corpus that involve inappropriate pairings of grammatical functions with predicates, the sentence pattern errors, are constrained in the types of failures they exhibit. The functional frames of sentence pattern errors all involve possible configurations of grammatical functions for some predicate in English. The error frames can be categorized as either frame substitutions or as frame blends. There are no examples in the data of errors involving collections of grammatical relations that are incompatible with any predicate.

The error patterns of functional frames suggest that frame computation may be competitive, and not incremental. On a competitive model, frames are not necessarily the output of functional processing as they are in models that see a functional representation as a collection of functional relations among lemmas (cf. Bock & Level 1994). Frames in a competitive model are viewed as complex units with internal structure that are selected and serve as input to functional encoding along with lemmas.

CHAPTER 7

CONCLUSIONS: SUMMARY AND MODEL IMPLICATIONS

This study has provided certain insights into the processes of grammatical encoding during speech production, specifically the first stage of encoding, functional processing. Functional processing in the clause involves the assignment of elements to a set of grammatical functions defining a functional frame. The output of functional processing is a functional representation that forms the basis of constituent assembly and the sequencing of words during the positional processing stage of encoding.

Three fundamental questions about functional processing have been investigated. The first question concerns the means by which the functional frame of a clause is computed. Clausal frames are complex structures that can be articulated into the grammatical functions they comprise. During production, it may be that the structures are built up incrementally by computing individual grammatical functions and assembling the structure out of function "atoms" that are subject to constraints on function combinations. Alternatively, functional frames may be production units that are deployed during functional processing as complex wholes. The second question asks when the information necessary for computing a functional frame for the clause is available to the production system. Functional frames reflect the functional dependencies of words in a clause, and frame computation may only be possible after lexicalization has selected the words that will be used to convey a message, since the words presumably entail the information necessary to determine dependencies. However, both individual functions and constellations of functions are correlated with semantic, thematic, and discourse-pragmatic information that is independent of individual words, and this information may form the basis for frame computation. Finally, the third question concerns the units that are assigned to the relations of a functional plan at all levels of functional representation. These elements may be constituent structures, word lemmas, or even pre-lexical units of production corresponding to the conceptual chunks of a message.

The empirical domain of investigation in this study was a corpus of speech errors. One contention at the base of this research is that error data can continue to provide evidence that will answer questions about the production process. Data from the corpus were applied to the three questions about functional processing, and some answers were proposed as a result of analysis of these data. Two analytic approaches that have been used in previous studies of encoding were adopted in the study. The first approach is to consider lexical error phenomena and derive from these data constraints on production. The second approach is to look for error evidence that suggests the existence of production units other than words or segments by identifying errors involving the interaction of these units.

This chapter presents a summary of the results of the analyses as they bear on each of the three questions posed and reviews the implications for a model of grammatical encoding in §7.1. In §7.2, it concludes with some speculations about the uses of error data for future research.

7.1 MODEL IMPLICATIONS.

Chapter 4 argued that the production model that emerges from the error evidence should include a lexicon with non-decompositional lexical semantics. In a non-decompositional

representation of meaning, each word is associated with a concept. Concepts are non-distributed representations that have no internal structure, but are selected in a network of semantic features by matching them to conceptual chunks of a speaker's message. In a model with a conceptual level of representations, lexicalization is a simple mapping from concepts to lemmas.

The evidence that argued for a non-decompositional representation of word meaning came from an examination of noncontextual displacements, a subtype of lexical errors that has not been thoroughly investigated in previous studies. Recall that in noncontextual displacements the error word is strongly related to a word in the utterance that is not the target that the error replaces (e.g., 'an archaic form of German in that *language*', for '...in that movie'). The error word in a noncontextual displacement is not a repetition of a planned word, in contrast to the subtype of contextual displacements. In contrast to substitutions, the error word in a noncontextual displacement is not related to the target it replaces. These properties make noncontextual displacements a useful probe into functional processing. The results of the analyses lend support to a non-decompositional lexical semantics in the following way.

Noncontextual displacements behave like other displacement and substitution errors with respect to the grammatical properties of error-target pairs, and not like combined form errors. Their strong tendency to be of the same grammatical class as their source, to strand source morphology, and to accommodate to the morphology of the target they replace all suggest that they are errors of functional processing. It was found that all noncontextual displacements in the corpus are semantically related to their sources, and that no noncontextual displacement bears only a form relation to a source in the utterance other than the target. Because noncontextual displacements can thus be considered a type of semantic error, they can be compared to other semantic error subtypes. The comparison revealed that semantic displacements have a profile of error-target relations like the profile of word pairs found in semantic blends, and unlike the profile of the error-target pairs of semantic substitutions. Semantic blends are clear cases of function assignment failure, while semantic substitutions must originate at some other point during production. They appear not to be attributable to a failure of function assignment but were argued to be failures of lemmatization, which follows function assignment and involves the access of word lemmas and their association to syntactic slots.

The similarity of noncontextual displacements to semantic blends leads to the conclusion that noncontextual displacements should be considered errors of proper function assignment. A consequence of this conclusion is that the error words in noncontextual displacements are active during function assignment along with planned words. If the elements that undergo function assignment are word lemmas, then a globally interactive architecture would entail the activation of the associated lexemes. This lexeme activation could feed back to the lemma level and cause form displacements, which do not occur. The conclusion drawn was that the elements that undergo function assignment cannot be word lemmas. They also are unlikely to be constituents, as proposed in some models, because of the rarity of constituent exchanges in the set of all unit exchange errors. The alternative is that the elements that undergo function assignment are active before lemmatization, from which we infer that concepts are the domain of function assignment.

In the model proposed, concept nodes become active during function assignment based on the conceptual chunking of the message that constitutes the conceptualization process. Conceptualization can lead to the activation of alternative functional plans at the word level. The activation of alternative plans is consistent with the contextual appropriateness of errors in semantic blends and displacements. Alternative, contextually appropriate concepts may undergo function assignment to the same function of the utterance plan to surface as semantic blends, or

may undergo function assignment to different functions in the utterance plan to surface as noncontextual semantic displacements. A lemma associated with a selected concept node may be partially activated during function assignment, but its lexeme is only weakly activated, making form displacements very unlikely. However, the likelihood that an alternative concept will surface as a displaced error is greatly increased by an additional form similarity to some word in the context, explaining the high incidence of form similarity of the error words in semantic displacements to their targets. In a model architecture with strict modularity, feedback from lexemes to lemmas is not possible. However, the differing behaviors of semantic substitutions compared to semantic displacements and blends means that substitutions originate during the processing of different levels from displacements and blends. The need for different levels is compatible with a non-decompositional semantic representation of lexical meaning, argued for under the assumption of a non-modular architecture. Finally, function assignment must entail inhibition of the assigned element as in the binding-by-timing theory of lexicalization. Inhibition after assignment would explain the lower rate of perseveration in contextual displacements compared to the rate of perseveration in noncontextual displacements, since planned elements are inhibited at assignment, but semantic relatives are not.

At the level of the clause, when does the production process compute the grammatical functions to which participant concepts are assigned? At the clause level, this question asks when the grammatical functions of subject and any object types are available for assignment. I argued in chapter 5 for a model of frame computation in which functional frames can be computed either from the combinatorial and mapping information available from lemma access or from conceptual information available before lemma access. The possibility of lexical or conceptual guidance in frame computation is compatible with a dual route model of encoding.

The question of when frames are computed was addressed by considering a subtype of errors that involve functional frames, the sentence pattern errors. The core of the sentence pattern errors were identified from among substitutions of predicate-taking words, particularly verbs, in which there is a mismatch between the functional requirements of the predicate and the participant mappings to grammatical functions realized in the error utterance. It was argued that the grammatical class constraint characterizes all errors that occur during functional processing, but that sentence pattern errors reflect a constraint on the functional dependencies of words in the clause, although constituency requirements are violated because the sentence patterns produced in these errors are incompatible with the error predicate. The conservation of functional dependencies, but not constituency requirements, places sentence pattern errors at an early stage of functional processing, when functional frames are being established. The subtype of sentence pattern errors was extended to errors other than substitutions using the criteria of functional appropriateness and syntactic inappropriateness. The subtype of sentence pattern errors thus crosscuts the category of lexical errors and establishes a new subtype of error, which originates during grammatical encoding.

The results of the analysis of sentence pattern errors suggests that lexical guidance in frame computation is not necessary. Obligatory lexical guidance would entail that for every sentence pattern error there is a lemma that can serve as the source of the frame as well as a lemma that can serve as the source of the incompatible predicate in the error. In a proportion of the sentence pattern errors, there is no identifiable target that could serve as the frame source, and the predicate itself is never compatible with the frame, so it also could not serve as a lexical source for the frame. In addition, the sentence pattern errors are more likely to be corrected using the predicate of the error than some other "target" predicate, which suggests that the predicate

was often intended, and not a substitution for some other word. Conversely, speaker self-corrections in substitutions that are compatible with the error frame of the utterance are more likely to involve a change of predicate lexeme than of the utterance frame, suggesting that these are true lexical errors. Taken together, the evidence indicates that lexical guidance of frame computation is not obligatory.

If frames are not computed from the combinatorial and mapping information accessed in verb lemmas, what information serves as the domain of frame computation? Evidence was found that the error frames produced in sentence pattern errors are consistent with general discourse-pragmatic tendencies of frame content that are independent of individual lexical items. The frames produced in errors tend to suppress predictable and underspecified participants and to promote more animate participants. In addition, the frames produced in errors tend to have reduced valences compared to the frames compatible with the predicate produced. Valence reduction implicates a speaker strategy in which functional frames are simplified by expressing causative relations lexically, rather than periphrastically, without regard to the ability of the lexicalized predicate to express a causative lexically.

In the model proposed, the computation of a functional frame for a clause can be conceptually guided or lexically guided. Evidence that frames are very often computed from lexical information is found in the semantic similarity of error-target pairs in sentence pattern errors involving verb predicates to semantic blends and semantic displacements. The similar semantic profiles of the three groups is consistent with the proposal that for the most part the error words and frames in sentence pattern errors are the result of multiple lemma access, since blending and semantic displacements are also cases of multiple lemma access. Conceptual guidance of frame computation is arguably based on the constellation of participant roles in the to-be-expressed message, the conceptualization of the situation predicate, and general discourse-pragmatic tendencies in clause argument structure.

The final question addressed in the study concerns how frames are computed. One possibility is that functional frames are pieced together from individual functions, the incremental view of frame generation. Alternatively, frames may be elements that are accessed as wholes and compete for selection during production. In chapter 6, I presented evidence that is compatible with the notion that frames are production units that may compete for selection in a way that is similar to the competition among other units, such as words.

The domain of investigation in chapter 6 was once again sentence pattern errors. Two lines of evidence converge to suggest that sentence pattern errors result from the manipulation of functional frames as units by the production system. First, I argued that the subtype of sentence pattern errors can be viewed as frame substitutions, in which a frame that is incompatible with the predicate is produced in place of a compatible functional frame. That these errors are frame substitutions is supported by the fact that the frames in sentence pattern errors are semantically and pragmatically appropriate for the utterance. In addition, the error frames are always possible functional frames for some predicate in English, and never incoherent collections of grammatical roles that could not be produced with any predicate. Second, I showed that the notion of sentence pattern error can be extended to include errors that can be construed as blends of two alternative patterns. The alternative patterns are compatible either with different predicates or with different frames of the same predicate. The sentence pattern blends consist of overlapping utterance plans that do not necessarily correspond to constituents, indicating that they do not originate during constituent assembly.

Under the Processing Uniformity Hypothesis, production units at any level should be subject to the same processes, and as a result should exhibit the same failure types. The similarity in error profiles observed in lexical errors and sentence pattern errors is compatible with the proposal that functional frames, like words, are units manipulated by the production system.

Recognizing that the functional frames are production units, together with the possibility that these units can be computed without accessing verb lemmas, is equivalent to an approach, like some versions of Construction Grammar (Goldberg 1995), in which verb argument structures are templates, or constructions, conventionalized pairings of form and meaning. Functional frames are thus seen as complex structures that link form and denotation.

7.2 FUTURE RESEARCH.

The study did not exhaust the analyses of error data from the corpus that might lead to a more complete understanding of grammatical encoding. The study focused on error data that were appropriate for a study of the initial stages of encoding during functional processing, and concentrated on processing at the clause level. Two broad areas of encoding thus remain unexplored.

A detailed analysis of frame computation and function assignment was carried out only at the level of the clause. While the functional frame of a clause is important for utterance planning, functional dependencies at other levels must also be met. There is some data in the corpus that may be appropriate for studying how functional frames within a phrase are computed. The examples in 7.1 can be interpreted as lexical errors, but, like the sentence pattern errors, can also be construed as the interaction of alternative functional plans, within a NP. In 7.1a, there is a conflict between quantification using a partitive (*lot of*) and an adjective (*large*) modifying a template converting from mass noun (*money*) to count phrase (*amount of money*). In 7.1b, there is a similar conflict between contextually appropriate lexical alternatives with respect to their functional dependencies in the NP as mass (*time*) or count (*chance*). Similar observations could be made for other levels of functional planning.

- (7.1) a. companies that have a large money (for 'a lot of money' or 'a large amount of money')
b. when did we have *chance*? (for 'have a chance' or 'have time')

The study has left unexplored the second phase of encoding, constituent assembly. There are three types of errors that may be helpful in understanding how constituents are built up from functional plans. The first subtype includes errors that were excluded from consideration in the identification of sentence pattern errors because they involve only formal aspects of complementation. In 7.2, the errors could be considered lexical substitutions. However, as in the case of sentence pattern errors, they are not closely related to their targets semantically outside of the utterance context. Just as words have functional dependencies, they also have formal requirements. The ways in which these requirements are violated could say something about how syntactic plans are produced.

- (7.2) a. there was one other thing we didn't *deal about* – with (for 'deal with' or 'talk about')
b. they *devoted* their entire lives *on* something (for 'devoted to' or 'spent on')

A second subtype of error that may have implications for constituent assembly can be found among the movement errors. Movement errors are shifts, rather than replacements, of words, and like the combined form errors appear to originate during positional processing. In the errors of 7.3, the shifted elements respect constituent boundaries and are also placed appropriately for alternative syntactic plans (*when the number of letters gets...* in 7.3a and *I once could do this* in 7.3b).

- (7.3) a. when the number of letters gets *in common* to be too large (for 'the number of letters in common gets...')
 b. I *once* think I could do this (for 'I think I once could do this')

Finally, there is a subtype of blends in the corpus that I have called *contextual blends*. The contextual blends are unlike the semantic blends of contextually synonymous alternatives that we have discussed. Contextual blends involve a fusion of planned elements (7.4). Like the combined form errors, the contextual blends accommodate to target inflection (7.4a), are independent of phrasal accent (7.4b), and do not involve function words (7.4c). These properties may make contextual blends, together with combined form errors, a useful probe into frame content and construction.

- (7.4) a. have 'Love Boat' tackled – tattoed on his knuckles
 b. give him the *cord* (no stress) – cútting board
 c. the *concello* – concerto for cello and orchestra

Interestingly, the contextual blends have a parallel at a larger scale. There are a subtype of amalgam errors in the data that can be construed as involving the fusion of sequential planning domains (7.5). The principle of Processing Uniformity would entail that amalgam errors and contextual blends are failures of the same processing vocabulary at different levels of production. If this is correct, then planning domains undergo a stage of positional processing analogous to the sequencing of words in a syntactic plan. This conclusion has implications for model architecture in a realm of production at or even before conceptualization.

- (7.5) a. I think that's *actually their* main *office* is in Duane
 b. which is something *I think we should think real seriously about* taking this step

The analyses in this study, as well as this discussion of possible extensions of the study in future work, indicate that error data may continue to constitute a productive empirical domain for production research.

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APPENDIX: THE ERROR CORPUS

The errors of the corpus are presented here, organized by unit type (lexical, morphological, phrasal, or other) and distribution type (blend, insertion, deletion, replacement, and movement), following the coding scheme outlined in Chapter 3. Following each error is its source, with wdr = the author, ucla = the UCLA corpus, df = D. Fay, cutler = A. Cutler, MIT = the MIT corpus, stem = J. P. Stemberger, harley = T. Harley, vw = V. Wallace, swbd = the Switchboard corpus, and fromkin = V. Fromkin. Errors in this corpus that also occur in the BR97 corpus (Bell & Raymond 1997) are cross-classified with the identification number from that database.

LEXICAL ERRORS

BLENDS

at the end of the tren- the [training and] retention test	wdr
is there enough money to reser- to restore	wdr
and preserve the wall?	
the concello - the concerto for cello and orchestra	ucla2751
that these appear on the balletin [on the ballot in the bulletin]	ucla2628
if your first reanger is - [reaction is a flash of anger]	ucla2202
to a monsoosan- monsoon, or seasonable flow.	wdr
part and parcible [parcel responsible]	ucla2439
I like him a letter - a little better	ucla683
I will give you the dirate [direct rate]	ucla753
have 'Love Boat' tackled - tattooed on my knuckles	wdr
give him the cord (no stress) - cúting board	wdr
names will be reheld	ucla1150
he's the one who made it eight feet hall	wdr
that's more troublematic (four syllables)	wdr
this really isn't an issue of whether a latent fingerprint was	wdr
president - present	
Because this is my maynor area	ucla137
but with the eggs I used all boil - oil	df
a lunch of - bunch of other interesting people	df
a lot of morphemes that you then struck together	wdr
one thing we've all talked about	wdr
to redistribúte 1300 hours of...	wdr
the compost is worked into the topper part - the top part of the soil	wdr

18000 hose- houses were destroyed	wdr
as soon as I got to the co-op he dripped - dropped right off to sleep	df
you see garbage pans, I mean, pails, just filled...	swbd2013
they have expoused	wdr
even though you're not do-ming any particular gesture	wdr
as composed to	ucla1888
behortment	ucla1929
bost	ucla1931
brief discussion about the relaction between	ucla1943
difficult to determine watch	ucla2008
feature swiftng	ucla2046
feeling sadry for herself	ucla2047
he's a grandcestor of yours	ucla2120
in this three way difference between strick-	ucla2229
it depends on how much time you want to stend there	ucla2251
omnipiscent	ucla2407
Consonants are more likely to be devoiced if they're on a highing pitch	ucla253
dick my hand in water	ucla2586
the class of human languages is very constricted(?)	ucla2748
the response was a dell silence	ucla2821
these are all examples of stritch	ucla2901
we weren't sure we could avord - afford it	ucla3027
He still gets hegraines - migraines	ucla504
How much time has been sput	ucla554
I read a survview of a nice article	ucla702
As long as it's somehow relected to my work	ucla78
Irvine's quite clear	ucla886
it [the Arab oil embargo] was the cataclyst that	ucla899
brought it [economic decline] on	
It depends on the aspoint	ucla906
It reminds me of Mexico with all the falms	ucla918
As talkers you know a lot about your audiencers	ucla80
good quaint	wdr
it isn't that she súspekts us - suspécts us	wdr
that's the real travedy - travesty	wdr
that is was sevérious - severe	wdr
at the end of today's lection	MIT
I just snabbed it	MIT
nobody gets very upcited about that	MIT
I don't want to intervere	MIT
I don't know what the outshot of that is	MIT
I have no idea what [whet?] it would V [e.g., require] X	wdr
that's what my life isolves -is all about	wdr
flire	harley84
shlocked	harley84
hydrome	harley84

herknew
 you could surely spell - you could surely tell as
 many stories about scientists as about literary people
 my data consists monly - maistly
 do you want to try just a tab - uh, a dad, uh, Jesus!
 Do you want a dab or a tad of this stuff?

harley84
 cutler (BR97-9)

ucla2375
 MIT

DELETIONS

That would be Ø-having like Harry.
 to get him through Ø a hearing - to a hearing.
 what aspect he's interested Ø is - in is...
 It looks as if Ø you tell someone - when you tell someone...
 I have to go downtown to get a transformerØ Ø typewriter
 You either dó things or dón't Ø things...dón't do things.
 and kill as many of the Indians Ø they get their hands on.
 I can still make reservations for Ø, tonight.
 along that line in the 60's because of pesticide use at Ø time
 this is a very very Ø kind - common kind of operation,
 and it's a very very Ø kind - common kind of...
 although there's a little bit Ø ja- a little bit of jaggedness...
 how to keep teenage drivers Ø becoming - from becoming...
 You haven't seen half Ø it.
 it's still a relatively small number of schools Ø are involved
 one might want Ø have - want to have
 I wanted Ø buy it
 I wanted him Ø be chosen.
 It's an extremely Ø way - extremely interesting way to look things up
 It just Ø not grabs you.
 the Ø operation, uh the formal operation
 the way x-ray do-s - does - the way x-ray machines do.
 it's so Ø cheaper - it's so much cheaper than faxing...
 and encouraging the community Ø come out
 Ø I try to convey that to the guys is (-) you're helping families

ucla1514
 wdr
 wdr
 wdr
 ucla666
 wdr
 wdr
 wdr
 wdr
 wdr
 stem
 wdr
 stem
 wdr
 ucla2416
 ucla744
 ucla745
 ucla942
 stem
 ucla2679
 wdr
 wdr
 wdr
 wdr

INSERTIONS

what's it meant to be done with it?
 I really don't think it's much any different.
 You have a block in the middle to hang it up on - hang it on.
 she's on the program, isn't she not?
 I am sure am tired
 the letter you haven't yet figured out yet.
 Oh, Evan put back his globe up.
 I just saw this friend of mine today that he has to
 go to Ft. Collins to get...

ucla3066
 wdr
 wdr
 ucla2539
 ucla719
 wdr
 stem
 wdr

Maybe I'll ask you next time I'll see you.	wdr
From which airport do you leave from?	ucla414
Let's to assume that competence does equal performance	ucla1051
In some sense that's what we're all would like to find.	wdr
She was really surprised me.	wdr
it does néver - it néver...	wdr
I did must've	wdr
finish that one back up.	wdr
he seemed to think a lot of more cubs would die without that	stem
wherever there's a little bit of more light.	stem
need not to become	wdr
What the Mitchell bill does is to put...	wdr
The risk becomes greater--stroke, heart attack,	wdr
death--as the older you get.	
I can be here early, it's just that am I ever here early?	wdr
What we'll do is to put a hole in the wall right here.	wdr
what you want to do is sear in the outside of the lamb	wdr
to what extent am I responding to odors that I'm not conscious of it	wdr
Any map that I'm able to been find	ucla67
That's another thing that occurred to me reading the article was...	wdr
as you probably know that...	wdr
There's one thing that I like to do is add another cleat.	wdr
that's the only way that I can see it's going to be resolved	swbd2013
is there are going to be people in the rich district that are...	
that's one thing I feel really strongly about though is	swbd2015
people coming up to my door	
those are the problems that we think we see it	wdr
I don't think she's terribly strong enough to talk very long	wd r
I don't see any many paddocks around here	MIT
it's nothing I would ever permit to happen if I knew anything about it	wdr

MOVEMENTS

we're gonna be much ba- back with much more in a minute	wdr
whether or not you ever need down to get _ - need to get	wdr
down the list to this point here.	
why do have - _ why do OV languages have	ucla3124
He has spent the most of _ time on his synthesizer	ucla498
I once think I _ could do this	ucla573
for each three of those _	wdr
It seems easily to be _ fixed.	stem
This is the longest sport I've stuck to _	wdr
what difference - to what _ do we ascribe this difference	wdr
It could be even have _ termed psychological	ucla904
without being to due _ - without being due to...	wdr
It's perhaps the riskiest move since I've ma-[de] _ -	wdr

[I've made since I've] been making these decisions.	stem
and not both can_ be the true measure of grayness.	wdr
a week away and a half _	MIT
when the number of letters gets in common _ to be too large	MIT
hardly this place is _ well run	wdr
we're sort of waiting for to - waiting for the Gonzalez	
family to arrive	
You want _ to send me somebody else to you?	ucla1717
a half _ bag of eaten candy	ucla1786
The only thing I hate _ Cricket Graph about...	wdr
and definitely _ no means by - by no means...	wdr
_ Not only it darkens the sky...	stem
and until we have that we can't establish _ a crime that occurred	wdr
I _ hate to really correct exams	ucla568
I don't want to part _ this book with too long	ucla629
ask _ what you need for	ucla1894
Yeah, you _ really end up don't winning.	stem
I _ admit to being frankly subjective in my evaluations	ucla640
But my English teacher _ doesn't know what she's really doing	ucla160
I _ say that because I don't want - I don't say that	ucla560
because I want to go to Mexico	
_ beads of little blood will pop out on my brow	MIT
if you can't figure _ what that out is	MIT
who _ did I think else left	MIT
Not normally do we _ have all these boxes here stacked to the ceiling	wdr

REPLACEMENTS - ANTICIPATIONS

like we every do every lead	wdr
We've been working on ways to which - ways in which to make...	wdr
translate all the things that were said into French - in French into English	wdr
You'll save it half - [of it]	wdr
they've been through us - they've been through it with us	ucla2934
Are you going to be on town - in town on June 22nd?	ucla71
the most effective kind of organization takes plant - takes place in the plant	ucla1531
deafness is no acquisition - no handicap for the acquisition of language	ucla1995
there already seems there are one too many cars in Colorado	wdr
if there's no further question - if there's no further	ucla855
speaker on the question	
a small body of instru- of compositions written for these instruments	ucla1811
as to the arrowhead process - the arrowhead conference	ucla1892
proposal regarding the process	
it's members to all ICS - it's open to all ICS members	wdr
when the verb of the - object of the transitive verb	ucla3080
I'm going to mainly point about - to talk about three main points	ucla800
I got in the radio today - I got in the radio! -	wdr

I got in the car [today] and on the radio I heard...	
these words have not exceeded nine words in length -	ucla2900
uh, these slides have not exceeded nine words in length	
are you ca- are you confident that the midterm is capable of...	wdr
Notice there are a number of strings we can associate	ucla1163
with these - uh, notice there are a number of structures	
we can associate with these strings.	
I don't have time to work - to watch (television	wdr
because I have to work)	
a coach who threatens - a player who threatens to kill his coach...	wdr
if you force yourself into regularly [regu-ly?] pressed -	wdr
[scheduled] press conferences	
I think it's careful - I think it's reasonable to measure with care	ucla726
which pinker would you like - which paper would	ucla3112
you like? The pink one?	
many players think - many people think he's the most	ucla1112
underrated player in the nation.	
I didn't fold out - throw out any folder	ucla605
I want to get my feature locators - detectors located	ucla743
J.M. who was an apologist from - apologist!	wdr
he's a linguist from William and Mary. He kept apologizing.	
put your ax to the grindstone	ucla2478
They tried to convict a murder on him.	wdr
They used to follow railroads along rivers.	stem
He tried to reverse the car back up	ucla507
she is flying through - sailing through with flying colors, rather	wdr
they even fly on the wing	harley84
you have to eat with food in your mouth - have to talk	ucla1700
with food in your mouth	
you know, David, I washed it - watched it through one	df (BR97-335)
cycle and no water came out	
does that lead you to cause - does that lead you	wdr
to construe causal explanations?	
I don't feel competent to qualif- [-y] to comment on this quality	ucla610
he was charged with drinking while intoxicated, and failure to comply	ucla513
Malagasy, a language you'll learn to grow and love	ucla1111
do my compute - or my commute in log time	wdr
we always never do that	stem
I knit my sweater Michelle a scarf	stem

REPLACEMENTS - EXCHANGES

I don't need a monitor activity	wdr
that's why they sell the cheaps drink.	ucla2646
It looked like hell's Dante	ucla913
when I roasted the cook	ucla3071

I have caked a bake	ucla652
I'm sorry I didn't recall your turn sooner.	ucla822
there aren't as many weeks in the day as I need	ucla2869
I changed in a turn of address notice	ucla738
only no restroom has a sign	ucla2417
some smalls are twelve-[er] twelves are smaller than others	wdr
he smooshed her.	vw
he'll call to find out when he wants me to pick him up	ucla2113
they didn't want to get their blood all over him.	wdr
the producers have a very time (no stress) [hård] - a very hard time...	wdr
coach Fitzsimmons likes to have his rest teamed	ucla249
through a dark glassly	ucla2962
I have to get my cash checked	ucla664
I can give you some top of the thought heads	ucla580
How did that flat get tired in the first place	ucla550
she has one aunt and two uncles.	ucla1431
can you thing up the picks	ucla1959
the plant has been seeded in everybody else's mind	wdr
do you love in that livable apartment?	ucla324
I would rather gamble \$125 than have a hole full of floors	ucla760
brain and I were just Jimstorming on the way over here	ucla987
work is the curse of the drinking classes	ucla290
the handle needs to be tied down screwder	ucla1529
What will you do if they ask you to part take (no stress) - participate in...	wdr
They do never take the form of questions	ucla1554
The verb in have - have in the expression...	wdr
oh, no! Now I'm in really trouble!	ucla2404
I would agree with everything that Talmy has certainly said.	ucla757
why you do miss teaching when you're on leave?	ucla3122
things are already hung up anyway everywhere.	ucla1558
but when you will leave?	ucla165
I had go better check out Croft's book.	wdr
there could no be better	wdr
what it i- what is it?	stem
uh oh, where it is?	stem
tell Peter that he has a big room enough	ucla2607
you may have well said this.	wdr
she would have gone back right into the house.	wdr
how long has been Bill here?	wdr
I have no what idea - no idea what...	vw
there is one no more - there is no one more...	wdr
there's real no, no real dress code where I work	swbd 2006
we meditated it on - meditated on it.	wdr
you're taking account into - you're taking into account...	wdr
it comes back again up in August	vw
most of those are not about being irritable, they're being about - about	wdr

I'm really not sure how old is he.
 the next day you can go in and tear all it out.
 we can't eat all it right now.
 well, you've never had in her class yet.
 I will at least try to have the morphology read one as well.
 you aren't the first ones I've ever heard this say - say this.
 to see if his definition seems to up-hold.
 hardest area hit.
 Cheez Whiz has one less third
 the way we can characterize the situation would by be - be by
 they invited up me
 what I'm working then on
 A: sorry for giving us - B: your back. A: for giving you our backs
 what kind of frame time?
 he ever doesn't forget
 how he can get it - how can he get it done in time?
 I had it planned all out.
 are going you to the Renaissance fair this year?
 I'm working reference on
 if we really are as good as people keep telling we us are
 it's all almost finished
 it's going to keep the length muscle constant
 my sore is throat
 and an explicit procedure that your choose you sampled
 languages from the frame
 the subject of problem raising
 milk goes fast so bad in our refrigerator.
 the unique factor of feature analysis
 they're actually predicting a normal than warmer November
 we can't hold you against that
 go up to say and her -
 don't remember to forget
 don't drop a waste of gas
 I didn't know Ravel had him in it
 I have to get a gas of tank
 I need a fresh of breath air
 put it on the sink of the edge.
 the cleaning of the cost of the carpet
 threw the window through the clock
 what child will a grammar learn given...
 what's the policy on our decision?
 if you break it it'll drop
 how park did you close?
 Jane told her to meet me.
 I didn't get a copy with my cover
 are you going to your lab or the office?

wdr
 stem
 stem
 wdr
 wdr
 wdr
 wdr
 wdr
 wdr
 ucla2853
 ucla2917
 ucla3047
 wdr
 ucla3055
 ucla479
 ucla545
 ucla648
 ucla69
 ucla826
 ucla857
 ucla935
 ucla946
 ucla2373
 wdr

 ucla2710
 wdr
 ucla2848
 ucla2929
 ucla3012
 wdr
 ucla341
 ucla344
 ucla602
 ucla663
 ucla690
 ucla1268
 ucla2665
 ucla2961
 ucla3052
 ucla3067
 wdr
 wdr
 wdr
 ucla599
 ucla73

I want to find how open they are late	ucla741
I'll tell, I can say that.	ucla787
In claim of Jakobson's support	ucla875
In the year most every news	ucla883
It's sort of like putting a new typewriter in a ribbon	ucla963
that the students should acknowledge the departments	ucla2627
used the door to open the key	ucla2992
I started dieting because my doctor told me that I was	ucla717
way too fat to be so young	
I'll see that when I believe it.	ucla771
my keys should be in your purse	ucla1677
we'll drop them bosses while we bomb their leaflets	ucla3030
push a paper around on a piece of pencil.	ucla1267
please get out the chicken so I can start cooking the kitchen.	ucla1261
a laboratory we have located in our own computer.	ucla1742
do you think working with these younger voices are they responding...	wdr
this note indicated that (-) ever who had written it...	wdr
no, it won't camp to cost - won't cost to camp	wdr
so how can we get the 'n' up back - back up again, though	wdr
the hair raises on the neck of your back	wdr
so we can pay some down - down some of our own debts	wdr
fancy getting your model renosed	MIT
slips and kids -- I've got both of enough	MIT
I broke a dinghy in the stay yesterday	MIT
although murder is a form of suicide	MIT
I've got to go home and give my bath a hot back	MIT
McGovern favors pushing busters	MIT
I hate working on two-word letters	MIT
it just sounded to start	MIT
oh, that's just a back trucking out	MIT
prior to the operation that had to shave all the head off my hair	MIT
I have to fill u p the gas with car	MIT
she donated a library to the book	MIT
older men choose to tend younger wives	MIT
which was parallel to a certain sense in an experience	MIT
every time I put one of these buttons off, another one comes on	MIT
she sings everything she writes	MIT
make it so the apple has less trees	MIT
rolls windowed up	MIT
all the scorers started in double figures	MIT
O.J. is quench thirsting	MIT
the Cognitive study's Center of	MIT
the smashlight he flashed	MIT
I had instayed tending	MIT
he didn't get awell so long	MIT
but the clean's two-er	MIT

I'm not in the read for mooding
 he made a lot of money intelephoning stalls
 she's already trunked two packs
 who would else like one
 there's very something peculiar about this
 they not might be too losely glued together
 I'll bet you what that he said was
 it's just heavy plain stop-and-go traffic down there
 though the long day-Labor week - Labor day weekend
 I'd like to make a credit-call card
 you're not allowed to meat mix with milk
 you find a physician you can speak to these things about
 having a project pulled away from them because it's
 of no longer any interest to management
 Iowa's very important in Indiana

MIT
 MIT
 MIT
 MIT
 MIT
 MIT
 MIT
 MIT
 MIT
 wdr
 wdr
 stem

REPLACEMENTS - PERSEVERATIONS

why we do not might - want to derive some sentences
 they seem they know where the problem is
 because he was seen as viewed - being a significant candidate
 what they made their based - what they made their decision on
 that's a mistake on Tony's fault - on Tony's side
 which we're not reading in this novel
 a very archaic form of German in that language
 Wayne Lea of Electrical Engineering School of electrical University
 you can move any old focus...into the matrix focus
 It doesn't mean you should try not to have them.
 It tries to mean - it means you should try...
 the task stayed the same, all we did was decrease the task
 rewards and punishments do make a difference
 in punishments - performance
 A: She usually uses it. B: Maybe we should use it.
 depending on where you are in the country,
 the colder north or the warmer south, that will depend on when...
 come hell or dead water.
 they're taking me for advantage.
 you have such long lines.
 take off! - take care! (saying good-bye to someone)
 you can stay here because I want to spend my time.
 the more involved the roof, the more expensive it'll cost
 head for the west coast and die of sun cancer
 we can't get that one on this channel - on this radio
 a branch falling on the tree
 A: when are you going to have the ale?B: with the beer
 something more on the long - the lines of 5

ucla1665
 ucla2918
 wdr
 wdr
 wdr
 wdr
 wdr
 ucla1614
 wdr
 wdr
 wdr
 df
 wdr
 wdr
 vw
 vw
 wdr
 wdr
 wdr
 wdr
 harley84
 wdr
 fromkin73
 fromkin73
 wdr

we found out that there weren't bridges over the roads	wdr
driver's license plate - place	wdr
as long as the air pressure is high enough to keep	ucla1891
the water out, you'll have air at the right pressure to drink.	
even computers don't do anything like this	wdr
for very large programs - for extremely large problems, I should say	
if you ask your question in a normal voice people	ucla860
in the back will not answ- will not hear.	
We know quite a lot a-bit it	ucla1625
Keenan's category of subtype, uh, subject	wdr
I could stand to use a little weight.	wdr
there's a bug in the error	ucla2883
he can't even get a reply to an answer	ucla488
you need to know who the editors are, how many	wdr
editors will look at the journal	
company turned an enormous product	wdr
I guess I left all the clothes out on the laundry - I mean, line	df
the cure is worse than the remedy	ucla2756
King Soopers doesn't use videos to make movie.	wdr
I'm sorry I can't get on my long distance skis and go snowing	ucla2172
I'm using that term rather usely - rather loosely	wdr
but maybe you want some of those with your crackers.	wdr
a fork wrapped up in a spoon?	stem
your analysis of the earnings was right on the market	BR97-313
they got a contract to develop web sites for one	BR97-305
of the largest advertising firms in the company - country	
so a man who was married to a woman for sex object	
persons - purposes would...	cutler (BR97-57)

REPLACEMENTS - SUBSTITUTIONS

if people don't know you're here.	wdr
I would like you to read that letter	ucla759
you're hurting my thumb [(with your thumb)]	wdr
that in our wildest dreams we ever imagine that...	wdr
how strong you feel to be a member of your group.	wdr
there's no doubt I live a privileged environment	wdr
he gave a speak for his foundation.	ucla?1
now you can relaxed	ucla1164
she made him to do the assignment over	ucla1432
the last experiment I want to say to you about	ucla1530
but I tell you he's not crazy...I mean, he's insane	ucla154
there's a hitch in the ointment.	ucla1547
this would really smell good if you were a dog, doesn't it?	ucla1562
usually as soon as I step foot in the kitchen	ucla1580
Vicki is the chairman of the department, doesn't she?	ucla1587

when I go on a diet I want to eat twice more	ucla1654
you can write real better	ucla1692
you have to be there to listen how the words were said	ucla1701
you've got to make a choice between one.	ucla1727
and he's dressed very elegantly, has a, a very neat suit -	ucla1860
wears a very neat suit	
burning the midnight oil at both ends	ucla1950
companies that have a large money	ucla1981
does it hear different?	ucla2015
does it increase the difference between one groups?	ucla2016
the existing space is no useful - is not use [jus?] - is no use	ucla2365
two names you'd never think of in the same breath	ucla2603
that's what we're going to be do today	ucla2645
the doctor said you should be dead 20 years ago	ucla2762
the report was what made me to stop smoking	ucla2820
there was one other thing which we didn't deal about - with	ucla2874
this is something that we should discuss about	ucla2951
this was the first in my occasion	ucla2958
we began to collect a lot of data to determine what that	ucla300
may meant9	
where does it buy me?	ucla3049
what seems is that	ucla3054
when everybody was left	ucla3077
when you find out, tell me know	ucla3091
we and I	ucla3149
you don't have to believe - convince me	ucla3155
he has already went--gone	ucla496
he's going with her, won't he?	ucla526
...get him up on the stand and see his worth as	wdr
a human being. And that's going to be deprived of him now	
how can anyone force him play if he doesn't want to?	ucla546
50% had a rather fearful look on their eyes - in their eyes	wdr
they devoted their entire lives on something	wdr
now his body (-) is conveniently been misplaced	wdr
these types of research should learn us - should allow us to learn...	wdr
that'll hope - that'll help bring people in.	wdr
Now you can blame him on ever- for everything	wdr
I wanted to say tell me what the meant.	wdr
you're mainly concern is to...	wdr
it's glad that you marshalled your evidence.	wdr
obviously my synapses are slippery than usual.	wdr
your legs aren't that longer.	stem
whatever you like is best with me.	wdr
it's actually longer than using a hand - hand opener	wdr
the first big rock knocked me cold on my head.	wdr
it's also not so understanding - it's also not so apparent.	wdr

a group of comets hitting for earth.	wdr
if that's all there is to have a mind - all there is to having a mind	wdr
how about let's gettin' some light on for the birdie	vw
to producing - produce a cue	wdr
how likely is I to get...	vw
what he was saying was kind of implied - was implying	wdr
you describing Darwin in that his theory is descriptive.	wdr
and I think it bears to remember that..	wdr
It might be worth to wait.	stem
...having all those incredibly nice things	stem
saying about State College.	
and then you go back and figure out how your character	wdr
would got in that situation.	
how long is the talk last	wdr
a person who has looked a lot about - at	wdr
one will be so totally revised that I'm not paying	wdr
a whole lot of time with it - spending a whole lot of time with it.	
she heard out - found out about it anyway.	wdr
the theta-grid that 'risk' could belong into	wdr
without any evidence to support 'em up.	wdr
I just want to point to you here a few things along this back wall.	wdr
Aren't you going to telephone her up?	ucla75
We can hardly avoid to visit my grandmother.	stem
by seeing how did he decide to approach this problem.	wdr
the landlord did not return me a security deposit.	wdr
It'll avoid us from causing problems.	wdr
I was always managed to - able to...	wdr
you didn't have to sleep for a long time.	wdr
designed to encourage - discourage hate speech.	wdr
I saw what devastation drugs played with families.	wdr
I'll explain these tornadoes in a little moment	ucla780
the constraint, which is usually due to J. Feldman,...	wdr
you introduce the bill, the committees tamper around with it...	wdr
so many young musicians dream to come to NY to try to make it.	wdr
y'know I think Dykstra fin- they finished the d- Dykstra	wdr
in ninety-one or so and that was the last dorm they finished.	
that poor guy got over to pass me.	stem
I tell you, there are a lot of people I'd pack up -	ucla789
pass up, but people with packs on their backs...	
and [he] uses that to bring in audiences and taunt with crowds	wdr
service stations are going to require to have a special device	swbd2006
where you feel your privacy to be invaded on a day-to-day basis	swbd2012
I continually to forget - continue to forget what...	stem
what is that different from having 2 words...	wdr
that could lead to bloodshed, even lost (.) of life	wdr
today that's a feeling we're all common to	wdr

I read in a newspaper at one week - that they	wdr
were going to send five college students to Bolivia.	
I'm not really know	ucla811
I don't know. It's not sure to me - clear to me that we even want it in	wdr
what would it do to keep you in Austin?	df
we just couldn't let to see them be broke up any more than they already are	wdr
I'm very strange about Fishman's definitions.	ucla825
I've began to change my mind	ucla829
you'd be easier to heat it up all at once	ucla848
it was on a hundred and page -	ucla926
it weighs a fortune	ucla928
it would be of interesting to see	ucla931
it would have to be one or the either	ucla932
It's only later that they learn out that tags are just	ucla957
as hard as auxiliary inversions	
Kerry forced him go to the doctor	ucla1016
Laurie's boyfriend forced her go	ucla1044
A subject can be learned to change	ucla13
a community the name of which I've escaped.	ucla1776
everything we've discussed about	ucla2032
may be explained to the fact	ucla2339
it just wonders	ucla677
how old's the piercing been in for?	wdr
I can't believe in all those bags you don't - (have what you need)	wdr
they finally approved us to go to Windows 95.	wdr
so, what I'm driving - dropping by is...	wdr
it notices to me...	wdr
I was recommended that book a long long time ago.	wdr
have the kids been eaten yet?	vw
up to six men may have been di [died]- killed.	wdr
that you were committed of - convicted of a murder.	wdr
compound their results to what had been occurred in -	wdr
what had been found in...	
it is reminded to Caliban that he must do what Prospero says	wdr
I'm appealed - you appeal to me.	stem
no, it brings - bring it.	stem
maybe she continued her on it.	vw
thanks for calling that out.	wdr
he doesn't like the thought that he's trying to be put away.	stem
we were hoping on burning a lot of the effluent up there	swbd2006
in the generation we grew up in, the mothers milked - nursed their babies	df
all along I had been thought-in' (-ing) I had to sign both names.	vw
but Faulkner's perception in Britain...	wdr
the rule that is going to agree those things in voicing	ucla2824
there's a guy in Banning who's teaching teenagers it -	ucla2888
teaching it to teenagers	

it will deter- [-mine] be determined by...	wdr
these definitely haven't finished sorting.	stem
when the skillet was washing.	stem
if there's one lesson that comes out of that is should be...	wdr
we saw one of the terrorists made it to a bus.	wdr
see, she fell it - I mean, dropped it	stem82
did he get eaten? I mean, did he get fed?	stem82?
who do not take the seriousness of the drunk driving charge (.) in mind	wdr
I take issue with you on there	wdr
dole it up	wdr
I felt the gun to my head	wdr
when they're in stock order than when they're not	wdr
('stock' active in dialogue)	
it's okay to, to doing it this way	swbd
for anybody to be worth - for it to be worth anybody's time to...	wdr
when people come and fly on our airline, they're gonna	wdr
notice a huge different	
Lise will be taught - teaching it	wdr
I've been requested by a number of undergrads...	wdr
I wish we could have more support with Ling Circle	wdr
the sagging is starting to eliminate	
at low speeds it's too light	MIT
I'm chronically on the fringe of - on the verge of making a bread	MIT
now that's what I call a full cup of tea	MIT
what I've done here is torn together three -	MIT
uh, torn apart three issues that...	
I have to leave in at least - in at most an hour	MIT
I would like to see it now that I've written the book - uh, read the book	MIT
we thought we were d- over with this	wdr
I just book someone who'd never been going before	wdr
for a president there are limited - there are limits	wdr
to the influence that he can have on the economy	
cause I had school tomorrow	wdr
I felt up fine at 8:52	harley84
so they're not so conscientious of the surrounding medical environment	wdr
and that solves me - that saves me having to listen to	cutler (BR97-364)
[hours of speech recordings]	
we're no longer only concerning - we're no longer	cutler (BR97-414)
consid[ering] - we're no longer only considering	
that particular issue didn't really consider us - concern us	cutler (BR97-429)
maybe it'd be interested - interesting to find out a little more about...	wdr
put someone in the shit house - I mean, the dog list, no, the dog house	ucla2477
I washed face on my soap.	wdr
I'm afraid that's beyond my opportunity to be of any comment on that	ucla2168
it wouldn't be Ø as forthcoming as I'd (-) hoped, though	wdr
he was just thri[v]ing in the road	wdr

in linguistics there are _ kind_ of two peoples - two kinds of people
How sharper than a serpent's thank-s it is to have a toothless child

ucla2211
ucla555

MORPHOLOGICAL ERRORS

what grow-Ø in that planter? ucla3043
when a person grow-Ø old ucla3074
There's not a day go-Ø by... wdr
a university that is celebrating it's 50th anniversary a couple of years ago. ucla1817
I'll just get up and mutter Ø-intelligently MIT
our board asked him to, no hold-Ø barred-Ø - ucla2427
no hold-Ø bar[red?]s - no holds barred-Ø, consult
the one exPosner experiment that MIT
They don't study the things that in depthly vw
Adele didn't even concern herself with the problem. wdr
it turned-ed out - it turned-Ø out to be very tender wdr
in order to builds one-_ career ucla2214
we have several prints out-_ ucla3019
we bothing - we both-_ are having ucla3010
the infants did visually scan-_ the targets. stem
the lexicalist hypotheses can't handle thing-_ like - things like ucla2785
show me how weakened he look-_ wdr
it come-_ ons at ucla2244
You can bring together utterances that resemble vw
each other close-_ enoughly that...
kids who test as being _-able to unhear anything above 6000cps. ucla1017
that's so she'll be ready in case she decide-_ to hits it MIT
they get weird-_ everier day MIT
he get-_ its done MIT
he go-_ backs to MIT
pull its gene-_ downs MIT
that's exactly what that job with the French company involved (-) into wdr
they collect them here because these are where - wdr
this is where the oldest padlocks were made.
in a way that bricks and mortars (-) companies can't do. wdr

PHRASAL ERRORS

it would Ø to have a better solution, swbd
like the Sherman facility, than just letting it go
I think that's actually their main office is in Duane. wdr
which is something I think we should think real wdr
seriously about taking this step.
I figured I did something, didn't I? stem
it was not only (-) did it recórd out lives... wdr

how much _ do you think of that - of that do you think...
 how _ do you get in the hell there?
 these lips of the tube- of the neural plate of the tube
 in the many arrows 'the sentence - I mean,
 in the sentence 'many arrows didn't hit the target'
 a difference in gerunds of the syntactic behavior.
 it's a waste to buy kids for macadamia nuts
 I have to smoke my coffee with a cigarette in the morning
 I'd like to speak to this matter about you
 let's go see if we can find a good place on these for the wall.
 when the department was in Angela
 when UCLA swept through the pi- UCLA -
 when the pigs swept through UCLA
 If that's Noam Chomsky, then I'm a grammatical sentence
 he looks a lot younger than he appears to be
 I didn't think there would be that many people
 who were interested to do that.
 If you're not here when I'm gone
 water over the dam - uh, over the bridge - I mean under the bridge
 she became seriously ill as well as her assistant did too.
 You are going, isn't it?
 it goes in one ear and gone tomorrow
 where's the grand ballroom, by any chance?
 they make fun - they make it a fun evening.
 A: It's touching, isn't it? B: It very much so is.
 you said Michelle didn't call at all, did she?
 they said that was the best way, wasn't it?
 the public was becoming increasingly angry and angry.
 Tim is at a loss to say here.
 things that have been successful on Earth may
 have tried out - tried their hand on Mars

wdr
 ucla551
 ucla2904
 ucla2226

ucla1779
 ucla2286
 ucla671
 ucla770

wdr
 ucla3070
 ucla3083

ucla853
 ucla2122
 stem

ucla865
 ucla3006
 wdr
 ucla1680
 ucla2253
 ucla330
 wdr
 Wdr
 stem
 stem
 wdr
 wdr
 wdr

OTHER ERRORS

I can't be done that to.
 I can remember my sisters being done that to.
 these notions have been around for a long time,
 and have rarely been tried to be put into a coherent theory.
 I have a problem with what I think is the transmission.

stem
 stem
 stem

 wdr