Derivational Morphology in Agrammatic Aphasia

Evidence from an Oral Reading Task

by

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ABSTRACT

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The defining characteristic of agrammatic aphasia is the disruption of inflectional morphology. By contrast, derivational morphology has generally been regarded as relatively spared. In the last twenty years, however, there has been a growing literature on how derivational morphology, too, can be disturbed in agrammatic aphasia.

Studies have focused on both inflectional and derivational morphology, and have provided substantial evidence for the dual route model of the mental representation of morphologically complex words, i.e., full-form storage, and decomposition into the stem and affix.

The present study was undertaken to investigate the extent to which derivational morphology is impaired across a group of four agrammatic speakers, to determine if aspects of derivational morphology are differentially affected, and to provide further evidence concerning the mental representation of morphologically complex words.

Four lists of monomorphemic and morphologically complex words were developed and were pseudo-randomized into twelve sets of fifty words. Comparisons were drawn between i. monomorphemic and derived words, ii. monomorphemic, derived and inflected words, iii. Level I and Level II derived words, and iv. two morphological matched cohorts, ending in a suffix of high- or low-frequency.

Four mild-to-moderate chronic agrammatic speakers read the lists aloud. Responses were transcribed, and coded for correct and error responses. Results showed that i. Overall, derived words were substantially impaired across this group of agrammatic speakers compared with monomorphemic words; ii. Derived and inflected words were not treated differently in this experimental comparison; iii. Levels I and II derived words were not treated differently in terms of overall correctness or suffix errors; iv. Words of low-frequency suffix were produced overall more successfully than words of high-frequency suffix.

Analysis of the suffix errors revealed a distinct pattern for free-stem derived words compared with bound-stem derived words. We interpret this pattern as representing a processing distinction between the two types of words, suggesting that bound-stem words are accessed both as fully-listed as well as by decomposition procedures; free-stem words are decomposed into constituent parts. Thus, results provide further evidence for a dual-route model of lexical representation for morphologically complex words.

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CHAPTER 1

INTRODUCTION

1.1 Overview

A subset of people with Broca's aphasia are also agrammatic. The defining feature of agrammatism is the disturbance of sentence formulation, specifically a disturbance in the processing of those elements that express the grammatical and syntactic relations in the sentence (known as morphosyntax or inflectional morphology). The speech of the agrammatic speaker is generally characterized by the selective omission and/or substitution of inflectional affixes, of free-standing grammatical markers, and of other functor words. For a succinct and elegant definition, see Goodglass, Kaplan and Barresi, 2001.

The first formal descriptions of this acquired language disorder emanated from Germany in the late 19th and early 20th centuries.[1] These early researchers (variously neurologists, neuropathologists or psychiatrists) focused on this breakdown of syntax and grammar in sentence formulation. They related the observed disturbances to distinct brain areas, and constructed models of psychological and linguistic organization relevant to the dominant intellectual questions of their time. Their work was so influential that more than a hundred years later, it continues to provide the theoretical underpinnings of aphasia research, though not without considerable debate and dissension.

[1] In an overview introduction such as this, no justice can be done to the rich theoretical background, and insightful clinical descriptions of these seminal reports. Refer to Kertesz and Kalvach (1996), Geschwind (1966), and most specifically to de Bleser (1987) for a comprehensive review and analysis of the historical background, relating especially to the putative contrast between agrammatism and paragrammatism.

Foremost of those associated with the study of agrammatism is Arnold Pick (1851-1924). In his 1902 article, he described the speech characteristics of a female patient: "most of the time in spontaneous speech she did not speak in connected sentences, but more often in single catchwords, a sort of telegraphic style: for example, "away-away- home - children ..... travel (*infinitive*) tram" (p. 83).[2] In his 1913 monograph, Pick provided no data from agrammatic patients. He did, however, provide a definition, which, interestingly, refers only to speech production. "Agrammatism is a form of pathologically-changed speech whereby the processes that operate in the grammatical and syntactic construction of language are disturbed in multiple ways, or do not develop at all, or develop only incompletely" (p. 124).[3, 4] Much later, Goldstein (1948) described the word-finding difficulties of patients with what he called "motor agrammatism" (p. 81). He pointed out that these patients might have "special difficulty with the so-called small words, prepositions, articles, pronouns, grammatical forms, etc." (p. 68). In reporting a case of his own (Case #3, p. 195), and a case of Minkowski's (p. 144), Goldstein remarked respectively on the omission of "prefixes[5] and suffixes," and on the omission or substitution of "grammatical endings, flexions and articles."

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[2] *Beim spontanen Sprechen spricht sie meist nicht in zusammenhängen Sätzen, sondern mehr mit einzelnen Schlagworten, eine Art Telegraphenstyl: z.B. „furt- furt- daheme Kinder.........Bahne fahren."* p. 83, lines 9-11 (present author's translation).

[3] *Agrammatismus ist die Form pathologisch veränderten Sprechens, in welcher die bei dem grammatischen und syntaktischen Aufbau der Sprache wirksamen Vorgänge in verschiedenfältiger Weise gestört oder überhaupt nicht oder nur unvollständig sich vollziehen.* (present author's translation).

[4] In this monograph (p. 112), Pick attributed the origin of the term "agrammatism" to Adolf Kußmaul, (1877).

[5] Unlike English where prefixation is solely a derivational process, prefixation in German is an aspect of morphosyntax as well as of derivation. For example, the past participle of regular verbs is formed by adding the prefix *ge-* and the suffix *-t* to the stem of the verb (*tanzen* - to dance – *getanzt* - [have] danced).

These early clinical descriptions of agrammatic speakers find their counterpart in modern reports on agrammatism, not confined to only one language, but across language typologies. Verbal output is still described as laborious, often dysprosodic (the defining "dysfluency"). In severe cases, a "sentence" consists of a concatenation of single words, often nouns or (presumably for English) infinitival verbs, or of short, simple declarative statements, again with heavy reliance on content words. Depending on the structure of the particular language, and therefore the manner in which grammatical and syntactic relations are expressed, there are omissions or substitutions of functors (pronouns, prepositions, articles — Goldstein's "so-called small words" p. 60), and of both bound and free grammatical morphemes (e.g., Goodglass and Kaplan, 1983; Goodglass, 1976; Kertesz, 1979; Albert, Goodglass, Helm, Rubens and Alexander, 1981; Lecours, Lhermitte and Bryans, 1983; for cross-linguistic data, see Menn and Obler, 1990; Bates, Wulfeck and McWhinney, 1991.

Investigations into the breakdown of morphosyntax in agrammatic aphasia have continued to be a dominant theme in neurolinguistic research over the last thirty years. Studies have focused, often through single or multiple case studies, on delineating ever more finely the underlying nature of the breakdown itself (e.g., Goodglass, Gleason, Ackerman-Bernholtz and Hyde, 1972; Kean, 1977; Bradley, Garrett and Zurif, 1982; Job and Sartori, 1984; Kolk and Friederici, 1985; Kolk, van Grunsven and Keyser, 1985; Caramazza and Hillis, 1989; Martin, Blossom-Stach and Feher, 1989; Jarema and Kehayia, 1992; Cholewa and de Bleser, 1995; Luzzatti and de Bleser, 1996; Penke, Janssen and Krause, 1999; Luzzatti, Mondini and Semenza, 2001). Such studies have typically used the observed agrammatic disturbances to construct, modify, or otherwise test various theoretical models of the functional architecture of the unimpaired language system. In this regard, the neurolinguistic studies have been reciprocally motivated by, and have contributed to, models of lexical organization developed both from linguistic theory (e.g., Chomsky, 1970; Aronoff, 1976; Kiparsky, 1982; Bybee, 1985; Anderson, 1988; Pinker, 1991), and psycholinguistic research (e.g., Burani and Caramazza, 1987; Tyler, Marslen-Wilson, and Rentoul and Hanney, 1988; Marslen-Wilson and Zwitserlood, 1989; Feldman, 1991).

In describing the breakdown of morphology, the early writers appear not to have distinguished inflectional from derivational morphology. The more recent studies, however, have done so, and there is now a large body of research literature that has focused predominantly on the breakdown of inflectional morphology (e.g., Bates, Friederici and Wulfeck, 1987: Lukatela, Crain and Shankweiler, 1988; Nespoulous, Dordain, Peron, Ska, Bub, Caplan, Mehler, and Lecours, 1988; Miceli, Silveri, Romani and Caramazza, 1989; Semenza, Butterworth, Panzeri and Ferreri, 1990; De Bleser and Luzzatti, 1994; Miceli, 1994; Janssen and Penke, 2002).

Less attention was initially paid to derivational morphology, and it appears to have been generally accepted that in comparison to inflectional morphology, derivational morphology is largely preserved in agrammatism. This claim for the relative preservation of derivational morphology has been based on the proposed distinct linguistic nature of the two morphological types (Anderson, 1982; Badecker and Caramazza, 1989; though see Bybee, 1985 for a different perspective). Based on this theoretical distinction, and furthermore on observations of actual performance in spontaneous output as well as on experimental tasks, models of lexical organization have been proposed that have distinguished inflectional and derivational morphology as functionally autonomous (Miceli and Caramazza, 1988; Laine, 1995).

The focus of research has gradually extended to include derivational morphology. More recent case-studies have shown that derivational morphology, as well as inflectional morphology, is subject to disruption in agrammatic aphasia. This growing literature has provided further insights into the nature of the disorder itself as well as into the lexical organization of morphologically complex words (e.g., Tyler, Behrens, Cobb and Marslen-Wilson, 1990; Badecker and Caramazza, 1991; Jarema and Kehayia, 1992; Libben, 1994; Cholewa and de Bleser, 1995; Mathews and Obler, 1997; Luzzatti, Mondini and Semenza, 2001).

This introductory chapter is divided into sections which will consider various aspects of the theoretical framework for the proposed study: 1.1 has provided an overview of the historical background; 1.2 provides a description of pertinent aspects of inflectional and derivational morphology of English; 1.3 discusses derivational and inflectional morphology in terms of models of lexical organization and processing; 1.4 lays out the factors associated with lexical retrieval and production in general; 1.5 explores some of the neurolinguistic literature pertinent to the breakdown of inflectional and derivational morphology.

1.2 Inflectional and Derivational Morphology

The linguistic operations by which a new word is formed in a language through changes in its internal structure fall under the rubric of morphology. Of the three types — inflectional, derivational and compounding — only the first two are discussed as relevant to our study. Languages differ greatly in the complexity of their morphological systems, and Modern English, in contrast to its ancestor Old English (Anglo-Saxon) does not have an extensive system of inflectional morphology. Pick, himself, remarked how "such a highly cultured language as English for example, should, in the course of its development, have become increasingly like the inflectionless Chinese" (1913, p. 125).[6]

For English, the linguistic facts about morphology are taken as follows: Inflectional morphology provides by *suffixation*, or by *patterned word-internal change*, the systematic variation of forms assumed in different syntactic environments by the underlying abstract form (the *lexeme*, see Matthews, 1991 for a discussion) (e.g., *cat cats*; *man men*; *walk walks walked walking*; *sing sang sung singing*; *tall taller tallest*). These grammatical markers constitute what is termed a "closed" set in that their number is limited — new members do not develop. This domain of morphosyntax operates on nouns, verbs, adjectives, adverbs, and pronouns according to the grammatical and syntactic requirements of the language. English marks nouns only for number, but marks pronouns for number, case and, incompletely, for gender. The definite article is invariant and the indefinite article variant only by phonological rule. In contrast, German, a typologically very closely related language, marks both the definite and indefinite article for gender, number and case; both nouns and adjectives for number, gender and, incompletely, for case. The operations of inflectional morphology do not result in the formation of new lexical items with new meanings. Though expression of

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[6] *Daß eine so hoch kultivierte Sprache, wie das Englische, z.B. sich im Laufe ihrer Entwicklung immer mehr dem flexionslosen Chinesischen genähert* (present author's translation).

meaning clearly must dictate the choice of syntactic markers, the resulting changes in the words are those required by the syntactic structure of the sentence, and the new form retains the lexical class of the root form.

By contrast, the operations of derivational morphology (*prefixation* and *suffixation*, known collectively as *affixation*) do result in the formation of a new word, one with a different, though related, meaning from the root form. The root is either a free morpheme (i.e., an autonomous word) (e.g., *joy joyful*; *mountain mountainous*) or a bound morpheme where removal of the suffix leaves a non-word (e.g., *mutable mut___*; *vicious vic__*). Typically, the root form appears either totally or partly in the derived form and the derivational character of the latter is maintained: e.g., *king kingly kingdom kingship*; *navigate navigation navigable*. As we see in the examples above, affixation has the potential for changing the lexical class of the derived form from that of the root form.

Derivational morphology also produces novel words.[7] They may be idiosyncratic nonce words that do or do not subsequently enter the language permanently, e.g., *motherese*; *togetherness*; *scroogious* (admitting to reluctance to spend money on Christmas gifts); not *ovenable* (prohibition imprinted on a plastic container); or words that describe historical events or movements, e.g., *forty-niner*; *suffragette*; *flapper*; *Reaganite*), or advances in technology, e.g., *submarine*; *hacker*; *refax*. Sometimes the derived form remains in the language while its root form becomes unusual (e.g., *ruthless*, but not *ruth*).

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[7] Speakers also generate new words by analogy, e.g., *funnyment*, presumably on analogy with *merriment* (Shorter Oxford English Dictionary First Edition, 1911, under entry for *-ment*).

As with the suffix markers of English inflectional morphology, English derivational prefixes and suffixes are also considered as "closed" sets. New affixes do not develop, though one may well be borrowed from another language (e.g., *–ette* as in *suffragette* above, *–nik* as in *beatnik*). For the most part, inflectional and derivational markers form discrete sets, yet the suffixes *–ing*, *–ly* and *–er* appear in both morphological categories. The first acts inflectionally as a marker for the present participle, and derivationally as a verbal noun or a verbal adjective; the suffixation of *–ly* certainly allows a related word to be derived from a root form but its assignment to a morphological category is arguably related to the lexical class of its operanda. It may well play an inflectional role in changing adjectives to adverbs (e.g., *stubborn stubbornly*), and a derivational role in changing nouns to adjectives (e.g., *king kingly*). Significant for our proposed study, the word-final *–er* appears as an inflectional morpheme for the comparative adjective (e.g., *hot hotter)*, as a derivational morpheme for the agentive (e.g., *swim swimmer*), and as part of the integral final syllable in certain monomorphemic bisyllabic words (e.g., *beaver*, *feather*).

Within derivation itself, prefixes and suffixes operate differently in English. Prefixes produce a derived word of opposite meaning (e.g., *true*–*untrue*; *interested uninterested*; *like dislike*; *understand*–*misunderstand*), or of meaning modified in some way (e.g., *interested*–*disinterested*; *paint*–*repaint*; *cook*–*precook)*. No change of word class occurs. By definition, of course, suffixation produces a derived word that is semantically, morphologically, and phonologically related to its root form. The derived word is usually, but not invariably, of a different lexical category than its root form (e.g., *govern*–*government* (verb > noun): *specific*–*specificity* (adjective > noun): *book*–*bookish* (noun > adjective), but consider also *mother motherhood* (noun > noun) and *red reddish* (adjective > adjective), and the diminutive form *dog doggie* (noun > noun).

The ways in which derivational affixes combine with root or stem forms are as rule-driven as the equivalent combinations in inflectional morphology. First, derivational and inflectional operations are strictly ordered: when the two processes appear together, inflectional suffixes always operate on the derived forms, (e.g., *attach attach**ment**–attachments*; *capable capab**ility**–capabilities*). Second, the rules specify the order of affixation when a word is derived by both suffixation and prefixation. For example, *unrecognizable* must be constructed as [*un ([recognize] able)*], not as *[*(un [recognize])* *able*], because the verb **unrecognize* does not exist. Third, the rules specify which stems and affixes can form combinations. For example, in its most productive sense, the prefix *re–* combines with verbs to expresses *repetition* of an action (e.g., *fill refill*).[8] Similarly, the prefix *pre–* combines with adjectives, nouns or verbs (e.g., *pre-industrial*; *pre-admission*; *preshrink*). With regard to suffixes: *–ness* combines only with adjectives to form nouns. Unlike *kindness* or *weakness* which enjoy general currency, the forms **honestness* and **simpleness* exist only for the nonce. The suffix *–ment* combines with some verbs and adjectives to form nouns (e.g. *attach attachment*, but not *apply *applyment*; *merry merriment*, but not *happy *happyment)*; *–ize* with some adjectives to form verbs (e.g., *legal–legalize*; but not *shallow *shallowize*; *hood* with only a very small set of nouns to form another noun (e.g. *brother brotherhood)*. The corollary to

[8] Seven other meanings are listed for the prefix *re* , including *secrecy, opposition, intensity*. In such words, today, the meaning of the prefix has been retained, but the *re* has lost its nature as a prefix, and has become integral to the word. Words can be nouns, verbs or adjectives, as in the following examples: *recluse*, a noun denoting secrecy; *remonstrate*, a verb denoting opposition; *refulgent*, an adjective denoting intensity (Shorter Oxford English Dictionary, First Edition, 1911)

these restrictions is the power carried by the affix to enforce a specific lexical class on a stem morpheme. This phenomenon is especially marked in prefixes, where for example, the prefix *re* forces the interpretation of a word like *carpet* as a verb when its citation form can be verbal or nominal. Suffixes, by their very nature, always determine the lexical class of the derived word.

Perhaps the most striking feature of the English derivational system is that of morphophonological change. The addition of certain suffixes causes different sorts of phonological change in the base word. The suffixes *–ion*, *ive*, *–ic* and *ity* all cause primary stress to move to the syllable immediately preceding the suffix, e.g., *e'lectric elec'tricity*. This stress change rule will be obeyed by speakers and readers even in non-words (e.g., _*'haslop *has'lopic *haslo'pation_), or nonce words (e.g., *patrio'ticity*, *humo'rosity*). Other changes are evident, both phonological and orthographic: i. stem-final phonological change, without orthographic change, e.g., *confess confession*; ii. stem- final phonological change and orthographic change, e.g., *include inclusion*; iii. stem-final phonological change, orthographic change, and a stem-internal change, e.g., *receive–reception*; *decide–deception*; *assume–assumption*. With these sorts of phonological changes, the derived word now has a bound stem in the sense that the stem minus the suffix is no longer an autonomous word, though note that the nature of the base word is orthographically preserved in (i) above, but not in (ii) and (iii). Conversely, other suffixes, such as *–ment*, *–ness* and *–ful*, force no phonological changes. While there may be orthographic change (e.g., *merry merriment*), the stem remains relatively transparent. In these instances, the stem is considered free because, stripped of the suffix, it remains an independent word.

Summary: Inflectional and derivational morphological processes are the operations that transform a simple word into a complex one by combining in a specified manner a root or stem form and one or more suffixes and/or prefixes. Inflectional markers express the sentential syntactic requirements, but neither the meaning of the word nor its lexical class is changed in the resulting inflected form. Derivational affixation produces a word of different, though related, meaning, and usually of different lexical class. Derivational operations are effected before inflectional operations. Certain suffixes cause different types of phonological change in the stem, including stress shift. Orthographic change is sometimes also associated with these morphophonological changes. In these cases, the stem and suffix lose their discreteness, the stem is considered to be "bound" because it cannot stand alone as an autonomous word. Other suffixes attach to a stem word and induce no change. In these cases, the stem retains its character as an autonomous word, and is considered to be "free."

This section has discussed the characteristics of inflectional and derivational morphology from an atheoretical standpoint. Theoretical issues will be addressed in a later section.

1.3 Models of Lexical Organization

In the last thirty years or so, the notion that the internal structure of a word is integral to the structure of the mental lexicon has become a dominant theme of morphological theory. This notion has provided the theoretical underpinnings in this area of psycholinguistic and neurolinguistic research. Researchers have used different experimental tasks as a means of investigation: visual and auditory lexical decision tasks, with and without priming; shadowing; word monitoring; gating; naming; controlled reading, writing and repetition tasks. These tasks have been used, within a single language and across languages, to investigate various aspects of morphological processing: similarities and differences between inflectional and derivational processes; differences between prefixation and suffixation; and differences among the categories of inflectional and derivational affixes themselves. The evidence from these studies of normal processing and language breakdown has led to the development of various models of lexical organization. These models have, in their turn, generated further debate and research as new information made modifications necessary.

The concept of the *mental lexicon* appears to have arisen with Oldfield (1966). This term may be taken to refer to the notion that the words, and by some accounts also the rules for word formation that are known by the speaker/listener, are stored in some sort of functional mental structure analogous to a dictionary. Brown and McNeill (1966) investigated the "tip-of-the-tongue" (TOT) phenomenon in normal speakers. Their results led to the conclusion that normal speakers possess the "functional equivalent of a dictionary," organized in such a way that words could be "looked up" according to certain specifications.[9] It is precisely the question of the "certain specifications" that has constituted the scope of research and debate in the field, a debate that has addressed the

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[9] It is interesting to note how the authors model the process: They liken it to the keysort card, a method current in the middle 1960s and 1970s for managing cross-referenced data: cards were punched for various features along the margin; a sub-set of the total data can be retrieved from the stack by inserting a metal rod through the appropriate punched hole and lifting out the cards. We now model such processes in terms of computer storage and access procedures (see Taft and Forster, 1975; Taft, 1986) – an interesting sidelight on how technological and intellectual progress evolve in a mutually motivating fashion.

following interrelated issues:

- Is lexical information represented in terms of words or morphemes? By either account, a monomorphemic word would be represented in its entirety (e.g., *happy*; *table*). Conversely, a multimorphemic word would, by the first account, be represented as an entire word (e.g., *happiness*; *tables)* or, by the second account, represented as decomposed into its constituent morphemes, even if that morpheme is a sub-lexical unit, i.e., something not itself a surface word (e.g., *happy* + *ness*$_{(derivational\ affix)}$; *table* + *s* $_{(inflectional\ affix)}$.

- With respect to morphological variation, what are the procedures for accessing lexical information? For example, decomposition (i.e., breaking a word into its constituent parts) is a process that may occur in language processing: Is the decomposition of complex words a <u>required</u> part of "looking up" an item in the lexicon, or used only as necessary, either in understanding a previously unencountered word, or in composing a complex word? There is, of course, mutual constraint between the structure of the lexicon and the manner of access to its contents.

- Are inflection and derivation treated differently by the language system? As a corollary to this, the same question is asked of prefixation and suffixation within derivation itself.

- What role is played by the affixes themselves? Do the rules that govern stem and affix combinations permit some affixes to engage in (de)composition procedures, while restricting others from doing so? This concept may be differently articulated as questioning under what circumstances a complex word may be retrieved as a single unit (if at all), or (de)composed as needed.

In general, two opposing and initially extreme accounts were proposed concerning the basic unit of lexical representation, accounts which rapidly became the dominant models of explanation: the *Prefix-stripping model* (Taft and Forster, 1975), and the *Full-listing hypothesis* (Butterworth, 1983). In their influential article, Taft and Forster presented a model of the lexicon for the visual recognition of prefixed words (emphasis added) in which the word is stored as a representation of its stem plus information about the units that can combine with it to make other related words. Their proposal was that in reading a prefixed word, the reader first strips the prefix from the stem, and uses the stem alone to achieve lexical access. Once the stem is found, the appropriate prefix information stored with the lexical entry is consulted and the word recognized. The procedure required that both free stems and bound stems are listed, and that all affixed allomorphs of a stem are accessed through the lexical entry for the stem.

The experimental work in the article dealt only with prefixes, but in their introduction, Taft and Forster applied the logic also to suffixes, both derivational and inflectional. For example, the word *unlucky* is recognized by the stripping of prefix *un–* and suffix *–y*, the root word *luck* being used to gain lexical access. Likewise, for inflection, the word *cats* is stored in the lexicon as *cat*, and recognized only after the suffix is stripped off, this algorithm applying to all regularly inflected nouns and verbs in English. It is noteworthy that the distinction Taft and Forster made was not one between inflectional and derivational affixation, nor between prefixation and suffixation, but between root or stem and affix. Taft and Forster made two other important points: the process of affix-stripping was *obligatory*, and *pre-lexical*, i.e., a word could not be sought in the lexicon before the affix was stripped off and the stem isolated. By this account, decomposition is an absolute requirement of lexical access, and the nature of the stem, free or bound, is irrelevant.

In Butterworth's *Full-listing hypothesis* (1983) model of lexical organization, conversely, every lexical item and each of its allomorphic variants have separate representation in the mental lexicon. By this account, decomposition of the input may well occur, but it does not take place prelexically, nor is it, for obvious reasons, a necessary procedure.

Much of the subsequent psycholinguistic and neurolinguistic research on the structure of the mental lexicon was undertaken within the framework of these mutually exclusive accounts of lexical organization. Some work previous to 1975 had provided support for the notion that suffixed words are stored in the lexicon in their base form (Kintsch, 1972, and Murrell and Morton, 1974). We may also look to later studies by Manelis and Tharp, 1977; Rubin, Becker and Freeman, 1979; Andrews, 1986; Tyler, Marslen-Wilson, and Rentoul and Hanney, 1988; and Emmorey, 1989, for work which does not wholly support the notion of a morpheme-based lexicon by which decomposition is an obligatory procedure for lexical access.

Gradually, "compromise" models were proposed to account either for new and sometimes disconfirming evidence (see references above), or for constraints imposed by the structure of a particular language.[10] These models, which came to be known as "dual-

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[10] Hankamer (1992) pointed out that the agglutinative nature of Turkish and Finnish, for example, makes the full-listing hypothesis unlikely because of the enormous number of multimorphemic forms that exist for every noun and verb in those languages, 2000 for a given Turkish verb root (p. 403). Conversely, a pure morphological-decomposition model will not account for the phenomena observed from psycholinguistic and neurolinguistic studies of Finnish speakers (Laine, 1995).

route models"[11], proposed that both full-listing and morphological decomposition strategies could be used for lexical access. Which of the two routes is used is determined by interacting characteristics of the words (e.g., lexical class, nature of the base form, frequency of occurrence). Pinker (1991) proposed a dual-route model based on experimental evidence whereby regular and irregular past tense inflections of verb forms are distinctly represented in the lexicon. The former are accessed and produced by algorithm (verb + affix-*ed*), and the latter are stored in what he termed an "associative memory structure," new forms being produced by generalization to the stored forms. The rule-based algorithmic procedure assumes decomposition, while the associative structure is akin to full-listing.

The model proposed by Laine, Niemi, Koivuselkä-Sallinen, Ahlsén, and Hyönä, 1994 (Stem allomorph/Inflectional decomposition model: SAID) also invokes the notion of dual-route, and comes from psycholinguistic and neurolinguistic data on the visual processing of written multimorphemic Finnish nouns. The model distinguishes inflectional and derivational processes, and also proposes the notion of non-unitary lexicon that has levels specific to certain modalities, in turn related to discrete channels for input and output. In the visual input lexicon and in the semantic lexicon, inflected nouns have morphologically decomposed representation, and all allomorphic variants of the stem have connections to form-appropriate inflectional suffixes. Derived nouns and base form nouns have whole-word representations "at these levels of the mental lexicon." Derived forms are easier to access than inflected forms because they can be reached via

[11] Note that in the literature on reading and reading disorders, the term "dual-route" refers to reading aloud via the lexical or the sub-lexical route. In the context above, the term refers to lexical access via either full-listing or via decomposition procedures.

the whole-word representation. In this model, the distinction of whole-word versus morpheme-based representation for inflection and for derivation is modified by the frequency of the word, for example, the most frequent inflected forms having both whole-word and morpheme-based representations. This notion of a non-unitary lexicon with modality-specific levels is proposed by various researchers in other studies (e.g., Taft 1988; Laudanna, Badecker and Caramazza, 1989; Badecker and Caramazza, 1991).

Elements of the two original contrasting proposals were combined in yet other dual-route models: one was the Augmented Addressed Morphology of Caramazza, Laudanna and Romani (1988), developed to account for Italian psycholinguistic data. This model referred specifically to a morphologically decomposed visual-input lexicon, and invoked the notion of speed of parallel processing using both full-listing and decomposition procedures (dual-route model). Inflected and derived words are not distinguished in this model. Familiar words are always accessed by full-listing regardless of their morphological complexity because this is the faster route. Unfamiliar multimorphemic words are accessed by morpheme decomposition regardless of morphological type. In the experiments from which the model was developed, the authors used non-words as the stimuli, a procedure that was criticized as inducing the use of special strategies not used in normal reading because non-words cannot have prior lexical representations (Taft, 1994).

Again, speed of access based on the surface frequency of a multimorphemic word, rather than distinctions based on morphological type and/or category, is the determining factor for the Morphological Race Model (Frauenfelder and Schreuder, 1992). High-frequency words are accessed by the full-listing route; for medium-frequency to low-frequency words, linguistic factors (phonological and semantic transparency) interact with frequency factors (cumulative frequencies of stem and affix) to determine which route will be used to gain lexical access.

All the early work used written stimuli, and from the results, inferences were drawn about language processing in general, regardless of input modality. With the advent of technology that allowed "on-line" research using auditory stimuli, models of spoken-word recognition were developed. Marslen-Wilson and Welsh (1978) proposed a model for the recognition of spoken words that invoked the concept of sequential access (Word-Initial Cohort). The initial string of phonemes activates for the hearer all possible lexical candidates, which are then continuously mapped against the input. The word is recognized at the point where it is uniquely distinguished from its competitors (the recognition point — the RP). The model is one of full-listing; it is simultaneously a stem-based theory, but *ipso facto* does not rely on decomposition. Monomorphemic and affixed words are treated in the same way, in that recognition requires first the identification of the stem, the identification of which rests on the stem's unique RP. "Non-prefixation" and prefixation are not distinguished in this model. For example, the words *press* and *depress* will have the same RP and be recognized at the same point in time because the stem has to be identified. Conversely, the model does distinguish monomorphemic and suffixed words. For example, the words *depress* and *depressing* will not have the same RP. The presence of the suffix will determine a later RP for the word *depressing*. By extension, then, the Word-Initial Cohort model differentiates prefixation from suffixation.

Taft's 1988 morphological-decomposition model was developed with reference to this influential model of continuous mapping in the auditory modality. It extended Taft and Forster's original affix-stripping model (1975), which itself had been modified by Taft's own subsequent research (Taft, 1981), as well as by that of others (some of which did not support the notion of decomposition, for which, see above). This 1988 model proposed modality-specific "access files" (for visually-presented stimuli, and for spoken stimuli), and a central system that is modality-free. Affix-stripping still occurs pre-lexically, and both inflected and prefixed derived words are accessed through the free-stem or bound-stem morpheme. The central lexicon contains orthographic and phonetic information about the word (e.g., its spelling and pronunciation), and a single entry in the central lexicon underlies both the orthographic and the phonetic input stimuli. Word frequency is integral to this model. Cumulative frequency (i.e., the frequency of all forms of the base word + related affixed words) has its effect at the level of the input lexicon where related morphological forms are accessed through the stem; surface frequency (the frequency of the actual presented form) is important at the level of the central lexicon where the affix is recombined with its stem.

A yet later evolution (Taft, 1994) proposed an interactive-activation model of lexical storage and access, using as framework the connectionist model of McClelland and Rumelhart (1981). Connectionist models of lexical organization made irrelevant the distinction between full-listing and decomposition. By a connectionist account of lexical access, in reading, for example, there is an interaction between the stored representations (units) and the visual perception of letters in various contexts, (words, letter strings, even non-words). In the language system, every unit is represented by a node. Nodes are located in separate levels, all of which mutually interact. Lexical access is achieved through simultaneous parallel processing of nodes at different levels, with spreading activation of both facilitatory and inhibitory mechanisms. While Taft's variant of this interactive-activation model continued to support decomposition, he made one important change: prefix stripping was no longer a pre-lexical obligation, now taking place inside the lexicon. Nevertheless, in his model, prefixes are considered independent units of activation and are still treated separately from the stems. Multimorphemic words continue to be represented in decomposed form.

Summary:

Initially proposed in theoretical models of lexical organization were two contrasting views which rapidly became the dominant framework for research: that of full representation for every lexical item, and that of obligatory pre-lexical morphological decomposition for every morphologically complex item. Although the initial experiment had investigated only prefixed-derived forms, the logic of the morphological-decomposition model applied also to inflected forms and suffix-derived forms. Within the framework of the contrast between the full-listing hypothesis and the morphological-decomposition hypothesis, compromise models of lexical organization (dual-route) have been developed. These compromise models have focused on distinctions within inflectional morphology (specifically verb forms), and variously have and have not distinguished access-procedures for the recognition of inflected as compared with derived words. The models discussed in this section have not specifically distinguished derivational prefixes from suffixes, with the exception of the Word-Initial Cohort model of auditory word-recognition. This stem-based model of lexical access and representation would distinguish prefixation from suffixation in that the two processes have differential effects on the recognition point of a word. Other models have been based on factors different from the morphological characteristics of the word: speed of recognition as a function of *familiarity* of the word and speed of recognition as a function of *word frequency*.

These dual-route models of lexical access, developed to account for new and/or disconfirming information, and information pertinent to other languages, have now become the framework within which much of the present work on lexical organization is pursued. Experimental studies (e.g., Taft, Hambly and Kinoshita 1986; Lima, 1987; Libben, 1993; Kehayia, 1993) have provided much evidence that the notions of full-listing and morphological decomposition are not mutually exclusive. Their respective contributions to lexical access are determined by various interacting factors, and are discussed in more detail in the following section.

1.4 Factors in Lexical Access and Production

1.4.1 Word frequency

In an early experiment in visual lexical recognition, Howes and Solomon (1951) showed that the recognition time for a word presented tachistoscopically is a function of the logarithm of its frequency of occurrence. This word-frequency effect, whereby high-frequency words are recognized and named more rapidly than words of low-frequency, is a robust phenomenon in studies of visual word recognition and naming (Forster and Chambers, 1973; Whaley, 1978; Taft, 1979). Debate has centered, however, on determining the class of words (open or closed) that enters into frequency-ordered search (Biassou, Obler, Nespoulous, Dordain and Harris, 1997; Bradley, Garrett and Zurif, 1982; Gordon and Caramazza, 1982; Segui, Mehler and Frauenfelder and Morton, 1982), and which part of the word provides the determining frequency for lexical access for multimorphemic words (Taft and Forster, 1975; Taft, 1981). Researchers have manipulated word frequency in attempts to answer those questions, and to determine to what extent a base word and its inflected or derived forms are stored separately as fully-listed forms, or in a manner requiring decomposition. Differences in other aspects of morphological structure have also been explored via contrasts in word frequency: for example, the representation of inflectional morphology; the differential representation and processing of prefixes and suffixes; and any differential among derivational suffixes themselves.

Bradley (1980) investigated the question of full-form listing versus decomposition among derivational suffixes. She manipulated word frequencies in a visual lexical decision task to investigate whether the lexical "address" for the representation of a derived noun also contained the representation of the base form and other related forms, or whether the derived form had representation independent of its other related forms. Sets of word-pairs were constructed to contrast the frequency of occurrence of a particular word-form (F_p), e.g., *briskness*, versus the cumulative frequency of occurrence (F_c), e.g., *brisk, briskly, briskness*. Sets of pairs were matched for value on F_p and contrasted on F_c; other sets were matched for value on F_c and contrasted on F_p. For example, *sharpness* and *briskness* are matched on F_p, but contrast on F_c: conversely, *happiness* and *heaviness* are matched on F_c, but contrast on F_p. Sensitivity to the F_c of a target word, in terms of the distribution of reaction times, would indicate that the word was stored and accessed via its stem, whereas sensitivity to the F_p would imply an independent listing for that particular word. Results showed a contrast in storage among the three suffixes *–ness*, *–ment* and *–er* on the one hand, and *–ion* on the other. The response time for a word in *–ness*, e.g., *sharpness*, was reliably tied to the cumulative frequency (F_c), while response time to a word in *–ion*, e.g., *elevation* was tied to its particular frequency (F_p). Bradley proposed that common storage of the stem and its derived forms would lead to sensitivity to the cumulative frequency effect, arguing that these derived forms were decomposed and accessed through the stem form. Conversely, results for the words suffixed in *–ion* showed that the frequency of only the surface form was the predictor of response time, evidence that the derived form is itself fully-listed, and stored separately from the base form (but see also Gordon and Caramazza (1982) for disconfirming results).

Using a similar paradigm to that of Bradley (1980), Taft (1979b) investigated whether prefixed words from the same are stored together, or stored as separate entries in the lexicon, either access procedure requiring decomposition. The theoretical underpinnings for the experiments were the two major models of visual word recognition current at that time, both based on the effect of word frequency: a frequency-ordered serial search (Forster, 1976), and the frequency-based logogen model (Morton, 1969). By this latter account, every lexical item has an intrinsic "resting" and "activation" level, determined by its frequency. The higher the frequency, the less sensory input is required to activate the logogen representation of the word and make it available to the reader. Taft's study (1979b) itself was an extension of an earlier study by Taft and Forster

(1975), which had shown strong evidence in support of morphological decomposition in the visual recognition of prefixed words, i.e., lexical access was achieved via the stem of the prefixed word, even if the stem was not an autonomous word (e.g., "*–suade*" in *persuade*). The corollary, therefore, was that both *persuade* (frequency, 17 per million) and *dissuade* (frequency, 3 per million) would be accessed via the stem *–suade*, and, crucially for the 1979 experiments, the recognition time for either of these two exemplar prefixed words would depend on their cumulative frequency of 20 per million (the notional frequency-ordered position of the stem *–suade* in the lexicon). If recognition times were similar regardless of the difference in surface frequency, then this would imply access via the verb-stem for all words derived from the stem, real-word stem or not (single-entry access). Conversely, if words with the same stem are stored separately, then recognition time for the words would be reliably tied to the surface frequency. This would mean "separate-entry access." Note that separate-entry access here does not mean "full-listing," as articulated by Butterworth, 1983. In Taft's model, both single-entry and separate-entry lexical storage require decomposition of the affix from the stem. Indeed, as has been remarked above, Taft has always maintained the model of morphological decomposition, though he has varied its details in response to continuing research.

In Experiment 1, prefixed words were chosen in pairs. Words of high-frequency stem (e.g., *–proach* as in *reproach* compared with *approach*) were paired with words of low-frequency stem (e.g., *–suade* as in *dissuade* compared with *persuade*). The words were matched within pairs for surface frequency, and also for the number of words derivable from the stem that were of higher frequency than the word presented. This matching was required in order to balance the two conditions for the number of possible interfering candidate words in each case (recall that the model posits lexical search to be based on an ordering by frequency). The same paradigm was used in Experiment 2 for inflected words (therefore suffixed). The results of the experiments showed that lexical decision times for both prefixed and inflected words were reliably tied to the frequency of the stem, both non-word stems (e.g., *–suade*) and free morpheme stems (e.g., *like*). These results were interpreted as evidence that words related by affixation are stored as single-entry items, the affixed forms accessed via the stem following morphological decomposition.

In Experiment 3, the design was altered. Inflected words were again investigated, but now the frequency of the stem form was held constant and the surface frequency varied. Results conflicted with those of the first two experiments. For Experiment 3, it was not the stem frequency that influenced the reaction times, but the surface frequency. Logically, of course, this is evidence for the separate-entry storage and access of related words. Taft accounted for this apparent conflict by appeal to a model of visual word recognition where lexical access can be conceptualized as taking place in two distinct stages (Forster, 1976; Taft, 1979). A "master file," the lexicon itself, stores the sum of information about every lexical entry, and all forms of a word are represented there in some form. In addition, "peripheral access files" relating to different input and output modalities (orthographic, phonologic, and semantic) store relevant representations and these are directly linked to an entry or entries in the master file. With reference to orthographic input, each orthographic lexical representation is the "basic orthographic syllable structure" (the BOSS). The peripheral file needs to provide only enough information for the correct entry to be found in the master file (i.e., the stem or the BOSS of the word). Taft proposed that words are stored in their stem forms in the peripheral file, but in the full surface form in the master file (emphasis added). Thus, the results of the three experiments could be reconciled by assuming that both stem frequency and surface frequency influence recognition time, because word frequency has an effect at two different stages of the visual recognition process: the peripheral file and the master file. Note that this notion of a modality-free master file and modality-specific "access" files resurfaces in Taft, 1988.

In a later production study, Anshen and Aronoff (1988) provided converging evidence for (de)composition procedures in that their results showed *-ness* forms to be constructed by rule as needed, rather than stored. Burani and Caramazza (1987) demonstrated effects of both the frequency of the whole-word and that of the root form for visual lexical decisions on Italian derived words formed with highly productive derivational suffixes (e.g., *-zione*, *-mento*, *-tore*). This effect was interpreted as further evidence for dual-route processing, i.e., lexical access by both whole-word as well as by morphological decomposition.

Differential processing for prefixed and suffixed words has also received some attention. Colé, Beauvillain and Segui (1989), working in French, manipulated surface frequency and cumulative root frequency within visual lexical decision tasks to examine the recognition of prefixed and suffixed words. Their results provided evidence that only suffixed words (as opposed to prefixed words) are accessed through the stem morpheme, this giving access to all the morphologically related words, which are then examined in a frequency-ordered search. Consistent with these findings, Meunier and Segui (1999), working within the framework of the Word-Initial Cohort Model (Marslen-Wilson and

Welsh, 1978), showed that auditory lexical decision times to suffixed derived French words of high and low frequency varied as a function of the word's frequency position in the morphological family. All members of the morphological family share the same lexical entry. The members are organized according to surface frequency, and compete with each other for primacy in lexical access procedures. Based on the results of a cross-modal priming study in French, Meunier and Segui (1999b) continue to propose a frequency-based model of lexical representation for suffixed derived words and their stems. In this model, a derived word of low frequency is represented only in decomposed form: a derived word of high frequency is represented both in full form, and as decomposed into its constituent morphemes.

Evidence that word frequency is found to affect *inflected* forms differentially has come from both psycholinguistic and neurolinguistic experimental studies. Stemberger and MacWhinney (1986) proposed that regular verb forms of high frequency are stored lexically while those of low frequency are constructed as needed. Using a visual lexical decision task, Gordon and Alegre (1999) found frequency effects at all frequency levels for the morphologically simple control words, but no frequency effects were found for inflected forms of very low frequency (below 6 per million).

Goodglass and Berko (1960) described a hierarchy of impairment in the production of grammatical form in agrammatic aphasic people. In addition, clinical observation shows that agrammatic speakers of English may read irregular past verb forms correctly while inconsistently omitting the regular past tense marker *–ed*. This relative disruption gives empirical support to the notion of differential representation of regular and irregular verbs (Pinker, 1991), that regular past tenses are subject to decomposition routines, and constructed as needed, but irregular past tenses are lexicalised. Even so, some mode of common access based on frequency must be present because Kelliher and Henderson (1990) showed from lexical decision latencies in English that the frequency of the citation form (i.e., the English verb infinitive) was the reliable determinant of recognition speed for irregular past tense forms, even though the citation forms were not presented to the participants in the study.

It is clear from the studies discussed above that word frequency is a potent organizing principle of the lexicon, at least in terms of visual and auditory recognition, and in speed of naming. The cumulative root frequency, surface frequency, as well as the frequency of the stem in the case of complex words have all been shown to have differential effects.

1.4.2 Word length

Word length can be measured by the number of phonemes, letters or syllables in the word. Most relevant for the proposed study are the latter two. As we see in the following examples, derivation almost always involves an increase in the length of a word by one or two syllables, and if not length, then stress assignment changes: *joy–joyful–joyfulness, command–commandment, flesh fleshy*; but see also, for example: *lethargy leth'argic, melody me'lodic.*

The effects of word length have been well documented for one sub-set of Broca's aphasics, those with apraxia of motor speech. Multisyllabic words provoke more speech errors than monosyllabic words (Nespoulous, Lecours and Deloche, et al., 1981, cited in Wertz, LaPointe and Rosenbek, 1984). Errors increase as a function of word length but tend to occur on those phonemes common to all the words in a set of related words, e.g., the /ʤ/ or /b/ in *jab, jabber,*) *jabbering*[12] (Johns and Darley,1970). Lastly, connected speech can reveal difficulties in production that are typically obscured in the production of monosyllabic words (Shankweiler and Harris, 1966). The effects of increased word length for agrammatic speakers without apraxia of motor speech[13] have been documented in a number of studies (Miceli and Caramazza, 1988; Badecker and Caramazza, 1991, Libben, 1993; Meth, 1998). However, very few aphasic speakers, even when not apraxic, are free from difficulties in phonological assembly and output, and to this extent word length will have an effect on production.

1.4.3 Morphophonological change

The phenomenon of morphophonological change in derivation was briefly described in 1.2, but without reference to theoretical underpinnings. A dominant theoretical model continues to be Kiparsky's Lexical Phonology (1982). In this model, both words and morphemes are represented in the lexicon, derivational procedures operating in a hierarchical fashion. Each level in the hierarchy has its own set of suffixes and phonological rules which must be applied to the formed word before it is passed on to the next level. Suffixes designated as Level 1 (e.g., *–ion, ive, ic, ity*) are those that on attachment to the stem cause phonological change in one of the following ways:

[12] This is not to ignore the fact that some phonemes and phoneme combinations are more likely than others to provoke error, even in unimpaired speakers, and especially for people with aphasia (compare /p/, /l/, /t with /pl /, /sl/, /str/. In addition, fewer errors are seen on simple CV combinations (e.g., *run, easy*) than on consonant blends and clusters (e.g., *stretch, tusks*).

[13] We should note here apraxia and agrammatism are possible overlapping conditions in Broca's patients.

i. stem-final change without orthographic change (*congest-congestion*); ii. stem-final change with orthographic change (*conclude-conclusion*); iii. stem-final and stem-internal phonological change and orthographic change (*assume-assumption, receive-reception*); iv. change in stress assignment (*'decimate-deci'mation*).

In contrast, those suffixes designated Level 2 (e.g., *–ment*, *–ness*, *–ful*) do not cause phonological change in the stem. The suffix is attached to the stem (though there may be orthographic changes) and the stem remains an autonomous word (e.g., *merry-merriment, kind-kindness, rest-restful*). This hierarchical model accounts also for the order of attachment of different levels of suffix to the stem word, Level 1 suffixes preceding Level 2 suffixes.[14] An important aspect of this linguistic phenomenon is the possible change in stress assignment caused by a Level 1 suffix. Irrespective of the placement of stress in the stem word, a Level 1 suffix assigns primary stress to the syllable immediately preceding the suffix (e.g., *'senior-seni'ority, 'speculate-specu'lation*). Native speakers know implicitly where to assign stress in previously unencountered derived word (e.g., *coalifi'cation, dirigi'bility, e'daphic*), in nonce words and even in non-words, as was illustrated in 1.2. Clinical observation reveals, however, that aphasic speakers typically experience some difficulty with stress assignment, and increased difficulty producing unstressed syllables, especially in the initial position. Goodglass (1968) reported on the frequent omission of an initial unstressed word in a phrase. In a previous study of the effects of length and stress change on the production of suffixed derived words, Mathews and Obler (1997) showed that stress change in

[14] The dichotomy between Level 1 and 2 suffixes has different designations in the literature: respectively, phonologically opaque and transparent; weak-boundary and strong-boundary; phonologically nonneutral and neutral; cyclic and noncyclic. I shall retain the Kiparsky taxonomy.

derived forms provoked errors in excess of those provoked by the lengthening of the word. In addition, there are case study reports of aphasic speakers, both Italian-speaking, who demonstrated a selective impairment in the ability to assign stress in polysyllabic words (Cappa, Nespor, Ielasi and Miozzo, 1997; Laganaro, Vacharessa and Frauenfelder, 2001). The above observations certainly indicate that the rules for stress assignment are instantiated together with the suffixes in the mental lexicon and can be differentially impaired in acquired brain injury.

The morphophonological distinction between Level 1 and Level 2 suffixes has formed the core of the debate concerning the lexical representation of complex words (e.g., Bradley, 1980; Burani and Caramazza, 1987; Anshen and Aronoff, 1988). Working within this framework, Tsapkini, Kehayia and Jarema (1999) investigated whether phonological change in derivation "is reflected in on-line psycholinguistic performance" of word recognition (p. 318), proposing that if derived words are decomposed during word recognition, then the presence of phonological change would be reflected in longer decision latencies on Level 1 words because of the added processing operations. The authors administered three visual lexical decision tasks within a priming paradigm (simple lexical decision, visual priming, and cross-modal priming). While input modality had some effect, overall decision latencies on the Level I derived words were significantly longer than were those on Level II words. The study did not address the issue of full-listing versus decomposition, in fact decomposition was assumed for Level 1 words as well as for Level 2 words. However, the results do provide further evidence for a distinction between those derivational processes that involve phonological change and those derivational processes that do not, at least in terms of word recognition.

The issue of full-listing versus decomposition in Level I and Level 2 derivation was addressed by Vannest and Boland (1999) in two visual lexical decision experiments. The underlying theoretical framework was Kiparsky's (1982) Lexical Phonology and Morphology. The authors investigated the hypothesis that Level 1 suffixed words are fully-listed in the lexicon, whereas Level 2 suffixed words undergo morphological decomposition. The experimental paradigms were adapted from the word-frequency paradigms of Taft (1979) and Bradley (1980). The data from the authors' two experiments suggest that Level 1 derived words are fully listed, and that in some circumstances, Level 2 derived words are decomposed. According to their interpretation, decomposition depends both on the affix itself, and on whether it forces phonological change on the stem.

1.4.4 Phonological output

The presence of phonological impairment in non-fluent (Broca's) aphasic speakers must be taken into account in any study of speech production with such participants. This is especially important where their responses will provide evidence for claims concerning the nature of the aphasic disruption, and for more extended claims concerning the organization of the mental lexicon. While the exact specifications are not agreed upon, there is consensus in the field of research into speech production that lexical access for speaking requires at least two distinct levels of mental representation, including a semantic-syntactic level, and a phonological level. Evidence for the validity of this conceptualization comes from a number of different sources. Normal speakers experiencing the tip-of-the-tongue phenomenon (TOT) have access to the semantic features of the word (Brown and McNeill, 1966), and to the syntactic features (Vigliocco, Antonini and Garrett, 1997), but there is no access, or only incomplete access, to the phonological form. Both Levelt (1989) and Garrett (1988) have distinguished semantic-syntactic processes from phonological processes. Based on his study of naturally-occurring speech errors (word and sound exchanges) in normal speakers, Garrett proposed a model of sentence production that distinguishes different levels of representation. At the *functional* level, there is access to the lexical-semantic representation of a word plus information about its argument structure; at the later *positional* level there is access to the word's phonological representation. This representation is mapped onto phonetic and articulatory representation, and lastly realized as a spoken word. Further evidence for an early stage of lexical semantic activation followed later by phonological encoding is provided by psycholinguistic studies, and by electrophysiological studies on the time course of speech production in unimpaired speakers (Peterson and Savoy, 1998; van Turennout, Hagoort and Brown, 1997).

The TOT state can be quite marked in aphasic speakers, especially anomic speakers (e.g., Goodglass, Kaplan, Weintraub and Ackermann, 1976). The authors interpreted the naming errors from these aphasic speakers as indicating the ability to achieve appropriate access to semantic representations, but the inability to maintain the word's phonological shape, and/or difficulty in bringing the word to articulation.

Miceli and Caramazza (1988) investigated the repetition errors of an Italian-speaking aphasic patient. Note that while the authors reported neurological information and described a language profile both consistent with a non-fluent aphasia, and with agrammatism in particular, they did not classify the patient as such. In this study, which is discussed in detail in 1.5, the patient repeated lists of words, specifically designed along different language dimensions. The point to be made here is that the patient had difficulties with phonological processing, and the authors devoted considerable energy to a careful explication why the patient's patterns of error were "not reducible to a phonological processing disorder" (p. 48), and why "the putative morphological errors [were], afterall, (*sic*) really morphological error" (p. 53).

The foregoing has relevance to the present study in that oral reading errors of aphasic people have typically been classified as semantic, visual or phonological, with a further category of morphological error in studies where that has been the focus. Unequivocal assignment of error to a specific cause is not, however, always so easy. The assignment of semantic error is usually straightforward, though its actual provenance may be somewhat obscure (e.g., *emerald* → *shamrock*, *catapult* → *deliver*). Conversely, it is an open question as to which error category the word *bless* → *bliss* should be assigned: visual, phonological, or even semantic? It is clearly a "different word" but where does the error arise? Visual errors have been shown sometimes to have a phonological basis (Goldblum, 1985, Katz and Lazzoni, 1997); thus what is taken as a morphological error, may well have a quite different underlying cause. For example, Luzzatti, Mondini and Semanza (2001) point out that the substitution of *liberal* for *libertine* may well be a morphological error, but could equally be a semantic, visual, or phonological error.

Another important factor is the instance where a literal paraphasia, sometimes a change in a single phoneme, produces a different word altogether, but one with close phonological and/or visual resemblance to the target word, e.g., *cantaloupe* → *antelope*, *wider* → *wiser*. Again, it is not an easy task to decide whether such responses reflect visual-input or phonological-output error, or should indeed be counted as an error. There is clearly no neat solution for all instances; and depending on the parameters of correctness and error, responses would be differently assigned, which in turn has implications for the results of the study. Therefore, in developing the Coding Taxonomy, the niceness of these distinctions was kept in mind, and a framework constructed such that instances could be minimized where claims were made for an error response that arguably could be differently interpreted. The overall goal was to develop a coding taxonomy that could consistently capture the variability and highlight the richness of the participants' responses without fractionating the coding to such an extent that meaningful conclusions would be difficult to draw. The specifics are laid out in the Coding Taxonomy, Chapter 3.5.

Summary: This section has examined four factors that have been shown to influence lexical access, and putatively the processing and production of derived forms:

i. Word frequency: Overall, high frequency items are more readily available than low frequency items.

ii. Word length: Longer words have indeed been shown to be more difficult for aphasic speakers than shorter words. Derived words may, therefore, be more problematic for aphasic speakers because they are longer than their stem or base forms.

iii. Morphophonological change: Evidence has been presented for the differential storage, and by extension, access procedures, for Level 1 and Level 2 derived forms, and for increased processing time for the recognition of Level 1 derived words. With its entailment of re-assignment of stress, and, variously, stem-internal and stem-final changes, Level 1 derived words may be expected to occasion increased production problems for agrammatic speakers than do Level 2 words.

iv. Phonological output: Aphasic speakers are rarely free from disturbance in phonological output, a feature that has to be taken into account in coding the responses in a production study. This is especially important in studies where an error may be assigned to one category, but arguably have a different underlying cause, and where claims may be made concerning the nature of lexical processing.

1.5 Breakdown of Derivational versus Inflectional Morphology in Agrammatism

Studies of language breakdown after focal brain damage have supported the claim that a word is represented in the mental lexicon in terms of its morphological constituents. Clinical observations and controlled studies of aphasic speakers have shown that the language system does indeed differentiate stems from affixes (Tyler, Behrens, Cobb and Marslen-Wilson, 1990; Badecker and Caramazza, 1991; Laine, Niemi, Koivuselkä-Sallinen, Ahlsén and Hyönä, 1994). Further evidence for this differentiation comes from reports of speakers with jargon aphasia who attach correct inflectional and derivational affixes to neologistic stems (Butterworth, 1979; Buckingham and Kertesz, 1976; Panzeri, Semenza, Ferreri and Butterworth, 1990).

Much of the literature on the breakdown of morphology in agrammatism has focused on inflectional morphology, and how such breakdown informs models of lexical representation (Bates, Friederici and Wulfeck, 1987; Kehayia, Jarema and Kadzielawa, 1990; Jarema and Kehayia, 1992; De Bleser and Bayer, 1990; Badecker, 1997; Penke, Janssen and Krause, 1999). Until recently, by contrast, the status of derivational morphology in agrammatism has received less attention, and the notion of its relative preservation somehow took shape in the field as fact. As discussed in a previous section of this chapter, it has been proposed that derived words are represented independently as full-forms (as are monomorphemic words) (Stanners, Neiser, Hernon and Hall, 1979; Butterworth, 1983). By this account, therefore, derived words should be no more subject to disruption than monomorphemic words. Recent studies have nevertheless shown that in agrammatic aphasia, derivational morphology can be subject to disturbances like those seen in inflectional morphology (e.g., Job and Sartori, 1984; Libben, 1994). Patterson (1980) noted patterns of error in the oral reading of single words by two patients with deep dyslexia. Apart from semantic and phonological substitution errors, these patients (DE and PW) also made numerous morphological errors involving both inflection and derivation. In their reading corpora, errors on inflected and derived words involved suffix deletions, additions and substitutions. However, among the criticisms leveled against Patterson's conclusions was the fact that she did not systematically distinguish inflectional and derivational suffixes, and furthermore, that errors interpreted as morphological could have had a semantic, visual, or phonological cause (Badecker and Caramazza, 1987; Luzzatti, Mondini and Semenza, 2001). Consequently, later researchers have been interested not only in distinguishing inflectional and derivational processes in language breakdown, but also in separating from true morphological errors, those errors which appear to be morphological, but which are, in actuality, visual, semantic or phonological.

An asymmetry in performance on inflectional and derivational morphological tasks has been remarked in a number of investigations (e.g., Tyler and Cobb, 1987). This observed asymmetry forms the essential point of Miceli and Caramazza's (1988) case study of an Italian-speaking patient, FS. The study was undertaken within the framework of the Strong Lexicalist Hypothesis (Lapointe, 1979), which claims that the operations of both inflectional and derivational morphology are located in the lexicon. A further assumption (following Aronoff, 1976, and Anderson, 1982) is that inflectional operations and derivational operations are "functionally distinct processes" (p. 25 of Miceli and Caramazza's study). The scope of this paper is extensive. In unraveling possible explanations for the patient's patterns of repetition errors, the authors make closely-argued and rich reference to a number of the then-current theories of lexical organization. They discuss their data in terms of alternative accounts that could be offered as explanations, examining each in detail. From detailed analyses of the patient's spontaneous speech,[15] and his responses on the repetition tasks, the authors conclude that they have provided very strong evidence for the functional dissociation of inflectional and derivational morphological processes within the mental lexicon, and therefore the possibility of selective impairment to either in brain damage.

The spontaneous speech of the patient in this study was characterized by grammatical errors, e.g., omissions and mis-selections of free-standing grammatical markers and of inflectional suffixes, and violations of subject/verb agreement. FS was presented with a list of words and non-words for repetition (1832 words, and 283 non-words). The lists were controlled along various dimensions: inflectional vs. derivational affixation; presence/absence of prefix vs. pseudo-prefix; part of speech; word frequency;

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[15] The authors do not classify FS as agrammatic. The authors imply that FS is an agrammatic speaker, with reference to a comparison of his speech "together with the performance of another patient whose speech would also be clinically classified as "agrammatic" and a matched normal control subject" (pp. 31-32).

word length; and morphological complexity. Results showed a severe impairment in the ability to repeat single words. The patient's error score was 919/1832 (50.25% error). From a close analysis of the pattern of errors on words and non-words, Miceli and Caramazza concluded that FS' impairment was characterized by morphological error rather than by lexical or phonological error, although FS did have a concomitant disorder of phonological processing. Crucially, however, the full corpus of FS' morphological errors showed a very marked difference between inflectional and derivational items. Of his total errors, 96.7% -occurred on inflected items compared with 3.3% error on derived items. Furthermore, FS also showed a distinction between prefixes and suffixes in his ability to repeat, with prefixes much better preserved. FS' impairment in morphological processing was judged to be restricted to suffixes, in particular to inflectional suffixes.

There were many more inflected words than derived words in the stimulus set, a fact that, according to the authors, may have biased the findings. The authors therefore undertook *post hoc* analyses of various subtests as well as the presentation of new word-lists, to investigate whether FS made fewer errors on derived forms because there was less opportunity to do so, or whether derivational processes were indeed better preserved than inflectional ones. The results of the analyses reconfirmed the striking contrast between inflectional and derivational processing in this patient (for the repetition task), with inflectional processing markedly more impaired than derivational. An analysis of a subset of 305 suffix-derived words from the total stimulus set showed the following results: 64.1% (109) of FS' error responses were morphological, of which 52.9% (90) were inflectional error and 7% (12) were derivational error (the remaining 7 responses were uncodeable).

Yet, while these authors report lesser impairment in the processing of derivational morphology than in inflectional morphology as revealed on these repetition tasks, they nevertheless conclude that derivational processing in this patient was "not entirely normal" as he made a "nonnegligible proportion" of derivational errors (10.3%) (p. 42). Interestingly, there is a later somewhat contradictory report concerning the extent to which FS could be considered impaired in derivational morphology. In reviewing the literature pertinent to their own case presentation, Badecker and Caramazza (1991) describe this patient, stating that "derivational morphology was virtually unaffected" (p. 337).

In a study in which derivational and inflectional operations were directly compared (as in the case of the polyvalent word-final *–er*), better preserved performance on the former has been reported. Badecker and Caramazza (1987) reported reading errors from their study of an English-speaking patient, FM. This patient was more successful in reading pseudo-affixed words (e.g., *corner*) than derived agentive *–er* words (e.g., *driver*), and more successful in reading the derived agentive *–er* words than inflected *–er* words (e.g., *taller*), all of which were matched for letter length and frequency. By controlling for stem frequency and surface frequency factors, but maintaining the agentive/comparative distinction in lists of words extracted from the original lists, the authors showed that FM produced morphological errors of deletion and substitution that affected inflection more than derivation. Even so, derivation was not totally spared.

Concerning the question of full-form storage or on-line composition of morphologically complex items, Badecker and Caramazza, (1991) described a female patient, SJD, who presented with problems in the production of morphological form.

Comprehension of morphologically complex words was unimpaired. Her production errors, however, could be attributed as much to impairment in phonological processing and assembly as to impairment in morphological processing. The authors were able to show, however, that at least some of SJD's errors were directly attributable to a morphological deficit. Analysis of the patient's reading errors on controlled lists of single words and sentences showed that firstly, when she made errors on affixes, and in so doing produced non-words, SJD substituted other affixes. Secondly, in a comparison of homophone words matched for suffixation and non-suffixation pairs of words, e.g., *frays phrase*; *teas* tease; *links lynx*, the suffixed words not only induced more errors than the non-suffixed, but the dominant error type was morphological (*bowled* → *bowling*; *chilly* → *chill*). The dominant error type for the non-suffixed words was a phonemic word error (*bread* → *breast*; *mode* → *code*). Thirdly, SJD made errors that appeared to be a combination of morphological and phonological impairment, e.g., *influence* → [influ'ential] → /ɪnfə'bɛnʃəl/, the bracketed item, according to the authors, being the hypothesized intermediate representation. Fourthly, SJD produced a number of non-words that were comprised of illegal combinations of a real word and a real suffix (e.g., *newer* → *newing*; *involvement* → *involveness*; *dangerous* repeated as *dangerment*). These neologistic constructions, consisting of real stems and real affixes that nevertheless violate rules of combination, involved both inflections and derivations. This phenomenon supports claims that the speech production system composes at least some morphologically complex words on-line, and furthermore that the procedures for composing derived words can be disrupted as can those for composing inflected words.

SJD's production of inflectional and derivational suffixes was directly compared. Fifty high-frequency and fifty low-frequency inflected words were matched in frequency and length to derived words (e.g., *listed*, *useful* (high-frequency inflected and derived respsectively) and *switching*, *joyous* (low-frequency inflected and derived respectively). SJD showed no notable tendency to read the derived forms more correctly than the inflected forms (77% derived and 70% inflected). Morphological errors were the predominant error category for both inflection and derivation while other error types (visual and semantic) were roughly equal across the comparanda. Error rates for inflected words were: 23% morphological; 4% visual/phonemic (word); and 3% phonemic (non-word). Error rates for derived words were: 14% morphological; 5% visual/phonemic (word); and 4% phonemic (non-word). Clearly, for this patient not only was inflection impaired, but so was derivation. (See Miceli, 1994, for a detailed review of these studies).

Other aspects of breakdown in derivational morphology have received attention. In a previous study, Mathews and Obler (1997) investigated the effects of increased word length and stress shift on the production of derivationally related words by a group of agrammatic speakers. Three matched lists of words were constructed: a base-word list, and two lists of words, both derived from the base word. Between the base form and the simpler derived form, e.g., *magnet, magnetize; local, localize*, there was a consistent increase in the number of syllables, but no change in stress assignment. Between the simpler and the other derived form there was a consistent change in stress assignment, but some pairs increased in syllable number, while other pairs maintained the same number of syllables, e.g., *magnetize, magnetic; localize, locality*. Participants read the words aloud, pseudorandomized among a list of foil words. Results showed that stress shift increased the likelihood of error in producing a derived form, independently of word length.

This notion of an increase in phonological complexity reducing the resources available for morphological processing gives support to Libben's (1990) findings in the case-study report of an aphasic patient, JZ. JZ was a left-handed college-educated man who suffered a right middle cerebral artery infarct at the age of 48. Initially diagnosed as a Broca's patient with severe expressive difficulties, his speech was characterized as agrammatic. JZ had no difficulty with the comprehension of complex words, but rather, he showed a specific production deficit. Across output modalities, i.e., repetition, writing to dictation and spontaneous production, JZ showed impairment in the correct production of derived words where affixation forces a morphophonological change across the formative boundaries. Instead of the derived word, JZ produced the underlying form of the constituents of the derived word. For example, *irregularity* was repeated as **inregularity*; *illegal* repeated as **inlegal*. JZ showed no such difficulty with derived words that did not force phonological change across formative boundaries, e.g., *unhappiness*, *materialism*, and *ungratefulness* were all repeated correctly. JZ also showed a tendency to maintain the stress on the syllable assigned in the underived form (*repair*), e.g., *ir'reparable* was repeated as **inre'parable*. Overall, JZ's error patterns were interpreted as suggesting that correct performance was inversely related to the number of computations required by the derived form.

Summary

The literature on morphological breakdown after focal brain damage complements evidence from psycholinguistic studies that the mental lexicon is structured according to morphological principles, though of course no claim is made that this is the only organizing principle. Studies of the performance of agrammatic speakers on tasks targeting inflectional and derivational morphology have been used to delineate more closely those principles. Breakdown of inflectional morphology is established. Earlier studies presented conflicting reports concerning the status of derivational morphology. While it was initially regarded as relatively preserved in contrast to inflection, there is now a developing literature which suggests that derivational morphology is also subject to impairment in agrammatic aphasia.

CHAPTER 2

OVERVIEW OF THE STUDY

2.1 Rationale

This study investigates whether the disturbances reported in the literature and similar disturbances observed clinically by the author, appear to be a feature of agrammatic speakers more generally.

This study addresses the following questions:

1. To what extent is derivational morphology disrupted in agrammatic speakers?
2. Which linguistic factors have an effect on the relative preservation or disruption of derivational processes?
3. Is the relative preservation or disruption of derivational morphology a function of the derivational suffix itself?

In this study, agrammatic speakers were presented with lists of single words for reading and for repetition. The reading and repetition of controlled stimulus items is a well-established paradigm in neurolinguistic research. The use of controlled stimuli, selected to highlight specific aspects of language, often reveals phenomena not readily observable in spontaneous speech. Patterns of error in such tasks help delineate the nature of the aphasic impairment, and further allow us to make some inferences concerning the organization of the undamaged language system.

Each experimental stimulus list was designed according to a factor that relates to derivational morphology. Four factors were examined; thus there were four experimental lists which are reported in what follows as Experiment I through Experiment IV (total

414 words).[16] A list of foil words (F Words – 186 words) was constructed. For presentation to the participants, the planned experimental word lists (i.e., Experiments I-IV, and Experiment V), plus the list of foil words were merged into what was then termed the master list (total 600 words). The master list was then appropriately pseudo-randomized into 12 matching sets of 50 words each, as described below. These sets were then named the Presentation Sets 1-12.

The candidate factors follow in 2.2 with a general description of the related experimental tasks. The general procedures for the construction of the experimental lists follow in section 2.3. The specific details for the construction of each experimental list (Experiment I – IV) are laid out in Chapters 4-7 respectively, immediately preceding the results and discussion of each experiment. The details of the construction of the foil word list are provided in 2.4. Section 2.5 describes the procedure for the construction of the presentation sets. Section 2.6 describes the construction of the practice words. Lastly, section 2.7 describes the standardization of the experimental tasks (reading and repetition.

2.2 Description of the Factors Tested

Experiment I: Monomorphemic versus Derived Words: 120 words total (Chapter 4)

What is the effect of derivation when monomorphemic and derived words of the

[16] As the study was originally prepared, there was a further set of 66 words, planned as Experiment V, and divided equally among a set of base forms (22 words of 2-syllables) and 2 sets of words of 3 and 4-syllabls) derived from that base form (22 words per set). These 66 words formed part of the corpus on which was based the structure of the Foil Word list, and that of the Presentation Sets. They were presented to the participants for reading and repetition. The data were coded, but were subsequently set aside for the purposes of this study. There were, therefore, 600 words in the total Presentation Sets.

same syllable length are compared? This experiment compares trisyllabic monomorphemic words (e.g., *hyacinth, vestibule*) with trisyllabic derived words, with both free and bound stems (e.g., *venomous, therapist*).

Experiment II: Word-final–ER: 90 words total (Chapter 5)

An interesting contrast is afforded in English by the word-final –ER. It may appear as a final segment on a monomorphemic word, with no morphological function (e.g., *cider, panther*), and as both an inflectional and a derivational suffix, respectively marking the comparative adjective and the derived agentive (e.g., *richer, wider: swimmer, mourner*). The research question asks what the processing differences are among these three uses of one phonological shape. Comparison permitted an examination of monomorphemic versus derivational versus inflectional processing.

Experiment III: Morphophonological Change: 96 words total (Chapter 6)

What is the effect of morphophonological change on production? The comparison in this experiment was between two sets of 3-syllable derived nouns, both sets terminating in denominal suffixes. Derived nouns ending in *–ion* (Level I) require stem-final and/or stem-internal changes, thus the stem of the derived form is bound (e.g., *confuse–confusion; congest–congestion*). This set was contrasted with a set of derived nouns ending in *–ment* (Level II) where the stem is a free morpheme (e.g., *recruit recruitment*; *conceal concealment)* and suffixation requires no phonological change or reassignment of syllable structure.

Experiment IV: High-Frequency Suffix versus Low-Frequency Suffix: 42 words total (Chapter 7)

Taft and Forster's initial prefix-stripping model (1975) requires that free-stems and bound-stems have representation in the lexicon, a representation that is based upon the cumulative frequency of occurrence. By corollary, affixes would also be represented in the lexicon, also arguably by some frequency count. The question for derivation then is whether the frequency of the suffix is, itself, a factor. The comparison in this experiment was between two lists of paired words, both derived from a single base word. One derived word had a suffix of high frequency, the other word a suffix of low frequency. For example, *theorist* - *theor* *(stem)* - *ist* *(high frequency suffix)* versus *theorem* *theor* *(stem)* - *em* *(low frequency suffix)*. Suffix frequencies were calculated from frequency counts culled from a corpus of written newspaper articles, as detailed in the Methods Section for Experiment IV.

Foil Words (186 words)

This list was not an experimental list *per se*, but served to provide foils by masking and separating the large number of derived words in the total stimulus set. The foil words were all monomorphemic: one-syllable and two-syllable nouns, verbs, and adjectives. Details of the construction of this list are provided in 2.4.

Practice Words

Two practice lists of 10 one-syllable and two-syllable monomorphemic words were constructed in order to familiarize the participants with the procedure for each task.

It was judged that ten words would provide sufficient practice in each task without adding significantly to the overall task requirements Details of the construction of the practice lists are provided in 2.6.

2.3 Construction of the Experimental Lists

General Procedures

The process of constructing the four experimental lists was the same. Candidate words were culled from various sources: Frequency Analysis of English Usage, Francis and Kučera (1982); The Complete Rhyming Dictionary Revised, Wood (1991); The Oxford Dictionary of English Etymology, Onions (Ed.), (1995); Teaching Vocabulary, Volumes 1 and 2, Barrett, Huisingh, Jorgensen and Zachman (1986). Each set of candidate stimulus words was then progressively pruned and refined to conform to the requirements specific to that particular experiment. While it was possible for certain words to fit the requirements of more than one experiment, each experimental list was kept separate. For example, the words *theorem* and *theorist* appear as a matched pair in Experiment IV, but neither word appears in Experiment I where either one would fit the requirements for the derived-bound stem words.

No homophones were used (e.g., *cereal serial; bolder boulder)* because in the repetition condition the meaning accessed by the listener could not be controlled.[17] Homonyms were likewise excluded because the meaning, and therefore pronunciation, accessed by the participants in reading the single words could not be controlled.

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[17] A few such forms were, indeed, inadvertently included in the Foil Words List (e.g., *dense, seize*).

Examples of such words are 1. *bow* / bou / [noun: *ribbon tied in a special fashion,* or *weapon;* verb: *act of bending into the shape of a bow*], compared with *bow* / bau / [noun or verb: *act of obeisance* or noun: *front end of a ship*]: 2. *brook* [noun: a *stream,* cf. *brook* [verb: *inability to tolerate*).

For all experiments and the foil word list, frequency counts were taken from Francis and Kučera, 1982. Frequencies of occurrence are reported in counts per million. Where words belonging to more than one lexical class were used (e.g., *alien* in Experiment I) with frequency counts of 14 and 5 per million for adjective and noun usages respectively (Francis and Kučera, 1982), the word was assigned to the lexical class of the greater or greatest individual frequency. The cumulative frequency, however, was used for frequency calculations. Such words were dubbed "*hybrids,*" and were marked in each list. Tables with details of frequency of occurrence and lexical classes are provided for these words as they occur in each experimental list.

As a basic operating framework in the present study, those factors significant for lexical access and production, as discussed in 1.4, were controlled. The exact role of word frequency in production (e.g., in reading aloud as in the proposed study) is not clear. However, a word must be accessed before it can be produced, and control of frequency of occurrence of the stimulus words provided a framework for consistency in the construction of the experimental lists. Likewise, word length in terms of syllable number and number of letters in the word, and stress patterns were kept consistent within each experimental list.

Each experimental list consisted of 2-4 sub-lists. With reference to frequency of occurrence, items were matched across the sub-lists for approximate raw frequency, resulting in sub-lists that were approximately equal in mean logarithm frequency by virtue of the pairs, triplets or quartets being equal, or approximately so, in raw frequency. Such construction also ensured an approximately equal range of frequencies for each sub-list of items. Where exact matching of cohort items was not possible, the overall composition of the sub-lists was balanced such that the mean logarithmic frequencies for the sub-lists were equal, or very nearly so, and the ranges of frequency among the sub-lists were approximately equal.

2.4 Construction of the Foil Word List

2.4.1 Method

It has been noted that particular stimulus environments can induce certain responses (Rubin, Becker and Freeman, 1979), an observation that has implications for the present study. The experimental word-sets contained 224 (54%) derived words, plus the 70 words (17%), which were base forms for target derived words. Thus, 71% of the experimental stimuli were morphologically related. Only Experiments I and II contained sets of words that were all morphologically unrelated to each other. Even then, the monomorphemic words in Experiment II all terminated, like the derived and inflected words of that experiment, in word-final–ER.

Monomorphemic words of 1- and 2-syllables were therefore added to mask this preponderance of derived words, and to provide a basis for potential later comparisons of performance between yet more derived and monomorphemic words. As noted above, the foil word list was not an experimental list *per se*, but its construction was as constrained as that of the other experimental lists.

The foil word list was set *a priori* at 186 words, a number chosen to make a total stimulus set of 600 words. Its structure reflected the lexical and frequency characteristics of Experiments I-V, but within the constraint of containing monomorphemic words of only 1- and 2-syllables, compared with the 2- 3- and 4-syllable words in Experiments I-V. As a starting point then, the construction of the foil word list was based on the distributions of lexical class, the only matching feature across Experiments I-V and the Foil Word list.

2.4.2 Lexical class

The lexical characteristics of Experiments I-V were calculated and summarized. The 414 total words consisted of 226 nouns, 95 verbs, and 93 adjectives (55%, 23% and 22% respectively). The proportionate percentages of nouns, verbs, and adjectives for the foil word list were then calculated. Words of 2-syllables were the only overlapping lexical class between the experimental lists and the foil word list. Therefore, the total distribution of words for Experiments I-V was calculated (all lexical classes by syllable number and stress assignment). The applicable numbers were then used to calculate proportionately the number and distribution of 2-syllable words of 1st and 2nd syllable stress for each lexical class for the foil word list.

With these first-level calculations for the distribution of 2-syllable words across lexical class and syllable structure completed, the numbers for the remaining cells were then derived, first by simple arithmetic, and then by using the ratio between the 2-syllable words of 1st and 2nd syllable stress across Experiments I-V.[18] This procedure yielded the numbers of nouns and adjectives of 2nd syllable stress. The remaining numbers were then calculated by simple arithmetic.

2.4.3 Frequency

With the proposed lexical structure of the foil word list set up, its word frequency characteristics were now determined, again to reflect those of Experiments I-V. The 186 words in the foil word list were then selected as follows within each lexical class and syllable structure such that their summed frequencies yielded a mean log frequency equal, or approximately equal, to that of Experiments I-V.

Experiments I-V were reorganized by frequency as the main classifier. At each frequency level, the member words in each lexical class and at every syllable structure were grouped, and the total for each group was calculated as a percentage of the 414 words in the total stimulus set. These percentages were then applied by proportion to the foil word list and the numbers of total words at each frequency level were calculated. Words of similar lexical characteristics were assigned in similar distribution within the frequencies of the foil word list.

The exigencies of reconciling lexical class, syllable structure, and word frequency forced a number of adjustments but the foil word list was constructed approximately within the projected limits. Three words in the foil word list (*sharp*, *coward* and *devil*)

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[18] In Experiments I-V, the ratio between the 2-syllable words at 1st and 2nd syllable stress is about 2.5:1. The former are of mixed lexical class and the latter are, fortuitously, only the 48 verbs from Experiment III. While this reduction by ratio worked for the nouns and adjectives, it did not do so for the verbs where the difference is five-fold in the opposite direction. At this point, however, the numerical determinants of the experimental lists were maintained because further adjustments to the foil word list would likely be necessary.

were inadvertently the base forms of experimental words (*sharper* (Exp.II), *cowardice* (Exp I) and *devilish* (Exp I). Inadvertently, too, a few homophones crept into the foil word list (*carrot*, *dense*, and *seize*). Frequency and lexical class for hybrids are as follows, and are entered in the lexical class of greater frequency:

blush:	12 verb	1 noun	*mellow*:	2 verb	1 adjective
bump:	9 verb	2 noun	*slouch*:	1 verb	1 noun
flick:	6 verb	2 noun	*triumph*:	24 noun	1 verb
hiss:	4 verb	1 noun			

The foil word stimulus list is shown in Table F1 at the end of the chapter.

2.5 Construction of the Presentation Sets

2.5.1 Method

The stimulus set consisted now of 600 words (Experiments I-V+F), and was reorganized into 12 sets of 50 words each, to be presented to the participants for reading aloud and for repetition. Each set was constructed so as to constitute a microcosm of the stimulus set, simultaneously therefore reflecting the other eleven blocks in terms of distribution of lexical class, syllable number and stress assignment, frequency weighting and frequency range. Mean log frequency of each set was approximately equal to that of the total stimulus set (0.77).

2.5.2 Frequency and lexical class

Experiments I-V+F were merged into a master list and the master list was ordered by frequency of occurrence. The overall frequency range for the master list was 1-308, with slightly more than half the words falling between frequency 1 and frequency 5 (303/600 words – 51%). Within each frequency, words were listed with lexical class as the lead parameter, followed, in encapsulation, by syllable number, stress assignment, and lastly by identifying tag (i.e., its experimental list (Exp I-V) and its alphabetic position within that list, e.g., *abdomen*: I.001). These "chunks" of "words by lexical class" were then alphabetized. Thus, for each frequency represented in the stimulus set of 600 words, there was a chunk of alphabetized monosyllabic nouns, of monosyllabic verbs, and of monosyllabic adjectives, and so on for the three lexical classes at each level of syllable structure.

Each chunk of monosyllabic nouns was taken from every applicable frequency level and merged alphabetically in order of ascending frequency (there were a total of 54 monosyllabic nouns in the stimulus set). This procedure was followed for the remaining nouns of 2, 3 and 4 syllables, and for the verbs and adjectives at each syllable level. At this point, the master list was now organized into 18 unequal chunks corresponding to the six categories of syllable number and stress assignment within the three lexical classes.

2.5.3 Assignment of stimulus words to presentation sets 1-12

The words in each chunk were then randomly assigned to a presentation set (01-12) by a computer program for the generation of random numbers (courtesy of Arlene Neumann, Ph.D., City University Graduate School and University Center, Ph.D. Program in Speech and Hearing Sciences, 1998). Let the procedure for the monosyllabic nouns serve as illustration for the whole stimulus set, as the identical procedure was implemented for each chunk of words within each lexical class and at each level of stress assignment. The 54 monosyllabic nouns, randomly distributed across the 12 presentation

sets, fortuitously gave 5 words each to presentation sets 01- 06, and 4 words each to presentation sets 07-12. These 54 monosyllabic nouns were shuffled successively among the 12 presentation sets (4-5 words each), so that the mean log frequency of each chunk of monosyllabic nouns within each presentation set was ultimately equal across the 12 presentation sets (between 0.74 and 0.76). In addition, and very importantly, pre-determined prohibitions were not violated; in particular, the separation of a base form and any derived form or forms (obviously not applicable at the monosyllabic level), but also the separation of phonologically similar words (e.g., *bliss, blister: orchard, orchid*) or words with semantic associations (e.g., *sprint, antelope*;
bison, buffalo, moccasin; *shrimp, salad*).

With this procedure being implemented for each of the 18 chunks of words, the final disposition of each chunk was maintained at very similar mean log frequencies across the presentation sets. For example, the 12 chunks of 3-syllable nouns with 1st syllable stress had a mean log frequency range of 0.57 - 0.63 across the presentation sets; the 12 chunks of 2-syllable adjectives with 1st syllable stress had a mean log frequency range of 0.93 - 0.98 across the presentation sets.

Each of the now-reorganized 18 chunks of words was reassembled into its assigned presentation set (01-12). Each presentation set now contained a representative distribution of lexical class, syllable structure and frequency range, but they were, however, not equal in number — some had more than 50 words, and some fewer. With judicious re-shuffling to keep the mean log frequencies of the presentation sets and the distribution of lexical class approximately equal, and to avoid violating the other criteria described above, words were re-assigned across the presentation sets to level all 12 sets at

50 items. The order of the candidate words in each presentation set was again randomized by computer program. Each presentation set was again examined for any preponderance or contiguity of the same suffix (e.g., *–er*, *–ize*), of the same (pseudo)prefix (e.g., *ex–*, *en–*, *a–*), of phonologically similar words and of semantically associated words. As much as possible, a base word and its derived form(s) were separated by at least one set.

In the final pseudo-randomization, the experimental words were equitably disposed across the presentation sets so that the lexical and frequency structures of each set reflected in microcosm the total stimulus set, and was approximately equal to the other 11 sets. Master List Table 1 shows the distribution of words by lexical class and frequency range across the presentation sets. Master List Table 2 shows the distribution of words across the presentation sets by experimental list. Master List Tables 1 and 2 are shown at the end of the chapter. The presentation sets are shown in the Appendix.

2.6 Construction of the Practice Words

Method

As a basic operating framework, these practice lists were constructed, like the presentation sets, to reflect in miniature the lexical and overall frequency characteristics of the total stimulus set (the master list). The summary calculations (i.e., number of words by lexical class) for the master list were used to yield appropriate distributions in the practice lists. The ratio of 1-syllable to 2-syllable words for each lexical class in the total stimulus set was also calculated (1:2 for nouns and verbs and 1:3 for adjectives), and the equivalent words in the practice lists were based on these ratios.

The mean log frequency for each practice list was the same as for the master list (0.77). It should be noted that the specific range of frequencies for the practice lists was not determined in advance: it was obvious, however, that the range would necessarily be much narrower than that of the master list. The range for each practice list was ultimately 1-17.

The practice words were chosen according to the predetermined parameters and were pseudo-randomized, in similar fashion to the presentation sets. The practice lists in presentation form are displayed in Practice List Tables 1 and 2 at the end of the chapter.

2.7 Standardization of the Presentation Tasks: Reading and Repetition

With the final disposition of the total list of 600 words (experimental and foil), appropriately pseudo-randomized into 12 sets of 50 words each, they were now designated Presentation Set 01- through Presentation Set 12.

2.7.1 Reading

For the reading task, every word within each presentation set was printed separately and centered on an unlined index card (5" by 8") at 18 point in Arial Font. Each set of fifty words was bound in book form with three rings. The participants read aloud the words in the set, turning the page at his or her own pace. In this way, participants saw only one word at a time, thus reducing the potential interference effects of upcoming words.

2.7.2 Repetition

The recording of each presentation set was made in the soundproof recording booth of the Audiology Suite in the Speech and Hearing Department, City University of New York Graduate School by a female speaker of standard American English. A battery-powered Sony Digital Tape recorder (TCD-D8) (DAT) with Maxwell Digital Audiotape (DM 120) was used. The microphone was external and connected to the DAT at its Microphone Input port. Appropriate settings on the DAT were made for recording: Sampling: at 44.1kHz; AVLS: OFF; Recording Level: 10; Recording Mode: Speech; Microphone Sensor: H. Checks and rehearsals for the appropriate recording levels were made.

Each data set consisted of the carrier phrase "Say the word," followed by 2 seconds of silence; then by the target string, and then approximately 5 seconds of silence. Each data set was recorded twice, thus providing a choice in editing if one rendering was considered less clear. The speaker recorded the data sets, maintaining a constant distance from the microphone, ensuring that the recording volume did not exceed a predetermined level on the tape. The investigator monitored the volume and the quality of the recordings visually (i.e., watching the volume indicator) and via stereo headphones (Sony MDR-V600) attached to the DAT recorder at the Phones/Line Out port.

Each presentation set of 50 data sets was then down-loaded digitally onto computer hard disk, using the *Wave for Windows* software program (*Turtle Beach Systems*, 1992). Sampling rates were set at 22.050 kHz, Mono, 16 Bit. At the completion of the down-loading of the data set, two copies were made onto two separate Zip Disks, and stored separately. The data sets were then edited using the *Wave for Windows* (1992) computer program, with monitoring through headphones: First, the target word was isolated, its beginning- and end-position in milliseconds on the computer recording was noted. Then, 150-200 milliseconds were added at the beginning and end of the section, and the "sandwich" copied to a separate file. The data sets within each presentation set were designated 01-50. Thus, the words in presentation set 01 were designated 0101-0150, and so on through the 12 sets. Only one edition was made of the carrier phrase (named Set 00100). The practice list for repetition was named Set 001. At the completion of the editing of each presentation set, two copies were made to separate Zip disks.

Two volunteers, age 45 and 72, with normal hearing acuity and without neurological or speech/language impairments, completed the repetition task to check for clarity of recording. The identity of 6 words was questioned (e.g., *caller* (Experiment II) questioned as *collar*.) The presentation sets which included these words were re-recorded under the initial recording conditions.

A computer program was written for the presentation of the repetition task via laptop computer by Eddy Yeung, City University Graduate School and University Center, Ph.D. Program in Speech and Hearing Sciences.

Table F.1
Foil Words Stimulus List

Word	Frq	L/c	Word	Frq	L/c	Word	Frq	L/c	Word	Frq	L/c
abrupt	18	adj	carrot	5	n	greed	3	n	scant	5	adj
accuse	45	vb	carton	1	n	gripe	1	vb	scarce	6	adj
acorn	1	n	cheese	9	n	hero	70	n	scold	2	vb
acute	13	adj	cherub	1	n	hiss*	4	vb	scorch	2	vb
afford	58	vb	chess	3	n	ignite	3	vb	seize	33	vb
afraid	57	adj	chink	1	n	lizard	2	n	shark	4	n
alcove	5	n	clench	7	vb	manage	68	vb	sharp	71	adj
almond	4	n	cling	30	vb	marsh	5	n	shave	23	vb
annoy	10	vb	clown	6	n	mellow*	3	vb	sheep	24	n
anvil	1	n	cobra	3	n	mend	6	vb	shelf	20	n
arcade	5	n	cotton	36	n	merge	20	vb	sheriff	28	n
argue	78	vb	coward	4	n	mink	5	n	shirt	29	n
athlete	16	n	crate	4	n	moist	11	adj	shove	16	vb
avoid	91	vb	crave	5	vb	mustard	19	n	shrewd	8	adj
bailiff	9	n	cringe	5	vb	nerve	34	n	shrimp	2	n
bald	4	adj	crust	1	n	niece	9	n	skunk	1	n
ballast	2	n	curt	1	adj	nymph	2	n	slouch*	2	vb
bandit	6	n	deceit	3	n	onion	19	n	sparse	5	adj
banjo	1	n	delve	2	vb	oppose	71	vb	speck	9	n
beckon	12	vb	dense	9	adj	orchard	8	n	spinach	2	n
belong	88	vb	devil	32	n	orchid	3	n	spine	6	n
biscuit	7	n	douse	1	vb	ordain	6	vb	sprint	2	vb
bison	1	n	drench	1	vb	ounce	8	n	stark	3	adj
blade	26	n	droop	3	vb	parch	2	vb	starve	10	vb
bland	3	adj	drought	8	n	peach	4	n	stout	2	adj
blare	2	vb	drown	14	vb	pearl	9	n	stove	17	n
bleak	10	adj	dwell	15	vb	pierce	7	vb	stow	2	vb
blink	13	vb	fabric	44	n	piston	10	n	strange	84	adj
bliss	4	n	faith	110	n	poach	2	vb	straw	18	n
blizzard	8	n	fetch	7	vb	pomp	1	n	strict	11	adj
blouse	2	n	flick*	8	vb	pork	14	n	swap	2	vb
bludgeon	3	vb	flint	1	n	porpoise	1	n	syringe	1	n
blurt	3	vb	flirt	2	vb	porridge	1	n	syrup	4	n
blush*	13	vb	fluke	1	n	prance	3	vb	tantrum	4	n
bodice	2	n	foist	1	vb	prank	2	n	tennis	15	n
booth	7	n	frail	8	adj	proof	40	n	thief	18	n
borrow	31	vb	fright	2	n	quaint	12	adj	tight	28	adj
breeze	17	n	frock	2	n	quiz	2	n	triumph*	25	n
brick	24	n	fruit	49	n	rabbit	16	n	turban	2	n
broom	2	n	gambit	3	n	radar	23	n	turnip	1	n
brunch	1	n	garlic	4	n	ramp	7	n	typhoid	2	n
brunt	1	n	gazelle	1	n	ravine	2	n	velvet	4	n
budge	3	vb	girth	1	n	rhubarb	2	n	vouch	1	vb
bump*	11	vb	gland	15	n	ridge	22	n	walrus	1	n
cabbage	4	n	gloom	14	n	salad	12	n	wince	5	vb
cabin	30	n	goose	7	n	saloon	20	n			
cadet	4	n	gourd	2	n	sandwich	13	n			

KEY: Fr. Frequency of word
L/c lexical class
* Word is entered into multiple lexical classes in Francis and Kučera, 1982

Master List Table 1: Lexical and Frequency Characteristics of the 12 Presentation Sets

Presentation	Lexical Class Totals			Mean	Frequency	Word
Set	Nouns	Verbs	Adjectives	Log Frq.	Range	Length
1	27	11	12	0.77	1-299	5-11
2	27	14	9	0.77	1-288	4-11
3	28	13	9	0.76	1-308	5-10
4	27	9	14	0.77	1-161	4-12
5	29	14	7	0.77	1-110	5-13
6	27	14	9	0.77	1-99	5-10
7	29	13	8	0.76	1-70	5-10
8	25	12	13	0.78	1-166	4-11
9	29	12	9	0.77	1-149	5-10
10	32	10	8	0.77	1-91	5-10
11	28	12	10	0.77	1-34	5-10
12	29	15	6	0.76	1-83	4-11
Totals	**337**	**149**	**114**	**Av: .77**		

Master List Table 2: Distribution of the Experimental Lists across the Presentation Sets

Presentation	Experimental Lists						**Totals**
Set	I	II	III	IV	V	F	
1	11	8	9	3	4	15	**50**
2	10	8	8	0	9	15	**50**
3	10	8	8	4	5	15	**50**
4	9	7	7	6	5	16	**50**
5	10	7	8	1	6	18	**50**
6	8	8	7	6	6	15	**50**
7	9	7	10	3	7	14	**50**
8	12	6	8	5	4	15	**50**
9	8	5	8	6	7	16	**50**
10	10	9	6	4	6	15	**50**
11	11	9	6	3	3	18	**50**
12	12	8	11	1	4	14	**50**
Totals	**120**	**90**	**96**	**42**	**66**	**186**	**600**
Range of Words	8-12	5-9	6-11	0-6	3-9	14-18	

Practice List Table 1

Reading

Number	Word	Frq.	Lexical Class
1	tumble	2	verb
2	gust	4	noun
3	satin	5	noun
4	torch	4	noun
5	solemn	12	adjective
6	dazzle	13	verb
7	moan	4	verb
8	dragon	3	noun
9	snug	2	adjective
10	jacket	5	noun
Ttl Log Frq.		7.27	
Mean Log Frq.		0.73	
Frq. Range		2-13	

Practice List Table 2

Repetition

Number	Word	Frq.	Lexical Class
1	reckon	13	verb
2	lame	2	adjective
3	pigeon	5	noun
4	bake	17	verb
5	wizard	3	noun
6	gallop	6	verb
7	scarf	4	noun
8	wallet	6	noun
9	glee	4	noun
10	shallow	14	adjective
Total Log Frq.		6.58	
Mean Log Frq.		0.66	
Frq. Range		2-17	

CHAPTER 3

TESTING PROCEDURES

3.1 Screening for Participants

At the initial meeting between the potential participant and the investigator, the proposed study was fully explained, and the letter of informed consent was given to the participant to read. The contents of the letter were also explained orally as necessary, as the reading of extended text is typically disturbed in agrammatism, while understanding of spoken language is generally spared. On agreement to take part, the letter was signed by both the participant and the investigator. Given adequate grapho-motor skills (i.e., writing with the non-dominant hand), the aphasic person's ability to write his/her name typically remains essentially intact even in the face of quite significant expressive language impairment. Indeed, all potential participants were able to sign the letter.

Formal screening for ability to participate in the study was undertaken using selected subtests from the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass and Kaplan, 2nd ed., 1983). Details are given below. Hearing screening was administered using pure-tone audiometry. Hearing acuity in the better ear of minimally 30db at 500 Hz, and 25dB at 1000, 2000 and 3000 Hz was required. These levels are consistent with the ability to hear conversational speech in a quiet environment when the listener can see the speaker (Harvey Gardner, Ph.D. personal communication, 1997). If the results of the screening showed that the volunteer was not suitable for inclusion, then he/she was thanked for his/her interest and co-operation, and regretfully excluded from the participant pool. The screening of approximately 33 volunteers yielded four appropriate participants.

3.2 Participants' Biographical and Test Data

The participants were between 3 and 15 years post-stroke. Three of the four participants had suffered a single dominant-hemisphere anterior stroke. The fourth participant (P4) had suffered two strokes to the anterior dominant hemisphere, fourteen years apart, but was included because she met the required speech/language profile. All participants had residual right upper extremity paralysis or paresis. Brain imaging was not a necessary criterion for inclusion in the study, and, in the event, proved to be unavailable.

The four participants were monolingual native speakers of standard American English. Hearing acuity was within the prescribed limits. They had no history of alcohol or substance abuse, psychiatric disease, or indications of dementia or other neurological disease based on their medical history. The participants' biographical data are shown in Table A at the end of the chapter.

Mild-to-moderate agrammatic aphasia was diagnosed based on the participants' scores on selected subtests of the Boston Diagnostic Aphasia Examination (Figures A and B, at the end of the chapter). The participants' rating scale profiles for selected speech characteristics (i.e., melodic line, phrase length, articulatory agility, and grammatical form) are indicative of effortful speech, reduced phrase length with omissions of words, and reduced syntactic processing, and are consistent with mild-to-moderate non-fluent aphasia (Figure A). Figure B shows the participants' results, scored according to the

BDAE scoring protocol, for selected reading and repetition subtests. There is variability within and across the participants. For example, P1's reduced performance on the Word Recognition subtest relative to the other participants on that subtest, and relative to his own performance on the other subtests, reflects his deep dyslexia, a condition not shared by the other participants. P4 did not show the typical Broca's profile for phrase length and articulatory agility, slightly exceeding the traditional upper limit of 4 on the scale. Her use of grammatical form, however, was markedly restricted in open-ended conversation.

Overall, the participants showed relatively good performance on these tests of reading and repetition. It should be noted, however, that P1's and P3's verbal responses were marked by literal paraphasias and errors of phonological sequencing, while P2's and P4's responses were relatively free of such output errors (almost completely in the case of P4). In general, however, the participants' motor speech was judged to be sufficiently clear to satisfy the criteria for reading aloud and for repetition, with relative overall accuracy for the target words (subtests 4, 5, and 6). Reading comprehension was likewise relatively well-preserved (subtests 1, 2 and 3).[19]

Agrammatism was diagnosed based on performance in an open-ended conversation, and on the Cookie Theft picture description subtest from the BDAE. In their verbal output and their descriptions, the participants met the prescribed criteria,

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[19] While participants' ability to comprehend the experimental words was not the focus of the present study, some of their responses certainly indicated understanding of the words that they were reading (e.g., *colonist* → /kɑ:..lɪ../... *200 years ago*; *adopt* →/ ədɑ:p..dɪd/... /ədɑ:p/... *oh! not biological*). It is arguably the case that target words evoking a response such as, "*no, nothing*", or "*no idea*" were not understood, as such responses suggest that no lexical representation was achieved. Conversely, responses such as "*in my mind, but can't spit it out*" or "*sorry, can't pronounce it*" suggest understanding, but inability to bring the word to articulation.

omitting or substituting at least three tokens of obligatory function words (e.g., prepositions, articles) or bound morphemes (e.g., plural, past tense and/or present tense third person markers). Illustrative excerpts from the participants' conversations are provided below.

3.3 Presentation of the Experimental Tasks

In the larger study, of which this dissertation reports on a subset of the collected data, there were two experimental tasks: Reading and Repetition.[20]

Each participant received the stimulus words in the same order within each presentation set; and the sets were presented in numerical order (1-12), but alternated between the experimental tasks for every presentation set. The order of the experimental tasks was counter-balanced among the participants. Thus, P1 and P3 started the experimental procedures with a reading set and alternated between reading and repetition. P2 and P4 completed a repetition set first, and then alternated between repetition and reading. The participants worked through sets 1-12 in the initial set-up, then worked through the sets again in the alternate set-up. Thus, the participants did not read and hear the same word in the same testing session.

Two to five sessions, not exceeding two hours each, were necessary for the completion of the screening and the experimental tasks, the administration of which took place in a quiet room in the participant's home. The investigator and participant were seated at a table and the tasks were explained to the participant as follows: "I am

[20] The repetition data were recorded and coded, and set aside. Only the reading data are presented at this time because initial inspection of the data suggested that the repetition results were overall too close to ceiling to provide answers to the research questions.

going to give you some words to read from these booklets, and then you will repeat some words that you will hear from a recording in the computer. Please say the words as clearly as you can. I will make a tape-recording of the words you read and repeat so that I can listen later to what you say. Let's practice with a few words now."

The 10 practice words for reading and the 10 practice words for repetition were presented in the presentation order appropriate for that participant.

With the presentation of the experimental tasks, the participant was encouraged to respond to each stimulus item. A short rest break (approximately 5 minutes) was taken at the end of every set, and breaks were taken during the reading or repetition of a set, either as the participant requested, or if the investigator judged that the participant was becoming too fatigued to respond optimally. In addition, the investigator unilaterally concluded a testing session, again if she judged the participant to be too fatigued to respond optimally. In the event, this occurred only on one testing session with P1.

Completion of the tasks was untimed, the participant being given as much time as he or she required for making a reading response. For the repetition task, the computer program presented via loudspeakers the carrier phrase "Say the word…." followed by the stimulus word, and presented the next carrier phrase and stimulus word after the investigator depressed any key on the laptop keyboard. During the practice trials, each participant adjusted the volume at the loudspeaker to ensure a comfortable hearing level for himself or herself. The carrier phrase and stimulus word could be repeated as necessary if the participant requested repetition or otherwise indicated that the word was not heard or perceived correctly. The computer program was set up in such a way that in the repetition task, the participant could discontinue at any stimulus word within a set and continue from the next word, even from one testing session to the next. In fact, all participants were able to complete full sets, and did not finish a testing session in the middle of a presentation set. Typically, each participant was able to complete 4-5 sets in one testing session. P4 was able to complete the 12 sets in one session (repetition first and then reading). A month later, she completed the 12 sets in the converse setup (reading and then repetition).

The participant was allowed to make multiple responses. These were recorded onto digital and audio recording tape. The investigator monitored the participant's responses through headphones to check recording levels, as well as noting on the participant's response sheets any significant information that would aid in the eventual transcription and scoring.

3.4 Editing and Coding Responses

The investigator first listened to the participant's responses *in toto* for a set, then transcribed them according to sets 1-12 using IPA close transcription (Set-response form). She then listened again to check for accuracy and consistency All attempts at response were transcribed, including false starts, word-fragments, and self-corrections. A form for coding Correct and Error responses was set up for each experimental list (Experiment-response form). Recall that the presentation sets contained a representative distribution of words from all experimental lists. Participants' responses were then re-transcribed from "Set-response forms" into the Experiment-response forms. Responses were coded for Correctness and Error Category (see Coding Taxonomy, 3.5 below). The responses used for coding were those which could reliably be taken as the participant's final attempt. For example, *cruelty* → *cruel*... ...*no, no*... *cruelty* was counted as correct; *richer* → *rich*... ...*but this (*pointing to the suffix)... ...*no* was counted as a "can't" error. Multiple passes through the materials were made to maintain accuracy and consistency of coding decisions.

3.5 Coding Taxonomy

The following 2 response types counted as a Correct Response:

1. A. Correct

There was almost complete overlap between the participant's response and the target word in terms of CV structure, stress pattern, and suffix (where applicable). Mild to moderate phonological output errors were ignored if it was possible to discern the participant's target (*e.g.*, *avalanche* → / 'æbəvænʃ /.

B. Suffix-correct: Two types of response fell into this category:

i. The participant produced the correct suffix, but made phonological output error on the stem. The response could nevertheless be discerned as the target (e.g., *disruption* → dɪʃ'rʌtʃn , *vigorous* → wɪʤən^{w}əs/).

ii. The participant produced the correct suffix, but error on the stem led to the production of a different word. In most cases, the error on the stem took the form of the substitution of one or two phonemes. In any event, the putative origin (visual or phonological error) was moot for the purposes of coding the error, but it was noted in the response coding sheets, as described below. For a response of this sort to be counted as correct, it had to match the target along the following parameters: (The criteria for the inclusion of a response under this rubric were adapted from Kohn and Smith, 1995; and Kohn and Melvold, 2000.)

a. suffix was correct

b. stress pattern was correct

c. number of syllables was the same

d. the response had considerable segmental overlap with the target word.

Thus, for example, *wiser* → *wider*; *tinder* → *tender*; *excitement* → *'citement* all counted as suffix-correct under these criteria. The following examples did not: *restriction* → *resurrection* (counted as different-word error, see below), and *steeper* → *steeple*.[21]

In the tables of results for each experiment, the number of suffix-correct responses for each participant appears in a separate cell within parentheses. That number is subsumed in the cell for Total Correct: therefore, Total Correct includes the numbers for Correct and Suffix-correct above (see Coding Table below).

The following 4 types of responses counted as Errors:

1. Suffix error: There were three types of suffix error.

i. Suffix addition:

A suffix was added to the target word, whether that target was itself monomorphemic, e.g., *champion* → *champion<u>ship</u>*, or a derived word, e.g., *specialize* → *specializ<u>ation</u>*.

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[21] **The final syllable error here could arguably be a phonological output error, especially given the acoustic overlap of syllabic /l/ and /r/. The need to maintain consistency across the responses dictated the assignment of this response type to that of Different-Word error.**

ii. Suffix omission

The suffix was omitted, and the stem was produced as a response, e.g., *certainty* → *certain*; *merciless* → *mercy*; *adoption* → *adopt*; *negation* → *negate*.

iii. Suffix substitution: The following two types of responses fell into this category:

a. A derivational suffix, different than the target suffix, was produced, but on the target stem (i.e., a morphological relative was produced). Examples are: *cowardice* → *cowardly*; *colonist* → *colony*; *intrusion* → *intrusive*; *inspection* → *inspector*.

b. A derivational suffix, again different than the target suffix, was added or substituted, and the resulting response was not a real word. e.g., *fanciful* → *fanciless*.

The addition or substitution of an Inflectional Suffix was included in the appropriate score for total score for Suffix Addition or Suffix Substitution, but its occurrence was noted (see Coding Table below). Examples are: *swimmer* → *swimming*; *driver* → *driving*; *amazement* → *amazing*; *terrify* → *terrified*; *pyramid* → *pyramids*.

2. Different-word: Two types of response counted as different-word error:

i. The participant produced an altogether different word. The provenance of the error can often be deduced (phonological, visual or semantic), though it may not always be easily discernible. Again, the origin of the error was moot for the purposes of scoring, but note was taken in the response forms. Examples are: *idiom* → *idolize*;

tentacle → *tennis* (likely phonological or visual error); *motorist* → *vehicle*; *emerald* → *shamrock*; *hyacinth* → *chrysanthemum*; *mourner* → *mortician* (likely semantic error); or from combinations of phonological, visual and/or semantic error. Examples are: *gazelle* → *zebra*; *pyramid* →'pɪrəd.. pɪr'anɪ.. pɪr'ano ..... *alligator*. Through different processing errors, which possibly lead to *piranha*, the participant finally said *alligator*.

ii. The participant produced a response that was the base or some form of related word for the required target word. Examples: *clerical* → *clerk*, *cavernous* → *cave*, *socialize* → *society*. This differed from <u>Suffix Omission</u> or <u>Suffix Substitution</u> because the response was not simply the surface form with the suffix omitted, nor a simple substitution on a bound stem. For such coding, the examples above would have read: *clerical* → *cleric*; *cavernous* → *cavern*.

3. <u>"Can't"</u>:

The participant acknowledged that she or he was unable to produce or complete a response, or to retrieve the lexical item: e.g., *"inside a moment ago, but not now."*; *"in my mind, but can't spit it out!"*; *"sorry, no, nothing."* and even, *"sorry, can't pronounce it."* Also included in this category was <u>No Response</u>: The participant was silent, or made non-committal grunts.

4. Miscellaneous error:

There were two different categories of error, ultimately subsumed under this rubric:

i. The response was frankly unintelligible or indecipherable, even if stress pattern was correct.

ii. The response was a non-word other than that coded under Suffix substitution or addition.

The following categories, which have been mentioned briefly above, were not counted in the overall error counts, but were noted in order to provide further information concerning participants' performance.

i. Phonological error: The participant made errors in sequencing or in motor planning. Note that phonological errors *per se* did not constitute an incorrect response. Thus, this notation could be marked against both correct and incorrect responses: e.g., *stallion* → … …*s..k..skæl*ʲ*ən/*; *daffodil* → ***dæpədɔɹ***ʷ ; *walrus* → *wɔ*ʷ*lsprʊs/*…, *oh, the sea lion!*

ii. Semantic error: This was usually seen in connection with a different-word response: e.g., ***tiger*** → ***lion***; ***motorist*** → ***car radio***; ***affliction*** → ***guilt***; ***triumph*** → ***machine***.

iii. Visual error: The participant produced a response by processing some part of the word visually, e.g., ***cantaloupe*** → ***antelope***; ***retirement*** → ***tired***; coward → ***kaɹ…ka../…now just a minute*** … … ***milk*** … ***but not milking.***

The following Table illustrates the Coding procedure: A summary of the participants' responses for Experiment II: Derived-ER words are used. The Table shows both correct and error scores for the individual participants, and summed scores for the group.

Coding Table 1 Example

Experiment II: Word-Final–ER: Derived–ER Reading Data

30 Responses for each of 4 Participants

				Error Analysis						
	Total	(Suffix-	Total	Suffix Error				Diff		Misc
Participant	Correct	Correct)	Error	add	om	sub	(infl)	Word	"Can't"	Error
P1	10	(1)	20	1	11	2	(2)	6	-	-
P2	6	(-)	24	1	12	7	(7)	-	4	-
P3	26	(2)	4	-	3	-	(-)	-	1	-
P4	29	(-)	1	-	1	-	(-)	-	-	-
Ttl Grp Correct	**71**	**(3)**	**49**	**2**	**27**	**9**	**(9)**	**6**	**5**	-

Key

Total correct: Total number of correct responses. This includes the numbers in the (Suffix-correct) cells.

(Suffix-correct): The suffix was produced correctly, but the participant made an error on the stem, or the response was a different word, but with the correct suffix. (See Coding Taxonomy for criteria).

add: A suffix was added to the target word.

om: The suffix was omitted from the target word.

sub: A suffix replaced the suffix of the target word.

(infl): An inflectional suffix was added or substituted, e.g., -ing. The count is subsumed under Suffix Addition or Suffix Substitution.

Diff Word: Different-word. The participant produced an altogether different word.

"Can't": The participant acknowledged inability to respond or did not respond.

Misc. error: The response was undecipherable or otherwise non-codeable.

3.6 Procedure for Inter-Rater Reliability

A sample of each participant's responses was subjected to inter-rater reliability. For each participant, one set of responses from the presentation sets was chosen randomly, and the following set was taken as well. The same sets were used for reading and repetition, therefore a representative sample of participants' responses across the experimental lists, and across words of different lexical class and syllable structure, were checked. Approximately 17% (100 responses) of the participant's responses for Reading were subjected to reliability check, and the same percentage for Repetition. No participant had both identical sets examined. The following sets were chosen for the four participants: P1: Sets 04 and 05 P2: Sets 09 and 10 P3: Sets 08 and 09 P4: Sets 07 and 08.

Two separate recordings of the chosen sets were made by direct connection from the master digital recording onto high-class audiotape. One rater, an experienced speech-language pathologist, was used in addition to the investigator. First, the rater read the sets of words chosen for each participant in order to familiarize herself with the data set to be examined. She then read the coding taxonomy, and discussed it in detail with the investigator. Next, the rater listened to the sets in full. On a second listening session, she made transcriptions of the participant's responses in close IPA, and then scored the responses as correct/suffix correct/incorrect. The incorrect responses were then coded for category of error. Lastly, the rater listened again to the relevant sets, checking for accuracy and consistency of decision.

Both investigator and rater completed the task simultaneously and independently, each listening through individual headphones to identical tape recordings on identical audiotape recorders. Thus, the investigator, having already completed the task previously, was able to complete the coding of the data again.

The reliability checking procedure was as follows: Coding decisions concerning "correct/suffix-correct" and "incorrect" responses were compared for every word in each set that was checked for each participant. Where there was agreement on correctness, then the word was passed. If there was no agreement, the word was set aside temporarily. On words where the response of "incorrect" was agreed upon, coding decisions for "category of error" were compared. If there was agreement, then the word was again passed.

On those words where agreement concerning "correct/incorrect" had not been reached, the audiotape recordings were first re-checked, and the two transcriptions re-checked (individually, and between investigator and rater) and compared. The coding decision was discussed and the procedure followed as above. Where coding decisions concerning category of error were not in agreement, the coding decision was again discussed, and the procedure followed as above agreement. Where agreement was still not reached, the word was submitted for examination to a third experienced speech pathologist whose decision was binding. In the rare instances (N = 7) where assignment was not agreed upon, then the response was counted under "miscellaneous error" as "non-codeable." As for the initial coding of the responses, multiple passes were made through the materials to ensure maximum accuracy and consistency of coding.

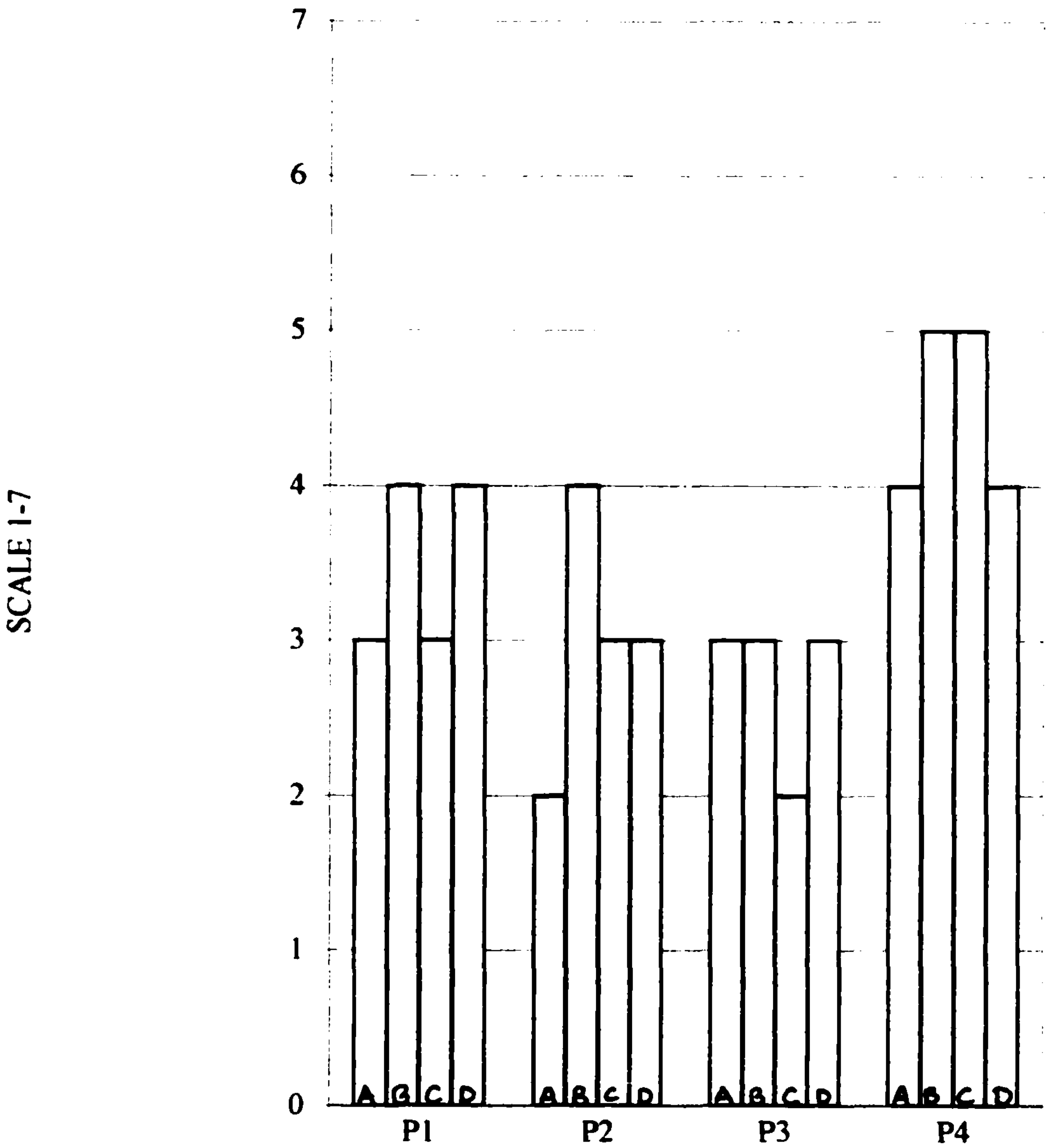
Overall, the inter-reliability check between the two sets of data (Investigator and Rater) level at the first checking level was between 83% and 96% for the participants across the experimental conditions.

TABLE A

PARTICIPANTS' BIOGRAPHICAL DATA

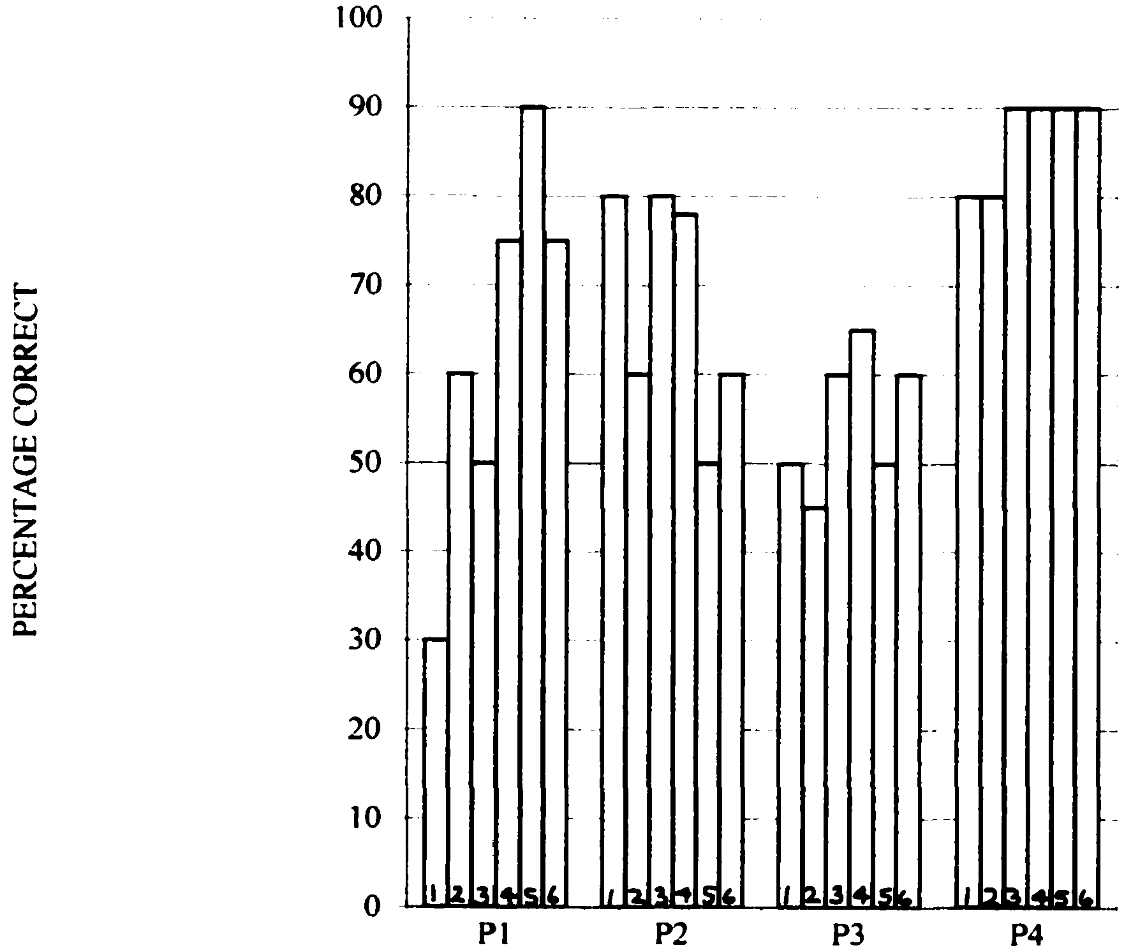
	P1	P2	P3	P4
Male/Female	M	F	F	F
Handedness pre-stroke	right	right	right	right
Education	college	college	high-school	college
Occupation	V.P. in wholesale	music teacher	school-bus driver	V.P in banking
Date of stroke	1992	1994	1997	1982 and 1995
Age at stroke	55	34	49	44 and 56
Age at testing	61	39	52	62
Years post-stroke at testing	6	5	3	5 yrs post 2nd stroke

FIGURE A
PARTICIPANTS' RATING SCALE PROFILES for
SELECTED SPEECH CHARACTERISTICS.
BOSTON DIAGNOSTIC APHASIA EXAMINATION,
1983, 2nd ed.



	P1	P2	P3	P4
☐ A. Melodic line	3	2	3	4
☐ B. Phrase length	4	4	3	5
☐ C. Articulatory agility	3	3	2	5
☐ D. Grammatical form	4	3	3	4

FIGURE B
PARTICIPANTS' SCORES: SELECTED SUBTESTS:
BOSTON DIAGNOSTIC APHASIA EXAMINATION,
1983, 2nd ed.



	P1	P2	P3	P4
☐ 1. Word recognition	30	80	50	80
☐ 2. Word-Picture matching	60	60	45	80
☐ 3. Sentence and paragraph reading comprehension	50	80	60	90
☐ 4. Word-reading aloud	75	78	65	90
☐ 5. Word repetition	90	50	50	90
☐ 6. Phrase repetition: high probability	75	60	60	90

3.7 Samples of Participants' Spontaneous Speech

The following are illustrative excerpts from the participants' conversations. Speech output errors have been transcribed into regular orthography for ease of reading. Note the occasional spontaneous use of derived forms.

P1: describing his job as a vice-president for sales in a manufacturing company for women's and children's clothing:

I... ... ... read-ing some pa-pars... ... I ... um... "can't get it out"... ... vice-pre-si-dent... ... all around the ... town... no... um... go down south... twenty people get 'round me... down south. All the people 'round me... I have three hun-dred people... go 'lanta (Atlanta) *Charlotte, I... 'ponsible... ... .everything in factory... ... go out.*

P2: describing the events of the stroke, and her therapy placements, the present one an hour's drive away:

Almost died... er... but... er... Christa (daughter) *need... need me. Not even yes... or no, not even... ... out of bed... ... because trying to speak... um... bless you!* (Investigator sneezed)*... ... but fall on floor... and... um... um... ... immediately Jim* (husband)*... ... er... um... er... call 911 and... ... long wait... ... but here now... not wheelchair but walk. Not speak... in fact, two months not even here... but one month hospital... and then ... Kess... Kessler hospital one month... actually, three different places, but ... ... um... um... .oh, darn it! ... ... now hour away, but more and more and more speak... ... still improving... ... speech... ... hope so.*

P3's verbal output was so sparse that both conversation and the Cookie Theft description are provided.

1. describing the stroke:

I ... ... um ... school bus ... ... um ... drive ... ... One day ... ... um ... I ... I ... I ... headache, then ... ... boom! ... ... hospital, don' 'member.

2. Cookie Theft.

The ... er ... um ... boy ... er ... girl get cookies ... chair over ... ... woman, mother, I s'pose ... ... dish ... wash dishes ... um ... um ... water ... um ... come over ... ... fell ... the ... the ... boy ... ... fall

P4: describing her frustration after the stroke, her plans to move to Arizona sometime in the future to escape cold winter weather, and her efforts to regain her speech.

In the hospital ... and the nurse or mother ... talk ... ... what ... what? ... ... and ... frustration, believe me ... kicked over ... ... ba-ba ... ba-ba ... ba-ba ... yeah ... no ... and then ... singing, singing, lots of singing ... getting better speaking ... and daddy and mother helpless ... ... so I glad, believe me ... ... twenty years back I helpless ... daddy and mother gone ... ... freeze right now and pain all over my body ... ... I ... and then go Arizona ... ... warm weather. Mother and I ... ... fifteen, sixteen years back ... al..pha..bet, a,b,c ... ... a,b,c and 1,2,3 ... 1,2,3 over and over and over and over. Now in the head I know, but ... ..sa-ay! ... ... uh-oh! ... it's hard ... ... speaking.

CHAPTER 4

Experiment I: Monomorphemic versus Derived Words

4.1 Introduction

The first experiment investigated whether derivational morphology is overall largely preserved in agrammatic aphasia. To this end, an oral reading task was developed that compared the production of matched monomorphemic and derived words. A distinction within derivation was incorporated, that between derived free-stem and derived bound-stem words. As discussed in Chapter 1, a substantial number of reports in the psycholinguistic and neurolinguistic literature have claimed differential status for these two types of derived words in terms of lexical storage, and, by corollary, in the procedures for lexical access: Derived free-stem words are more likely to enter into morphological (de)composition routines while derived bound-stem words are claimed to be fully-listed (see for example, Bradley, 1980; Anshen and Aronoff, 1988). The foregoing has implications for the sorts of suffix errors that might be predicted on the derived words if

i. derivational morphology is, indeed, disturbed in agrammatic aphasia, and

ii. the processes of derivational morphology parallel those of inflectional morphology, i.e., a derived word with a free stem may give rise to omissions or substitutions of the suffix (the former more likely), while a derived word with a bound stem will give rise to substitutions of the suffix. In English, the parallel is not exact because inflectional morphology has to do only with free-stem words. For derivational morphology, however, the parallel can be drawn, and so this phenomenon was investigated with the inclusion of matched free-stem and bound-stem derived words.

Research Questions:

Are monomorphemic words read more successfully than matched derived words? Are derived words with free stems read more successfully than matched derived words with bound stems? Will patterns of suffix errors, if any, differentiate the free-stem and bound-stem derived words?

Prediction

If derivational morphology is indeed spared in agrammatic aphasia, then the derived words will be read as successfully as matched monomorphemic words. Furthermore, any errors occurring on the derived words should not disproportionately involve the suffix. Errors on the derived words, however, especially on the suffix itself, as compared with the monomorphemic forms, will indicate that derivation itself is problematic for agrammatic speakers.

Under an account claiming that derived free-stem words are more likely subject to decomposition routines (an operation that would allow the stem — now a shorter word — to be processed first, followed, arguably, by the processing of the suffix), we would predict that the free-stem derived words would be read more successfully than the bound-stem derived words. Furthermore, if the latter are, as claimed, more likely to be fully-listed, then they have to be accessed and produced as full words because they cannot be broken down into a shorter word plus a suffix. As such, bound-stem derived words would be less prone to suffix errors than free-stem derived words. However, the observations already in the literature concerning the sorts of suffix errors associated with free-stem and bound-stem derived words lead to a further prediction: if suffix errors occur on both sets of derived words, then substitutions of the suffix will predominate on bound-stem words, and omissions of the suffix will predominate on free-stem words.

4.2 Method

There were 120 words in the stimulus set: 60 three-syllable monomorphemic words (e.g., *hyacinth, vestibule*) and 60 three-syllable derived words (e.g., *venomous, therapist*). All words had first syllable stress.

Within the list of derived words, 30 had free stems, e.g., *venomous* and were matched to 30 with bound stems, e.g., *therapist*. In this way, a further comparison would be possible between the production of matched derived free-stem and derived bound-stem words. A word was judged to have a bound stem if the stem cannot exist as an independent word, and if at least one other similar form exists with the same stem, e.g., *therapist*-therapy; *regulate*-regular; *magnitude*-magnify, the italicized words being stimulus words.

The set of 60 monomorphemic words was initially constructed in 2 sets of 30 words, matched for frequency of occurrence (Francis and Kučera, 1982). The set of 30 derived free-stem words and the set of 30 derived bound-stem words were also mutually matched, as well as respectively matching the 2 sub-lists of monomorphemic words. In effect then, Experiment I consisted of 4 matching sub-sets: two sets of 30 words within the monomorphemic set, matched by set, and two sets of 30 words within the derived set, also matched by set, and matched with the monomorphemic words.

The mean log frequency for the set of 60 monomorphemic words was 0.58. The geometric mean was 3.80. The frequency range was 1-34. Word length was 6-10 letters. Fifty-seven of the 60 words were nouns, 1 was a verb, and 2 were adjectives. Three words in the sub-list were *hybrids*, as noted below.

alien:	14 adjective	5 noun
catalog:	16 noun	4 verb
champion:	31 noun	2 verb

The mean log frequency for the set of derived words was 0.59. The geometric mean was 3.9. The frequency range was 1-30. Word length was 6-9 letters. The mean log frequency for the 30 derived free-stem words was 0.56. Ten words were nouns, 2 were verbs and the remaining 18 were adjectives. The mean log frequency of the 30 derived bound-stem words was 0.62. In this sub-set, there were 10 nouns, 10 verbs and 10 adjectives. Thus in the total set of 60 derived words there were 20 nouns, 12 verbs, and 28 adjectives. One word in the derived bound-stem sub-set was a *hybrid*, as noted below.

militant: 7 adjective 1 noun

The stimulus list for Experiment I is displayed in Table I.1.

4.3 <u>Results</u>

The participants' table of results is laid out in Table I.2. Item-based analysis of the correct percentages of responses (using a t-test for independent samples) showed that the monomorphemic words (overall, 70.4% correct) were read more successfully than were the derived words (overall, 43.3% correct), $t(118) = 5.39$, $p < .0001$. Better performance on the monomorphemic words than on the derived words was a consistent pattern for each participant. Figure I.1 shows each participant's correct scores, expressed as a percentage, for each set of words.

Within the derived set, however, the free-stem derived words enjoyed no notable advantage over the bound-stem derived words (Figure I.2). The average rates of successful reading were close (47.5% and 39.2% for free-stem and bound-stem words respectively), and analysis of these data (again using t-test for independent samples) showed that the slight numerical advantage for the free-stem words was not reliable, $t(58) = 1.19$, $p > .10$. Moreover, in contrast to the advantage seen for monomorphemic over derived words, individual participants showed no consistent pattern of performance across the two sets of derived words.

Inspection of Figures I.1 and I.2 shows the considerable variability among the participants in the performance of each across the comparison sets. This is particularly noticeable in Figure I.2 where the differences in overall correct responses across the two sets of derived words range from a low of 3% (P4) to 33% (P3), with more relatively equal performance across the sets for P1 (a 13% difference) and for P2 (a 10% difference). This variability extends into a fractionation of the "correct" responses. Recall that one criterion for a correct response was suffix-correct under certain constraints (see Chapter 3.5). The total correct responses for P1 and P3 subsume a proportion of suffix-correct responses: the suffix-correct column of Table I.2 shows that 6 of P1's 28 correct responses (21.4%) and 5 of P3's 28 correct responses (17.9%) on derived words were of this type. Participants P2 and P4 produced no such responses.

Error Analysis

Comparison of the error categories produced (Figure I.3), shows that the monomorphemic words were numerically more susceptible to different-word and "can't" errors than were the derived words. Derived words were as susceptible to suffix error as they were to "can't" error, with different-word error only slightly less.[22] Non-parametric analysis of the three main categories (suffix error, different-word and "can't"), excluding miscellaneous error) showed that the distribution of responses over the error categories differed between derived words and monomorphemic words, $\chi^2(2) = 23.14$, $p < .001$.

Details of the variability in the participants' responses for the derived words can be read from Table I.2. The derived words were overall more difficult for P2 and P3 than they were for P1 and P4 in terms of "can't" responses. Note that P4, who read both monomorphemic and derived words better than the other three participants (markedly so, in the case of the monomorphemic words), nevertheless made the second largest number of suffix errors on the derived words.

Recall that the initial statistical analysis comparing response data for the free-stem and bound-stem derived words showed no statistical significant difference overall. Figure I.4 displays the breakdown of error categories for these two sets of words. Inspection of the average rate of Suffix-Error shows these to be equally likely, (constituting 38.1% and 32.9% of all errors for free-stem and bound-stem words,

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[22] There were only three instances of suffix error, in total, among 71 error responses to monomorphemic words. In reality, of course, these are not suffix errors at all, there being no suffix on which to err. Rather, they are "end-of-word" errors, and consist only of legal additions (inflection, as well as derivation) to the target word (e.g., *pyramid*→*pyramids*; *champion* →*championship*). In the derived set, there were 48 instances of suffix error among 136 error responses. Only 4 of these suffix error responses were additions (e.g., *circulate* →*circulation*), a number remarkably similar to the addition errors for the monomorphemic words.

respectively). This was the most common error category for derived free-stem words; but for derived bound-stem words, suffix error was overshadowed by the participants' inability to respond (constituting 46.6% of errors). *Post hoc* analysis (χ^2 2x3 table of independence) confirms that bound-stem words and free-stem derived words differ in the types of errors incurred, $\chi^2(2) = 10.94$, $p < .01$.

A difference in the distribution of error is seen also in the types of suffix error that were made in responses to free-stem and bound-stem words. While the overall rates of Suffix-Error were similar, as noted above, response content does provide evidence of a systematic difference between the two sets of derived words. Figure I.5, which pulls out a detail from Table I.2, illustrates that substitution errors predominated for the bound-stem set compared with a very small proportion of additions. Note that for these stimuli, suffix omissions would result in the utterance of a non-word. For the free-stem words, suffix errors were divided about equally between substitutions and omissions, the latter, of course, producing a legal word for this stimulus type.

<u>Summary</u>

- Derived words were overall more difficult to read aloud than were matched monomorphemic words. Each participant showed this pattern.
- Different-word and "can't" errors predominated for the monomorphemic words: suffix error and "can't" errors predominated for the derived words.
- Participants showed individual variability in the distribution of errors across the error categories for the monomorphemic words compared with the derived words.

- For the derived words, there was no evidence of difference in the overall rate of error for the free-stem compared with the bound-stem words (all categories of error combined). There was no consistent pattern of performance across the participants.
- Rate of suffix error was approximately equal for the group across the derived free-stem and derived bound-stem words.
- The type of suffix error, however, contrasted between the two sets of derived words: in the free-stem set, omissions and substitutions appeared about equally; in the bound-stem set, there were no omissions, a small number of additions, and a very large number of substitutions.

4.4 Discussion

The results of Experiment I provide evidence that overall monomorphemic words are indeed read more successfully than matched derived words. This similar pattern of better performance on monomorphemic words was seen for each participant, although, of course, there was variability in both error rate and types of error produced, phenomena that may relate to the peculiarities of each participant's language disorder.

The data provided by our participants do not bear out the notion that derived words are similar in access status to monomorphemic words. The derived words were not treated similarly, overall, to the monomorphemic words. More than one-third of the errors on the derived words were those of suffixation. All participants made suffix error, again in varying degrees. While the concept of suffix error cannot, by definition, apply to monomorphemic words, "end-of-word" errors are quite possible. The participants made very few "end-of-word" errors, and those were only additions to the full target word.

Furthermore, although the monomorphemic words were not selected in such a way that there was any *a priori* systematic opportunity for the last syllable to be omitted and leave a real word, or a different last syllable to be substituted, there were some opportunities for such responses. For example: *violet* could be read as *violin* or *viola*; *cabinet* read as *cabin; pedigree* read as *pedicure*. The single response of this type was *cabinet* → *cabin.* Conversely, a number of the monomorphemic words did allow syllabification into real words, the syllables of which could have been isolated and read as words (e.g., *car-a-van*; *mad-rigal; ten-tacle* or *tent-acle; cat-a-log*). There were no such responses. Nor did the participants make errors on words where the last syllable could be read as a pseudo-suffix. While the first two syllables were phonologically distorted, the final syllable was correct (e.g., *turpentine*→ /sɝpəmpɑɪn/; genuine→ /ʤɛn^{p}juɑɪn/; madrigal→ /mæʤɪgəl/ or as /mæʤrɪŋ^{g}əl/, the latter then followed by an exasperated "Huh! You know …… singing"). These observations provide converging evidence, arguably, that the participants recognized the target monomorphemic words as indivisible units.

The large error score for different-word and "can't" within the monomorphemic set is likely attributable, at least in part, to the recognition of indivisibility. In making such an error, the participant either was able to reach the word's semantic field (at times somewhat distant) but produced a related word (*hyacinth* → *chrysanthemum*; *catapult* → *deliver)*, or was able to locate the actual word, but could not grasp or maintain the phonological shape, or perhaps bring the word to articulation (*hyacinth* → "……. *also flowers……… no idea"; "I know what it is, I can't spit it out"; "daffodil*→ ……… *can't say it… but… plant …… spring").*

As to the question whether the derived free-stem words would be any easier to read than the derived bound-stem words, recall that the total rate of errors for these derived sub-sets did not differ. There were, however, differences in the distribution of the total error responses (Figure I.3). Furthermore, although the total number of suffix errors did not differ across the word sets, there was a difference in the distribution of type of suffix errors.

These differences imply that derived free-stem and bound-stem words have different status in the lexicon, even if they are equally vulnerable to agrammatic error. On the bound-stem words, there were no omissions of the suffix, but mostly substitutions with a small number of additions. The occurrence of substitutions on bound-stem words was the expected outcome in the event of suffix error, and is consistent with Grodzinsky's observation (1984) that suffix (or other) omissions will not occur where the result will be a non-word, or an unpronounceable phonological string. The large number of "can't" responses (more than twice as many as those for the derived free-stem words) can be interpreted within this view (refer to Figure I.4). An attempt to produce a derived bound-stem word is, presumably, abandoned because it cannot be parsed into a (shorter) autonomous word with a lexical or sublexical suffix, as is the case with the derived free-stem words. Conversely, responses on the derived free-stem words show both omissions and substitutions of the suffix, both allowable by decomposition procedures. More omissions than substitutions on the free-stem derived words suggests that this type of word is more likely to be parsed into stem plus suffix (or, in these instances, minus suffix) than accessed as full-forms.

The foregoing is not presented as *prima facie* evidence for the necessary full-listing of derived bound-stem words, and the necessary decomposition of derived free-stem words. There is ample evidence for the processing of derived bound-stem words by both paths of the dual-route. Decomposition may be attempted, and the agrammatic reader processes the stem but cannot process the suffix. At this point, the reader may simply make a guess, producing an apparently morphological substitution. As has been discussed earlier, morphological relatives are similar semantically, visually, and phonologically. Thus, what appears to be a morphological substitution may actually have a different underlying cause (Luzzatti, Mondini and Semenza, 2001; Badecker and Caramazza, 1987; Katz and Lazzoni, 1997). It has been shown, however, that words within a morphological family prime each other (Meunier and Segui, 1999). Thus, it is not surprising that a morphological relative would be substituted, regardless of the underlying cause.

Substitution-by-guess or by equal activation may, of course, also account for substitution errors in the derived free-stem words, but it is harder to account for the omissions of the suffix in this set. It may be the case that there are fewer substitutions of a morphological relative in the free-stem words than in the derived bound-stem set because there are simply fewer opportunities to do so. Either derived free-stem words in general have fewer morphological relatives, and/or this caveat applies to the specific free-stem stimulus words in this experiment. (This point can be reserved for later examination.) The omissions may, of course, be accounted for by invoking the explanation of substitution of zero-morph (Grodzinsky, 1984). However, such an explanation seems to obscure the fact that there is a structural difference between derived free-stem and bound-stem words, and that our agrammatic speakers have indeed treated the two sets differently. Agrammatic speakers do have difficulty with morphologically complex words. The types of suffix errors do suggest differential status in the lexicon for free-stem and bound-stem derived words. Despite these difficulties, however, the agrammatic participants remained subject to normal lexical bias (that is, they try to produce real words), and, in addition, subject to the normal priming effect where the presentation of one morphological form activates one of its morphological relatives in the lexicon. Overall, despite the disruption in derivational morphology, Experiment I shows that the participants with agrammatism nevertheless remain sensitive to derivational processes.

CHAPTER 5

Experiment II: Word-final–ER: Monomorphemic versus Derived versus Inflected Words

5.1 Introduction

This experiment investigated an aspect of derivation that allows a direct comparison with inflected and monomorphemic words of the same segmental shape. The production of words ending in –ER were compared across three categories: monomorphemic words where the final –ER has no morphological function, the derived agentive, and the comparative adjective.

Research Questions

Are monomorphemic-ER words better preserved than matched derived-ER words? Are derived-ER words better preserved than matched inflected-ER words?

Predictions

Given the standard descriptions of agrammatism we would certainly expect to see both monomorphemic and derived words better spared than the inflected words. From the claim that derivational morphology is largely preserved in agrammatic aphasia, we would expect the derived words to be read as successfully as the monomorphemic words. Thus, overall, we would expect to see a pattern of errors where the inflected words are least spared, and the monomorphemic and derived words more equally spared compared to each other.

5.2 Method

The stimulus set for this experiment consisted of three sets of words with word-final–ER, matched for frequency of occurrence (Francis and Kučera, 1982). There were 90 words in the total stimulus set: 3 sets of 30 words in the three categories: 30 monomorphemic-ER words (Mmp-ER), e.g., *chowder*; 30 derived-ER words, specifically the derived agentive (Der-ER), e.g., *banker*; and 30 inflected-ER words, specifically the comparative adjective (Infl-Er), e.g., *richer*.

The mean log frequency for the Mmp-ER list was 0.61, with the geometric mean of 4.10; for the Der-ER list, it was 0.61, with the geometric mean of 4.10; for Infl-ER list it was 0.61, with the geometric mean of 4.10. The frequency ranges for the three sub-lists were 1-19, 1-22 and 1-19 respectively. All 90 stimulus words were bisyllabic, with the stress falling on the first syllable. Word length in number of letters ranged from 5-8.

The Mmp-ER words were of mixed lexical class: there were 23 nouns, 6 verbs, and 1 adjective. There were 7 "hybrid words" in the Mmp-ER list (all classified as nouns). Their frequencies of occurrence and lexical classes are as follows:

blister:	4 noun	3 verb
blunder:	3 noun	2 verb
copper:	12 noun	1 adjective
lather:	3 noun	3 verb
pepper:	13 noun	2 verb
slumber:	3 noun	1 verb
thunder:	12 noun	6 verb

The Der-ER words were all agentive nouns. Fourteen of the 30 words were derived from verbal stems, e.g., *heal, mourn, think*. The remaining 16 were derived from stems that were both verb and noun, but necessarily, it is the verb stem that gives rise to the agentive. Of these 16, eight had a greater verbal frequency than noun frequency, e.g., *hunt*: 44 verb and 4 noun, and the remaining eight had a greater noun frequency than verb frequency, e.g., *dream*: 88 noun and 45 verb.

The 30 Infl-ER words were all comparative adjectives. Seven were derived from adjectives, e.g., *harsh*. The remainder were derived from stems of mixed lexical class, of which the adjectival frequency was, in almost all cases, predominant, e.g., *smooth* 36 adjective, 15 verb; *sweet* 68 adjective, 2 noun, 1 adverb. The notable exceptions were *kind* (333 noun, 17 adjective) and *near* (156 preposition, 17 adjective, 20 adverb).

The stimulus list for Experiment II is displayed in Table II.1.

5.3 Results

The participants' table of results is laid out in Table II.2. Item-based analysis of the data using one-way ANOVA showed that, as expected, the monomorphemic-ER words were significantly better preserved than either the derived-ER or the inflected-ER words, $F_{2,87} = 4.85$, $p < .001$. Paired comparisons confirmed the better preservation of the monomorphemic words (75.0% correct) compared with the derived words (59.2% correct), $F_{1,58} = 9.98$, $p < .01$, and compared with the inflected words (61.7% correct), $F_{1,58} = 5.21$, $p < .05$. However, a comparison between the derived and inflected words showed no evidence of difference, $F_{1,58} = 0.65$, $p > .50$.

We can see, however, from the data broken down by participant, that the individual patterns of performance were different (Figure II.1). The monomorphemic words were, indeed, best preserved for P1 and P2, but not for P3 and P4. For each participant, however, derived words were overall no better preserved than were the inflected words.

A proportion of the participants' correct responses in all three word sets was that of suffix-correct. Almost all responses of this type contained one or more phonological changes in the stem that resulted in the production of a different word, but which otherwise met the requirements for correctness under the suffix-correct criteria (see Chapter 3.5). Examples of such responses are: *tinder* → *tender*; *blunder* → *blender*; *wider* → *wiser*. Table II.3 shows the suffix-correct scores for each participant across the three word sets. Note that there is considerable variability across the participants and across the word sets. Overall, the monomorphemic words induced the most suffix-correct responses, with far fewer occurring in the derived and inflected words, but more equal to each other (15% compared with 4% and 8% respectively). Across the participants, suffix-correct responses ranged from zero in some instances (P2 and P4) to 30% (P3). Individually, P3 made the largest number of suffix-correct responses, those appearing across all word sets, but predominantly in the monomorphemic words. P1's suffix-correct responses were likewise made across the three word sets, but were more evenly distributed.

Error Analysis

Analysis of response frequencies tabulated in error categories by χ^2 table of independence provides evidence that the distribution of errors differs significantly across the three word sets, $\chi^2(4) = 24.44$, $p < .001$ (the miscellaneous error category was excluded in this analysis). "Can't" and different-word were the categories of error most often elicited by the monomorphemic words, and, moreover, were more common than the "can't" or different-word errors elicited by either the derived or the inflected words. These latter word sets were much more likely to elicit suffix errors than they were other categories of error (see Figure II.2). As discussed in Chapter 4, suffix error on a monomorphemic word does not exist, and in these stimulus sets refers to "end-of-word" error. In this present experiment, there were very few "end-of-word" errors, and these appeared as additions, e.g., *linger* → *lingering*; *hunger* → *hungry*. Derived and inflected words were prone to suffix error to roughly the same extent, both quantitatively and qualitatively (Figure II.3). Analysis showed that the likelihood of making one or another type of suffix error did not differ depending on whether the word was derived or inflected, $\chi^2(1) = 0.33$, $p > .50$. What is striking in this comparison is the preponderance of omission errors compared with substitution errors for both the derived and the inflected word sets.

Summary

- The monomorphemic words were read significantly more successfully than either the derived words or the inflected words.
- The derived and the inflected words were overall read equally successfully.
- There was no consistent pattern of correct performance across the categories of words across the four participants.
- "Can't" and different-word errors were the largest categories of error for the monomorphemic words.

- Suffix error constituted the largest category of error for both derived and inflected words compared with different-word and "can't" error.
- The derived and inflected words were equally prone to suffix error, and to the same type of suffix error: omission errors were equal across the derived and inflected word sets, as were substitution errors.
- The majority of suffix errors for both derived and inflected words were omissions.

5.4 Discussion

The results of Experiment II are consistent with our predictions that the monomorphemic words would be the best spared compared with the derived and inflected words, but does not hold across the participants. The alternate prediction that the derived words would be spared similarly to the monomorphemic words was not borne out. Nor was the alternate prediction that the inflected words would be the least spared, because performance on both the derived and inflected words was strikingly similar, whether correct reading rates or error categories are considered.

Analysis of the errors, however, shows that the picture is not quite so simple: As mentioned above, it has been proposed that inflectional and derivational morphology are separate autonomous lexical processes (e.g., Miceli and Caramazza, 1988). The data indicate that such a sharp distinction cannot be drawn, at least for this aspect of derivational and inflectional morphology. The participants treated the derived and inflected words similarly, in that suffix error was the preponderant category of error for both sets. Here all the stimulus words are bimorphemic with free stems, and as such susceptible to omissions of the suffix, with substitutions perhaps less likely, though possible. In the derived set, substitutions consisted of the verb markers *–s* and *–ing* (*hunter* → *hunts* and *swimmer* → *swimming*, respectively). In the inflected set, however, the substitutions were varied, and included the adverbial suffix *–ly* (*sadder* → *sadly*), the superlative suffix marker *–est* (*dearer* → *dearest*), the verb/noun marker *–s* (*sweeter* → *sweets*), and the deverbal suffix *–en* (*broader* → *broaden*). Participants did not make any illegal combinations of stem and suffix, that is, they did not produce combinations such as *blister* → **blisting*; *drummer* → **drummering*; *slower* → **slowen*. Thus, although the participants made errors on these derived and inflected words, the type of errors produced show a preserved sensitivity both to the morphemic structure of the word, and to the lexical nature of the stem.

Further evidence for this retained sensitivity is seen in the nature of the errors in the monomorphemic set. Firstly, as was also seen in Experiment I, these words were clearly recognized as monomorphemic and treated as such, even where the first syllable formed a full word (of which there were six in this stimulus list, e.g., *<u>tin</u>der*, *<u>pan</u>ther*, *<u>pep</u>per*, *<u>hung</u>* or perhaps *<u>hung</u>er*). Participants made no attempt to read the first syllable as the whole word. Thus there were no omissions of the final syllable, but there were additions to the end of the word. These additions consisted of adding a verbal marker, but noticeably only to words that are either verbs, or have usages in both verb and noun lexical classes.

The second point refers to the suffix-correct category. All responses of this type consisted of a real bisyllabic word ending in –ER, differing from the target word by only one or two segments, e.g., *dagger* → *danger*. This type of response was much more prevalent in the monomorphemic set than in the other two word sets, which by their structure are susceptible to suffix errors. It is arguably the case that the target word was processed as a monomorphemic word, but a similar monomorphemic word was activated and produced, based on visual, semantic or even phonological activation.

The third point refers to the large number of "can't" errors in the monomorphemic set, compared with those of the derived and inflected sets. This provides further support for the claim of retained sensitivity to the structure of monomorphemic words. Decomposition, which arguably would help with processing, is not possible. In the "can't" responses, the participant's attempt to process the target word, recognized to be monomorphemic, broke down. Either lexical representation was not activated from the print, or lexical representation was indeed activated, but phonological assembly and/or motor planning was not effective.

The findings of Experiment II reinforce those of Experiment I: the monomorphemic words in this experiment were indeed preserved in comparison to either the derived or the inflected word sets. The contrast between the monomorphemic and the derived word sets in this experiment, however, shows that the derived agentive words were not treated as if they were monomorphemic, despite observations that the former tend to become lexicalised (Bradley, 1980). The marked occurrence of suffix error for the derived word set, with omissions far outnumbering substitutions, shows that this particular type of derivational morphology can break down in agrammatic aphasia. Furthermore, the almost identical treatment of the derived and inflected-ER words implies a blurring of the distinction between derivation and inflection in this respect at least, and that preservation or breakdown might have more to do with the internal structure of the stem than with its assignment to a specific morphological category.

CHAPTER 6

Experiment III: Morphophonological Change versus No-Change

6.1 Introduction

As was discussed in the introductory chapter (section 4), Level I derived words have been associated with increased processing times in lexical decision tasks. This observation has been taken as evidence that such words are decomposed in recognition and access is achieved via the base form (e.g., Tsapkini, Kehayia and Jarema, 1999). The morphophonological change in the derived form is claimed as responsible for this increase in the latency of recognition. Level II words, which also enter into decomposition routines, do not incur this increase in latency of recognition because they can be decomposed more directly. Conversely, there is opposing evidence that Level I words are lexicalised and therefore fully-listed, so reaching them through the stem form is an unnecessary operation, while Level II words are decomposed and reached via the stem form (e.g., Bradley, 1980;Vannest and Boland, 1999). This evidence has related to visual and auditory recognition, not to the production of these words. Kohn and Melvold (2000) have developed a two-stage model of production by which lexical entries, which are initially phonologically underspecified, are first activated and then become phonologically specified through the application of morphophonological rules. By this account, the processing load increases for Level I words at the level of phonological assembly because of the increased number of phonological operations.

Thus, the first research question asks whether derived words are produced more successfully when derivation involves only the affixation of a suffix to a free stem (Level

II suffix) than when derivation involves some form of morphophonological change in the stem (Level I suffix). We predicted that Level II derived nouns would be produced more successfully than Level I derived nouns because of the presumed fewer linguistic operations.

A second question is whether verbs giving rise to Level II derived nouns would be read more successfully than verbs giving rise to Level I derived nouns. While there is a reasonable argument for the possibility that Level I derived nouns will be more difficult to read aloud than Level II derived nouns, given the putative differences in linguistic operations, there is no compelling argument to suppose that the base verbs would be subject to the same constraints: there are, presumably, no linguistic operations to undertake for Level I base verbs compared with Level II base verbs.

Thus, the research questions for Experiment III are as follows:

1. Are Level II derived nouns read more successfully than Level I derived nouns?
2. Are Level II base verbs read more successfully than Level I base verbs?

6.2 Method

The stimulus set consisted of two sets of derived nouns and their base verbs, matched for frequency of occurrence (Francis and Kučera, 1982). One set was derived from verbs plus *–ion*, (i.e., Level I derivation, e.g., *convulse- convulsion*). The other set was derived from verbs plus *–ment* (i.e., Level II derivation, e.g., *excite–excitement*).

There were 96 words in the stimulus list: 24 base verbs with 24 derived-*ion* nouns, and 24 base verbs with 24 derived *–ment* nouns. The base verbs were bisyllabic, with second-syllable stress. The derived nouns in both *–ion* and *–ment* were trisyllabic, also with second syllable stress, as for the base verbs.[23]

Inclusion in the list depended on a base verb and its derived noun in the one set (e.g., in the *–ion* set) having an internal close frequency match, and a frequency match, or close approximation thereto, to a pair in the other set, which pair itself had an internal frequency match. Examples are: *explode* (frequency, 22 per million)–*explosion* (frequency, 16 per million) and *resent* (frequency, 16 per million)–*resentment* (frequency, 18 per million); *negate* (frequency, 2 per million)–*negation* (frequency, 5 per million) and *defer* (frequency, 3 per million)–*deferment* (frequency, 5 per million). Thus, two sets of overall matched base verbs gave rise to two sets of overall matched derived nouns. All pairs of nouns and verbs were semantically transparent.

The mean log frequency for the set of *–ion* derived nouns (N^{ion}) was 0.89 with a geometric mean of 7.9. For the set of *–ment* derived nouns (N^{ment}), the mean log frequency was 0.89 with a geometric mean of 7.9. Frequency ranges for the derived nouns were 1-48 and 1-49 (N^{ion} and N^{ment} respectively). Word lengths were 8-10 and 9-13 respectively. For the base verbs, the mean log frequency was 1.1 (geometric mean 13.7) for the V^{ion} set and 1.1 (geometric mean 13.0) for the V^{ment} set. Frequency ranges were 1-71 and 1-66, and word lengths were 5-8 and 5-9, respectively.

Table III.1 displays the lists of stimulus words for Experiment III.

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[23] One general consideration in the construction of the experimental lists was to exclude prefixed words, partly because of the debate concerning the differences in the linguistic status and the processing of prefixed words compared with suffixed words. This would have introduced another linguistic element. Avoidance of such words was not possible for Experiment III, but only one member of a morphological family of such words was allowed, e.g., *repress* or *depress* or *oppress*, etc.

6.3 Results

The answer to our first question was in the negative, as the N^{ment} set was not read more successfully than was the N^{ion} set. Item-based analysis of the data by t-test for independent samples shows that rates of successful reading for the N^{ion} and the N^{ment} word sets did not differ significantly (55.2% and 59.4% respectively), $t(46) = 0.54$, $p > .50$. The participants' scores are shown in Table III.2. Figure III.1 shows that there were differences in individual performances across the participants, ranging from 25% correct to 83% correct. For two out of the four participants, however, there was a pattern of equal or relatively equal performance between the sets of derived nouns.

The proportion of the group's correct responses that were suffix-correct is shown in Table III.3. While this type of response varied across the participants and across the noun sets, the results here were clearly driven by P1 in the N^{ion} set, and P3 in both word sets. P3's correct responses in the N^{ion} set were solely suffix-correct (9/9), and in the N^{ment} set, 14/18 (78%) of P3's correct responses were suffix-correct. P1 produced as many suffix-correct responses as P3 in the N^{ion} set, and these accounted for slightly more than half of his correct responses (10/19–51%).

Error Analysis

Between the N^{ion} and the N^{ment}, there was a strikingly similar pattern of error distribution across the categories of error across the noun sets, $\chi^2(2) = 0.52$, $p > .50$. The following points can be seen from Figure III.2, where the results are graphically expressed as percentage error. Firstly, the differences between the noun sets for each of the four categories of error were non-existent or very small. Secondly, the distribution of error within each noun set for three of the four categories of error was relatively narrow. Lastly, there was exactly the same ranking of error type for the two noun sets.

That "can't" was the largest category of error for both sets of derived nouns points up the fact that overall the participants found the words difficult to read, though this difficulty was not a characteristic of each participant (see Table III.2). The "can't" error for N^{ion} set was the equal contribution of P2 and P3, and overwhelmingly of P2 in the N^{ment} set. All participants made different-word errors in either noun set, and each participant individually made about the same number of different-word errors across the two sets. Details are treated more specifically in the Discussion.

Overall, the rate of suffix error for both sets of words was small (Figure III.2), especially when compared with the suffix error in Experiments I and II: less than a quarter of the total group error for both sets in Experiment III was suffix error (23%:26% for the N^{ion} and N^{ment} sets, respectively) compared with the almost-half "can't" errors (49%:41% for the N^{ion} and N^{ment} sets, respectively). Analysis of the suffix errors by chi square showed no evidence that the distribution of errors was sensitive to noun-type, $\chi^2(1) = 0.20$, $p > .65$.

Figure III.3 shows interesting points concerning the types of suffix error. Firstly, there were no additions of a suffix to the target word. At first glance, this is hardly surprising. But additions are possible (for example, as was seen in Experiments I and II for both monomorphemic and derived words), and there was certainly opportunity in this experiment for the participants to make them. Secondly, both omissions and substitutions were approximately equal between the two sets (N^{ion} 40% omission compared with N^{ment}

50% omission: N^{ion} 60% substitution compared with N^{ment} words 50% substitution). Thirdly, despite similarities when group scores are compared, variability again showed up in individual performances. There was no consistent pattern of performance, neither among the participants, nor across the sets, nor within the types of suffix error.

Summary

- The N^{ion} and N^{ment} word sets were read equally successfully.
- There was variability in individual performance, but relatively equal performance across the noun sets for two of the four participants.
- The distribution of error across the error categories between the noun sets was strikingly similar.
- "Can't" error was the largest category of error for both noun sets, contributed mostly by P2, and to a lesser extent by P3.
- The overall rate of suffix error was relatively small, but equal across the noun sets.
- Suffix substitutions and omissions were approximately equal compared across the noun sets, and within the noun sets.
- There was variability in individual performance within the category of suffix error, with no consistent pattern of performance.

The second question is also answered in the negative. (See Table III.2 for the participants' scores for the base verbs. Item-based analysis of the group data by a t-test for independent samples shows that the rates for successful reading for the V^{ion} and the V^{ment} word sets did not differ significantly (44.8% and 47.9% respectively), t (46) = 0 .44, p > .65). Figure III.4 shows, however, that there was variability in the participants' performances. For three of the four participants (P1, P2 and P4), there was an advantage for the V^{ment} set compared with the V^{ion} set, but with only narrow differences for P1 and P4. For P2 there was a sizable difference in favor of the V^{ment} words, while for P3, the pattern was reversed with better performance on the V^{ion} words.

Error Analysis

As a preliminary point, it is noteworthy that in this experiment there were, indeed, omissions and substitutions of the prefix/pseudo-prefix, i.e., the unstressed initial syllable (e.g., *adopt* → *_dopt*; *repress* → *_press*; *disrupt* → *interrupt*). This was driven almost solely by P3, whose responses were characterized by this feature.[24] P3 consistently also omitted this first syllable in the sets of derived nouns, but in those instances she mostly managed to produce the suffix. Thus, her responses for the derived nouns counted as correct under the specified criteria for correctness (see Coding Taxonomy, Chapter 3.5). Of course, that metric cannot apply in the sets of base verbs because there is no suffix to get right or wrong. Thus, the question is raised whether this type of response counts as a separate category of error, or as a correct response but with phonological error. Ultimately, for the purposes of this study, this type of response was counted as correct. Table III.4 shows P3's contributions of "prefix omission/substitution" to the group's overall correct responses.

Figure III.5 displays the contribution of all error categories to the total group error, expressed as percentages. The χ^2 test on the three main categories of error

[24] P2 contributed one response of this type in the whole set: P4 contributed one substitution of the prefix.

(excluding miscellaneous error) provided no evidence that one set of verbs was more likely to evoke greater error rate than the other set, $\chi^2(2) = 4.05$, $p > .10$. Yet inspection of the data displayed in Figure III.5 reveals some interesting points regarding the distribution of the error responses. Firstly, the sets were overall equally difficult – the "can't" responses accounted for 40% of the total error, averaged across the verb sets. Secondly, different-word error across the verb sets was similar (21%: 10%, respectively). Thirdly, one must ask how there can be suffix error for these base forms, and so much of it?

Suffix error here, of course, means the addition of a suffix to the end of the target word. This was the case in Experiments I and II where suffix error on the monomorphemic words consisted of the addition of a derivational or inflectional suffix. In this present experiment, the addition of a suffix to the base verbs was the largest category of error for the V^{ment} set (48%), and the second largest error category for the V^{ion} set (30%). Overwhelmingly, the participants responded with the noun derived from the verb, though a different morphological relative was occasionally produced, both derived and inflected (e.g., *confuse* → *confusion*; *appoint* → *appointment*; but *attract* → *attractive*; *resent* → *resentful*; *restrict* → *restricted*. Lastly, all participants made this type of addition error, and in both sets of base verbs. Table III.5 displays the numerical data.

Summary

- The V^{ion} and the V^{ment} sets were read equally successfully.
- There was variability in individual performances, but with a pattern of slightly better numerical performance on V^{ment} set than on V^{ion} set for three of the four participants.
- The rate of error and distribution of error were similar across the verb sets.
- There was substantial "suffix" error, i.e., additions of a suffix to the base verb forms. (Note that there were no errors of addition to the derived words (Figure III.3).
- All participants contributed to "suffix" error, and across the verb sets.

6.4 Discussion

As detailed above, reports in the literature have consistently provided evidence for the differential lexical storage, and therefore access routines, for derived words, depending on the nature of the formative boundary between the stem and affix. Level I morphology has been shown to be intact in the mental lexicon. That is, derived words where the formative boundary forces a stem-final, or stem-internal orthographic/phonological change, are represented in full-form, listed separately from their base or stem form. Conversely, derived words where the formative boundary forces no such change, are represented as stem plus suffix, and are decomposed into the constituent parts in lexical access. Specifically, and pertinent to the present study, derived words with suffix *–ion* are listed independently from their base, while derived words with suffix *–ment* are accessed via the stem form (Bradley, 1980). The results of the 1999 study by Vannest and Boland were interpreted as consistent with this model of lexical organization, and further evidence for differential status between Level I and

Level II morphology comes from Tsapkini, Jarema and Kehayia (1999). Anshen and Aronoff (1988) proposed a distinction between Level I and Level II words in production, i.e., words suffixed in *–ity* (Level I) are fully-listed separately from their base forms while words suffixed in *–ness* are constructed by rule as they are required.

The findings of the present experiment appear to be at odds with previous work, at least in terms of reading *–ion* words compared with *–ment* words, as there was no evidence of difference between the two sets of derived words. The same applied to the underlying verbs.

Given this overall apparently equal treatment of the derived noun sets in terms of correctness and categories of error, the question is raised whether these data can nevertheless provide insights into the lexical representation of Level I *–ion* words and Level II *–ment* words. At the outset, it should be noted that this experiment compared only a single suffix from either level, thus the two suffixes must be considered as exemplars of each. A clearer distinction between the two sets of derived nouns in particular, might possibly have emerged if a variety of Level I and Level II suffixes had been compared.

Clearly, the words in both sets were difficult for the participants as a group. Inability to respond ("can't") was the largest error category for both sets of derived nouns, but we see variability in the contributions of the individual participants across the noun sets, with P2 and P3 contributing almost all, and P4 contributing none. The actual responses in this category offered by the participants indicate that the failure to produce the word appeared more often to be at the level of lexical access, rather than at the level of phonological assembly or motor planning. Responses on both word sets typically took the form of *"no, nothing," "no idea,"* or *"I don't know."* This implies, thereby, a different locus of difficulty than a response such as *"inside, no problem... but can't spit it out,"* or an attempt at production, and then, quite unequivocally, *"sorry, can't pronounce it."* The noun sets were not markedly different in this regard in terms of decoding the word and/or reaching its semantic representation. Conversely, mild to moderate phonological error in correct responses was much more evident in the production of the N^{ion} set than on the N^{ment} set, an indication that the former were indeed more difficult to produce at the level of phonological output. This further suggests that Level II derived words are assembled at the level of phonological output where morphophonological rules play a more direct role (Kohn and Melvold, 2000).

Sensitivity to the full word is shown by the participants' responses in both noun sets in the suffix-correct category (Table III.2). This was the case for instances where there was phonological error on the stem with a correct suffix, or where a real word was produced, which was different from the target word but had the correct suffix. These types of responses strongly suggest that the participants were processing the complete target word, whether the response was totally correct, or whether it was only partly correct by virtue of the suffix. Thus, inasmuch as the participants show this sensitivity despite other errors on the word, these responses are indications for the full-listing of both noun sets, but with the greater likelihood for N^{ment} words to be subject to decomposition routines.

In this experiment, the presence of both omissions and substitutions of the suffix on the Level II *–ment* noun set suggests that this type of word has dual status: that they are decomposed, as well as fully-listed. Omissions on the Level I *–ion* words suggests that, although they are generally regarded as fully-listed, they also can be subject to decomposition routines, given certain circumstances such as the visual presentation of the word. In reading, the morphophonological changes required by Level I derivation are not necessarily realized in the orthography where the underlying stem remains transparent (e.g., *adoption* → *adopt*). (See Kohn and Melvold (2000) for further discussion on this point). Thus, not only are omissions of the *-ion* suffix possible, but may even be induced by the visual presentation of these types of derived words.

In the case of the base verbs, the addition of a suffix to the target word provides some insight into the possible common storage of morphologically-related forms (Table III.5 shows the contributions of the participants). The participants overwhelmingly produced the derived noun with, it is to be noted, the appropriate morphophonological changes (e.g., *persuade* → *persuasion*). In those instances where another derived form or an inflected form was produced, they invariably gave the correct phonological segmentation (e.g., *ne`gate* → *`negative*; *ex`plode* → *ex`ploded*; *in`spect* → *in`spector*; *pro'nounce* → *pronunci'ation*. (Table III.7 shows the contribution of the participants to this category of error). That there are more "Derived Other" errors for the V^{ion} set than for the V^{ment} set may be due to a greater opportunity to make such errors on the former, because morphological families for Level I *–ion* words may generally be larger than for Level II *–ment* words. The occurrence of such errors is consistent with the notion of common storage for members of a morphological family whereby the activation of one member primes that of another and then competes for primacy (e.g., Meunier and Segui, 1999, 1999b).

To summarize in conclusion: The expected differences between the noun sets, and between the verb sets were not found. Both sets of nouns and sets of verbs were overall treated pair-wise approximately equally across the categories of correctness and of error. However, analysis of participants' responses provide indications for the full-listing of N^{ion} words, but with decomposition in certain circumstances; for both full-listing and decomposition routes equally usable for the N^{ment} words; and for common storage for morphologically-related words where presentation of one member activates another.

The data from Experiment III show once again that the agrammatic participants indeed have difficulties with derivational suffixes. Yet, again, they remain sensitive to the processes of derivational morphology, and sensitive to the morphophonological rules of suffixation. As is the case for people with undamaged language systems, the activation of one member of a morphological family facilitates the activation of another; the agrammatic speakers are different in that they are unable to inhibit the production of the inappropriate representation.

CHAPTER 7

Experiment IV: Derived words with High-frequency Suffixes versus Derived words with Low-frequency Suffixes

7.1 Introduction

The visual recognition of a multimorphemic word has been shown to be tied both to its surface frequency and to the cumulative frequency of the words derived from its stem (Taft, 1979; Burani and Caramazza, 1987). Colé, Beauvillain and Segui (1989) found this pattern for suffixed words, but not for prefixed words. They concluded that the cumulative frequency has this effect because of the different sequential morphological organization of suffixed words compared with prefixed words. With normal left to right parsing, the lexical representations of the related suffixed words are accessed via their stem, the process thereby sensitive to cumulative frequency. Within this lexical "address," related suffixed words are organized by surface frequency (Meunier and Segui, 1999).

Given that morphological decomposition takes place, in both the access and the production of derived words, (i.e., in recognition, the word is parsed into stem and affix, or is constructed by accessing the list of stems and the list of affixes in the mental lexicon), the relative frequency of the suffix itself might play a role: a frequently-occurring suffix would be more salient than one occurring less frequently. Thus, derived words with a suffix of high frequency will be accessed and produced more easily than equivalent words with a suffix of low frequency.

Experiment IV was therefore designed to investigate whether the frequency of a suffix plays a role in the production of a derived word. Specifically, is a derived word with a suffix of high frequency read more successfully than a matched derived word with a suffix of low frequency?

7.2 Method

7.2.1 Suffix frequency ranking

The construction of the experiment lists for Experiment IV required first a token count to determine the relative frequency of derivational suffixes. A number of written articles from various sources were collected: viz. all the articles that started on the front page of one issue of the *New York Times*; articles of different writing genres from an issue of the *New Yorker* magazine; and articles from magazines of more general interest. All derivational suffix tokens were tabulated, classified according to type, summed for each article, and across the articles. The total number of suffix-derived forms was 1068. Just over 50% of the corpus consisted of a single token of a particular word. A further 25% of the corpus consisted of between 2-4 tokens of a particular word. Twenty words appeared in the same form more than five times, but no single word appeared more than 10 times across the corpus.

The total number of words in each article was estimated by counting the number of words in the first ten lines and multiplying that number by the number of lines in the article. The total number of words for each article was summed to obtain an estimate of the total number of words in the corpus. The total corpus was 13,527. The percentage of suffix-derived words in the corpus was, thus, 7.9%.

The type of derivational suffix was ranked according to its percentage of the total number of derived words across the articles.[25] According to dictionary information, certain suffixes are considered variations of form. Such variations were separately tabulated for information, but were summed for the purposes of ranking (e.g., *–al* and *–ial*, Rank 2). The rank order of the suffixes is displayed on Table IV.1. The rankings were then used to construct the paired lists for Experiment IV.

7.2.2 Stimulus list

The stimulus set for Experiment IV consisted of 21 pairs of matched derived words (42 words). Each pair had the same stem, one member carrying a suffix of high frequency, the other member carrying one of low frequency. This obviated the problem of differences in stem frequency. Suffix frequency was initially determined as detailed above. High-frequency suffixes were those falling between Ranks 1 and 16; low frequency suffixes were those falling between Ranks 12 and 28. The division, therefore, was not absolute, and there was necessary overlap in the middle ranks. For each pair of words, however, the difference between the high-frequency suffix and the low-frequency suffix was at least 6 ranks.

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[25] In the first working of this section of the experiment, *-ly* was included as a derivational suffix. It was the most heavily represented suffix in the corpus, and was consequently ranked #1 (N=135 – 11%). However, its nature is controversial, and is argued to have both inflectional and derivational properties (Bybee, 1985). It was, therefore, excluded and the rank order of types recalculated.

Pairs of words were chosen on the basis of equal surface frequency, i.e., log frequency of the whole word, (Francis and Kučera, 1982) — and other criteria as detailed below. The mean log frequency for the high-frequency suffix set ($suffix_{HF}$) was 0.74, with a geometric mean of 5.5. The mean log frequency for the low-frequency suffix set ($suffix_{LF}$) was 0.70, with a geometric mean of 4.8. The frequency ranges were 1-31 and 1-26 respectively, and word length was 6-9 and 6-10 respectively. The pairs of words were not matched for lexical class as verbal, nominal and adjectival suffixes were used to construct the items. The $suffix_{HF}$ set contained 12 nouns and 9 adjectives. The $suffix_{LF}$ set contained 5 nouns, 5 adjectives, and 11 verbs. Stress fell on the first syllable of each member of the pair and each pair had the same stem characteristics (i.e., either bound or free). Each pair had the same number of syllables (the range was 2-3). Word length was between 6 and 10 letters, but for each pair, the difference did not exceed 2 letters.

The stimulus list for Experiment IV is shown in Table IV.2.

7.3 <u>Results</u>

The participants' table of results is laid out in Table IV.3. Overall, all participants found both sets of words difficult to read – no participant achieved a score much greater than 50% on either set. More noteworthy, however, the outcome was not as predicted: the $suffix_{LF}$ words were read more successfully than were the $suffix_{HF}$ words. Item-based analysis of the results by t-test for dependent samples shows evidence of a significant difference in favor of the $suffix_{LF}$ words, (overall 50% correct compared with overall 38% correct for $suffix_{HF}$ words), $t(20) = 2.1$, $p = .04$, and this pattern was seen for each participant. Figure IV.1 displays the correct percentage scores for each participant.

Error Analysis

Figure IV.2 shows the percentage contribution of the different error categories to the total group error data for both high- and low-frequency suffix words. Suffix error constituted the largest category of error within each set, and, moreover, was approximately equal across the two sets (42% compared with 50% suffix error for high- and low-frequency suffix words respectively). The pattern of equal error across the word sets is seen also for the other categories of error. The participants' scores can be read from Table IV.3.

Analysis of these error data by a χ^2 test shows no evidence that the likelihood of error was dependent on the status of suffix frequency, $\chi^2(2) = 0.30$, $p > .50$. An examination of the types of suffix error (Figure IV.3) shows that the participants made errors of all suffix types in the more successfully read set (the suffix$_{LF}$ words), whereas the less successfully read set (the suffix$_{HF}$ words) had errors of omission and substitution, but no errors of addition. More striking, however, is that substitution error was by far the largest category of suffix error for each set, and, furthermore, was equal across the sets (suffix$_{HF}$ 75%, and suffix$_{LF}$ 71%).

These patterns of relative consistency of group error within each set and across the sets are seen as well in the errors of the individual participants (displayed numerically in the results Table IV.3). All participants made some suffix errors in both high- and low-frequency suffix word sets. In the suffix$_{HF}$ set, all participants made errors of omission and substitution: in the suffix$_{LF}$ set, all suffix error types were present, with all participants making substitution errors. The patterns of error for the other error types were less consistent.

Across the participants within each set separately, the distribution of total suffix error was quite narrow. Table IV.3 shows that the total suffix error for the $suffix_{HF}$ set for each participant was 6, 6, 3, and 9 compared with the total suffix error for the $suffix_{LF}$ set for each participant was 5, 5, 3, and 7. Each participant had individually about the same number of errors for each type of suffix error across each set, a pattern that was reflected in different-word error and in the "can't" error across participants within each set, though less strongly for the latter category. Again, Table IV.3 shows that almost all of the errors in the "can't" category for both high- and low-frequency suffix word sets were the contribution of P2 (55% and 83% of the total group "can't" error respectively). However, the pattern holds whereby each participant made about the same number of "can't" errors across both suffix sets.

Our research question has been answered in the negative: derived words with a high-frequency suffix are not better produced than a matched derived word with a low-frequency suffix. Yet, the data show that in terms of error patterns, the word sets were treated by the participants in remarkably similar fashion.

<u>Summary</u>

- The $suffix_{LF}$ set was overall better produced than the $suffix_{HF}$ set.
- This pattern was seen for all participants.
- Suffix error was the largest category of error for both sets, and was equal across the sets.
- A pattern of equal error across the sets was seen for the other categories of error.
- In the $suffix_{LF}$ set, all participants made errors of suffix substitution.

- In the $suffix_{IIF}$ set, all participants made errors of suffix omission and substitution.
- The largest category of error for both sets was errors of suffix substitution.
- Each participant's pattern of error scores was relatively constant across the sets.

7.4 Discussion

From these data, it would appear that the relative frequency of the derivational suffix does, indeed, play a role in the production of a derived word, but in the opposite manner to that which was expected: *lower*-frequency suffixes evoked fewer errors than did *higher*-frequency suffixes. Yet, as was shown in the Results section, the participants, individually and as a group, treated both sets of words in remarkably similar fashion, making the same sorts of errors at similar rates for both sets. *Post hoc*, the sets were combined and the words arranged by suffix rank (2-28) as the head parameter, then by surface frequency within suffix rank as the second. The group score for each word showed no systematic increase in correctness as a function of higher suffix rank, or vice versa (Table IV.4). Similar arrangement by surface frequency as the head parameter, likewise showed no systematic increase in correct group score as a function of increase in surface frequency, or vice versa (Table IV.5).

The experimental word sets were originally carefully matched for a number of factors, as laid out in the Methods, namely surface frequency; word length; syllable structure; and suffix ranking. We shall consider different, but mutually interacting, factors that might have contributed to the results.

1. Productivity of the suffix: Suffix productivity is not equivalent to suffix frequency. The productivity of a suffix is defined in terms of the likelihood that it will

enter into new forms which will then enter the language (Anshen and Aronoff, 1988). For example, the suffixes *-ous* and *-ness* are highly productive, but did not have high suffix frequency ranking in the corpus (12 and 20 respectively, Table IV.1). A word with a suffix of *high productivity*, rather than suffix *frequency*, might be read more successfully than one with a suffix of *low productivity*. In fact, there were no *-ness* forms in the stimulus set, and the group did not do particularly well on the three *-ous* words in the set. However, this result may be due to the interacting factors, as further discussed below.

2. Abstract vs. concrete: In general, aphasic speakers produce words with concrete referents more successfully than they do words with abstract referents (Halpern, 1965; Spreen, 1968). Thus, in our experiment, the word *dentist* (frequency:19) has a probability of being read more successfully than the word *theorem* (frequency:18), two words of equal frequencies. The group did show this differential for these particular words.

3. Familiarity: This would appear to be on the same continuum as frequency of occurrence, but is not. For example, the words *puddle* and *archivist* both have a frequency of *3*, but are quite dissimilar in familiarity (see Forster, 1991 for a discussion). A pair of words from the present word sets further exemplifies this point: *falsity* and *falsify* each has a frequency of 3: Their suffix rankings are 7 and 26 respectively. According to surface frequency, the words should be produced equally successfully: according to high-low suffix ranking, the former should be produced more successfully than the latter. Yet, *falsity* is clearly a much less familiar word than its morphological partner, falsify, even though the former is a noun and the latter a verb (see below). The

group score may be interpreted as reflecting this fact for this pair of words (*falsity* 4 incorrect: *falsify* 1 incorrect).

4. Lexical Class: As mentioned above, the sets were not *a priori* balanced internally or comparatively for lexical class. In general, it has been consistently observed that agrammatic speakers produce nouns more successfully than they do verbs, and the latter more successfully than adjectives or adverbs (e.g., Miceli, Silveri, Villa and Caramazza, 1984; Zingeser and Berndt, 1990; Goodglass, Wingfield, Hyde, berlo Gleason and Ward, 2001). Yet in the present study, the participants read the suffix$_{HF}$ set (12 nouns) less successfully overall than the suffix$_{LF}$ set (7 nouns).

5. Free versus Bound Stem. What *is* clear from the participants' responses, is that the characteristics of the stem played a role in the production of the words of both high- and low-frequency suffix. There was no systematic *a priori* balancing of free-stem and bound-stem words within each set, although *each pair* of words did consist either of free-stem or of bound-stem morphological partners (see Table IV.4). It is striking, therefore, that the participants made systematic errors of suffixation as a function of the characteristic of the stem. Free-stem words provoked errors of both omission and substitution; bound-stem words provoked errors only of substitution. *Post hoc* examination of the sets showed a subset of words, considered in this experiment to be bound-stem, where the stem requires only minor orthographic change when a derived word is formed and, therefore, remains relatively discernible as a free-stem. For example, the stems of the words *virtu/al*, *rar/ity* and *nud/ity* are relatively transparent compared with those of *dent/al* and *clar/ity*. The former types of word provoked mostly, and notably, only omissions: *virtual*, *rarity* and *nudity* were read by some participants as

virtue, *rare* and *nude*, respectively. Where suffix-substitution errors occurred, they often took the form of the morphological partner in the other experimental word set. The substituted partner was overwhelmingly what might be considered the more familiar partner. Thus, for example, *horrify* (verb) → *horrible* (adjective), or *falsity* (noun) → *falsify* (verb), but not the other way round in either example.

Experiment IV shows that a low-frequency suffix is associated with more successful production of the derived word than is a high-frequency suffix, which was contrary to our expectations. The putative frequencies of suffixes have not been implicated in the literature as having an effect on access or production, but I have discussed other elements that should be considered when interpreting the results. If we look at the data in the framework proposed by previous researchers (Colé, Beauvillain and Segui, 1989; Meunier and Segui, 1999; Meunier and Segui, 1999b), then the production of the derived word's morphological "partner" in this experiment is less surprising, especially given the close frequency match between the pairs of word. The derived verb is accessed via the stem, and all members of the morphological family become available. A particular word achieves primacy based on the surface frequency of the specific word and the cumulative frequency of all the derived words in the family. Like the typical speaker, our agrammatic participants show this activation effect. The difference lies in that the agrammatic speaker did not inhibit the inappropriate representation, and actually produced the morphological relative. See Katz and Lazzoni (1997) for a similar argument in relation to the origin of semantic errors in deep dyslexia.

Therefore, while suffix frequency may or may not be a strong factor in production, the errors of suffixation again show that derivation itself is problematic for agrammatic speakers, as was seen in the previous three experiments. Yet, these very same errors also show that the participants do remain sensitive to derivation because, like normal speakers, the activation of one member of a derivational family facilitated the retrieval of another member. The participants are also sensitive to the difference between free and bound stem words, omitting the suffix only where a true word can be produced, as was observed by Grodzinsky, 1984. That suffixes on bound-stem words were not omitted, but rather only substitutions of the suffix were produced, indicates that bound-stem words appear to be accessed in full-form, in similar fashion to monomorphemic words. This effect was observed in the three previous experiments.

CHAPTER 8

GENERAL DISCUSSION

8.1 Derivational Morphology is Impaired in Agrammatic Aphasia

Our first research question asked to what extent derivational morphology is impaired in agrammatic aphasia.

Some of the case studies reviewed in Chapter 1.5 reported the overall preservation of derivational morphology in their agrammatic participant. This statement of "minor impairment" was generally made by comparing the status of derivational morphology to the frank impairment of inflectional morphology, which tended to obscure the extent to which derivational morphology *per se* might be disrupted. In addition, this claim for the generalized preservation of derivation appeared to have little specificity and there were few statements concerning the preservation of some aspects of derivation, and the impairment of other aspects.

As discussed in Chapter 1.5, there is a growing literature on how derivational morphology too can be disrupted in agrammatic speakers. To this literature, we can add our own data, which provide evidence for substantial breakdown in the production of derived words *per se* in agrammatic aphasia. In the present study, controlled stimuli were used, and the experimental tasks consisted of reading and repeating these single words. A pertinent question is whether the observed impairments in this study inform only about impairments of derivational morphology in agrammatic aphasia in relation to oral reading, or whether the impairments would carry over to the reading of derived words in sentence reading, or in spontaneous verbal output. Certainly, the syntactic deficits of agrammatism, evident in oral production, have also been shown to be present in both spontaneous speech and written narrative (e.g., Goodglass, 1990), and to exist in the comprehension of syntax (Caramazza and Zurif, 1976; Caplan and Futter, 1986; Grodzinsky, 1995; Sloan Berndt, Mitchum and Haendings, 1996). A number of observations have provided evidence that derivational morphology is likely more extensively impaired than is shown simply in the data from our study of the oral reading of single words: Libben's (1990) patient, JZ, showed deficits in repetition, as did the patient, SJD, studied by Badecker and Caramazza, (1991). In addition, patient SJD showed parallel deficits in the repetition of single derived words, and in the reading of derived words in sentences (see Chapter 1.5). The examples from our participants' conversations and test responses, moreover, show some, but very few, uses of derived words, which is not surprising given the syntactic impoverishment of their sentences. For example, P2, trying to say the word *adopted*, produced, after some struggle, *"not biological."* P4, describing her attempts to talk shortly after the stroke, said, *"frustration, believe me."* Then describing her elderly parents' health, she stated, *"daddy and mommy helpless."* Lastly, the observed errors in the corpus, other than the "can't" category, of course, were not related to the extent of the participant's reading disorder. P4 consistently scored very high on the reading tasks, and, phonologically, was the least impaired of all the four participants, making only rare phonological output errors. Nevertheless, overall she made as many suffix errors as P1, who had a mild phonological output disorder, and was also deep dyslexic (see Chapter 3.2). The extent to which the deficits observed in the present study could be shown via other language tasks or other modalities certainly bears investigation.

With regard to the deficits seen in the present study, there were omissions and substitutions of suffix across all four participants for various aspects of derivation, and using omissions and substitutions of suffixes as measures of impairment, we see impairment of derivation in comparison with monomorphemic words, and impairment of derivation similar to that of inflected words. In effect, errors on derived words look suspiciously like errors on inflected words. This is not to gainsay Miceli and Caramazza (1988), who argued for functionally different loci for these two language processes, and for the possibility of differential impairment. The similarity of the error patterns between inflectional and derivational morphology may be related more to the underlying nature of suffixation, rather than to the identity of the two processes. What the data do show is that the breakdown of derivational morphology in agrammatic aphasia is not only substantial *per se*, but is related to the suffix itself and to the nature of the stem.

8.2 Derivational Morphology versus Inflectional Morphology

Our second research question asked which linguistic factors have an effect on the production of derived forms.

First, we tested a subset of monomorphemic, derived and inflected words, in the case of the latter two, derived agentives and comparative adjectives. We used this multivalent word-final–ER because this affords a direct comparison of the three types of words. Recall that Badecker and Caramazza (1987) presented a case study of a patient, SJD, comparing her production of "pseudo-affixed," derived and inflected words. Notably, errors on derived words involved deletions and substitutions of the suffix, similar to the errors on the inflected words. Experiment II in the present study used the same linguistic contrast. The participants showed sensitivity to the nature of the stimulus words. The monomorphemic words were preserved significantly better than either the derived or the inflected words. Even when the first syllable was incorrect, and a different word was produced that had a final-ER, that word was overwhelmingly a monomorphemic word. Concerning the derived and inflected words, our results show both domains to be equally disrupted in terms of suffix error, and in similar fashion. We interpret these results as showing that in production, these agentive and comparative forms are constructed from morphologically decomposed elements, and in the case of the derived agentive such construction is certainly consistent with its huge productivity in English, i.e., new words are made up as needed (e.g., *faxer* (the person in the office who is responsible for sending out faxes); *bouncer* (the person responsible for ejecting unruly patrons, usually from a bar or dance hall); *lunger* (applied in the early 20^{th} century to people moving out to live in California desert towns, hopefully to recover from TB, or some other lung disease). Our own previous results are reinforced, showing that derivational morphology is susceptible to disruption in agrammatic aphasia, and that there is no evidence for special status for this type of derived word. The results further extend previous work because, whereas previous investigations were individual case studies, our study has shown disruption of derivational morphology across a group of four agrammatic aphasic speakers.

It is generally accepted that the language system makes a lexical distinction between inflection and derivation (e.g., Badecker and Caramazza, 1989; Tyler and Cobb, 1988). Miceli and Caramazza (1988) have argued for the functional autonomy of inflectional and derivational processes in the mental lexicon with the corollary of dissociable impairment. These observed similarities in the disruption of inflected and derived words with word-final-ER in the present study suggest that the distinction between inflection and derivation may not be so sharp, at least for these cases of derivation versus inflection studied here.

8.3 Morphophonological Change in Agrammatic Production

The presence of different types of morphophonological complexity has been shown to effect the production of derived words in agrammatic speakers Recall that stress assignment can be differentially disturbed (Laganaro, Vacharesse and Frauenfelder, 2002), and that, in a previous study, Mathews and Obler (1997) showed that stress shift, independently of word length, increased the likelihood of error on the reading and repetition of production of derivationally related words by a group of agrammatic speakers (Chapter 1.5).

The effects of stress change were not the focus of the present study. In fact, stress assignment was controlled, and remained constant across the underlying base verb and its derived noun in order to obviate possible effects. By one model of phonological encoding (Levelt, Roelofs and Meyer, 1999), lexical stress in a stress-assigning language such as English is not stored for the most frequent stress patterns of the language (i.e., it is assigned by default). Information about lexical stress is, however, stored and then retrieved for those words where lexical stress does not fall on the first syllable (i.e., the less frequent stress patterns), as, for example, the words in Experiment III of our present study. It may be the case that if a derived word is fully-listed, as is argued for Level I derived words, then its lexical stress pattern is stored *in tandem* and accessed simultaneously. By this account, there would be no expectation for difficulties with the stress pattern. The same would apply to Level II derived words, but in this instance, because access to the derived word via the stem involves no change of the stress pattern. Thus, stress assignment did not play the pivotal role in the present study that it did in the Mathews and Obler 1997 study. In fact, the present study investigated the differential effects of the formative boundary between the stem and suffix while minimizing the effects of stress change.

Previous studies have provided consistent evidence that derived words have differential storage, and therefore access procedures, depending on the nature of the formative boundary between stem and suffix. With reference to derived words of Level I and Level II morphology (specifically the *–ion* and the *–ment* respectively in the present study), Bradley (1980) used a lexical decision task combined with manipulations of word frequency effect. She concluded from her results that derived words ending in *–ness* and *–ment* are stored with their respective stems, and accessed via the stem (decomposed), while derived words in *–ion* are likely to be stored separately from their base forms (fully-listed). Other studies have shown a similar differentiation between these two suffixes in terms of lexical storage: *–ion* derived words are fully-listed, though they may still enter into (de)composition routines (Tsapkini, Kehayia and Gorema, 1999), while *–ment* derived words are accessed through the stem word (e.g., Vannest and Boland 1999; Alegre and Gordon 1999).

The results of the present study are not consistent with this differentiation between the two types of morphology, as no difference between Level I *–ion* words compared with Level II *–ment* words was revealed. In keeping with the types of suffix error seen in the other experiments in the study relative to free-stem and bound-stem derived words, differences in the type of suffix error could be expected in this comparison, as *–ion* and *–ment* words are essentially bound-stem and free-stem, respectively. That is, more substitutions than omissions (if any) for the bound-stem words, and relatively equal omissions and substitutions for the free-stem words, but with the greater likelihood of omissions.

The apparently equal treatment of the two types of words in this experiment may have roots other than in the intrinsic characteristics of Level I and Level II morphology. As was stated above, only the suffixes *–ion* and *–ment* were used in this comparison. Previous studies used various Level I and Level II suffixes, and such use may have been critical. More noteworthy is the possible effect of the modality of the task. The participants read the words aloud, a task that involves left to right parsing for decoding and recognition. In this set of *–ion* words, the stem was visually transparent, and morphological complexity was minimized. There were, for example, no *–ion* words in the set requiring stem-final and stem-internal phonological and orthographical change (as in *assume - assumption*). By the account that Level I words are fully-listed and also stored in decomposed mode (Vannest and Boland, 1999), then a reading task could increase the likelihood of morphological decomposition, i.e., inducing errors of omissions on the *–ion*, similarly to omissions on the *–ment* words.

Nevertheless, despite this apparent discontinuity between the results of the present experiment and previous findings in the literature, the patterns of breakdown, including the categories of error other than suffix error, do provide evidence for processing distinctions between stems and suffixes at Level I and at Level II. Thus, while this type of morphophonological change may not have a quantitative effect on production compared with that of "no-change," it certainly has qualitative effects.

8.4 Suffix Frequency

In our fourth experiment, we asked whether the relative preservation or disruption of derivational morphology was a function of the derivational suffix itself.

Recall that word frequency has been shown to be a potent organizing principle of the mental lexicon. Evidence for this comes from numerous studies of visual and auditory lexical decision tasks where both inflected and derived forms were the focus (e.g., Stemberger and MacWhinney, 1986; Taft, 1979, 1979b; Segui, Mehler and Frauenfelder, 1982). Within derivational morphology, both prefixed and suffixed words have received attention, and interest has also been shown for that part of a multimorphemic word which provides the motivation for a frequency-ordered lexical search (Burani and Caramazza, 1987; Meunier and Segui, 1999 and 1999b). Manipulation of frequency counts over the various combinations of a derived word, its stem, and its morphological cohorts have shown differential treatment among derivational suffixes in terms of lexical representation and access (e.g., Bradley, 1980; Tsapkini, Gorema and Kehayia, 1999). There is no reason to suppose that frequency effects found in psycholinguistic lexical decision tasks should not also operate in a clinical population.

It was an unexpected finding, therefore, that derived words with a high-frequency suffix were read less successfully than those with a low-frequency suffix, a pattern, moreover, that was seen for all participants. Examination of the data shows, however, that the patterns of error across the word sets, especially the morphological errors, are remarkably similar, as was also seen across the derived word sets in Experiment III. This suggests that the sets of words in Experiment IV were not, overall, processed very differently, one from another.

The question whether the frequency of the suffix itself plays any role for the lexical access of derived words speaks generally to a "decomposition" account of word recognition, and therefore to an "on-line" composition account of production. Thus, the pattern of suffix errors is noteworthy. Omissions of the suffix were seen on the free-stem words, or on the "quasi" free-stem words (i.e., *virtual* → *virtue*, *nudism* → *nude*, *rarity* → *rare*). Substitutions of the suffix were seen on the bound-stem words; suffix substitution was the largest category of error for both word sets; most of the word pairs were bound-stem words. Our findings here, and those of the preceding experiments, point up processing differences for free and bound stem words (overlapping with Level I and Level II morphology), and speak to the issue of differential lexical organization for derived words. This is discussed in 8.5.

8.5 Full-Listing versus Morphological Decomposition

Two opposing accounts were initially proposed to explain the organization of complex words in the lexicon (Taft and Forster, 1975: Butterworth, 1983). Subsequent work provided evidence that lexical organization, and therefore modes of access, was not dichotomous, but rather continuous, whereby the storage and retrieval of complex words was a function of the specific suffix and the rules of stem and affix combination (e.g., Bradley, 1980; Taft, Hambly and Kinoshita, 1986; Laine, Niemi, Koivuselkä-Sallinen, Ahlsén and Hyönä, 1995).

It is worth noting that much of the proposed distinction between derived words that are fully-listed and those composed on-line rests mainly on psycholinguistic studies of visual and auditory decision times, i.e., comprehension studies (e.g., Meunier and Segui, 1999). To date, psycholinguistic studies of production have indeed made the same point: some sorts of derived words are produced by rule; some are fully-listed; and people can use both routes (e.g., Anshen and Aronoff, 1988).

Production in normal speakers does not easily lend itself to seeing distinctions between full-listing and on-line composition: production in agrammatic speakers, conversely, does present the opportunity for seeing potential on-line composition *vis-à-vis* full-listing. In particular, the patterns of error observed in these experimental data provide insights into the organization of simple and complex words in the lexicon. Information does not rest solely on the participants' treatment of the suffix, but also from the error categories of different-word and "can't".

For the following discussion, the group scores were collapsed across experiments I-IV. With reference to monomorphemic words (Experiments I and II), it is a given that monomorphemic words are fully-listed. There is, after all, nothing to compose or decompose, and the word must be retrieved and produced in its entirety, though it is, of course, entirely possible for an error to be made based on decoding by Taft's (1979) BOSS principle (see Chapter 1.4.1). Thus, the finding of no errors of suffix omission or substitution for monomorphemic words is hardly surprising. Monomorphemic words will, however, allow the <u>addition</u> of a suffix. These sorts of errors were produced, with the addition of an inflectional suffix outnumbering that of derivational suffixes.

With reference to the derived words, even our small number of participants provide data that show differences in patterns of error between the derived words with free stems and those with bound stems. No claim is made for the invariant lexical status of a particular derived word or set of words, as it is quite possible for different participants to treat the same word differently. All the same, the error patterns on the derived free-stem words, and the derived bound-stem words, collapsed across the relevant Experiments, show differences that are very suggestive of the potential lexical organization of each type of derived word. Omission of the suffix on the free-stem words greatly outnumbers that on the bound-stem words (not surprisingly), and is consistent with Grodzinsky's observation (1984) that agrammatic speakers omit a suffix only where a legal word is the result. What is at first sight surprising, is that there are any omissions of the suffix on the bound-stem words at all. These may be accounted for by the fact that the stem was in fact a legal word, even though it might bear no semantic or morphological relationship to the surface word (e.g., fall*ible*). The data under discussion are from the reading task where the visual presentation of the word can evoke such parsing.

Both omissions and substitutions of suffix on the free-stem words are consistent with a composition account of storage for these words. There are fewer substitutions than omissions, but still a substantial number. In the case of substitutions, a wrong suffix is selected from the stored list and attached, producing a legal morphological cohort.

For the bound-stem words, substitutions of suffix overwhelmingly outnumber suffix omissions on the same type of word. Now, it is certainly the case that bound-stem words can be decomposed (a procedure that Taft and Forster, 1975) initially proposed as prelexically necessary). Thus, suffixes could still be stored separately, and one substituted for another on a bound-stem in a composition routine. However, the paucity of suffix omissions on the bound-stem words compared to the number of substitutions on the same suggests that the bound-stem words are more likely to be fully-listed. In addition, there are more substitution errors on the bound-stem words than on the free-stem words, another indication that the two types of words are not treated equally.

In the bound-stem words, the number of suffix-correct correct responses that had the same suffix as the target word, but error on the stem led to the production of a different word, again greatly outnumbered the same type of correct response in the free-stem words. This again suggests that the target word is accessed in full, and the different-word error is produced in full. A further question is why there are so many more "can't" responses for the bound-stem words than for the free-stem words. Difficulties in phonological assembly certainly cannot account for all the instances: we might speculate that if the bound-stem words are fully-listed, then they cannot reliably be broken up onto stem (legal word) and suffix — a procedure that would help with decoding. It would be necessary to read the word in its entirety because there is no easy "way in," so to speak.

The current error data strongly support the claim that bound-stem derived words are represented in the mental lexicon in full-form, and by their component morphemes, whereas free-stem derived words are represented as stems and affixes, as has been a strong finding in the literature (Tyler, Behrens, Cobb and Marslen-Wilson, 1990). Data on the appearance of substitution errors certainly provide evidence for the communal storage of the members of a morphological "family," as was proposed, for example, by Meunier and Segui, 1999. Both correct responses and error data overall, show that while agrammatic speakers have substantial disruption in derivational morphology, they nevertheless retain an underlying sensitivity to the nature of monomorphemic words, and the processing distinctions between different types of derived words. This sensitivity is deduced from the responses across the experiments. With reference to the monomorphemic words: the participants consistently processed and produced the whole word. They did not have difficulties with the ends of this type of word, disproportionate to other parts of the word. They did not try to segment monomorphemic words, even if the first syllable could be a word in itself; and when a semantically related word was produced in different-word error, it was clear that the target word had been processed in its entirety. This was consistently observed for the monomorphemic words in Experiments I and II.

With reference to the derived words: in the case of the *–ion* (Level I) words, the suffix-correct responses suggest that the participants are processing the whole word. For omissions of the suffix on these Level I words, participants invariably produced the correct base verb (e.g., *adoption* → *adopt*). Conversely, additions of a suffix on the base verbs produced the full morphophonological change (e.g., *confess* → *confession*). Suffix substitutions always resulted in the production of a related cohort – participants did not produce illegal combinations, as did the patient SJD (Badecker and Caramazza, 1991). Participants appeared to be subject to the same sorts of morphological priming effects, and use the same sorts of search procedures that have been seen in psycholinguistic studies.

In sum, this dissertation has contributed further support for the breakdown of derivational morphology in agrammatic aphasia, and moreover provides evidence for a number of points, namely: i. that consistent patterns of error can be seen; ii. that breakdown is not related to the extent of reading impairment, but to the agrammatism itself; iii. that there is a processing distinction between free-stem and bound-stem derived words as evidenced by the patterns of suffix error; iv. and that despite the errors, agrammatic speakers remain sensitive to the monomorphemic or derived character of words and to derivational processes themselves.

8.6 Future Work

All studies have limitations, and this one is no exception. Future work can redress some of these limitations. To start with, the participant pool was small. Thus, despite consistent patterns of error across the four participants for the phenomena that were examined in the current study, the sample is not large enough to allow an unequivocal statement that disruption in derivational morphology must necessarily accompany agrammatic aphasia. A first step would be to extend the participant pool and gather further data to strengthen the applicability of the present findings.

Processing distinctions between suffixed and prefixed words have been reported in the psycholinguistic literature (see Chapter 1.3 and 4). The present data on the disruption of suffixation raises interest in whether, in agrammatic aphasia, there is comparable disruption of prefixation. A comparative study would shed light on this aspect of morphology.

Again, the present study focused on English. English derivational morphology is less complicated than that of some other languages—to paraphrase Pick (1913), "a highly developed language, but becoming more like Chinese, without inflections."

Investigations, similar to the present study, especially in languages with different derivational patterns, would help shed light on what is language-specific in the breakdown of derivational morphology, and what is language-universal.

The further point to be raised is whether the disruption, presently reported, is an aspect of agrammatic aphasia specifically, or if it is manifested in non-fluent aphasia in general. Comparison of performance of agrammatic speakers and non-fluent aphasic speakers without disruption of inflectional morphology would yield information relevant both to the aphasic disorder, and also say something about morphology in general, if non-agrammatic speakers are free of disruption in derivational morphology.

There has been a long-standing debate about the distinction between agrammatism and paragrammatism. The distinction has been held to be putative (De Bleser, 1987: Heeschen, 1985), but continues to be used clinically as a diagnostic marker (Goodglass with Kaplan and Barresi, 2001). Comparison of performance between agrammatic and paragrammatic speakers would provide insights into the paragrammatic disorder itself, and perhaps provide evidence for or against a continued distinction between the two disorders.

With reference to the experiments presented in this study: Experiment III contrasted only the suffixes *–ion* and *–ment*, limiting what could be deduced about Level I and Level II suffixes in general. A wider selection of Level I and Level II suffixes would provide a better basis for proposals concerning processing differences. Similarly, a different focus for an experiment such as Experiment IV could be planned. A comparison of suffix <u>productivity</u> would be informative, if a clear metric for productivity could be formalized. The notion is widely used but it is left somewhat unspecific

(Baayen, 1991, reviewing Aronoff, 1976). Further, an investigation of high- versus low-frequency suffix on free-stem words might provide more insight into processing differences between stems and suffixes. One difficulty here is that the morphological "families" for free-stem words tend to be quite small.

A further point relates to therapeutic intervention: The data from the present study have direct relevance to aphasia therapy. Knowledge of patterns of error provides the bases for the development of structured exercises that can provide remediation.

Lastly, the corpus that we presently have in our hands will undoubtedly provide opportunities to discover more information of the speech of agrammatic individuals.

TABLES AND FIGURES

EXPERIMENT I

TABLE I.1

MONOMORPHEMIC versus DERIVED WORDS

STIMULUS LIST

Monomorphemic Words						Derived Words					
Word	Frq.	L/c	Word	Frq.	L/c	F/Stem	Frq.	L/c	B/Stem	Frq.	L/c
abdomen	6	n	alibi	9	n	anchorage	1	n	arrogant	2	adj
alcohol	15	n	alien*	19	adj	brutalize	1	vb	celebrant	2	n
apricot	1	n	almanac	1	n	cavernous	1	adj	cellular	3	adj
avalanche	1	n	amulet	2	n	certainty	21	n	circulate	11	vb
badminton	1	n	anecdote	13	n	clerical	9	adj	colonist	2	n
buffalo	10	n	antelope	7	n	cowardice	2	n	decimal	4	n
calico	2	n	aspirin	3	n	creditor	2	n	deviance	2	n
cantaloupe	1	n	cabinet	22	n	cruelty	13	n	dignify	8	vb
caravan	5	n	cameo	2	n	devilish	3	adj	diligent	2	adj
catapult	4	v	caramel	1	n	fanciful	2	adj	fortitude	3	n
champion*	33	n	caraway	2	n	fatalist	1	n	hesitant	3	adj
chariot	3	n	catalog*	20	n	glamorous	5	adj	literate	3	adj
chocolate	9	n	cholera	1	n	glorious	16	adj	magnitude	30	n
cinema	3	n	commodore	3	n	hazardous	5	adj	memorize	7	vb
corridor	19	n	daffodil	1	n	humorous	16	adj	militant*	8	adj
crocodile	1	n	elephant	18	n	marginal	26	adj	mystify	1	vb
diamond	15	n	genuine	34	adj	marvelous	11	adj	optimize	1	vb
emerald	9	n	hyacinth	1	n	merciless	3	adj	opulent	1	adj
filigree	1	n	idiom	10	n	merriment	3	n	privacy	12	n
labyrinth	1	n	idiot	3	n	motorist	8	n	radiate	7	vb
madrigal	8	n	paradise	12	n	organist	1	n	regulate	13	vb
mistletoe	1	n	parakeet	1	n	pivotal	1	adj	sanctify	1	vb
moccasin	3	n	pedigree	3	n	rancorous	2	adj	stimulus	20	n
porcelain	2	n	pinnacle	2	n	ruinous	1	adj	tedious	6	adj
porcupine	1	n	stallion	5	n	seasonal	8	adj	theorize	2	vb
privilege	28	n	stamina	2	n	socialize	5	vb	therapist	23	n
pyramid	2	n	tentacle	3	n	tidiness	1	n	tolerance	9	n
satellite	15	n	turpentine	4	n	venomous	2	adj	truculent	1	adj
venison	1	n	vestibule	2	n	vigilant	2	adj	turbulent	4	adj
violet	4	n	vinegar	9	n	vigorous	29	adj	violate	17	vb
Mean log frequency			0.58			Mean log frequency			0.59		
Geometric mean			3.80			Geometric mean			3.92		
Frequency range			1-34			Frequency range			1-30		
Word length			6-10			Word length			6-9		

Frq: Frequency

L/c: Lexical Class: *Listed in Francis and Kučera in more than one lexical class.

F/Stem: Free Stem: B/Stem: Bound Stem

n: noun, vb: verb, adj: adjective

EXPERIMENT I
TABLE I.2
TABLE of RESULTS

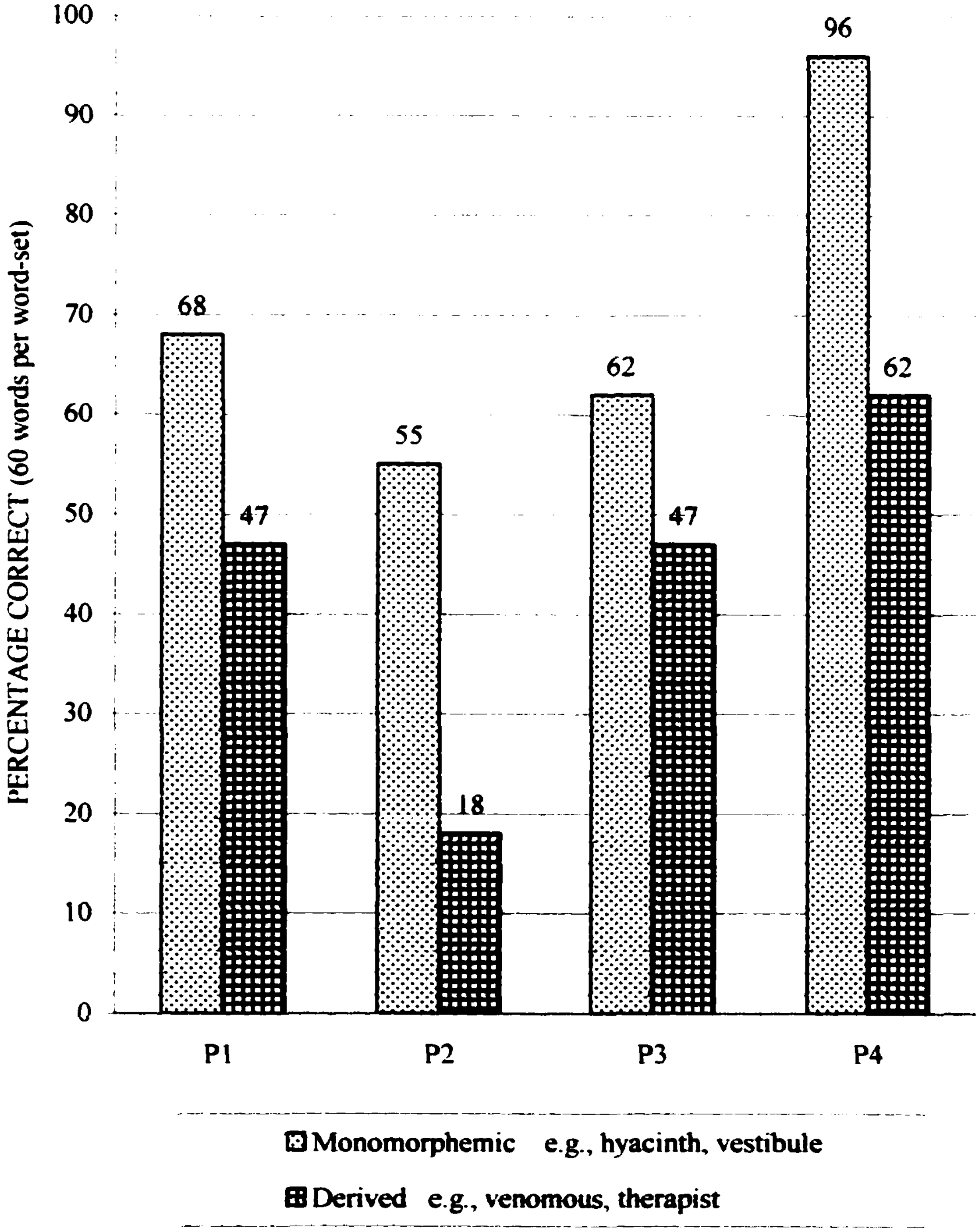
				ERROR ANALYSIS						
Monomorphemic (240 responses)				SUFFIX ERROR						
	Total Correct	(Suffix-Correct)	Total Error	add	om	sb	(infl)	Diff Word	"Can't"	Misc Error
P1	41	(-)	19	1	-	-	(-)	13	4	1
P2	33	(-)	27	1	-	-	(1)	9	14	3
P3	37	(-)	23	1	-	-	(1)	2	15	5
P4	58	(-)	2	-	-	-	(-)	-	1	1
Total	**169**	**(-)**	**71**	**3**	**-**	**-**	**(2)**	**24**	**34**	**10**
Derived: Free stems (120 responses)										
P1	12	(3)	18	-	1	4	(-)	10	1	2
P2	7	(-)	23	-	8	3	(-)	4	6	2
P3	19	(4)	11	-	2	-	(-)	2	7	-
P4	19	(-)	11	-	3	3	(-)	4	-	1
Total	**57**	**(7)**	**63**	**-**	**14**	**10**	**(-)**	**20**	**14**	**5**
Derived: Bound stems (120 responses)										
P1	16	(3)	14	1	-	6	(-)	2	4	1
P2	4	(-)	26	-	-	7	(-)	4	13	2
P3	9	(1)	21	1	-	1	(-)	3	14	2
P4	18	(-)	12	2	-	6	(2)	1	3	-
Total	**47**	**(4)**	**73**	**4**	**-**	**20**	**(2)**	**10**	**34**	**5**
Total Derived words (240 responses)										
P1	28	(6)	32	1	1	10	(-)	12	5	3
P2	11	(-)	49	-	8	10	(-)	8	19	4
P3	28	(5)	32	1	2	1	(-)	5	21	2
P4	37	(-)	23	2	3	9	(2)	5	3	1
Total	**104**	**(11)**	**136**	**4**	**14**	**30**	**(2)**	**30**	**48**	**10**

KEY

Total Correct	Total number of correct responses. This includes the score in the (Suffix-Correct) cells.
(Suffix-Correct)	The suffix was produced correctly, but the participant made an error on the stem, or the response was a different word, but with the the correct suffix (see Coding Taxonomy for criteria).
add	A suffix was added to the target word.
om	The suffix was omitted from the target word.
sb	A suffix replaced the suffix of the target word.
(infl)	An inflectional suffix was added or substituted, e.g., -ing. The count is subsumed under Suffix Addition or Substitution.
Diff Word	Different-word. The participant produced an altogether different word.
"Can't"	The participant acknowledged the inability to respond, or did not respond.
Misc. error	The participant's response was non-decipherable, or non-codeable.

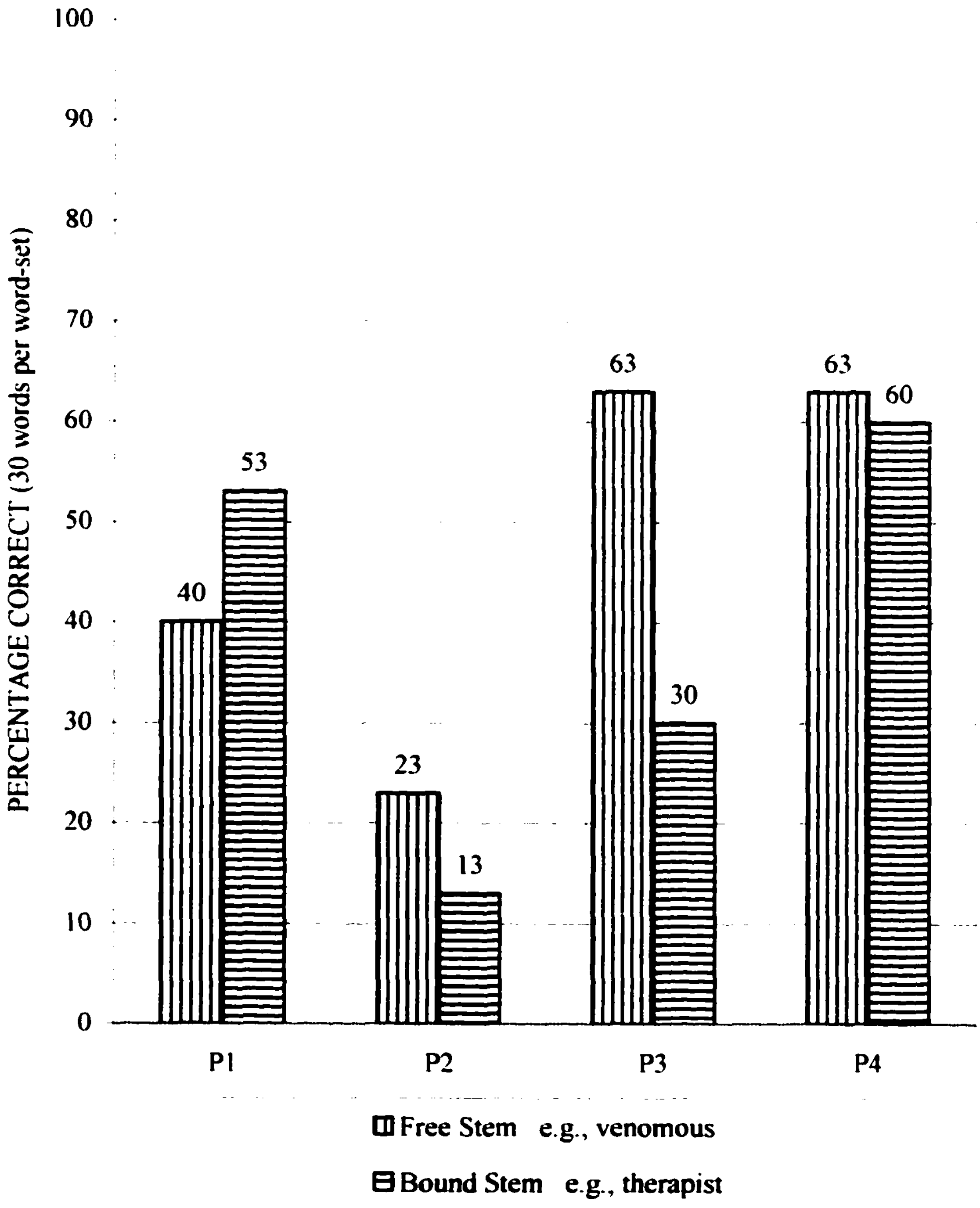
EXPERIMENT I
FIGURE I.1

PARTICIPANTS' CORRECT PERCENTAGE SCORES for
MONOMORPHEMIC versus DERIVED WORDS



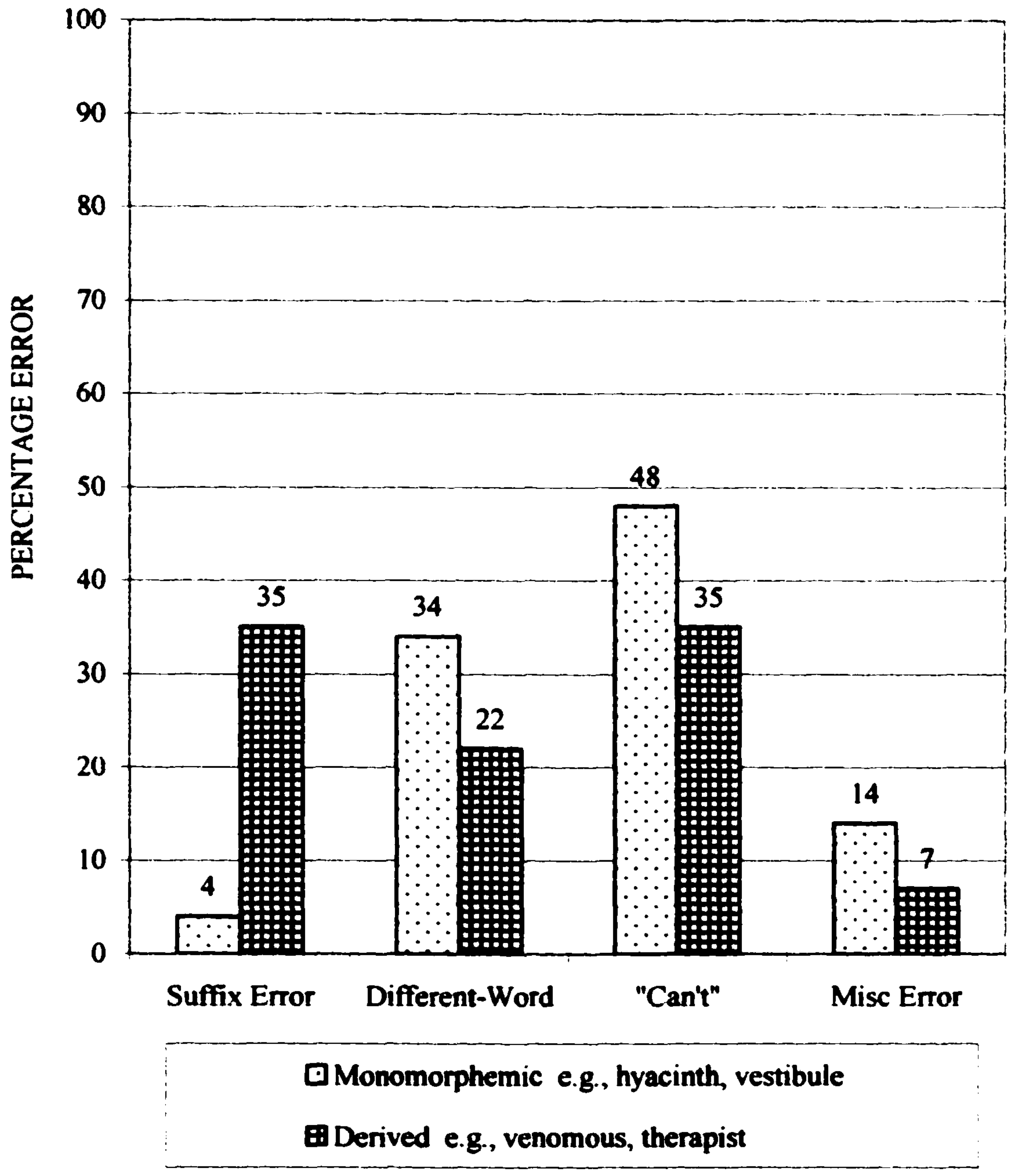
EXPERIMENT I
FIGURE I.2

PARTICIPANTS' CORRECT PERCENTAGE SCORES for DERIVED WORDS: FREE STEM versus BOUND STEM



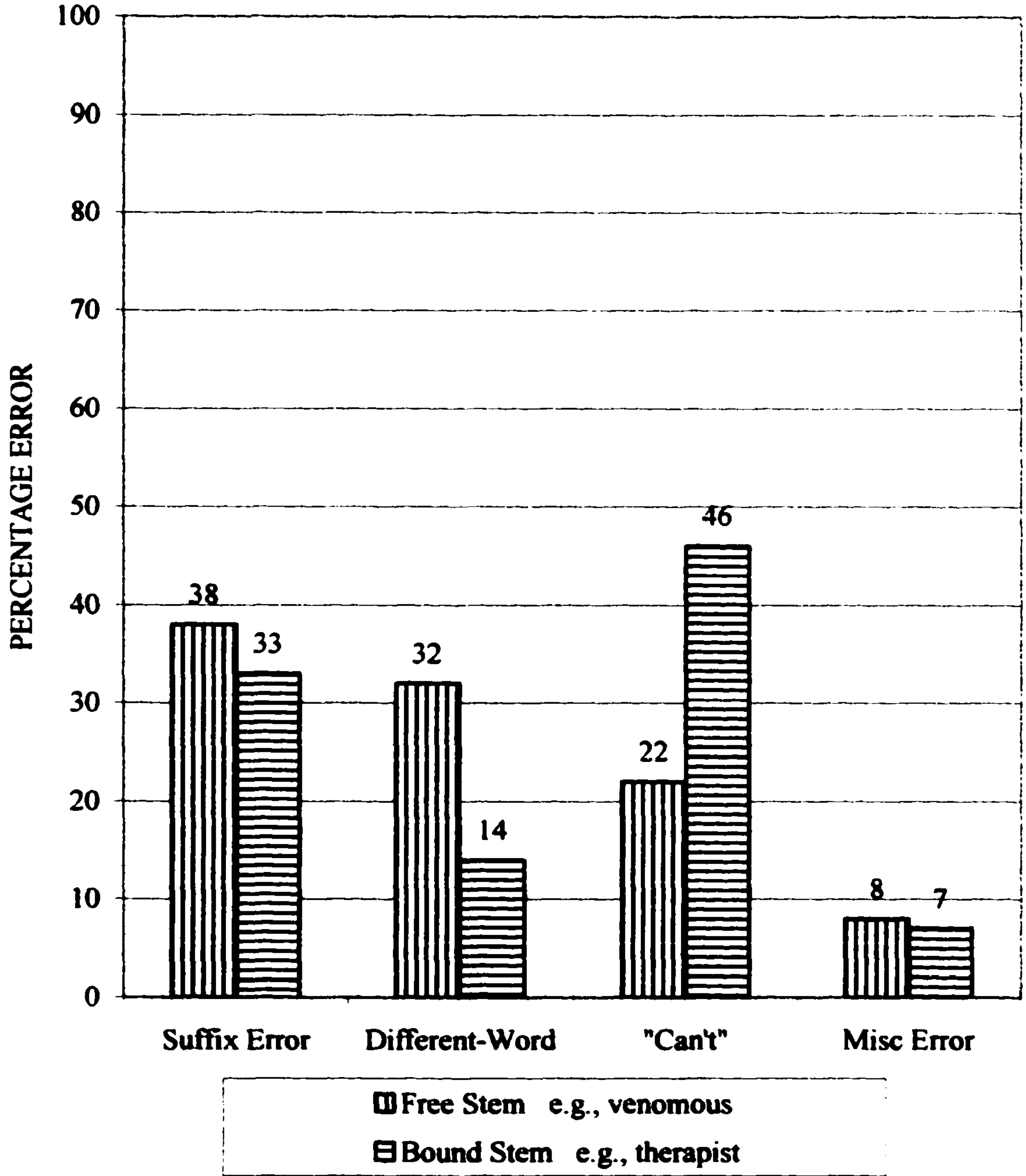
EXPERIMENT I
FIGURE I.3

CONTRIBUTION of ERROR CATEGORIES to TOTAL GROUP ERROR for MONOMORPHEMIC versus DERIVED WORDS



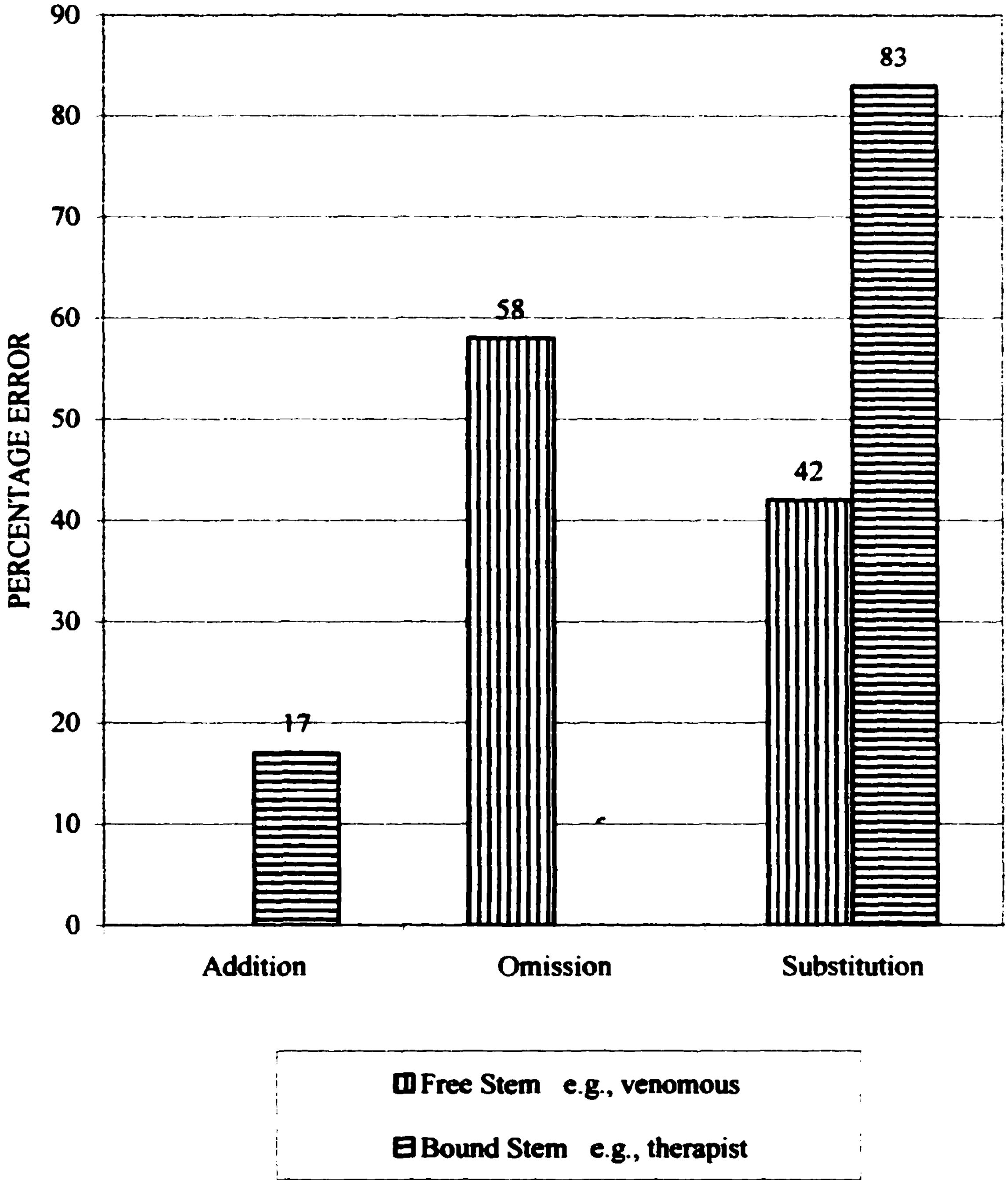
EXPERIMENT I
FIGURE I.4

CONTRIBUTION of ERROR CATEGORIES to TOTAL GROUP ERROR for DERIVED WORDS: FREE STEM versus BOUND STEM



EXPERIMENT I
FIGURE I.5

CONTRIBUTION of TYPES of SUFFIX ERROR to TOTAL GROUP SUFFIX ERROR for DERIVED WORDS: FREE STEM versus BOUND STEM



EXPERIMENT II TABLE II.1
MONOMORPHEMIC versus DERIVED versus INFLECTED WORDS
STIMULUS LIST

Monomorphemic-ER			Derived-ER			Inflected - ER		
Word	Frq.	L/c	Word	Frq.	L/c	Word	Frq.	L/c
beaver	2	n	baker	2	n	braver	2	adj
bicker	2	vb	banker	20	n	brighter	8	adj
blister*	7	n	bather	1	n	broader	19	adj
blunder*	5	n	brewer	2	n	calmer	2	adj
chowder	2	n	buyer	10	n	clearer	15	adj
cider	2	n	caller	5	n	colder	5	adj
cloister	1	n	dreamer	2	n	darker	2	adj
clover	16	n	drinker	5	n	dearer	1	adj
copper*	13	n	drummer	4	n	faster	18	adj
dagger	1	n	golfer	7	n	fatter	3	adj
dapper	6	adj	healer	2	n	harsher	1	adj
falter	6	vb	helper	8	n	kinder	1	adj
fever	19	n	hitter	6	n	louder	12	adj
fodder	1	n	hunter	17	n	nearer	14	adj
garter	2	n	learner	1	n	nicer	2	adj
hunger	17	n	loser	2	n	richer	5	adj
lather*	6	n	mourner	2	n	rougher	1	adj
linger	16	vb	preacher	13	n	sadder	1	adj
lobster	1	n	raider	2	n	safer	5	adj
monster	9	n	rancher	22	n	sharper	3	adj
pamper	2	vb	ranger	2	n	shorter	18	adj
panther	2	n	robber	8	n	slower	9	adj
pepper*	15	n	saver	1	n	smarter	2	adj
simmer	6	vb	seeker	4	n	smoother	3	adj
slander	1	n	sender	1	n	steeper	2	adj
slumber*	4	n	spender	1	n	sweeter	2	adj
stammer	5	vb	swimmer	3	n	taller	7	adj
thunder*	18	n	thinker	12	n	thicker	5	adj
tiger	9	n	waiter	15	n	wider	17	adj
tinder	1	n	winner	12	n	wiser	7	adj
Mean log frquency	0.61			0.61			0.6	
Geometric mean	4.1			4.1			4.1	
Raw frequency range	1-19			1-22			1-19	
Word length in letters	5-8			5-8			5-8	

KEY
Frq: Frequency
L/c: Lexical class. *Listed in Francis and Kučera in more than one lexical class.
n: noun, vb: verb: adj: adjective

EXPERIMENT II
TABLE II.2

TABLE of RESULTS

				ERROR ANALYSIS						
Monomorphemic -ER (Mmp-ER)				SUFFIX						
(120 responses)	Total Correct	(Suffix-Correct)	Total Error	ERROR add	om	sb	(infl)	Diff Word	"Can't"	Misc Error
P1	21	(4)	9	3	-	1	(2)	2	2	1
P2	18	(-)	12	-	-	1	(-)	5	6	-
P3	23	(7)	7	-	-	1	(-)	3	3	-
P4	28	(3)	2	1	-	-	(1)	-	1	-
Total	**90**	**(14)**	**30**	**4**	**-**	**3**	**(3)**	**10**	**12**	**1**
Derived-ER (Der-ER) (120 responses)										
P1	10	(1)	20	1	11	2	(2)	6	-	-
P2	6	(-)	24	1	12	7	(7)	-	4	-
P3	26	(2)	4	-	3	-	(-)	-	1	-
P4	29	(-)	1	-	1	-	(-)	-	-	-
Total	**71**	**(3)**	**49**	**2**	**27**	**9**	**(9)**	**6**	**5**	**-**
Inflected-ER (Infl-ER) (120 responses)										
P1	11	(2)	19	-	10	3	(2)	2	4	-
P2	9	(1)	21	-	7	7	(4)	3	4	-
P3	25	(3)	5	-	4	-	(-)	-	1	-
P4	29	(-)	1	-	1	-	(-)	-	-	-
Total	**74**	**(6)**	**46**	**-**	**22**	**10**	**(6)**	**5**	**9**	**-**

KEY

Total Correct	Total number of correct responses. This includes the score in the (Suffix-Correct) cells.
(Suffix-Correct)	The suffix was correct, but the participant made an error on the stem, or the response was a different word, but with the correct suffix (see Coding Taxonomy for criteria).
add	A suffix was added to the target word.
om	The suffix was omitted from the target word.
sub	A suffix replaced the suffix of the target word.
(infl)	An inflectional suffix was added or substituted, e.g., -ing. The count is subsumed under Suffix Addition or Substitution.
Diff Word	Different-word. The participant produced an altogether different word.
"Can't"	The participant acknowledged the inability to respond or did not respond.
Misc. error	The participant's response was non-decipherable or non-codable.

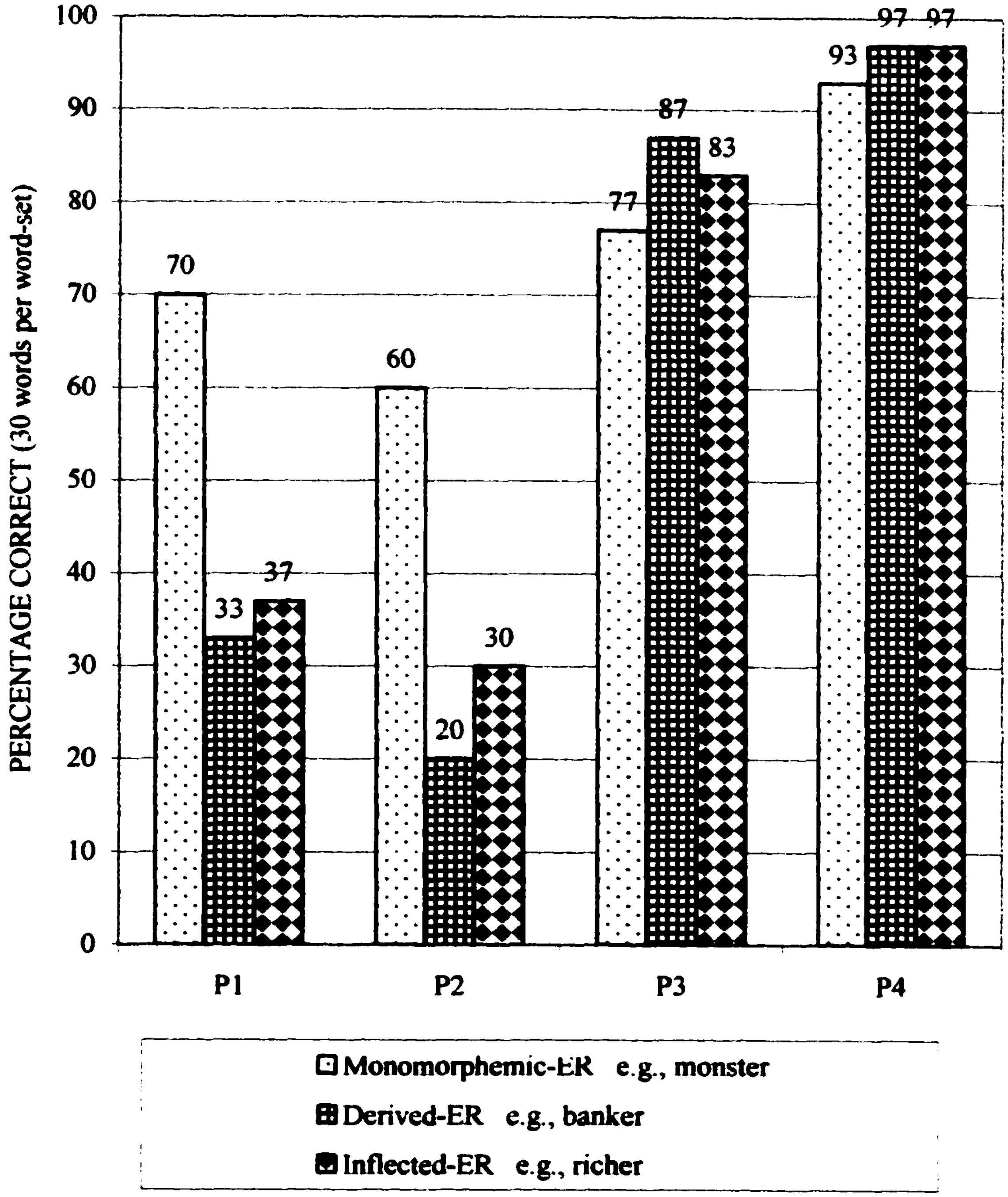
Experiment II. Table II.3

Participants' Suffix-Correct Responses as Percentage of Total Correct Responses by Word Set

	(Suffix-correct)	Total correct	% Sfx-correct	(Suffix-correct)	Total correct	% Sfx-correct	(Suffix-correct)	Total correct	% Sfx-correct
	Monomorphemic-ER			Derived-ER			Inflected-ER		
P1	(4)	21	**19**	(1)	10	**10**	(2)	11	**18**
P2	(-)	18	-	(-)	6	-	(1)	9	**11**
P3	(7)	23	**30**	(2)	26	**8**	(3)	25	**12**
P4	(3)	28	**11**	(-)	29	-	(-)	29	-
Ttl	**(14)**	**90**	**15**	**(3)**	**71**	**4**	**(6)**	**74**	**8**

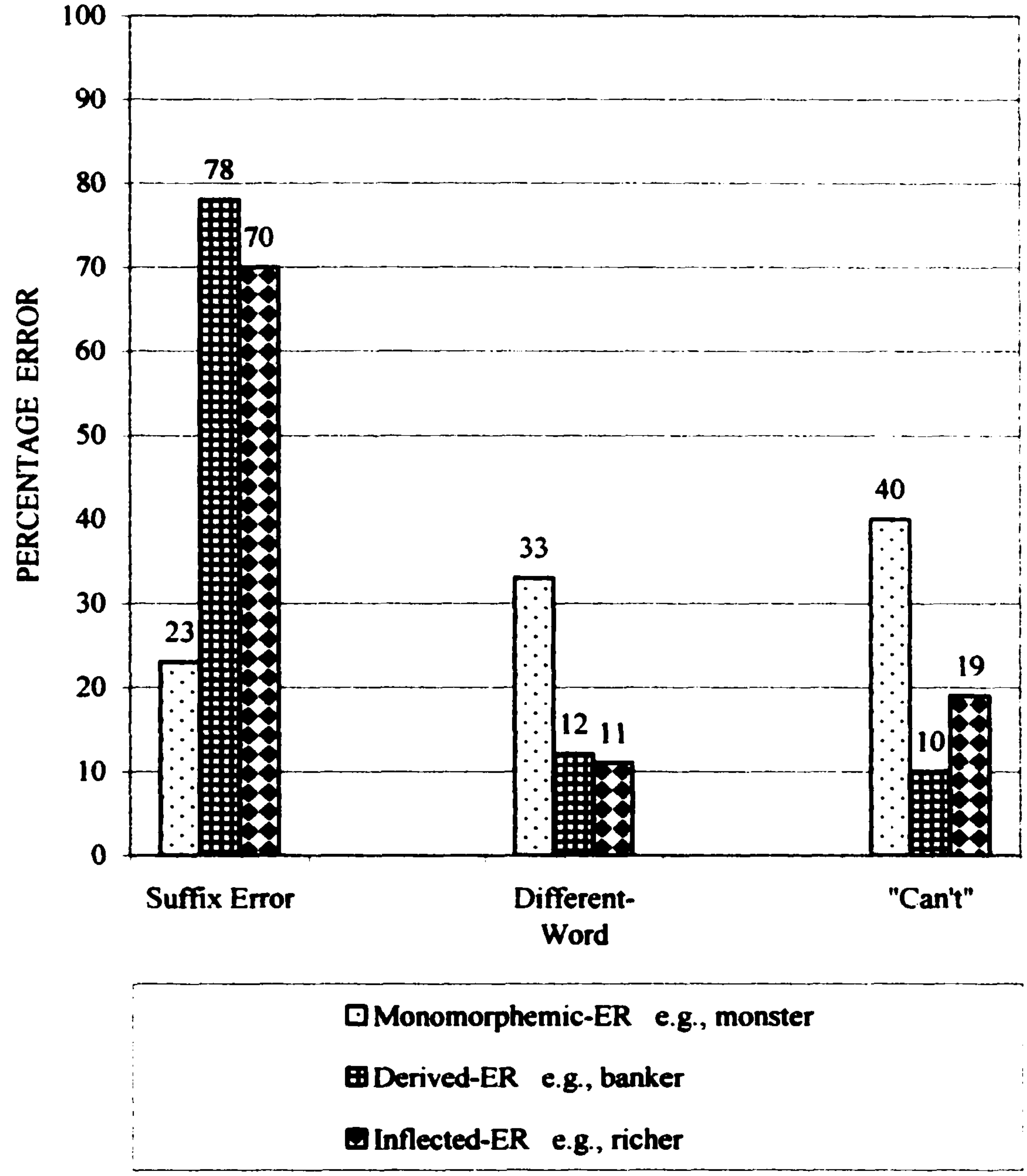
EXPERIMENT II
FIGURE II.1

PARTICIPANTS' CORRECT PERCENTAGE SCORES for MONOMORPHEMIC-ER versus DERIVED-ER versus INFLECTED-ER WORDS



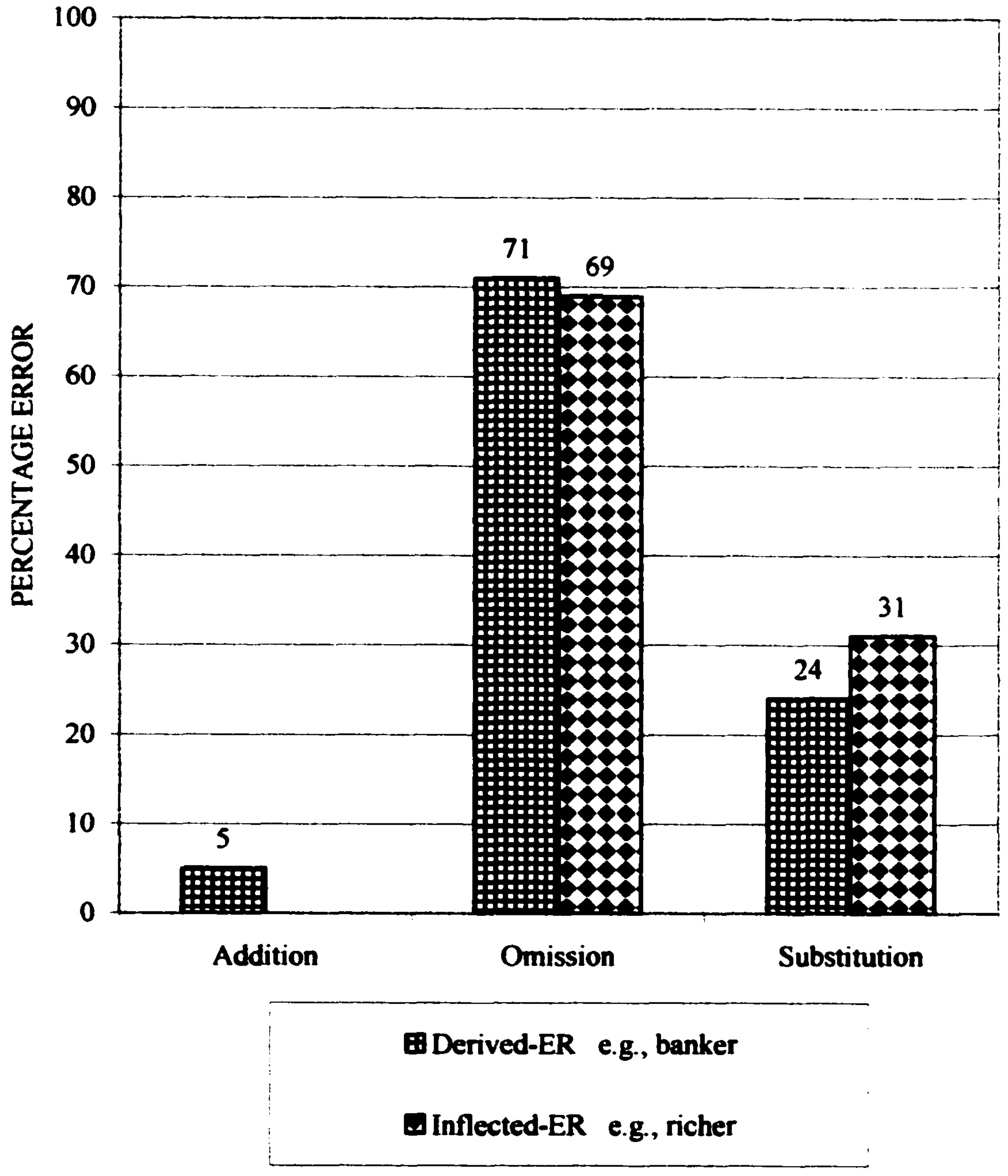
EXPERIMENT II
FIGURE II.2

CONTRIBUTION of ERROR CATEGORIES to TOTAL GROUP ERROR for MONOMORPHEMIC-ER versus DERIVED-ER versus INFLECTED-ER WORDS



EXPERIMENT II
FIGURE II.3

CONTRIBUTION of TYPES of SUFFIX ERROR to TOTAL GROUP SUFFIX ERROR for DERIVED-ER versus INFLECTED-ER WORDS



EXPERIMENT III
TABLE III.1

MORPHOPHONOLOGICAL CHANGE versus NO-CHANGE
STIMULUS LIST

Derived Nouns				Base Verbs			
-ion Noun	Frq.	-ment Noun	Frq.	Verb -ion	Frq.	Verb -ment	Frq.
adoption	11	adjournment	4	adopt	71	adjourn	4
affliction	2	alignment	5	afflict	8	align	9
assertion	10	allotment	49	assert	44	allot	25
attraction	24	amazement	10	attract	51	amaze	14
confession	19	amusement	9	confess	25	amuse	12
confusion	48	appeasement	3	confuse	52	appease	5
congestion	6	appointment	34	congest	2	appoint	50
convulsion	1	attainment	10	convulse	1	attain	35
corrosion	4	concealment	2	corrode	2	conceal	18
detection	13	deferment	2	detect	28	defer	3
disruption	4	detachment	4	disrupt	13	detach	13
diversion	11	disbursement	4	divert	7	disburse	1
evasion	2	enforcement	19	evade	5	enforce	35
exertion	2	engagement	30	exert	29	engage	66
explosion	16	enlargement	5	explode	22	enlarge	17
inspection	24	enrichment	3	inspect	16	enrich	8
intrusion	5	enrollment	8	intrude	4	enroll	15
invention	24	enticement	1	invent	21	entice	1
negation	5	excitement	32	negate	2	excite	28
persuasion	10	fulfillment	12	persuade	42	fulfill	25
prediction	13	pronouncement	5	predict	35	pronounce	21
repression	7	refinement	10	repress	4	refine	11
restriction	35	resentment	18	restrict	31	resent	16
submission	5	retirement	27	submit	47	retire	54

	-ion nouns	-ment nouns	vb (+ ion)	vb (+ ment)
Mean log frequency	0.92	0.89	1.13	1.12
Geometric mean	8.24	7.91	13.43	13.05
Frequency Range	1-48	1-49	1-71	1-66
Word length in letters	8-10	9-13	5-8	5-9
Frq. Frequency				

TABLE III.2
TABLE of RESULTS

				ERROR ANALYSIS						
Derived nouns *-ion* (96 responses)				SUFFIX ERROR						
	Total Correct	(Suffix-Correct)	Total Error	add	om	sb	(infl)	Diff Word	"Can't"	Misc Error
P1	19	(10)	8	-	-	-	(-)	7	-	1
P2	6	(-)	18	-	1	4	(1)	3	10	-
P3	9	(9)	15	-	-	-	(-)	4	11	-
P4	19	(1)	5	-	3	2	(-)	-	-	-
Total	**53**	**(20)**	**46**	**-**	**4**	**6**	**(1)**	**14**	**21**	**1**
Derived Nouns *-ment* (96 responses)										
P1	13	(-)	11	-	1	3	(1)	5	1	1
P2	6	(1)	18	-	3	-	(-)	3	12	-
P3	18	(14)	6	-	-	-	(-)	3	3	-
P4	20	(-)	4	-	1	2	(-)	1	-	-
Total	**57**	**(15)**	**39**	**-**	**5**	**5**	**(1)**	**12**	**16**	**1**
Base Verbs: *-ion* (96 responses)										
P1	11	(-)	13	4	-	-	(1)	3	3	3
P2	4	(-)	20	5	-	-	(1)	3	12	-
P3	11	(-)	13	2	-	-	(-)	3	7	1
P4	17	(-)	7	5	-	-	(-)	2	-	-
Total	**43**	**(-)**	**53**	**16**	**-**	**-**	**(2)**	**11**	**22**	**4**
Base Verbs: *-ment* (96 responses)										
P1	12	(-)	12	9	-	-	(4)	2	-	1
P2	8	(-)	16	3	-	-	(1)	1	12	-
P3	7	(-)	17	7	-	-	(-)	2	7	1
P4	19	(-)	5	5	-	-	(-)	-	-	
Total	**46**	**(-)**	**50**	**24**	**-**	**-**	**(5)**	**5**	**19**	**2**

KEY

Total Correct	Total number of correct responses. This includes the score in the (Suffix-Correct) cells.
(Suffix-Correct)	The suffix was correct, but the participant made an error on the stem, or the response was a different word, but with the correct suffix (see Coding Taxonomy for criteria).
add	A suffix was added to the target word.
om	The suffix was omitted from the target word.
sub	A suffix replaced the suffix of the target word.
(infl)	An inflectional suffix was added or substitute, e.g., -ing. The count is subsumed under Suffix Addition or Substitution.
Diff Word	Different-word. The participant produced an altogether different word.
"Can't"	The participant acknowledged the inability to respond or did not respond.
Misc. error	The participant's response was non-decipherable or non-codeable.

Experiment III. Table III.3

Participants' Suffix-Correct Responses as Percentage of Total Correct Responses by Noun Set

	Derived Nouns *-ion*			Derived Nouns *-ment*		
	(Suffix-correct)	Total correct	% Suffix-correct	(Suffix-correct)	Total correct	% Suffix-correct
P1	(10)	19	**51**	(-)	13	-
P2	(-)	6	-	(1)	6	**17**
P3	(9)	9	**100**	(14)	18	**78**
P4	(1)	19	**5**	(-)	20	-
Ttl	**(20)**	**53**	**38**	**(15)**	**57**	**26**

Experiment III. Table III.4

Participant 3: Distribution of "Prefix" Omissions across Correct and Incorrect Responses for the Derived Nouns and the Base Verbs

	"Prefix"	Correct	Incorrect responses
Derived Nouns	omitted	responses	(other errors)
Nouns *-ion*	6	9	-
Base Verbs			
Verbs *-ion*	9	11	-
Verbs *-ment*	8	7	5

Experiment III. Table III.5

Distribution and Type of Addition Errors on the Base verbs for all Participants

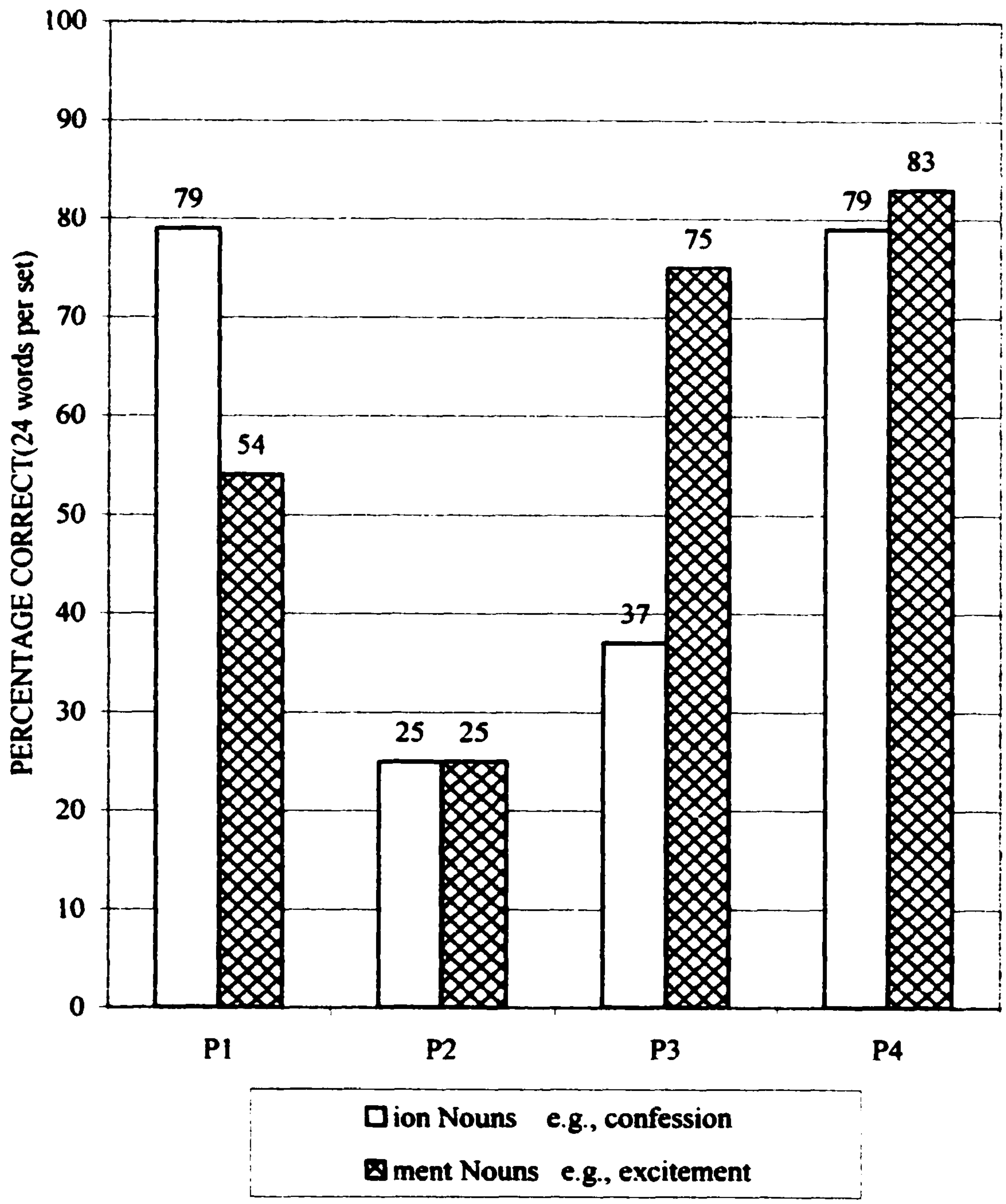
	ion- verbs (e.g., *confess*)			*ment-* verbs (e.g., *excite*)		
	Response Type			Response Type		
	Derived Noun	Derived Other	Inflection	Derived Noun	Derived Other	Inflection
P2	4	-	1	2	-	1
P3	1	1	-	7	-	-
P4	3	2	-	5	-	-

KEY:

Derived Other: Response was a derived word of different lexical class than the derived noun.

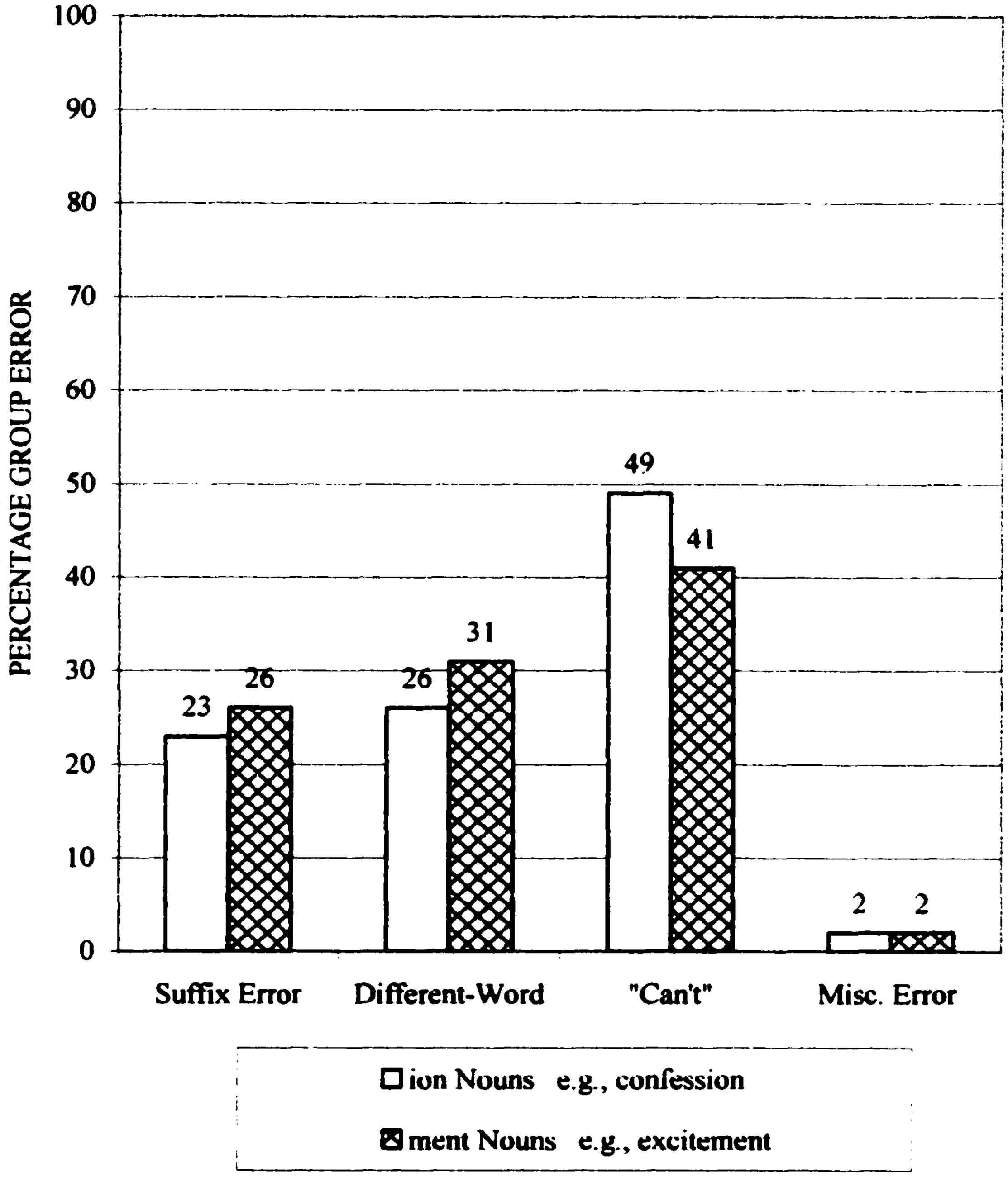
EXPERIMENT III
FIGURE III.1

PARTICIPANTS' CORRECT PERCENTAGE SCORES for DERIVED NOUNS -ion versus DERIVED NOUNS -ment



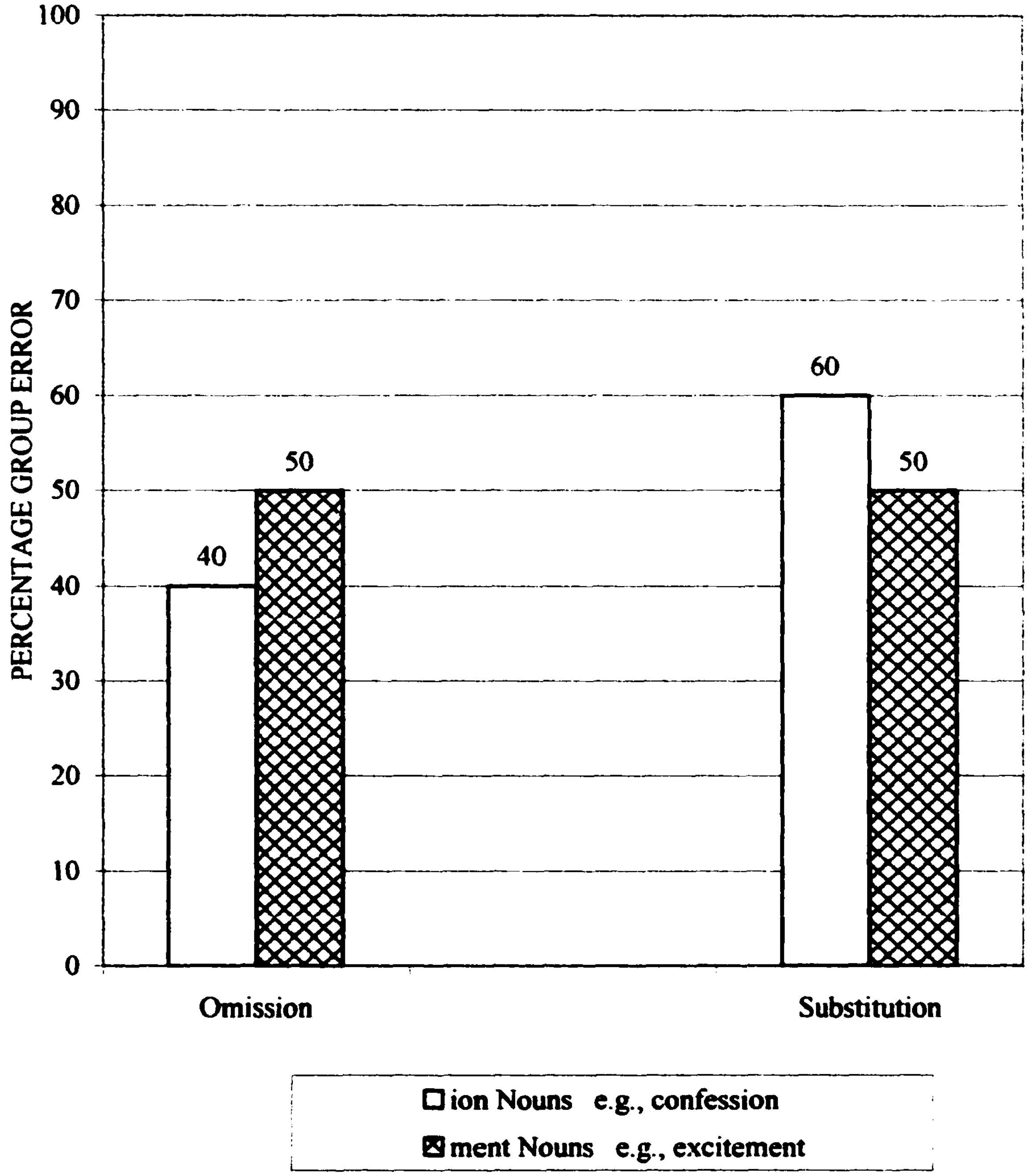
EXPERIMENT III
FIGURE III.2

CONTRIBUTION of ERROR CATEGORIES to TOTAL GROUP ERROR for DERIVED NOUNS -ion versus DERIVED NOUNS -ment



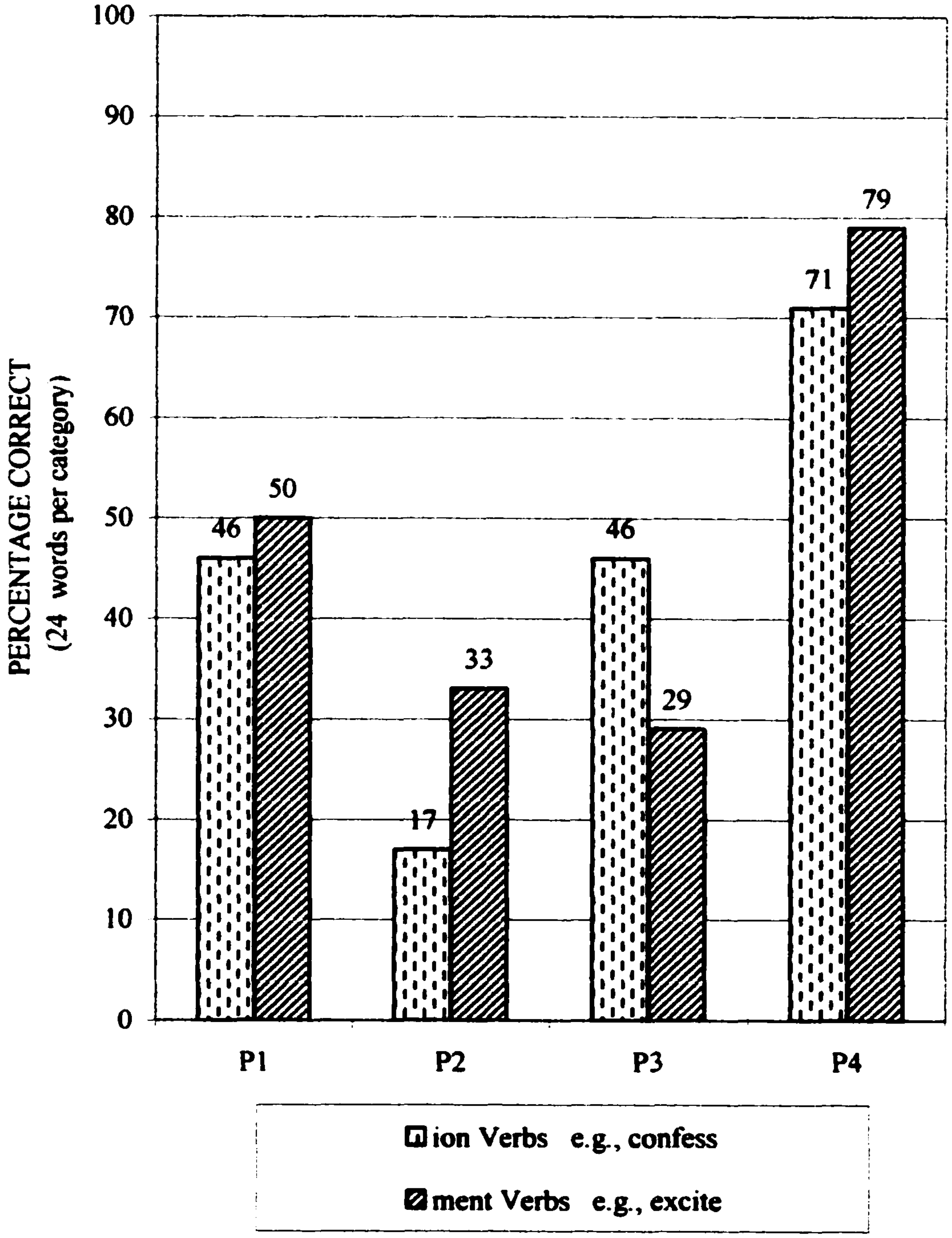
EXPERIMENT III
FIGURE III.3

CONTRIBUTION of TYPES of SUFFIX ERROR to TOTAL GROUP SUFFIX ERROR for DERIVED NOUNS -ion versus DERIVED NOUNS -ment



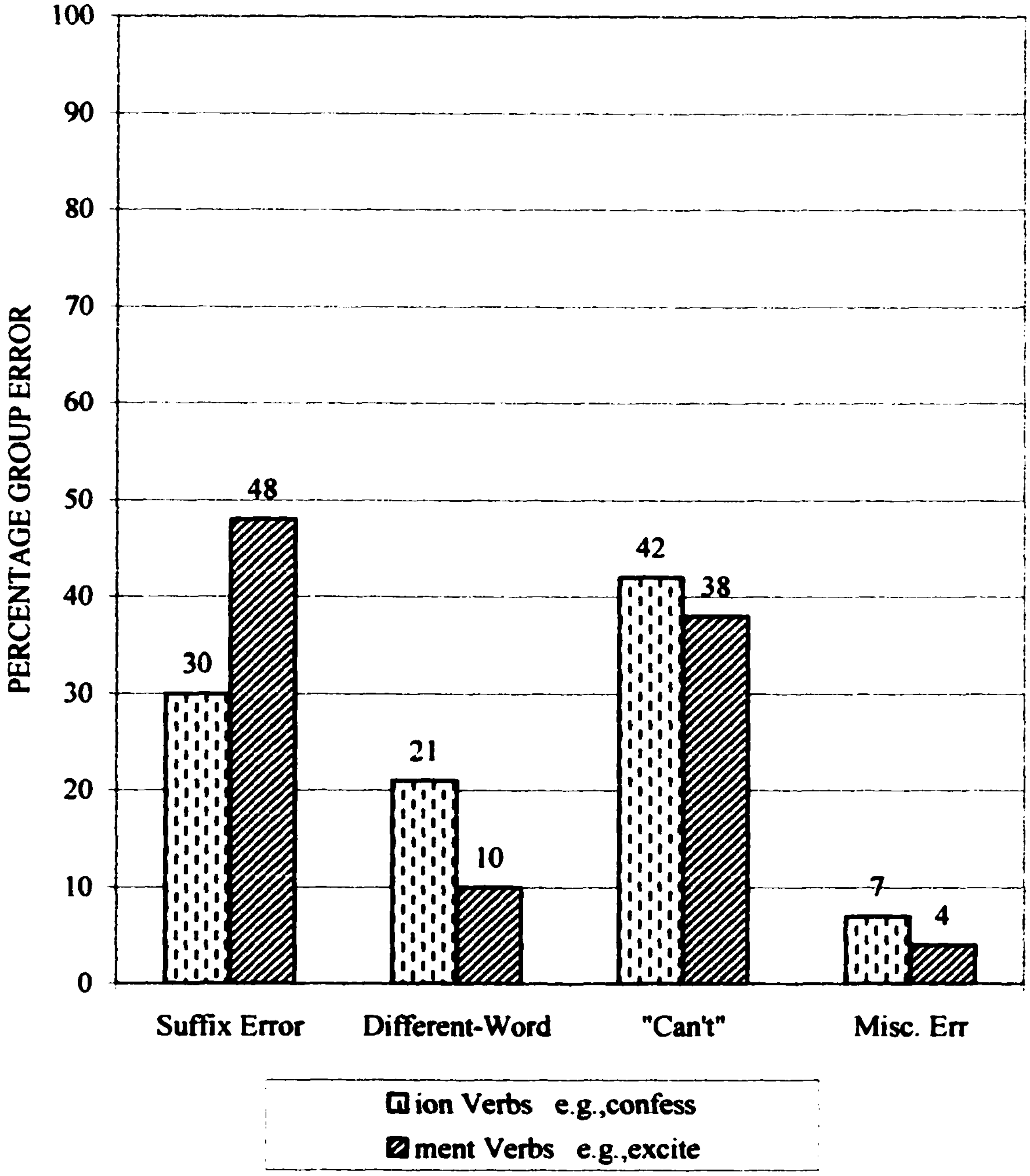
EXPERIMENT III
FIGURE III.4

PARTICIPANTS' CORRECT PERCENTAGE SCORES for BASE VERBS -ion versus BASE VERBS -ment



EXPERIMENT III
FIGURE III.5

CONTRIBUTION of ERROR CATEGORIES to TOTAL GROUP ERROR for BASE VERBS -ion versus BASE VERBS -ment



EXPERIMENT IV
TABLE IV.1

RANK ORDER OF SUFFIXES FROM SELECTED CORPUS

Rank Order of Derivational Suffixes
Total Words in Corpus: 13527
Total Derived Words: 1068
Percentage of Derived Words: 7.89

Rank	%	Sum %	Ttls	Suffix
	0.655		7	ion
	0.093		1	cion
	0.093		1	gion
	0.374		4	sion
	1.31		14	ssion
	8.89		107	tion
1		12.55	134	
	9.45		101	al
	1.31		14	ial
2		10.76	115	
3		10.29	110	er
	2.52		27	ant
	3.83		41	ent
4		6.36	68	
5		5.24	56	ate
	0.655		7	ar
	0.187		2	iar
	4.21		45	or
6		5.05	54	
	4.31		46	ity/ety
	0.374		4	ty
7		4.68	50	
8		4.3	46	ment
	1.87		20	ance
	1.68		18	ence
9		3.55	38	
10		3.46	37	y/age
11		2.99	32	ic/s
	0.936		10	ious
	1.59		17	ous
	0.093		1	uous
12		2.62	28	

Rank	%	Sum %	Ttls	Suffix
	1.96		21	an
	0.468		5	ian
13		2.43	26	
14		2.34	25	ist
15		1.96	21	ive
	1.31		14	able
	0.28		3	ible
16		1.59	17	
	1.21		13	ary
	0.28		3	ory
17		1.49	16	
18		1.4	15	th
19		1.31	14	logy/ure
20		1.12	12	ful/ize/ness
21		1.03	11	ship
		0.187	2	cy
		0.468	5	sy
22		0.66	7	
23		0.56	6	less
24		0.47	5	crat/ite
25		0.37	4	ade
	0.28		3	ice
	0.093		1	ise
26	0.37		4	ify
27		0.28	3	el/ency/ish
				graphy/ism
28		0.19	2	ee/em/m
28		0.19	2	en/ide/ile/ine/re
29		0.093	1	cracy
29		0.093	1	ese/hood/id

EXPERIMENT IV
TABLE IV.2

HIGH-FREQUENCY SUFFIX WORD versus LOW-FREQUENCY SUFFIX WORDS

STIMULUS LIST

High-Frequency Suffix (Rank 1-16)				Low-Frequency Suffix (Rank 12-28)			
Word	Word Frequency	Suffix Rank	Lexical Class	Word	Word Frequency	Suffix Rank	Lexical Class
auditor	5	6	n	audible	4	16	adj
clarity	28	7	n	clarify	25	26	vb
dental	12	2	adj	dentist	19	14	n
fallible	1	16	adj	fallacy	1	22	n
falsity	3	7	n	falsify	3	26	vb
fatty	7	10	adj	fatten	3	28	vb
heretic	2	11	n	heresy	2	22	n
horrible	15	16	adj	horrify	4	26	vb
joyous	5	12	adj	joyful	1	20	adj
maximal	3	2	adj	maximize	11	20	vb
minimal	27	2	adj	minimize	25	20	vb
nudity	2	7	n	nudism	1	27	n
rarity	2	7	n	rarify	1	26	vb
scrutiny	14	10	n	scrutinize	6	20	vb
sensual	6	2	adj	sensuous	2	12	adj
specialty	9	7	n	specialize	26	20	vb
testament	31	8	n	testify	23	26	vb
theorist	2	14	n	theorem	18	28	n
tyranny	11	10	n	tyrannize	1	20	vb
virtual	5	2	adj	virtuous	6	12	adj
wastage	1	10	n	wasteful	7	20	adj
High Suffix Rank			1-16	Low Suffix Rank			12-28
Mean log frequency			0.75	Mean log frequency			0.68
Geometric mean			5.60	Geometric mean			4.80
Raw frequency range			1-31	Raw frequency range			1-6
Word length in letters			6-9	Word length in letters			6-10

TABLE IV.3

TABLE of RESULTS

				E R R O R	A N A L Y S I S						
High-Frequency Suffix (84 responses)				SUFFIX ERROR							
	Total Correct	(Suffix-Correct)	Total Error	add	om	sb	(infl)	Ttl Sfx Error	Diff Word	"Can't"	Misc. Error
P1	7	(1)	14	-	2	4	(-)	6	4	2	2
P2	2	(1	19	-	2	4	(-)	6	3	10	-
P3	8	(1)	13	-	1	2	(-)	3	2	6	2
P4	10	(-)	11	-	1	8	(1)	9	2	-	-
Total	**27**	**(3)**	**57**	**-**	**6**	**18**	**(1)**	**24**	**11**	**18**	**4**
Low-Frequency Suffix (84 responses)											
P1	13	(3)	8	2	1	2	(1)	5	3	-	-
P2	5	(1)	16	-	-	5	(1)	5	-	10	1
P3	11	(2)	10	-	-	3	(-)	3	2	2	3
P4	13	(-)	8	2	1	5	(1)	7	-	-	-
Total	**42**	**(6)**	**42**	**4**	**2**	**15**	**(3)**	**21**	**5**	**12**	**4**

KEY

Total Correct	Total number of correct responses. This includes the score in the (Suffix-Correct) cells.
(Suffix-Correct)	The suffix was correct, but the participant made an error on the stem, or the response was a different word, but with the correct suffix (see Coding Taxonomy for criteria).
add	A suffix was added to the target word.
om	The suffix was omitted from the target word.
sub	A suffix replaced the suffix of the target word.
(infl)	An inflectional suffix was added or substituted. The count is subsumed under Suffix Addition or Substitution.
Diff Word	Different-word. The participant produced an altogether different word.
"Can't"	The participant acknowledged the inability to respond, or did not respond.
Misc. error	The participant's response was non-decipherable or non-codable.

EXPERIMENT IV
TABLE IV.4
HIGH- and LOW-FREQUENCY SUFFIX SETS COMBINED
GROUP CORRECT SCORES by SUFFIX RANK

Suffix Rank	Word Frq.	**Group Score Correct**	Word	Lex Class	F/B Stem
2	3	**0**	maximal	adj	B
2	5	**0**	virtual	adj	B
2	6	**3**	sensual	adj	B
2	12	**1**	dental	adj	B
2	27	**1**	minimal	adj	B
6	5	**2**	auditor	n	B
7	2	**1**	rarity	n	B
7	2	**2**	nudity	n	B
7	3	**0**	falsity	n	B
7	9	**2**	specialty	n	F
7	28	**2**	clarity	n	B
8	31	**2**	testament	n	B
10	1	**1**	wastage	n	F
10	7	**1**	fatty	adj	F
10	11	**1**	tyranny	n	B
10	14	**0**	scrutiny	n	B
11	2	**0**	heretic	n	B
12	2	**1**	sensuous	adj	B
12	5	**2**	joyous	adj	F
12	6	**0**	virtuous	adj	B
14	2	**2**	theorist	n	B
14	19	**4**	dentist	n	B
16	1	**0**	fallible	adj	B
16	4	**2**	audible	adj	B
16	15	**4**	horrible	adj	B
20	1	**0**	tyrannize	vb	B
20	1	**2**	joyful	adj	F
20	6	**3**	scrutinize	vb	B
20	7	**3**	wasteful	adj	F
20	11	**2**	maximize	vb	B
20	25	**3**	minimize	vb	B
20	26	**2**	specialize	vb	F
22	1	**2**	fallacy	n	B
22	2	**1**	heresy	n	B
26	23	**2**	testify	vb	B
26	25	**2**	clarify	vb	B
26	1	**3**	rarify	vb	B
26	3	**3**	falsify	vb	B
26	4	**3**	horrify	vb	B
27	1	**0**	nudism	n	B
28	3	**2**	fatten	vb	F
28	18	**2**	theorem	n	B

Key:
Word Frq. Frequency of stimulus word
Lex Class Lexical class
F/B Stem Free or Bound stem

EXPERIMENT IV
TABLE IV.5
HIGH- and LOW-FREQUENCY SUFFIX SETS COMBINED
GROUP CORRECT SCORES by SURFACE FREQUENCY of STIMULUS WORD

Word Frq.	*Suffix Rank*	**Group Score Correct**	Word	Lex Cl	F/B Stem
1	*10*	**1**	wastage	n	F
1	*16*	**0**	fallible	adj	B
1	*20*	**0**	tyrannize	vb	B
1	*20*	**2**	joyful	adj	F
1	*22*	**2**	fallacy	n	B
1	*26*	**3**	rarify	vb	B
1	*27*	**0**	nudism	n	B
2	*7*	**1**	rarity	n	B
2	*7*	**2**	nudity	n	B
2	*11*	**0**	heretic	n	B
2	*12*	**1**	sensuous	adj	B
2	*14*	**2**	theorist	n	B
2	*22*	**1**	heresy	n	B
3	*2*	**0**	maximal	adj	B
3	*7*	**0**	falsity	n	B
3	*26*	**3**	falsify	vb	B
3	*28*	**2**	fatten	vb	F
4	*16*	**2**	audible	adj	B
4	*26*	**3**	horrify	vb	B
5	*2*	**0**	virtual	adj	B
5	*6*	**2**	auditor	n	B
5	*12*	**2**	joyous	adj	F
6	*2*	**3**	sensual	adj	B
6	*12*	**0**	virtuous	adj	B
6	*20*	**3**	scrutinize	vb	B
7	*10*	**1**	fatty	adj	F
7	*20*	**3**	wasteful	adj	F
9	*7*	**2**	specialty	n	F
11	*10*	**1**	tyranny	n	B
11	*20*	**2**	maximize	vb	B
12	*2*	**1**	dental	adj	B
14	*10*	**0**	scrutiny	n	B
15	*16*	**4**	horrible	adj	B
18	*28*	**2**	theorem	n	B
19	*14*	**4**	dentist	n	B
23	*26*	**2**	testify	vb	B
25	*20*	**3**	minimize	vb	B
25	*26*	**2**	clarify	vb	B
26	*20*	**2**	specialize	vb	F
27	*2*	**1**	minimal	adj	B
28	*7*	**2**	clarity	n	B
31	*8*	**2**	testament	n	B
Key:	Word Frq.	Frequency of stimulus word			
	Lex Cl	Lexical Class			
	F/B Stem	Free/Bound Stem			

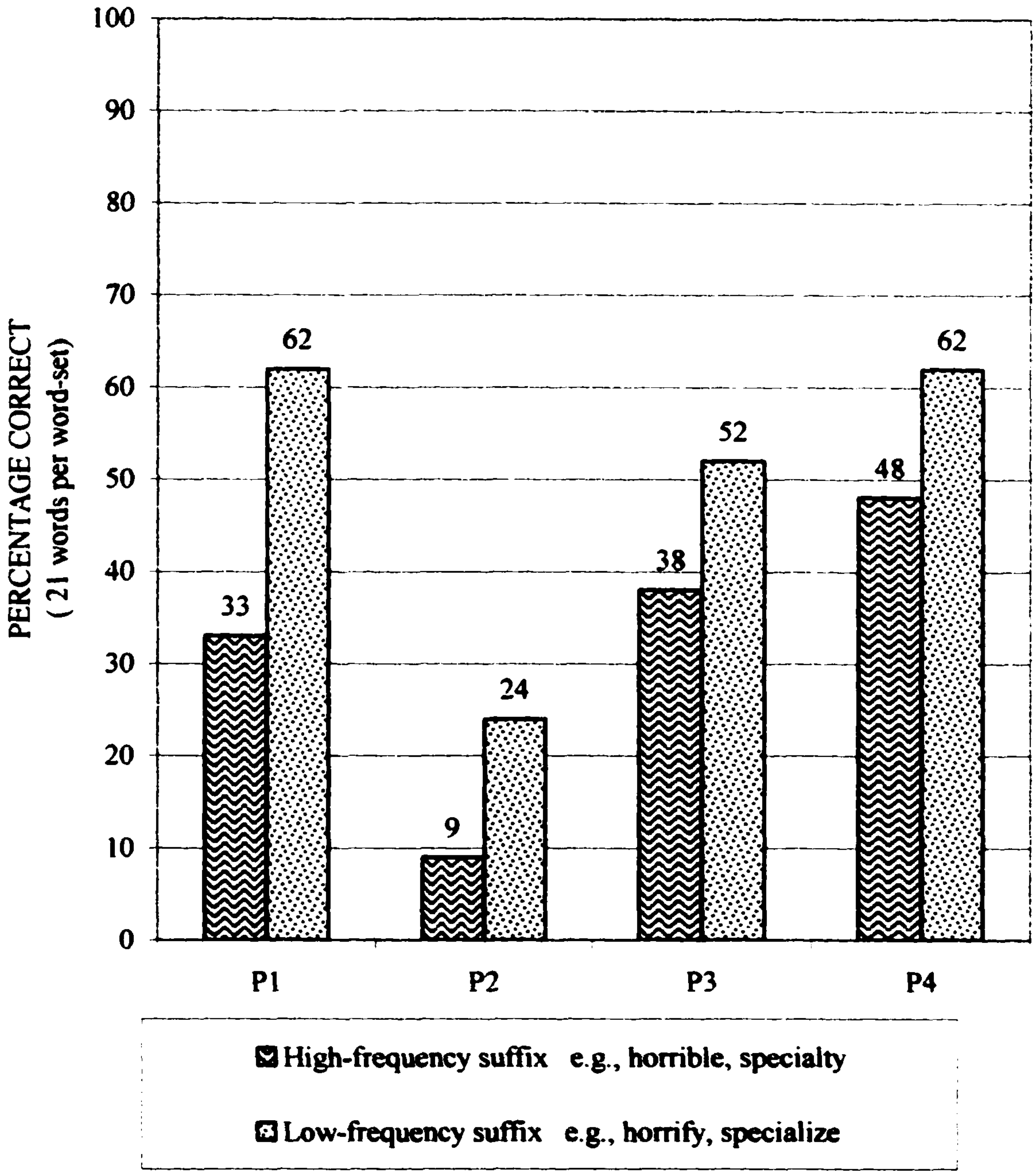
EXPERIMENT IV
TABLE IV.6
HIGH- and LOW-FREQUENCY SUFFIX SETS COMBINED
GROUP CORRECT SCORES by LEXICAL CLASS

Lex Cl	Word Frq.	*Suffix Rank*	**Group Score Correct**	Word	F/B Stem
adj	1	*16*	**0**	fallible	B
adj	1	*20*	**2**	joyful	F
adj	2	*12*	**1**	sensuous	B
adj	3	*2*	**0**	maximal	B
adj	4	*16*	**2**	audible	B
adj	5	*2*	**0**	virtual	B
adj	5	*12*	**2**	joyous	F
adj	6	*2*	**3**	sensual	B
adj	6	*12*	**0**	virtuous	B
adj	7	*10*	**1**	fatty	F
adj	7	*20*	**3**	wasteful	F
adj	12	*2*	**1**	dental	B
adj	15	*16*	**4**	horrible	B
adj	27	*2*	**1**	minimal	B
n	1	*10*	**1**	wastage	F
n	1	*22*	**2**	fallacy	B
n	1	*27*	**0**	nudism	B
n	2	*7*	**1**	rarity	B
n	2	*7*	**2**	nudity	B
n	2	*11*	**0**	heretic	B
n	2	*14*	**2**	theorist	B
n	2	*22*	**1**	heresy	B
n	3	*7*	**0**	falsity	B
n	5	*6*	**2**	auditor	B
n	9	*7*	**2**	specialty	F
n	11	*10*	**1**	tyranny	B
n	14	*10*	**0**	scrutiny	B
n	18	*28*	**2**	theorem	B
n	19	*14*	**4**	dentist	B
n	28	*7*	**2**	clarity	B
n	31	*8*	**2**	testament	B
vb	1	*20*	**0**	tyrannize	B
vb	1	*26*	**3**	rarify	B
vb	3	*26*	**3**	falsify	B
vb	3	*28*	**2**	fatten	F
vb	4	*26*	**3**	horrify	B
vb	6	*20*	**3**	scrutinize	B
vb	11	*20*	**2**	maximize	B
vb	23	*26*	**2**	testify	B
vb	25	*20*	**3**	minimize	B
vb	25	*26*	**2**	clarify	B
vb	26	*20*	**2**	specialize	F

Key:
Word Frq. — Frequency of the stimulus word
Lex Cl — Lexical Class
F/B Stem — Free/Bound Stem

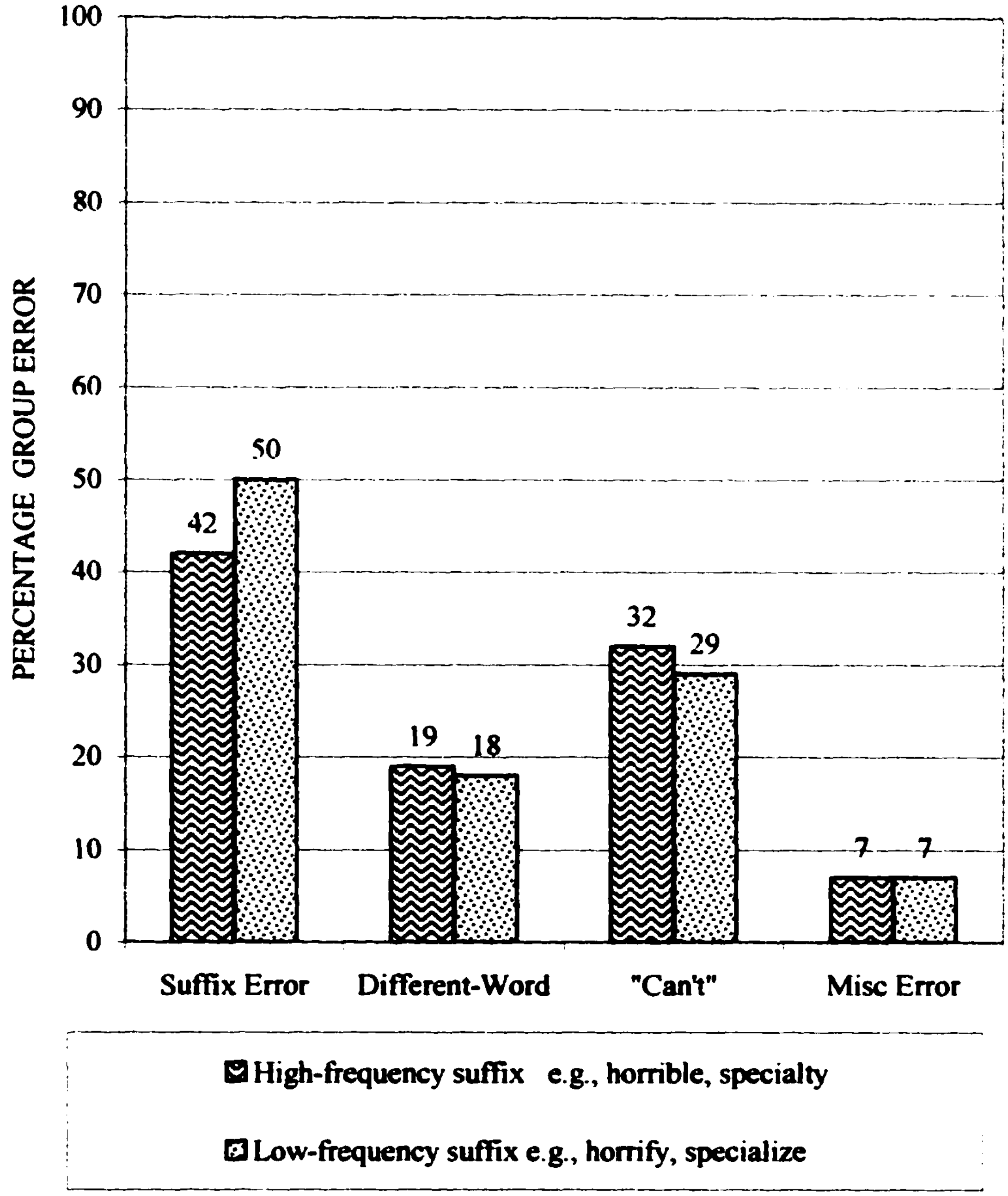
EXPERIMENT IV
FIGURE IV.1

PARTICIPANTS' CORRECT PERCENTAGE SCORES for HIGH-FREQUENCY SUFFIX WORDS versus LOW-FREQUENCY SUFFIX WORDS



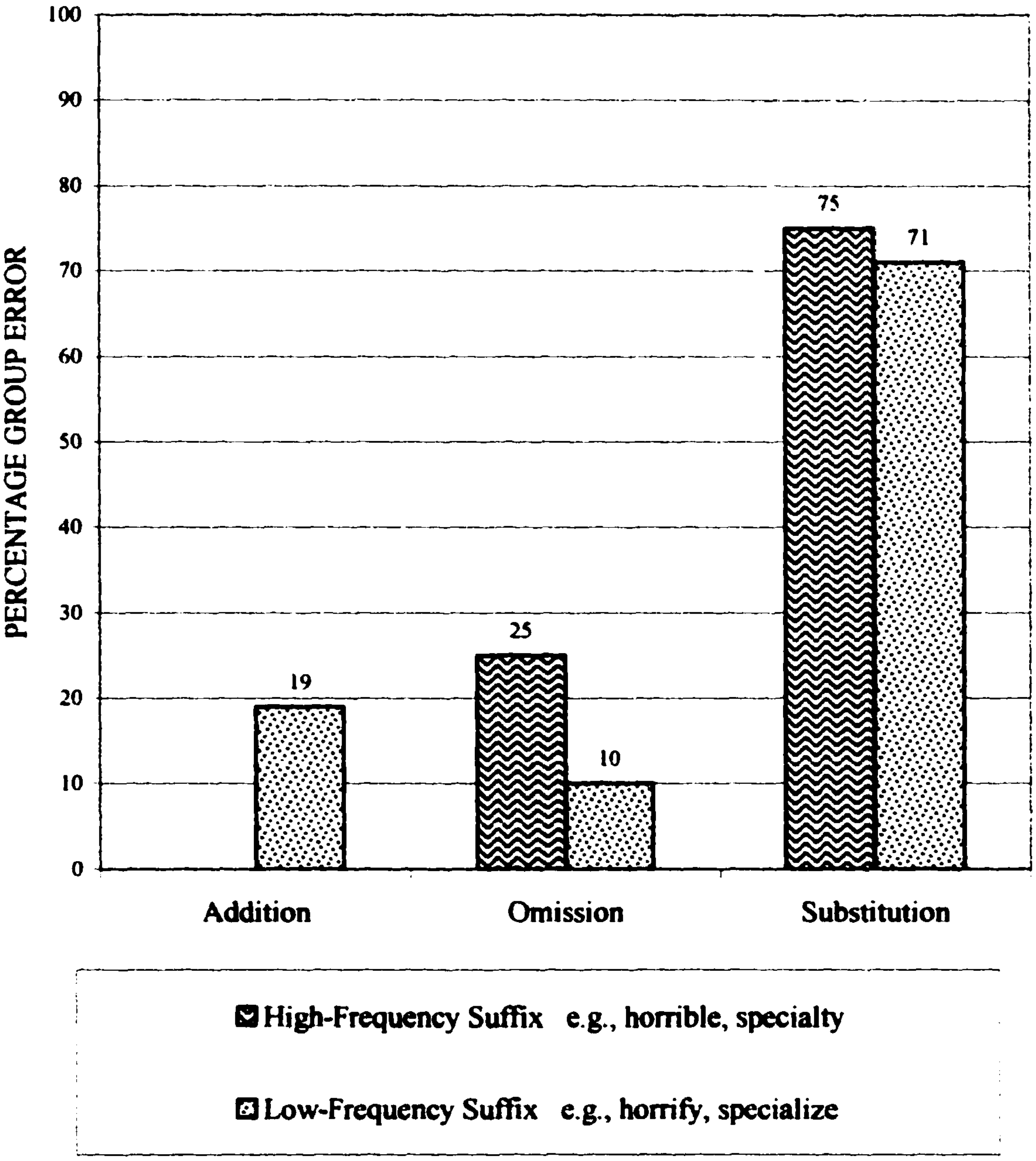
EXPERIMENT IV
FIGURE IV.2

CONTRIBUTION of ERROR CATEGORIES to TOTAL GROUP ERROR for HIGH-FREQUENCY SUFFIX WORD versus LOW-FREQUENCY SUFFIX WORDS



EXPERIMENT IV
FIGURE IV.3

CONTRIBUTION of TYPES of SUFFIX ERROR to TOTAL GROUP SUFFIX ERROR for HIGH-FREQUENCY SUFFIX WORDS versus LOW-FREQUENCY SUFFIX WORDS



APPENDIX
PRESENTATION SETS 1-3

	Set 1	Tag	Set 2	Tag	Set 3	Tag
1	fruit	F.086	cabbage	F.045	swap	F.172
2	seize	F.146	shove	F.154	allotment	III.027
3	pinnacle	I.054	predict	III.069	bump	F.044
4	convulsion	III.008	speck	F.160	engagement	III.038
5	greed	F.095	anchorage	I.061	cobra	F.057
6	adjournment	III.025	vivid	V.022	scorch	F.145
7	linger	II.078	fertility	V.049	assert	III.051
8	walrus	F.185	cruelty	I.068	personify	V.060
9	genuine	I.047	biscuit	F.022	modernize	V.036
10	theorize	I.115	thunder	II.088	abrupt	F.001
11	mourner	II.047	budge	F.043	safer	II.019
12	clown	F.056	sharp	F.148	frail	F.083
13	restriction	II.023	fodder	II.074	moccasin	I.023
14	booth	F.036	mobilize	V.035	enforce	II.085
15	calico	I.007	enrich	III.088	rhubarb	F.137
16	repress	III.070	sweeter	II.026	amaze	III.076
17	disrupt	III.059	local	V.012	cholera	I.043
18	sensuous	IV.036	equalize	V.026	sprint	F.163
19	buyer	II.035	truculent	I.118	buffalo	I.006
20	niece	F.110	decimal	I.096	bludgeon	F.032
21	raider	II.049	prank	F.129	shirt	F.153
22	amuse	III.077	commodore	I.044	caravan	I.009
23	stimulus	I.113	catapult	I.010	submission	III.024
24	enforcement	III.037	pork	F.125	mink	F.106
25	bleak	F.027	slander	II.085	human	V.007
26	auditor	IV.001	negate	III.067	lobster	II.079
27	sadder	II.018	humorous	I.075	credulity	V.047
28	drench	F.070	cherub	F.051	vigilant	I.089
29	victorious	V.065	attainment	III.032	dapper	II.071
30	stout	F.166	orchid	F.115	antelope	I.036
31	madrigal	I.021	enlargement	III.039	braver	II.001
32	flint	F.079	injury	V.031	persuasion	III.020
33	memorize	I.104	ranger	II.051	orchard	F.114
34	detach	III.083	colonist	I.095	audible	IV.022
35	ruinous	I.084	sandwich	F.141	preacher	II.048
36	monster	II.080	idolize	V.030	flick	F.078
37	legality	V.054	confuse	III.054	golfer	II.040
38	calmer	II.004	alibi	I.031	scrutinize	IV.035
39	sheriff	F.152	nearer	II.014	opulent	I.108
40	deferment	III.034	crocodile	I.016	corrosion	III.009
41	person	V.016	explosion	III.015	fever	II.073
42	acute	F.004	detect	III.058	parakeet	I.052
43	tinder	II.090	legalize	V.032	certainty	I.064
44	strange	F.169	ordain	F.116	frock	F.085
45	diamond	I.017	bland	F.025	organist	I.081
46	modern	V.014	harsher	II.011	rarity	IV.013
47	crave	F.061	liquidity	V.055	banker	II.032
48	nudism	IV.033	pomp	F.124	captivity	V.045
49	dignify	I.098	hunter	II.044	bliss	F.029
50	glamorous	I.072	argue	F.012	falsify	IV.026

Tag: The word's experimental list, and its position in the list.

APPENDIX
PRESENTATION SETS 4-6

	Set 4	Tag	Set 5	Tag	Set 6	Tag
1	carton	F.049	caramel	I.040	equal*	V.004
2	rancorous	I.083	moralist	V.037	cringe	F.062
3	garlic	F.088	gazelle	F.089	rarify	IV.034
4	afraid	F.006	louder	II.013	merciless	I.078
5	rougher	II.017	validity	V.064	humanist	V.029
6	ignite	F.099	brunch	F.041	shelf	F.151
7	fetch	F.077	swimmer	II.057	bicker	II.062
8	stallion	I.055	afford	F.005	moist	F.107
9	clerical	I.065	flirt	F.080	confusion	III.006
10	amulet	I.034	intrusion	III.017	onion	F.112
11	wasteful	IV.042	waiter	II.059	afflict	III.050
12	theorem	IV.039	paradise	I.051	morality	V.059
13	curt	F.064	athlete	F.013	thinker	II.058
14	champion	I.011	nicer	II.015	deceit	F.065
15	fatty	IV.006	prance	F.128	cloister	II.067
16	mend	F.104	concealment	III.033	explode	III.063
17	appeasemen	III.030	beckon	F.020	learner	II.045
18	blunder	II.064	sterile	V.019	vestibule	I.059
19	violet	I.030	attain	III.080	merge	F.105
20	fallacy	IV.025	militant	I.105	bodice	F.035
21	hunger	II.076	deviance	I.097	negation	III.019
22	resent	III.095	brighter	II.002	specialty	IV.016
23	vouch	F.184	ballast	F.017	accuse	F.002
24	vivacity	V.066	inspect	III.064	fertilize	V.027
25	robber	II.052	idolatry	V.052	joyful	IV.030
26	submit	III.072	turban	F.180	assertion	III.003
27	shark	F.147	creditor	I.067	labyrinth	I.020
28	cheese	F.050	cling	F.055	civilize	V.024
29	wiser	II.030	privilege	I.026	prosperity	V.061
30	nudity	IV.012	coward	F.059	venomous	I.088
31	confession	III.005	enlarge	III.087	alcove	F.007
32	pepper	II.083	faith	F.076	skunk	F.157
33	equality	V.048	pronounceme	II.045	testament	IV.017
34	drought	F.072	blouse	F.031	chess	F.052
35	disbursemer	III.036	helper	II.042	intrude	III.065
36	corrode	III.057	devil	F.068	badminton	I.005
37	gloom	F.092	merriment	I.079	smoother	II.024
38	porpoise	F.126	saver	II.053	borrow	F.037
39	injure	V.009	evade	III.061	tyranny	IV.019
40	regulate	I.111	brick	F.039	wince	F.186
41	cantaloupe	I.008	persuade	III.068	alien	I.032
42	quaint	F.131	scold	F.144	faster	II.009
43	simple	V.018	radiate	I.110	devilish	I.069
44	detection	III.010	sparse	F.159	fortitude	I.100
45	lizard	F.100	localize	V.034	maximize	IV.031
46	fertile	V.005	prosperous	V.039	healer	II.041
47	bald	F.016	nymph	F.111	delve	F.066
48	maximal	IV.010	testify	IV.038	enrollment	II.041
49	hazardous	I.074	venison	I.029	cabin	F.046
50	rancher	II.050	alcohol	I.002	brewer	II.034

Tag: The word's experimental list, and its position in the list.

APPENDIX
PRESENTATION SETS 7-9

	Set 7	Tag	Set 8	Tag	Set 9	Tag
1	goose	F.093	shave	F.149	fabric	F.075
2	almanac	I.033	fatten	IV.027	ridge	F.138
3	scant	F.142	divert	III.060	tedious	I.114
4	mobile	V.013	final	V.006	exert	III.062
5	finalist	V.028	privacy	I.109	tantrum	F.175
6	chink	F.053	tidiness	I.087	magnitude	I.103
7	confess	III.053	enrichment	III.040	tyrannize	IV.040
8	garter	II.075	stark	F.164	repression	III.022
9	satellite	I.028	seasonal	I.085	moral	V.015
10	pearl	F.120	dental	IV.003	alignment	III.026
11	appoint	III.079	bather	II.033	clarify	IV.023
12	breeze	F.038	cinema	I.014	porcelain	I.024
13	pierce	F.121	disruption	III.011	disburse	III.084
14	resentment	III.047	mustard	F.108	annoy	F.009
15	hero	F.097	tight	F.178	darker	II.007
16	brutalize	I.062	violate	I.120	blade	F.024
17	heresy	IV.028	arcade	F.011	idiot	I.050
18	liquid	V.011	porridge	F.127	sterilize	V.041
19	clearer	II.005	adopt	III.049	heretic	IV.007
20	sterility	V.063	chocolate	I.013	anvil	F.010
21	hiss	F.098	gambit	F.087	finality	V.050
22	vigorous	I.090	appease	III.078	stove	F.167
23	locality	V.056	belong	F.021	retire	III.096
24	align	III.074	stammer	II.087	shrewd	F.155
25	syringe	F.173	captivate	V.023	rabbit	F.133
26	victory	V.043	turbulent	I.119	caller	II.036
27	defer	III.082	brunt	F.042	scrutiny	IV.014
28	wastage	IV.021	gland	F.091	cadet	F.047
29	validate	V.042	spender	II.056	blister	II.063
30	mellow	F.103	cavernous	I.063	emerald	I.018
31	enticement	III.042	clarity	IV.002	fluke	F.081
32	restrict	III.071	appointmei	III.031	carrot	F.048
33	pivotal	I.082	aspirin	I.037	blush	F.034
34	apricot	I.003	hesitant	I.101	mistletoe	I.022
35	baker	II.031	crate	F.060	cowardice	I.066
36	amazement	III.028	broader	II.003	personage	V.038
37	taller	II.027	abdomen	I.001	douse	F.069
38	typhoid	F.182	blizzard	F.030	avalanche	I.004
39	pedigree	I.053	parch	F.118	gourd	F.094
40	vinegar	I.060	bandit	F.018	colder	II.006
41	steeper	II.025	civil	V.002	excitement	III.043
42	excite	III.091	joyous	IV.009	invent	III.066
43	attraction	III.004	congestion	III.007	beaver	II.061
44	cellular	I.093	simplicity	V.062	dense	F.067
45	acorn	F.003	kinder	II.012	refinement	III.046
46	slouch	F.158	daffodil	I.045	virtuous	IV.041
47	slumber	II.086	convulse	III.056	sensual	IV.015
48	minimize	IV.032	tiger	II.089	prosper	V.017
49	salad	F.139	stow	F.168	injurious	V.053
50	lather	II.077	horrible	IV.008	vivify	V.044

Tag: The word's experimental list, and its position in the list.

APPENDIX
PRESENTATION SETS 10-12

Set 10	Tag	Set 11	Tag	Set 12	Tag
1 ounce	F.117	syrup	F.174	slower	II.022
2 diligent	I.099	detachmen	III.035	therapist	I.116
3 thicker	II.028	bailiff	F.015	crust	F.063
4 modernity	V.058	glorious	I.073	invention	III.018
5 corridor	I.015	dagger	II.070	quiz	F.132
6 triumph	F.179	caraway	I.041	banjo	F.019
7 spinach	F.161	smarter	II.023	tolerance	I.117
8 circulate	I.094	porcupine	I.025	manage	F.101
9 hyacinth	I.048	prediction	III.021	amusement	III.029
10 catalog	I.042	gripe	F.096	cameo	I.039
11 drinker	II.038	falter	II.072	exertion	III.014
12 chariot	I.012	elephant	I.046	fatter	II.010
13 captive	V.001	turnip	F.181	marginal	I.076
14 poach	F.123	drummer	II.039	pronounce	III.093
15 saloon	F.140	cabinet	I.038	idol	V.008
16 idiom	I.049	socialize	I.086	filigree	I.019
17 shrimp	F.156	tennis	F.176	ramp	F.135
18 copper	II.069	oppose	F.113	cotton	F.058
19 diversion	III.012	droop	F.071	specialize	IV.037
20 dentist	IV.024	thief	F.177	winner	II.060
21 engage	II.086	velvet	F.183	arrogant	I.091
22 avoid	F.014	turpentine	I.058	hitter	II.043
23 proof	F.130	peach	F.119	foist	F.082
24 scarce	F.143	fallible	IV.004	humanity	V.051
25 radar	F.134	mobility	V.057	simmer	II.084
26 fright	F.084	girth	F.090	blurt	F.033
27 victor	V.021	optimize	I.107	refine	III.094
28 entice	III.090	adjourn	III.073	civility	V.046
29 broom	F.040	strict	F.171	clench	F.054
30 motorist	I.080	simplify	V.040	affliction	III.002
31 falsity	IV.005	anecdote	I.035	starve	F.165
32 marvelous	I.077	spine	F.162	credit	V.003
33 horrify	IV.029	clover	II.068	straw	F.170
34 loser	II.046	virtual	IV.020	allot	III.075
35 theorist	IV.018	shorter	II.021	tentacle	I.057
36 sharper	II.020	conceal	III.081	pamper	II.081
37 fulfill	III.092	retirement	III.048	sheep	F.150
38 pyramid	I.027	ravine	F.136	celebrant	I.092
39 wider	II.029	chowder	II.065	attract	III.052
40 sender	II.055	nerve	F.109	seeker	II.054
41 liquidate	V.033	enroll	III.089	sanctify	I.112
42 cider	II.066	blink	F.028	fanciful	I.070
43 dwell	F.074	drown	F.073	dreamer	II.037
44 credulous	V.025	stamina	I.056	literate	I.102
45 marsh	F.102	richer	II.016	inspection	III.016
46 valid	V.020	legal	V.010	almond	F.008
47 evasion	III.013	piston	F.122	mystify	I.106
48 panther	II.082	fatalist	I.071	congest	III.055
49 adoption	III.001	dearer	II.008	bison	F.023
50 blare	F.026	minimal	IV.011	fulfillment	III.044

Tag: The word's experimental list, and its position in the list.

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