# THE NATURE OF REPRESENTATION IN THE INTERNAL LEXICON

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by

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CHAPTER

## ABSTRACT

The first two experiments reported were concerned with the fact and growth of visual and acoustic representations of simple words in the Mental Lexicon. Using a Learning paradigm it was established that some form of visual and acoustic representations are formed within three exposures and that these forms of a word are also a basis for lexical organization.

Five experiments, employing different techniques, were aimed at testing the psychological reality of the morphemic structure of prefixed words. It was established that the morphemic structure of some of these words is represented; that the identity of some prefixes is represented; and that some non-specific knowledge concerning the relationship between orthographic and prefix structure is also represented.

Finally, the spelling errors of 11 year old children were analysed. This analysis revealed that acoustic, visual (more properly graphemic), and morphemic information, as well as some knowledge of phonotactic rules and statistical regularities, are represented in the Internal Lexicon.

It is concluded that the contents of the Internal lexicon are both redundant and heterogeneous.

# CHAPTER ONE

## 1. GENERAL INTRODUCTION (1)

The experiments to be reported here are concerned with the nature of the representation of a word in long term memory. Hypotheses as to what form this representation might take depend on our conception of a word: a word is a linguistic sign, which means that it is composed of a semantic element or aspect, and an aspect of form. The semantic aspect may be generally taken to include its meaning and features such as its syntactic category, while its form comprises on the one hand its written or visual realization, and on the other its acoustic or 'sound' realization. We shall be concerned here primarily with the written word, and with its meaning and sound only to the extent that these bear upon the written word.

The English writing system is based largely upon the sounds of the language, i.e. it is principally phonetic. The structure of these sounds, however, is far from simple, both physically, as an acoustic signal, and psychologically, as what we perceive. As a consequence, the nature of the internal representation of these sounds and that of the written word are likely also to be complex. Accordingly, we will consider, briefly, some aspects of the structure of speech sounds.

Our perception of the spoken word is remarkably robust. We can identify a word across a wide range of the voice qualities of the speaker; across a range of dialects, if not immediately then with only a little experience; and often when the signal is degraded by, for example, removing bands of frequencies (Miller & Nicely, 1955). These observations indicate that the internal representation of the spoken word, i.e. the acoustic representation, cannot be of some simple, absolute qualities of the sound, such as absolute frequency or absolute intensity, but must be of some more complex and perhaps abstract properties. This general notion receives support from the physical, linguistic and psychological aspects of the structure of the sound of a word.

The notion of the syllable is a familiar one, and the observation that, in polysyllabic words, syllables are concatenated is one that is seemingly clear and beyond dispute. However, even a superficial consideration of words such as window, compact and dagger reveals that the issue is clouded by the disputable nature of the location of the syllable boundary, e.g. is it wind/ow or win/dow? Furthermore, the idea of concatenation of relatively discrete units receives only a little support from an analysis of the physical signal, in which it is only sometimes the case that the unitary nature of the syllable is signalled by a specific cue - the waveform envelope (Cole and Scott, 1974).

In the same way that words may be conceived of as concatenated syllables, syllables may be conceived of as concatenated phonemes. For example, the word bat can be broken up into the three sounds |b|, |ae| and |t|, which are all phonemes. Evidence that this is a valid analysis comes from the fact that words are differentiated at this phonemic level. Thus the initial sounds in pat and bat are classed as different phonemes, as are the final sounds of nip and nib, because they distinguish between lexically different items. Further support for the psychological reality of these units of sound comes from the phenomenon of the categorical perception of phonemes (Liberman et al., 1967). There are however, several problems with this simple conception of the phonemic structure of words.

Firstly, consonant phonemes cannot stand without a vowel environment. That is, sounds like |b|, |t|, |s|, and so on, cannot be produced in isolation, but only with an accompanying vowel, such as in |bi|, |tə| and |sa|. Secondly, and following from the first point, the cues for consonant phonemes in the physical signal are not separable and sequential, but are shingled (Liberman et al., 1967). The cue for a consonant depends on the vowel it occurs with. For example, the second formant transition, a cue for the perception of |d|, varies with the identity of the vowel following. Finally, the phoneme is not really a single sound but a family of sounds. This is partly a consequence of its definition in terms of the fact that it distinguishes between words. Thus for example, the |p| in pen and nip are different sounds (the former is aspirated) but because they occur in complementary distribution they are not distinguished as being different phonemes. Similarly, |ℓ| and |r| are separate phonemes in English, but not in Cantonese, where they do not distinguish between words. Chomsky and Halle's (1968) conception of the phoneme as an abstract entity, having little to do with surface sound, is a logical extension of this notion of the phoneme as a family of sounds.

A unit of analysis smaller than the phoneme, and of bundles of which the latter is allegedly composed is the distinctive feature (Jackobson, Fant, Halle, 1952). These are binary entities that distinguish between sounds on the basis of their articulatory properties. For example, in the distinctive feature "voicing", sounds such as |p| and |b|, |t| and |d| and |k| and |g| are distinguished by virtue of the fact that the vocal chords do not vibrate in the production of the first member of each pair while they do for the second. There is evidence that these units of word structure also have psychological reality: e.g. distinctive features have been found to characterize perceptual confusions (Miller and Nicely, 1955) and, in a different vein, to describe some features of the speech production errors we call malapropisms (Fay and Cutler, 1977).

This brief discussion has given some flavour of the complexities of sound structure, and the range of candidates for internal representation of these sounds. The writing system, which we consider next, is similarly likely to present a number of complexities to the issue of internal representation, based as it is on the sounds of the language.

The written form of a word in English consists of a string of letters and there is a rough correspondence between these letters and the phonemes of the language. It is not entirely an alphabetic language however, as is evidenced by logograms such as the numerals (e.g. *1*, *2*, *3* ....), and signs such as $ and £. An intermediate (indeterminate?) case is the class of abbreviations such as *lb.* and *m.m.*

The history of writing systems (Gleitman and Rozin, 1977) reveals that the alphabetic principle is the most recent development (about 1500 B.C.) in the evolution of the representation of meaning by written forms. The earliest representations were of concepts or events, and were pictographic (e.g.  = *sun*), or ideographic (e.g.  = *brightness*, *day*, *sun*) in nature. The next stage was the logogram, a symbol representing the meaning of a word in the language (e.g. $ = *dollar*). The fundamental feature of the next major step in the evolution of writing systems was the mediation of the relationship between written form and meaning by sound. This was found in both the syllabary and its predecessor, the rebus. In a rebus, a symbol that represents a particular word (e.g.  for *eye*) is also used to represent that sound in other contexts, and wherever it appears (e.g. for *I*; the "I" in *Idea*; and for *aye*). In a syllabary the same situation holds with the difference that the symbol is tied only to the sound it represents and not at any time to meaning. Thus, for example, whereas in the rebus  is clearly tied to *eye*, in a syllabary the symbol would not be tied to that or any other word. It would probably assume some arbitrary form such as # ,  or whatever. Finally, and in contrast to these other systems it seems to have been invented only once, the alphabetic principle appeared. Each of the stages in the evolution of written language are, according to Gleitman and Rozin (1977), to be found in the current writing systems of particular languages of the world. Thus Chinese is predominantly logographic, Japanese has a logography (Kanji) and two syllabaries (the Kanas), and English is predominantly alphabetic.

The order of invention of writing systems suggests that systems based on the direct representation of meaning (e.g. logographies) may be generally easier to learn and use than systems where the relationship between written form and meaning is less evident because it is mediated by sound. (This notion is the basis of a reading curriculum devised by Rozin and Gleitman (1977). Interestingly in this connection, Sakomoto and Makita (1973) have claimed that the converse system, used in the teaching of Japanese children, is responsible for minimizing the incidence of reading disability in Japan. These children first learn the phonetic script and then are gradually introduced to the logography. Suggestion from this general notion is that there might be a psychologically optimal level of representation, the implication for English perhaps being that the unit of representation in memory might be of the complex of letters comprising a word or syllable, rather than, say, of the letters themselves. It is probably more realistic to speak not of optimality per se, but of optimality with respect to a particular requirement. Thus for example, in fluent reading the optimal level of representation of a word, for the purposes of its access, might be the whole word (e.g. word shape) rather than the individual letters, while in spelling tasks the reverse would probably be true. This task-linked optimality would of course require redundant representation of the word, i.e. several representations of, say, its visual form.

The correspondence between letters and sounds that occurs in an alphabetic system implies that the factors that constrain the sequencing of the sounds (phonemes), also constrain the sequencing of the letters (factors to do with the phonology of the language). The effect of these factors is to create a division between permissible and impermissible sequences for the language being considered. For example, the string ptibk is not a permissible sequence in English because the consonant phoneme sequences |pt| and |bk| are not permissible in word initial and word final positions. They might however, be permissible in other languages which allow combinations like |nk| (Nkomo), and |nd| (Ndabadinge); sounds which we find peculiar and which we instantly recognise as being foreign. Apart from this division between permissible and impermissible that is created by phonological factors, sequences also vary in their frequency of occurrence. Thus sequences such as ea are more frequent in English than sequences such as ae, the source of such data being the tables of bigram and trigram frequencies that are devoted to cataloguing these frequency differences (e.g. Mayzner et al., 1965). The result of these linguistic (permissible vs. impermissible) and probabilistic (frequency of strings) factors is that both English phonology and English orthography are redundant, i.e. the permutations of letters and sounds are subject to non-random constraints.

The relationship between the sound and the visual form of a word is complicated by the fact that the correspondences between the letters and the sounds (the grapheme-phoneme correspondences) are not one-to-one. Indeed English has achieved some notoriety on this count. For example, we have: the same sound expressed by different letters and letter groups (e.g. |k| → c, k; pain and pane; phrase and frays); different sounds expressed in the same way (e.g. |k|, |s| → c; lead (verb) and lead (metal)); bigrams where the sound is not predictable from the components (e.g. ch, sh, kn); and oddities such as cough, dough, bough and yacht. With a few exceptions there has been little attempt to make sense of English spelling. It is generally treated as a system consisting of a set of regular words in which there is a regular correspondence between grapheme and phoneme (e.g. bad, bid, bun...) with a set of exceptions, which quite simply have to be learned (bomb, womb, debt and doubt , in all of which the b is silent).

One of the most constructive attempts to make sense of English spelling is that by Venezky (Venezky and Wier, 1966, Venezky, 1972). Venezky's claim is that English spelling is not so irregular as it appears. This claim is based on a statistical analysis of sound-symbol correspondences in a corpus of 20,000 words. Firstly, according to Venezky, there are two kinds of regular correspondence, variant and invariant. Secondly, there is a class of irregular correspondences consisting of items where a particular correspondence is not predictable from any rule or regularity and which is peculiar to the word in which it occurs. For example, the th in thyme, the is in island and the ch in ache, cache and which.

The regular invariant class consists of correspondences such as that between V and |v|, which always holds. More interesting is the regular variant class consisting of items that can be brought into a state of some order from one of seeming chaos by a consideration of a number of underlying regularities: (1) Digraphs such as th and ch, whose sound is not a sum of the parts, cease to appear peculiar if we consider that together they function as a unit in the same way that a single letter does. Thus th regularly corresponds to |ð| in functors such as this, then and the, and in morpheme - final clusters as in brother, father, clothe and loathe; in most other cases it corresponds to |θ| as in moth, thigh and cloth. (2) The environment is an important factor in conditioning correspondences: (a) c is "soft" before e (cent), i (city), and y followed by a consonant or juncture (cycle), exceptions being some foreign loans such as cello and ceilidh. Elsewhere c is hard, e.g. card, cumulative. (b) Whether a vowel is long (as in mate), or short (as in mat), is determined by whether it is followed by a single consonant unit and another vowel (mate, anal), in which case it is long, or not (annal, mat), in which case it is short. (c) Another example of the conditioning effects of the environment is to be found in pairs of symbols that occur in complementary distribution. Thus the cluster -ous alternates with -os, with the latter form occurring with the suffix -ity, e.g. curious, curiosity. (3) The position of a letter in a word is often a cue to its correspondence. For example, the peculiar and troublesome gh occurs mostly in initial and final positions and the regularity is that when it occurs in initial position the correspondence is always |g|, as in ghoul, ghastly and gherkin. (4) Finally, the seemingly superfluous occurrence of letters in a word is often due to their function as markers of the pronunciation of other letters. This marking function is served, for example, by the u in guest and biscuit, and by the e in rage and rice. Without these markers the pronunciation of the cs and the gs would be ambiguous.

The correspondence between the writing system and the sounds of the language is complicated at levels other than the phoneme-grapheme level we have considered here. English orthography signals more than the phonemes of the language: it signals the morphemic structure of words as well as (indirectly) other phonological features such as stress. We shall return to these later. For the present we note that phoneme-grapheme correspondences are often not as irregular as they seem to be, and their irregularities are often systematic and subject to rule. Of psychological interest is whether these rules and probabilistic constraints are psychologically real. For example, do people spell using rules of these kinds?

We turn now to a consideration of some empirical phenomena that illuminate the nature of Lexical Memory. "Lexical Memory" will be used to refer to any and all information relating to words that is stored in long term memory. The term "Mental Lexicon" will be used to refer more specifically to the stored words in an individual's vocabulary.

The "Word Superiority Effect" (W.S.E.) dates back to the last century when, for example, Erdman and Dodge (1898) reported that under perceptually impoverished conditions (distance and brief exposure) a word was recognized more easily than a random string of letters. Gibson, Pick, Osser and Hammond (1962), found the same superiority for the report of regularly spelled non words over that for irregular letter strings. More recently, Reicher (1969), and Wheeler (1970) have confirmed the effect with the finding that recognition of a letter in a word is superior to recognition of either a letter on its own or a letter in a random string. The importance of their paradigm lies in its reduction, if not elimination, of guessing effects. Since the experiments to be described employ the paradigm we digress briefly to describe it.

The stimulus is presented tachistoscopically for a short time and immediately followed by a mask. Two probe letters are then presented and the subject is required to state which occurred in the stimulus. Thus if the word WILD was presented, the letters L and N might appear where the L had been and the subject would be required to state which had occurred.

The W.S.E. poses two questions: firstly, is it due to the meaningfulness of the word (a "lexical" effect), or to orthographic regularity, or to both? Secondly, assuming that regularity is a significant contributor to the effect, is the facilitation due to orthographic regularity as such or to the pronounceability of the items?

McClelland (1976) and Manelis (1974) have found an advantage for real words over orthographically regular non-words (pseudowords). This lexicality of the effect (i.e. a meaningfulness component) suggests an holistic or whole-word theory of recognition. This holds that words can be recognized before the individual letters because recognition is based on supra-letter and/or word-envelope features. Several findings bear on this claim. McClelland (1976) found that CaSe AlTeRnAtIoN did not eliminate the difference between real words and pseudowords, which is what would be expected if the effect was due to holistic word recognition. It might be argued however that these case alternated words are being read by prior conversion to an acoustic representation or code but that normally access to the mental lexicon is direct, visual and dependent on holistic features. Counter-evidence for this argument comes from the observation that a phonemic dyslexic, an individual who has lost the ability to convert spelling to sound (i.e. lost what is generally referred to as the phonological route) retains the ability to read case alternated words and words with the letters displaced (d$^{i}$s$^{p}$l$^{a}$c$^{e}$d) (Saffran and Martin, 1977). Two other results further indicate that transgraphemic features, features spanning more than a letter but less than a word, do not play a part in recognition: McClelland (1976) failed to find an interaction between case alternation and the superiority of pseudowords over random strings and Taylor (et al., 1977) found no difference in recognition between the occurrence of case alternation within a syllable and its occurrence across a syllable. If visual features spanning several letters, say a syllable, were the basis of identification then one would expect case alternation to have had an effect, as it would have destroyed these features.

In support of the notion of holistic recognition is the finding that in an "e cancellation" task the cancellation rate for the <u>e</u> in <u>the</u> was so low, compared to other <u>es</u>, as to lead Healey (1976) and Smith and Groat (1979) to conclude that <u>the</u> might function as a perceptual whole. More indirectly, support for the representation of holistic features comes from matching experiments of Henderson and Chard (1976) and Seymour and Jack (1978). Matching of acronyms such as BBC and GPO was faster than matching of controls, suggesting a lexical effect in that the superiority cannot be attributed to orthographic legality or pronounceability. Even more suggestive that the effect is one to do with visual features is the fact that the effect was no longer present when lower case was used, e.g. gpo, bbc. Evidence from eye-movement studies (Rayner and McConkie, 1977) suggests that word shape information and word length information are being picked up by the skilled reader up to 10 and 15 letters away from the fixation point respectively. The implication of this is that these whole-word features may well be used as preliminary and approximate lexical access codes. Putting these results together, the implication is that holistic recognition might occur, and if it does it is likely to be a function of word frequency (i.e. for very common words like the), and possibly the task involved (i.e. more likely in fluent reading than in tachistoscopic recognition). This conclusion is of course weak support for the notion of several task-orientated representations discussed earlier.

In addition to the difference between real words and pseudowords there is also a difference between the latter and random strings (Baron & Thurstone, 1973; McClelland, 1976).

One possible source of this difference between pseudowords and random strings lies in the orthographic regularity of the former. Henderson and Chard (1980) have reviewed studies attempting to identify the active principles of orthographic regularity. According to Henderson and Chard, most studies concerned with sequential redundancy as a principle of regularity deal with it on a post hoc basis (e.g. Gibson et al., 1970, Manelis, 1974). As a result of this they are usually not free of confounding factors and so their conclusions are equivocal. The study of McClelland and Johnstone (1977) is an exception in that it was rigorously planned; they failed to find an effect of bigram frequency on recognition thresholds. Sequential redundancy is concerned with the transitional probabilities of letters, a second possible basis for regularity effects is positional frequency. An example of positional frequency is that the letter b occurs 95% of the time in word initial and word medial positions, and only rarely in word final positions. Mason (1975) found a significant effect of positional frequency or redundancy on visual search, in letter strings that varied on this dimension. It seemed confined however to good readers. Henderson and Chard claim that while this study does show redundancy effects it is not clear whether the source is positional redundancy or sequential redundancy, as these tend to co-vary. Massaro et al. (1979) set out to compare the relative efficacy of a positional frequency redundancy measure with a rule governed measure, the latter being based on pronounceability and orthographic legality. They concluded that both these factors affected a letter search task and a recognition threshold task. Again however, Henderson and Chard point out that there is a complete confounding in this study of the rule governed factor with trigram frequencies (i.e. sequential redundancy). Henderson and Chard conclude that the case for positional and sequential redundancy is not proven and go on to suggest that is might be profitable to think not in terms of degrees of redundancy, as exemplified by bigram and trigram frequencies, but only in terms of permissible and impermissible strings.

If we accept this somewhat conservative conclusion we may then question what form this knowledge of permissible and impermissible strings might take. One possibility is simply that a list of permissible strings is stored. This seems unlikely for reasons of economy, but what does seem plausible is the storage of a limited number of unusual or infrequent strings that would supplement other information (e.g. rules) that dealt with more regular strings. This expression of the regularities underlying common sequences in the form of rules constitutes a second possibility as to the form this knowledge might take. A basic if somewhat superficial rule might be that consonant sequences of more than n (3?) letters, without an intervening vowel, are illegal. The third possibility is that legality may be a simple consequence of pronounceability. If a string is pronounceable it is likely to be legal, if it is not then it is not. Indeed, the superiority of performance on words and pseudowords over random strings might be reduceable to the fact that the former are pronounceable while the latter are not.

The advantage conferred on some strings by their pronounceability is presumably a function of their dual coding in short term memory, in visual and acoustic forms (Seymour, 1979). The evidence suggests that the w.s.e. is not in fact due solely to the acoustic (pronounceable) properties of the stimulus. Baron and Thurstone (1973) found that the homophonic relationship of the alternatives in the Reicher-Wheeler paradigm (FRANE vs. FRAIN) did not diminish the advantage of pseudowords over random letter strings, which is what would be expected if the effect were due to the sound of the word. They also found a comparable effect for "correctly spelled" formulae (HCl) over "incorrectly spelled" formulae (ClH), and thus claimed that pronounceability per se, was not a necessary condition for the w.s.e. Hawkins et al. (1976) argued that using large numbers of homophones, as Baron and Thurstone had done, might have discouraged the use of acoustic recoding. Accordingly, they blocked trials, varying the number of homophones in each block and found that subjects did vary their use of an acoustic code in the predicted direction; the size of the w.s.e. was reduced in conditions with large numbers of homophones.

The conclusion of this section dealing with the w.s.e. must be an imprecise one. The ability to perceive words better than random letter strings is probably due in some conditions to the internal representation of whole-word or transgraphemic visual features; in part to the conversion of pronounceable strings to an additional, acoustic, source of information; and to a "residual", internally stored knowledge of legality and regularity in English orthography. It is not clear to what extent this "residual" knowledge can be characterised by statistical measures such as positional redundancy or whether a characterisation in terms of knowledge of orthographic rules would be more accurate.

A large body of research is based on the lexical decision task. This task requires subjects to decide whether or not a letter string is a word, and as such requires access to the representation of a word in the mental lexicon. Consequently, investigations into the type of code used to access a lexical entry indicate the nature of the representation of this entry.

An acoustic recoding theory, such as that of Gough (1972), holds that a necessary process in the course of lexical access is the conversion of the graphemic representation of the word into an acoustic representation or code, which is then used to access the internally stored (acoustic) representation. Support for the notion that an acoustic code is used for lexical access comes from an experiment by Rubenstein et al. (1971), replicated by Coltheart (1977). The finding is that the time taken to reject, as non-words, pseudowords that are homophonic with real words (e.g. <u>brane</u>, <u>porze</u>) is significantly longer than for pseudowords that are not homophonic with real words (e.g. <u>brone</u>, <u>porce</u>). This could not occur unless the acoustic code for these "pseudohomophones" was making contact with the acoustic representation of the real word counterpart (i.e. of <u>brain</u> and <u>pause</u>). Similar effects have been found with a semantic classification task (Meyer et al., 1974), i.e. the relative classification times of <u>pear</u>, <u>pair</u> or <u>tail</u> as a fruit; and a phrase evaluation task (Baron 1973), i.e. the relative number of errors in the evaluation of phrases such as <u>my new car</u>, <u>my knew car</u>, and <u>my now car</u> as meaningful. Evidence for the view that the pseudohomophone effect is due specifically to the formation of an acoustic code comes from the performance of two phonemic dyslexics (Marshall and Newcombe, 1973) on the pseudohomophone lexical decision task (Patterson and Marcel, 1977). These patients are partly characterized by an inability to read nonsense words aloud and to judge rhyme. This deficiency in their ability to derive an acoustic code and their failure to exhibit the pseudohomophone effect indicates the role of acoustic coding.

The phenomenon of phonemic dyslexia is however, also the strongest evidence that an acoustic code is not necessary for lexical access, for even though these patients cannot derive an acoustic code they can read for meaning, (particularly content words), however influently. This accords with the general observation that while perhaps homophones may sometimes cause problems, or delay processing, we can and do nonetheless distinguish between them, both inside and outside the laboratory. In other words, lexical access must also be based on a visual code, that accesses a visual representation in the mental lexicon.

Klei man (1975) has suggested that the role of an acoustic code lies not as a necessary means of lexical access but in a post-lexical storage facility or working memory that is used in the decoding of sentences. He concluded this from an experiment in which he found that a concurrent shadowing task affected judgements of sentential acceptability (involving working memory) and judgements of phonemic similarity (tickle similar to pickle) to a greater degree than it did judgements of graphemic similarity (heard similar to beard), or judgements of synonymy (mourn synonymous with grieve). Notice that Kleinman's results show only that acoustic recoding is not occurring, and is thus not necessary, in the task involving lexical access (the synonymy task). They do not show that it does not ever form a part of lexical access procedures. Again, it seems likely that, as a general phenomenon, the use of acoustic recoding is likely to vary with task demands. Thus, Hardyck and Petrinovich (1970) found an increase in the amount of subvocal articulation as the difficulty of the text being read increased.

The lexical decision experiments indicate that the meaning of a word can be accessed by both visual and acoustic codes, and by implication indicate the existence of visual and acoustic internal representations. This notion of two channels of access, the visual and the acoustic, is a matter we turn to next, in connection with the deriving of an acoustic form of a word from its written form. At a more general level we are concerned with the pronunciation of written words.

One solution to the problem of how the acoustic form of a word is derived from its written form is to assume that part of the lexical entry for the word is information about its pronunciation. Support for this lexical source of derivation comes from several sources. Firstly, phonemic dyslexics, whilst being unable to pronounce non-words, can sometimes pronounce real words, i.e. words they already know, particularly frequent, content words. Secondly, it is not clear what other means exist for the pronunciation of irregular words such as bough, cough and dough, for each of which the pronunciation is unique. Thirdly, some naming latency studies (e.g. Forster and Chambers, 1973; Frederiksen and Kroll, 1976) have found that the lexical variable of word frequency affects response, while other naming latency studies have found that semantic priming (again suggesting a lexical source) facilitates naming (Jackobson, 1973).

A second means whereby an acoustic form may be derived is popularly known as grapheme-phoneme translation. This is a set of rules or procedures that operate on a letter string, and by assigning sounds to letters or to groups of letters in a regular manner, produce the acoustic form of the string as output. A procedure, or procedures, of this kind would appear to work well for strings with invariant correspondences, or strings that Venezky (op.cit.) would class as having variant but regular correspondences. Successful translation would be less assured however, in the case of irregularly spelled strings, be they real words or not, e.g. freak, greak, break; wough, cough, bough. The output of the operation of translation procedures on these strings would be, at best, ambiguous. Evidence for the existence of this means of pronouncing letter-strings comes from the phenomenon of "surface dyslexia". These patients are characterised by their laborious reading out loud, and their errors, when doing so, on phonemically ambiguous consonants and vowels (e.g. just for guest). General evidence for the dissociation of these two proposed channels, for the derivation of acoustic forms, comes from sources other than the two dyslexias considered. One of these is the finding that the pronunciation latency for non-words is longer than that for words: the former can only use the 'translation' channel while the former can use both the translation and the 'direct' channel. (Forster and Chambers, op.cit., Frederiksen and Kroll, op.cit.). Also, Baron and Strawson (1976) found that the naming of irregular words took longer than that of regular words. This was hypothesized to be because the regular words provoked no conflict between the output of the two channels while the irregular words often did.

The kinds of errors found in surface dyslexics (e.g. just for guest, boil for bowl, rikunt for recent) and the fact that the irregular words in studies like that of Baron and Strawson (op.cit.) are irregular in terms of phoneme-grapheme correspondence, suggest that the procedural conversion or translation from print to sound does indeed operate at the grapheme-phoneme level. However, other possibilities do exist. For example, sequences of letters that are pronounceable, e.g. spelling patterns (Gibson et al., 1962), might be the level at which spelling to sound conversion operates. Indeed, Frederikson and Kroll (op.cit.) found that naming latency was affected by the size of the initial consonant spelling pattern, supporting the viability of the spelling pattern as a unit of translation.

Another possibility is that conversion coccurs at the level of a unit roughly equivalent to the syllable: the "vocalic centre group" (vcg) of Hansen and Rogers (1973), which has been adopted after empirical test by Spoehr and Smith (1973, 1975). The conversion procedure operates in two stages: in the first stage a letter string is parsed into vcgs (syllable type units) on the basis of the number of vowels or vowel digraphs in the string. Thus for example, paper and beaver would each be parsed into two vcgs. The second stage consists of mapping each vcg onto a sound on the basis of letter-to-sound correspondences. Coltheart (1978) demonstrates that this procedure, as it is presented, is basically unworkable. For example, the initial parsing procedure fails for words with a final silent e such as mate and lute, which it will incorrectly parse into two vcgs. It will also fail for words such as lion and liar, which it will incorrectly parse into one vcg. Coltheart also argues that the second stage fails, largely because the conversion to sound does not take account of regularities that span more than one letter, or vcg boundaries: thus fungus would be assigned the wrong pronunciation fun/gus because the fact that when followed by a, o or u, ng is almost always pronounced |ŋg|, could not be used. Another major problem of the procedure is that in cases of multiple sound correspondences (e.g. the co in cover, move, love etc.), all these correspondences are not assigned and tested before the string is re-parsed.

This synopsis gives only a flavour of Coltheart's criticism of the Hansen and Rogers' proposal. He certainly demonstrates that, taken at exactly face value, it is not a viable proposition. However, his criticisms do not preclude the possibility that units of the size and type of a vcg might provide a working structure within which grapheme-phoneme conversion could occur, and within which a number of rules of phonemic co-occurrence could operate. Vowels certainly seem to have a status distinct from that of consonants: James (1975), for example, found that visual search for a letter target in a word was quicker when the target was a vowel; Spoehr and Smith (1975), found that the presence of a vowel contributed to the w.s.e. From speech perception research (e.g. Liberman et al., 1967) we know that consonants can not stand alone in that they need a vowel environment, whereas the converse is not the case. Finally, it seems to be the case that rules of phonemic co-occurrence span no more than one syllable, e.g. in words like congregate and termite the silent e only affects the pronunciation of the vowel in the same syllable. In short, the general principle underlying a vcg should not be dismissed on the basis of the inadequacy of a specific proposal for how it might function.

The general position that there are two distinct systems for deriving the acoustic form and pronunciation of a word has recently come under attack. Glushko (1979), has argued that there are not two separate systems, one relying on stored representations of the acoustic form of words, the other on string-sound conversion rules, be they grapheme-phoneme, spelling pattern or otherwise based; there is only the one system that activates knowledge of several kinds when a derivation is required. This knowledge includes the stored pronunciation of the string (if a known word), the pronunciations of similarly structured other strings and parts of strings, and multiletter spelling-to-sound correspondence rules. The evidence he presents is that non-words like tave take longer to read aloud than non-words like taze because tave resembles an irregularly spelled real word (have) while taze resembles a regularly spelled real word (haze). Also, words like wave, which have a regular spelling but which are like irregularly spelled items like have, take longer to pronounce than regularly spelled words like wade, which do not resemble irregularly spelled items. These results are not predicted by the two channel notion: rule-based conversion does not predict the difference between taye and taze, and the retrieval of only a stored pronunciation notion does not predict the difference between wave and wade.

Marcel (1980) has similarly argued against the notion of a conversion-rule based process, with reference to surface dyslexia and children. He has argued that the errors of surface dyslexics, when reading aloud, are not characterizable only in terms of failed grapheme-phoneme conversion rules: they make errors that reflect the effects of form class and frequency; their assignment of a sound to segments of the string is that of the most frequent correspondence and is context insensitive; and their attempts indicate an effort to make the result sound like a word they know. Children show the same trends: for example, they too will guess at the pronunciation of a word so that the error is in their vocabulary or is at least very similar to some word they know. In short, the errors show what in the two channel notion are referred to as lexical effects.

The current view then, does not favour the notion of two separate sources for the derivation of the sound of a word from print. Rather, it favours a single data base as the source of print-to-sound information; a data base comprising a rag-bag of rules, pronunciations of whole words and segments, and some grapheme-phoneme correspondences.

The logogen system (Morton, 1969) models the representation of some aspects of the words in our vocabulary. The logogen for each word (or more accurately each morpheme - Murrell and Morton, 1974) was, in early versions of the theory (1969), a device whose state of excitation reflected the perception of that word. The logogen was also responsible for the phonological output of the word (its articulation). In order for a logogen to "fire", and thus detect or output a word, its level of excitation must rise above threshold, the level of which is influenced by factors such as the frequency of the word and the degree to which it has recently been seen, heard, or used.

Morton has had to modify his views (1977a) and distinguish between an input logogen and an output logogen. The former is concerned with the perception of the word and the latter with its production. This division was forced by an experiment (a replication of Winnick and Daniels 1970) in which pre-exposure to and articulation of a visually presented word facilitated its subsequent visual recognition (as expected), whereas merely articulating it in response to a definition of its meaning did not have this facilitating effect. The next modification was the division of the input logogen into a visual and an auditory logogen. This was forced by an experiment in which visual, but not auditory, pre-exposure facilitated word recognition, and another experiment in which auditory, but not visual, pre-exposure facilitated auditory recognition. The experiments put together suggest a model of the mental lexicon in which visual, auditory and articulatory representations are separate aspects of the lexical entry of a word.

The research discussed so far has been concerned largely with perceptual processes. We turn now to a brief consideration of two areas of speech production: the "Tip of the Tongue" phenomenon and speech errors.

Brown and McNeill (1966) induced the "tip of the tongue" phenomenon (T.O.T.) in subjects by reading out the definitions of rare words, which subjects had to supply. While in the T.O.T. state subjects had to state how many syllables they thought the target word had, and its initial letter. They also had to generate words that sounded the same as the target (S.S. words). Subjects in the T.O.T. state were able to state correctly the number of syllables in the target in 57% of cases; this same figure also applied to their ability to identify the first letter of the target correctly. These results for syllables and the initial letter were substantiated when the structure of the SS words (some of which were non-words) was compared to that of the target word (48% correct matching for syllables, and 47% correct matching for initial letter). Subjects had also been asked to generate words of similar meaning to the target word and the comparable figures for these words were 20% and 8%. Placement of primary stress in the SS words agreed with that in the target 75% of the time and letters in positions other than initial position also matched with the target word. In general, a plot of percent correct matches (ordinate) against letter position (abscissa) yielded a U-shaped function, with initial and final letters matching about 45% of the time and medial letters matching in about 25% of cases. These results suggest that the representation of a word in lexical memory is at a phonemic level and that syllabic information (i.e. number of syllables), is also stored (this might take the form of syllable boundary markers for instance). The stress placement results are interpretable in two ways. One is that information about stress placement is stored as part of the lexical entry. The second alternative is that factors that affect stress, such as syllable structure and affixing, (Chomsky and Halle, 1968). are represented to a degree such that the SS match being generated will be subject to the same stress assignment rules as the target. Brown and McNeill also classified T.O.T. states on the basis of distance from the target, where the criterion for distance was whether the subjects eventually produced the target (close) or not (far). They found that the probability of the initial letter being correctly given increased with nearness to the target.

Brown and McNeill interpreted their results in terms of both storage and organization in the mental lexicon. Thus information such as syllable structure and the initial letter would be part of the entry of a word but they would also be a basis of lexical organization in that words with the same number of syllables and words with the same initial letter would be stored together and that they would be retrievable as a set if required. The general key sort notion of organization in the mental lexicon (Triesman, 1960, Broadbent, 1971) is also found in the speech error analysis of Fay and Cutler (1977).

Fay and Cutler (1977) were concerned with malapropisms, these being speech errors where a substitution of one word by another, similar-sounding word occurs. For example, in the sentence "If these two vectors are equivalent", equivalent might be replaced by equivocal. The meanings of the target and error are unrelated, in contrast to semantic errors such as "don't burn your toes" for "don't burn your fingers", which Fay and Cutler used as a control. Their findings were straightforward: target and error in both malapropisms and semantic errors were always of the same syntactic class; target and errors for malapropisms were of the same number of syllables significantly more than they were for semantic errors (87% and 75% agreement respectively); and given an equal number of syllables, there was agreement on the stress pattern on malapropisms significantly more often than on semantic errors 98% and 82% respectively). They interpreted these results to mean that syntactic class and syllable structure/stress pattern are principles of lexical organization over and above semantic principles. Furthermore, comparing the target and error at the point of phonological divergence, (working from left to right) revealed that the difference between target and error at this point was most frequently a difference of one, two or three distinctive features. This they interpreted to mean that words were arranged in the lexicon by phonemic structure, in a left to right manner and based on a distinctive feature system.

Both these studies indicate that the mental lexicon is organized on principles other than purely semantic principles. Stress pattern, the number of syllables and the phonemic structure of the word in particular seem to be candidates for organizational criteria, though the stress pattern criterion may be spurious as it may be a function of phonemic structure and the number of syllables (c.f. Chomsky and Halle, 1968).

Summarising: This discussion began with a consideration of the sound structure of a word, moved on to writing systems and then on to a consideration of spelling regularities in English. We then considered the implications of research into the word superiority effect and lexical decisions before moving on to empirical data on the conversion of print to sound. Finally, we considered the implications of research connected with speech production for lexical organization.

A very general conclusion of this section is that it may not be profitable to think of the representation of a word in the mental lexicon as consisting of a single, simple visual representation, a single, simple acoustic representation, and so on, but as consisting of many representations for each of these general forms: for example, a visual representation based on holistic features, one based on letter descriptions, and so on, each representation being optimal for a particular task demand. In addition to these representations of lexical items there is also very probably storage in lexical memory of information of a more general sort such as grapheme-phoneme correspondences, rules and statistical probabilities concerning spelling and the orthography, and (a point we shall return to) morphemic information.

In this Introduction I have used the term "acoustic" in a general way to refer to the sound of a word. I have not distinguished between an auditory, an articulatory, or indeed a more abstract phonological aspect of the sound of a word (Chomsky and Halle, 1968). I have not done so because it is not clear, when speaking of these different aspects of the sound of a word, to what extent we are dealing with separate entities, each of which is specified in terms of perceptual features, articulatory commands or whatever, and to what extent we are dealing with one complex representation, comprising a number of superficially isolated sub-representations which are in fact connected at a more abstract level. For example, one might speculate that there is in effect only one (abstract) representation of the sound of the word and that both perceiving and producing the word involve this representation (similar to the early logogen model). However, it might be that several more psychologically functional and practicable sub-representations are also set up to deal with the normal demands of perception and production and which also deal with the demands of a variety of experimental tasks, and it might be these sub-representations that are subject to the vagaries of task demands and which promote the notion of separateness. I shall continue to use the term acoustic in a generic sense, for while it allows for a possibility such as this, it does not lead on to any points of contention, as I only wish to distinguish between the representation of the sound of a word and the representation of its visual form.

The emphasis in a lot of the research dealt with here has tended to be on the sound aspects of a word: for example, in both the word superiority effect, and in the lexical decision literature, the strategy has tended to be to demonstrate that the phenomena are, or are not, the result of the acoustic or pronounceable aspects of the word. The two experiments to be reported in the next chapter seek to redress the balance to some extent in that they focus on the representation of the visual form of a word.

# CHAPTER TWO

## 2. EXPERIMENT 1

### INTRODUCTION

The topics discussed and the experiments reviewed in the preceding chapter bear, to a substantial degree, only indirectly on the issue of representation in lexical memory. For example, we concluded from the fact that recognition in a letter string is facilitated by orthographic regularity that rules or other information pertaining to this regularity are stored in lexical memory. The emphasis in many of these studies also tends to be on substantiating or refuting the primacy of acoustic factors to the relative neglect of the visual aspects of words. This is most often true of the lexical decision literature (e.g. Rubenstein et al., 1971).

This experiment concerns itself directly with some aspects of the representation in the mental lexicon of a recently learned word. It is concerned with whether such a word is represented in an acoustic form, in a visual form or both these forms.

The procedure, briefly, was that a subject was presented with a set of novel (nonsense) words, each with a definition or statement of its meaning, and was instructed to learn the meanings of the words. Thus he might have been presented with the word _flaight_ and learned its meaning: _a plant with small purple flowers_. Subsequently the words, or one of two transformations of them, were presented on their own and the subject was required to state whether or not he recognized them and to recall their meanings. Thus he would have been presented with one of _flaight_, _flate_ or _flaught_; _flaight_ is of course the original stimulus, _flate_ is a visual transformation of it and _flaught_ an acoustic transformation.

After a few exposures to a word a subject will have it represented in some form and to some degree in the mental lexicon. The degree to which it is recognized will be a function of the match between the representation and the item to be recognized. When this item is the one originally learned, e.g. flaight, then recognition is straightforward in that it will depend on factors such as the completeness of the representation acquired and the processes of forgetting. These factors need not concern us, for recognition performance on these original items serves only as baseline in this experiment. The information we seek is to be obtained by manipulating the nature of the item presented for recognition.

Suppose this item is not the original, learned item flaight, but a visual transform or homophone of it, flate. Given the identity of the sound of the two words, the degree to which flate will be mistakenly "recognized" as flaight will be a function of the degree to which a visual representation of the latter exists in memory. If there is no visual representation of flaight then "recognition" of the homophone will not differ significantly from the base line recognition of the original. If there is a visual representation of flaight then "recognition" of the transform will be significantly less than base line.

The same argument applies to the recognition, relative to base line, of an acoustic transformation (e.g. flaught) of the original, with one qualification: flaught is not only an acoustic transform of flaight but also a visual transform. This means that any difference in recognition performance between flaight and flaught might be due to either an acoustic representation, or a visual representation, or both. An interpretation of this difference in terms of an acoustic representation is saved if this difference is greater than that between flaight and flate. This is so because in this example, as well as in all the words used in this experiment, the visual difference between flaight and flaught (one letter) is never greater than that between flaight and flate (at least one letter, in this case more).

The relationship between the representation of the aspect of the word being transformed (e.g. the representation of the visual form of flaight) and the measure of it (the decrement in recognition performance of flate relative to flaight) holds for all but one situation. This is when the subject remembers the original word so clearly on both the visual and acoustic dimensions that he becomes aware of the relationship between the original and the transform. His behaviour at this point becomes unpredictable. One possibility is that he might regard the transform as a completely new word, treat the relationship between the two as coincidence, and hence respond that he doesn't recognize the item. Alternatively he might (correctly) regard the relationship between the two words as evidence that he is the victim of a deception and thereupon respond as he sees fit. What is important here is that so long as the subject responds that he doesn't recognize the transform the relationship between the representation and the measure of it doesn't break down. This is because it is not the absolute nature of the response ("don't recognize it") that matters but the response relative to that for the original word, which in these cases would be more positive. If for some reason the subject responds that he does recognize the transform the relationship breaks down because there will be no difference between the response to the transform and response to the original; a difference that should exist given the presence of the representation.

This experiment is also a potential source of information as to the principles of organization of the mental lexicon.

We have assumed that recognition involves access to the lexical entries of an organized mental lexicon on the basis of the form of a word. Now if both the visual and acoustic forms of words are general principles of this organization then, while a transformed word might be recognized on the basis of its untransformed aspects, the transformation might prevent the more precise access that might be needed to retrieve the meaning of the word. Thus for example, flate might be 'recognized' as flaight on the basis of the sound and perhaps the initial fl, but if the meaning of flaight has an address in the mental lexicon that is specified, in part, by its full visual form then flate would provide insufficient and partly misleading information to an access procedure.

The prediction then is that if, say, the visual form of words is a principle of lexical organization then a visual transformation might impair the recall of a word's meaning without affecting recognition of it, in both cases relative to the untransformed word.

## METHOD

### Subjects

64 undergraduates, 24 male and 40 female, participated in this experiment to fulfil course requirements. Subjects were allocated to each of 8 groups on a random basis, the only constraint being on the number of males and females in each group (3 males, 5 females).

### Materials

Three kinds of words were used in this experiment. The first was a set of 14 simple and common English words such as arm, city and school. The second was a set of 14 nonsense words, some of which were orthographically illegal and most of which were unlike English words. For example: jaoc, sahi, vrouw and lalk are representative. The third was a set of 21 nonsense words having in common a structure that was potentially homophonous (rather a lot of use was made here of the observation that words with a final silent e structure are often the basis of homophony. For example: pane-pain, here-hear, site-sight.

This isn't to say that the words in this set were all of this structure).

This set of 21 orthographically legal, potentially homophonous nonsense words formed the basis for the generation of a further two sets of nonsense words. The first of these consisted of the homophones of the basic set. The second was a set produced by changing one letter of the basic word to produce an item that was orthographically and visually minimally different but which had a different pronunciation. The basic set is henceforth referred to as the untransformed set (Ts); the set of homophones as the visually transformed set (Tv) and the third set as the acoustically transformed set (Ta). Examples of each are: smare, flaight; smair, flate; and smarn, flaught respectively. See Appendix 2.1.1 for all the words used in this experiment.

A total of 14 definitions or statements of meaning were also used in this experiment. They were all noun phrases consisting of a noun with one or more qualifiers. For example: "an instrument used by surveyors" and "a plant with small purple flowers". To reduce the degree of interference between these meanings their contents were kept as diverse was possible. Thus one dealt with a gas, another with a game, a third an animal, and so forth.

The set of 21 basic or untransformed words (Ts) were divided into 3 groups of 7: $W_1$, $W_2$ and $W_3$. Division into these three groups was motivated partly by the desire to assess context effects and so the items in $W_3$ were selected so that the degree of similarity (as judged by the experimenter) between these and those in $W_1$ was greater than between the items in $W_2$ and those in $W_1$. $W_1$ and $W_2$ were combined into one stimulus list and $W_1$ and $W_3$ combined into another stimulus list. This division into three groups and then recombination into two was also motivated by the more pragmatic considerations of trying to (a) maximize the number of words used in the experiment, (b) keep the number of items that a subject had to learn at a level such that his performance would be neither particularly good nor particularly bad; (an informal pilot study indicated 14 to be of the right magnitude), (c) keep the words and meanings generated as varied as possible. (It becomes surprisingly difficult to do this for numbers greater than those used here.)

The words on list $W_1/W_2$ were randomly assigned to the 14 meanings. Then, keeping the word-meaning combinations for $W_1$ the same in list $W_1/W_3$, the items in $W_3$ were randomly assigned to the remaining seven meanings (i.e. those used with $W_2$ items in list $W_1/W_2$.). Each word-meaning combination was typed on an index card (13 cms X 8 cms), the words being typed in upper case. Upper case was used because, in general, the degree of similarity between words written in upper case is greater than between words written in lower case. This is desirable because we wish to maximise the visual similarity of items in Ts to those in Ta. Of course, this also has the less than desirable effect of increasing the visual similarity of items in Ts to those in Tv but only by an amount that seems negligible relative to their general visual dissimilarity.

See Appendix 2.1.1. for the word-meaning combinations used in this experiment.

<u>Procedure</u>

Half of the subjects were given word-meaning combinations consisting of the words in $W_1$ and $W_2$ with their assigned meanings while the other half were given the words (and meanings) comprising $W_1$ and $W_3$.

Subjects were instructed as to the mechanical details of the learning phase of the experiment. They were informed that their task was to learn the meaning of each word, that they would have three trials on which to do so and that at the end of the third trial they would be given further instructions.

Each subject looked at each of his 14 stimulus cards for seven seconds, at the end of which time he placed it face down in front of him and looked at the next one. After the fourteenth card he shuffled the pack. This sequence constituted a trial and was repeated another twice, i.e. until each card had been seen a total of three times.

Following the learning phase of the experiment there was a period of four minutes before the subject was tested on what he had learned. During this time he was instructed as to the kind of test he was going to get and the form his responses should take. He was advised not to spend too long on each item as his memory for ones late in the test would fade. He was requested to deal with each item fully and in order. Finally, points of confusion on the part of the subject were clarified. The subject was not informed that some words would appear in the test in a transformed state. See Appendix 2.1.2 for the full instructions given to subjects.

In all, 42 words appeared on the test sheets given to subjects. These were typed on the left-hand side of the sheet and consisted of (a) the 14 real word distractors, (b) the 14 nonsense word distractors, (c) seven of the learned words in an untransformed state (all the members of one of the two groups (e.g. $W_1$) comprising the list) and (d) seven of the learned words (e.g. $W_2$) in a transformed state; either visually transformed (Tv) or acoustically transformed (Ta). A fuller explanation of the experimental design follows this section.

For each word on the sheet (their order, of course, was randomised) three responses were required. 1) A recognition rating score to express the certainty of having ever seen that word before, either in or out of the experiment. A four point scale was used for this: 1 - "definitely haven't"; 2 - "think I haven't"; 3 - "think I have"; 4 - "definitely have". An even pointed scale was used to force categorical responses (i.e. "yes" or "no") and a four-pointed scale rather than a six or eight-pointed scale was chosen because it was felt that this would reflect, with the most accuracy, the range of responses that subjects would wish to make. (No strong counter-argument would be raised against the suggestion that the use of a six point scale would be at least equally acceptable. However, it is felt that an eight point scale is too large.) 2) As much of the meaning as could be recalled. Subjects were urged to respond if at all possible, even if they were in considerable doubt as to whether or not their response was correct. Only if they had no idea at all of what the word meant were they to reply "no meaning". 3) A confidence rating of the correctness of the response given in (2) on this four-point confidence rating scale: 1 - "very unconfident"; 2 - "unconfident"; 3 - "confident"; 4 - "very confident".

After completing the response sheet the subject was asked, in a casual manner, if he had come across any "misspelled" words on the sheet. This question was directed at determining the degree to which, if at all, the subject had been aware of the fact that some of the words had been transformed. Any "misspellings" indicated by the subject were marked, the subject debriefed and an apology made concerning the deception. He was then asked if, now that he had been informed as to the transformations that had been made, he could remember any meanings that he had not remembered before. These were noted.

## Experimental Design

One half of the subjects, 4 groups of eight, learned the words and meanings comprising the word groups $W_1$ and $W_2$. These four groups, $G_1$, $G_2$, $G_3$ and $G_4$, differed as to which of $W_1$ or $W_2$ was transformed at the test phase and how it was transformed (Ta or Tv). Similarly, groups $G_5$, $G_6$, $G_7$ and $G_8$ learned the items comprising word groups $W_1$ and $W_3$. These four groups also differed as to which word groups were transformed ($W_1$ or $W_3$) at test and how it was transformed (Tv or Ta). Thus, in Fig. 1 we see that $G_1$ learned $W_1$ and $W_2$ and was tested on $W_1$ untransformed (Ts), and $W_2$ transformed (Tv). The seven items in $W_1$ are labelled $w_1$ ..... $w_7$, those in $W_2$ are labelled $w_8$ ...... $w_{14}$ and those in $W_3$, $w_{15}$ ...... $w_{21}$. Groups $G_1$ to $G_4$ are labelled $A_1$ and groups $G_5$ to $G_8$, $A_2$.

| | | $W_1$ ($w_1$ ..... $w_7$) | $W_2$ ($w_8$ ..... $w_{14}$) |
|---|---|---|---|
| $A_1$ | $G_1$ | Ts | Tv |
| | $G_2$ | Ts | Ta |
| | $G_3$ | Tv | Ts |
| | $G_4$ | Ta | Ts |

| | | $W_1$ ($w_1$ ..... $w_7$) | $W_3$ ($w_{15}$ .... $w_{21}$) |
|---|---|---|---|
| $A_2$ | $G_5$ | Ts | Tv |
| | $G_6$ | Ts | Ta |
| | $G_7$ | Tv | Ts |
| | $G_8$ | Ta | Ts |

Fig. 1

Experimental Design
(see preceding text for an explanation)

## RESULTS

### Recognition of test items

The first analysis is concerned largely with the effects of the visual and acoustic transformations on recognition. The comparisons that are relevant are firstly that between Ts words (untransformed) and Tv words (visually transformed) and secondly that between Ts words (untransformed) and Ta words (acoustically transformed). Two measures of recognition have been analysed but as they produced the same results only one will be discussed in any detail. The first is the recognition rating score and it is this that will form the basis of discussion; the second is to do with the probability of recognising a word.

For each subject two mean recognition rating scores were computed: one for the seven untransformed words (Ts) and one for the seven transformed words (Tv or Ta). Similarly, for each subject, two probability of recognition scores were computed. These were the number of words recognized (a rating score of 3 or 4) in each block of Ts and Tv/Ta words expressed as a proportion of the total number of words in the block (seven). Analysis was with a 3 factor ANOVA: factor A (see fig. 1) differentiated between those subjects who had learned word blocks $W_1$ and $W_2$ and those who had learned $W_1$ and $W_3$; factor G differentiated between the groups of subjects (who differed in the stimulus words at test, e.g. $G_1$, $G_2$, $G_3$, $G_4$ etc.); factor W, the within-subjects factor, differentiated between the two sets of words presented to each subject, e.g. $W_1$ vs $W_2$ or $W_1$ vs $W_3$ (one of these being transformed, the other untransformed). See Fig. 1 for reference and see Table 1 for the ANOVA table.

The effects of the transformations were tested with two planned comparisons. In the first, the results of groups $G_1$, $G_3$, $G_5$, $G_7$ were combined; the mean of all Ts words in these groups was compared with the mean of all the Tv words. The comparison is significant ($F = 50.617$; $df = 1,56$; $p < .01$). See Table 2 for the means. In the second comparison, the results of groups $G_2$, $G_4$, $G_6$, $G_8$ were combined and the mean of all Ts observations compared with the mean of all Ta observations in these groups. This comparison is also significant ($F = 103.86$;

| | D.F. | S.S. | M.S. | F | Prob. |
|---|---|---|---|---|---|
| Subject | 63 | 30.693 | | | |
| A($W_1/W_2$ vs $W_1/W_3$) | 1 | 0.025 | 0.025 | 0.0549 | 0.81 |
| G($G_1$, $G_2$, ... ) | 3 | 2.926 | 0.975 | 2.1454 | 0.10 |
| AG | 3 | 2.286 | 0.762 | 1.6765 | 0.18 |
| Error AG | 56 | 25.456 | 0.455 | | |
| W($W_1$vs$W_2$ or $W_1$vs$W_3$) | 1 | 0.104 | 0.104 | 0.2989 | 0.59 |
| WA | 1 | 0.191 | 0.191 | 0.5499 | 0.53 |
| WG | 3 | 54.031 | 18.010 | 51.7253 | 0.0001 |
| WAG | 3 | 0.949 | 0.316 | 0.9088 | 0.56 |
| Error WAG | 56 | 19.499 | 0.348 | | |
| Within | 64 | 74.774 | | | |

Table 1

ANOVA for recognition rating scores. Word lists and Groups are between subject factors; the within subjects factor is word blocks within each list, one of which is transformed and the other untransformed.

df = 1,56; $p < .01$). See Table 2 for means. Finally, to assess the effects of the two transformations relative to each other a third planned (orthogonal) comparison was made. In this, the decrement in performance due to the acoustic transformation (Ts-Ta) was compared to the decrement due to the visual transformation (Ts-Tv). The values of each of these are to be found in Table 2 and it can be seen that the decrement due to the acoustic transformation is greater than that due to the visual transformation. This difference is statistically significant ($F = 4.733$; df = 1,56; $p < .05$).

| | Recognition rating scores (max 4.0) | Number of words recognised (max 7) |
|---|---|---|
| Untransformed words (Ts) | 3.3 | 5.8 |
| Visually transformed words (Tv) | 2.3 | 3.3 |
| Ts - Tv | 1.0 | 2.5 |
| Untransformed words (Ts) | 3.4 | 5.9 |
| Acoustically transformed words (Ta) | 1.9 | 2.1 |
| Ts - Ta | 1.5 | 3.8 |
| Distractors (real) | 3.8 | 5.6 |
| Distractors (nonsense) | 1.3 | 0.4 |

<u>Table 2</u>

Mean recognition rating scores and mean number of words recognised according to the type of word presented at test.

Table 2 also presents the mean number of words recognised (maximum in each case is seven) in the various conditions. These scores are derived from the mean probability of recognition scores for these conditions. As stated earlier the results for this latter measure are as for those obtained with the recognition rating measure just discussed. The reason for presenting the mean number of words recognised is because this measure gives a slightly clearer idea of the performance levels being attained in the various conditions. Finally, table 2 also presents data bearing on the recognition of real wor d distractors and nonsense word distractors. The reason for the recognition of the real word distractors being less than perfect (they were common, simple words), is that some subjects (6) interpreted the instructions as enquiring whether they had seen the test words during the learning phase rather than as enquiring whether they had seen them anywhere and at any time. In consequence, they rated the real words 1.0 rather than 4.0. This misinterpretation of the instructions doesn't affect the validity of the results dealt with so far or the results as yet to be discussed.

Two checks were carried out to ensure that, because of the pooling procedures involved in the planned comparisons, the results are not due to a subject/word block interaction with which the effect of the transformation is confounded. Firstly, all 64 subjects exhibited the effect. That is, for every subject the mean recognition score for the untransformed words is greater than that for the transformed words. Secondly, collapsing over subjects, for every word bar one, the mean recognition rating score of the untransformed item is greater than that of the transformed item. (The exception is the word <u>smare</u> for which recognition of the transformed item (<u>smair</u>) was better.) We shall return to a more detailed consideration of individual words shortly.

There is no significant difference in performance on the word blocks. The mean recognition rating scores (presented below) for $W_1$ (presented at learning with $W_2$), $W_2$, $W_1$ (presented at learning with $W_3$), and $W_3$ do not differ significantly ($F = 0.5499$; df = 1,56).

| | | |
|---|---|---|
| $W_1$ (presented with $W_2$) | = | 2.69 |
| $W_2$ | = | 2.83 |
| $W_1$ (presented with $W_3$) | = | 2.74 |
| $W_3$ | = | 2.72 |

What this result means is that performance on a set of items remained stable across different subjects and in different contexts (the two scores for $W_1$ do not differ significantly). It also means that different items (those in $W_1$, $W_2$ and $W_3$) are relatively uniform in their behaviour and that even though differences may exist between specific items these differences are unlikely to be gross.

"Misspelling Detections"

Subjects had been asked at the end of the experiment to indicate which words, if any, on the test sheet they considered to have been "misspelled". The purpose of this was to ascertain whether subjects had had any misgivings as to the similarities and differences between the untransformed learned items and the transformed test items. Unfortunately it cannot be clearly determined whether or not subjects had been aware of the exact nature of the deception involved as they were not questioned after the experiment with this in mind, so interpretation of these "misspelling detections" must remain ambiguous. Subjects had also been asked, after debriefing, to try and recall the meaning of these "detected" items (henceforth "detections") in instances where they had not already done so during the experiment. Before analysing these detections as a source of information in their own right we consider their implications for the analyses performed so far.

It was argued earlier that the relationship between the recognition rating score and the internal representation of a word breaks down when the transformation has been detected and when the rating score for the detected item is a high score. Scores of exactly this type were included in the main analysis and what is at issue here is whether the inclusion of these high rating scores of detected items affects the conclusions drawn to any significant degree. The answer to this is in the negative for two reasons: firstly because the number of these items involved is small (if we regard recognition rating scores of 3 and 4, positive recognitions, as being "high" then only 15 of these occurred out of a total of 448 (transformed) observations); secondly, because inclusion of these items reduces the size of the decrement in performance due to a transformation, i.e. inclusion of these scores reduces the size of the effects being sought.

Table 3 presents the detection data in terms of the number of subjects making detections and the mean number of detections for these subjects. This data has been partitioned according to (a) the type of word involved (Tv or Ta) and (b) according to whether or not the item had been recognized at the time of the experiment (rating scores of 1 and 2 or 3 and 4 respectively). Also in Table 3 are the data on false detections, i.e. citing of untransformed words as having been "misspelled". These too are classified according to whether or not they had been recognized, and whether they had occurred in the untransformed words accompanying Tv words or in those accompanying Ta words.

| | | Tv | | Ta | |
|---|---|---|---|---|---|
| | | N | $\overline{x}$ | N | $\overline{x}$ |
| Negative recognition response — | detection — | 14 | 2.2 | 11 | 1.6 |
| | false detection — | 3 | 1.3 | 0 | 0 |
| Positive recognition response — | detection — | 10 | 1.4 | 0 | 0 |
| | false detection — | 5 | 1.2 | 0 | 0 |

Table 3

"Misspelling detection" data. Frequency of subjects (N) and mean number of detections per subject ($\overline{x}$) partitioned according to type of word (Tv vs Ta), type of detection ('true' or 'false') and recognition response (positive or negative).

There is no significant difference between Tv and Ta on the negative recognition response detections; either with respect to the number of subjects ($\chi^2 = 0.59$; d.f. = 1) or with respect to the mean number of detections ($t = 1.7338$; d.f. $= 24$; 2-tailed). In contrast, there is a significant difference between Tv and Ta on the positive response detections; both with respect to the number of subjects (sign test: $p < .01$) and with respect to the mean number of detections (sign test: $p < .01$). Finally, as can be seen from table 3 the false detections occur only in the Tv conditions, although only in the positive response condition are there sufficient data to be statistically significant on the sign test ($p < .05$).

There were several instances in the set of negative recognition response detections of subjects having recalled the meaning of these items after the debriefing but not having done so at the time of the experiment (11 subjects did this in the Tv condition and 6 in the Ta condition). This suggests that in these cases subjects had been to some extent aware of the relationship between the transform and the original, had treated the former as a novel word and had therefore not responded with the meaning.

The difference between the Tv and Ta conditions then, lies in the exclusive incidence of false detections and positive response detections in the Tv condition. Perhaps the most conservative interpretation of this is that subjects in the Tv condition were generally somewhat uncertain as to the relationship between the learned items and the items presented at test. In more colloquial terms they perhaps felt that something was amiss, even though they were perhaps unable to articulate its nature.

Recall of Meaning

The meanings recalled by subjects in response to the test words were simply marked correct or incorrect. The criterion for correctness was somewhat lax in that if the subject's recall was at all related to the correct meaning it was scored as being correct. The justification for the use of such a lax criterion, and indeed for encouraging subjects to respond with a meaning even if in doubt as to its correctness, is that we need to know whether a subject can and has acccessed the meaning of an item, not how much of it he can remember or how certain he is of its correctness.

Subjects only very rarely even attempted to recall the meaning of a word that they had responded to as not having recognized (11 instances out of a possible 358). Table 4 presents the total number of correct and incorrect recalls as a percentage of the total number of words recognized in particular conditions: Tv with its control Ts and Ta with its Ts control.

| | Ts | Tv | Ts | Ta |
|---|---|---|---|---|
| Proportion of correct recalls | 55% | 34% | 50% | 22% |
| Proportion of incorrect recalls | 20% | 20% | 22% | 30% |

Table 4

Total number of correct and incorrect meanings recalled expressed as a percentage of the total number of words recognized in untransformed (Ts) and transformed (Ta, Tv) conditions.

These results indicate that even when a transform has been recognized the recall of its meaning is impaired relative to the recall of meaning for the untransformed control. There is also an indication that the effect of Ta is greater than that of Tv.

The percentages in table 4 give a clear idea of performance levels but are not amenable to statistical analysis. Accordingly, for each subject two scores were computed: firstly the number of correct recalls in the set of untransformed words expressed as a proportion of the number of those that had been recognized and secondly the same proportion for the set of transformed words. A problem immediately became evident: a number of subjects had, usually in the transformed set, recognized only a very few and often none of the words. Consequently, their proportion - recalled scores were subject to much more variation than proportion - recalled scores based on larger numbers of items recognized. The solution adopted was to eliminate from the analysis all subjects who, either in the transformed set or in the untransformed set, had not recognized at least two of the seven items. Two was selected as the cut-off point as it seemed the point at which a reasonable number of subjects was left in the analysis while also being on the way to reducing variation. Each subject was then classified on the basis of whether the proportion-recalled score for his untransformed set was greater or less than that for his transformed set and the resulting frequencies subjected to statistical analysis.

There were significantly more subjects whose Ts score was greater than their Tv score than subjects for whom the reverse was true (frequencies of 15 and 6 respectively; $\chi^2 = 3.85$; d.f. = 1; $p < .05$). The same was true with respect to Ts and Ta scores (frequencies of 18 and 3; $\chi^2 = 10.6$; d.f. = 1; $p < .01$). The relative difference between these two sets of frequencies was not significant ($\chi^2 = 1.27$; d.f. = 1) indicating that the two types of transformation do not differ significantly in their effects on the recall of meaning.

Confidence Ratings

Subjects had been asked to rate how confident they felt that the response they had given pertaining to the meaning of an item (both when this response took the form of a definition and when it took the form of the statement "no meaning") was the correct response. They were asked to give this rating firstly because it was felt that if they could express their misgivings as to the correctness of the response in this confidence rating they would be a lot more prepared to respond with a meaning, even if they were uncertain as to its correctness. The second reason for requesting this rating was that it was felt that in it lay a potential for the identification of what have been referred to as detected items. It turned out that some subjects used the rating scale in a way that precluded the possibility of this potential being exploited. We shall not discuss this scale any further.

Individual Items

An earlier result, that the main effects of this experiment are not due to only a subset of the words used, does not preclude the possibility that the effects may be significantly more substantial for some items than for others. Accordingly, for each of the 14 words in the $W_1/W_2$ set and for each of the words in the $W_1/W_3$ set two scores were computed: one reflected the effect of the visual transformation on recognition and was obtained by subtracting the mean Tv score for the word from its mean Ts score; the other reflected the effect of an acoustic transformation and was similarly obtained by subtracting Ta scores from Ts scores. These data are presented in Appendix 2.1.3.

There is nothing immediately evident in the data to suggest what might influence or determine the size of the decrement due to transformation. For example, one might expect that the difference in visual form of the pairs flaight-flate, blign-bline and dite-dight would produce consistently large decrements in recognition rating scores while the effect would be smaller for the pairs meach-meech and dawl-daul. In fact there is no such consistency: when the items in the list in which these pairs occur are rank ordered for size of decrement the rank orders of these items are respectively 4, 9, 13, 6, 11 (a low rank signifies a large decrement).

To test more systematically whether the size of the decrement in recognition performance is related to the size of the visual and/or the acoustic transformation, ratings of the visual and acoustic similarity of all untransformed-transformed pairs of words were obtained from a different set of subjects (see Appendix 2.1.3 for details). The means of the similarity ratings obtained thus are presented in Appendix 2.1.3.

The acoustic similarity ratings indicate that the homophone pairs used in this experiment (i.e. Ts : Tv pairs) are not universally regarded as being homophonic, though it is the case that the mean scores for all but one of the twenty one pairs fall between the first ("very similar") and second ("similar") points on the rating scale. The means for the visual similarity of these pairs also fall with a restricted range on the rating scale, between the second ("similar") and fourth ("slightly dissimilar") points. The mean visual similarity ratings of the acoustically transformed pairs (Ts:Ta) are neither equal nor indicative of high visual similarity as would be expected from the fact that the difference between the members of each pair is one letter. They tend to occur between the second and fourth points of the rating scale. Finally, the mean acoustic similarity ratings of these pairs are spread between the second ("similar") and fifth ("dissimilar") points on the scale.

The coefficients of several correlations (Spearman's rho) between the recognition decrement scores and similarity ratings were computed. Table 5 presents these coefficients.

There are four lists of word pairs: the $W_1/W_2$ list when the words in each pair are Ts and Tv words and when they are Ts and Ta words; the $W_1/W_3$ list, also for Ts:Tv pairs and Ts:Ta pairs. For each of these lists three correlation coefficients were computed: between recognition

| | Word lists | Visual similarity | Acoustic similarity | Visual and acoustic similarity |
|---|---|---|---|---|
| Visual transform (Ts:Tv) | $W_1/W_2$ | 0.29 | 0.14 | 0.29 |
| | $W_1/W_3$ | 0.45 | 0.03 | 0.44 |
| Acoustic transform (Ts:Ta) | $W_1/W_2$ | 0.33 | 0.52* | 0.62* |
| | $W_1/W_3$ | 0.12 | -0.21 | -0.02 |

Table 5

Correlation coefficients (Spearman's rho) for various combinations of recognition decrement scores and similarity ratings. A * signifies that the coefficient is significant at .05 (value required for significance is 0.46).

decrement and mean visual similarity ratings; between recognition decrement and mean acoustic similarity ratings; and between decrement and a composite similarity rating score. This last score was computed simply by adding the means of the first two for each word, and is taken to be a rough measure of the overall similarity of the pair. A positive correlation in all cases indicates that the most similar pairs are those with the least decrement in recognition performance.

These results indicate that the correlations between similarity judgements and recognition decrement are either insubstantial, or inconsistent (varying with word list), or both.

Finally, we turn to the detrimental effect of transformation on the recall of meaning of specific words. Proportion-recalled scores were computed for words in the same way that they were computed for subjects in the earlier analysis, and again observations based on less than two recognitions were dropped. For observations in the Tv conditions, recall of meaning was impaired for 13 of the 21 words (i.e. the proportion recalled score was less for the transform than for the original); 4 words showed the opposite effect and no data was available on the remaining 4. For observations in the Ta condition, recall was impaired for 12 words; 2 went the other way and no data was available on 7 of the words. (For the seven $W_1$ words that occurred in both the lists $W_1/W_2$ and $W_1/W_3$, if one of the two observations available for that word went contrary to expectation (i.e. the transform produced superior performance) it was this observation that was counted).

These results indicate that the results obtained in respect of the detrimental effects of transformation on the recall of meaning are not due to only a few words. In the set of words which violated the general trend no common factor was apparent.

## CONCLUSIONS

The results of this experiment indicate quite clearly that after three exposures to a word subjects have established both visual and acoustic representations of it in lexical memory. There are two results that tempt the inference that the acoustic representation is in some sense primary: the first is the finding that the effect of an acoustic transformation on recognition is significantly greater than that of a visual transformation; the second is that false detections and positive recognition detections occur only in Tv conditions. The interpretation of this second result is that the discrepancy between the learned and the test item is responsible for a general feeling of uncertainty as to the status of the items but because acoustic information is primary the doubt is manifest not in the recognition response but in the citing of "misspelling". However, the temptation to interpret these two asymmetries thus must be resisted because of a flaw in the experimental material. This flaw is that what has been referred to as an acoustic transformation is also, albeit to a limited degree, a visual transformation and so the two types of transformation are not completely comparable.

There is good evidence to indicate that the visual and acoustic forms of words are principles of organization in the mental lexicon. Accessing the meaning of a word is dependent on both visual and acoustic information about the word as the recall of meaning data has shown.

It is possible to argue against the validity of these results on the grounds that if subjects were aware of the nature of the deception in this experiment (and there are reasonable grounds for arguing they were) then the logic of the experiment could be seriously undermined. This argument has been considered and has been dismissed, perhaps most convincingly on the grounds that the worst outcome the argument predicts (all positive recognition responses) would have resulted in non-significant results, and not the results obtained here.

In a more negative vein, a closer consideration of the materials used in the experiment, in terms of the (judged) visual and acoustic similarity of a word and its transform, has failed to reveal whether the size of the transformation is systematically related to performance. A possible reason for this however is that the materials used in this experiment may not have been sufficiently diverse for such a relationship to become evident.

2. EXPERIMENT 2

## INTRODUCTION

The last experiment showed that both a visual representation and an acoustic representation of a novel word have been established, to some extent, by the end of three learning trials. This experiment pursues essentially the same issue, namely, the development of acoustic and (particularly) visual representations. It does so however, by adopting a slightly different tack.

The experiment consisted of presenting subjects in each of four conditions with eighteen novel word-meaning combinations which had to be learned with a view to this learning being tested, after each learning trial, on a recognition test. The eighteen words consisted of nine pairs, in each of which the words were related on the basis of their spelling and their sound in various ways, e.g. one set were homophonic. In the recognition test each member of the word pair appeared once with its correct meaning and once with the meaning associated with the other member of the pair. Subjects had to tick or cross each item in the test appropriately.

Intuition, and the results of the last experiment, suggest that visual and acoustic representations of novel words are established gradually, over a period of time, and that some of the processes involved in the learning of new words and their meanings are concerned with the setting up of these representations at lexical addresses specified by the nature of these representations. One way of isolating this component is to compare the learning of novel words and their meanings under normal conditions with the learning of the same items under conditions where subjects have been familiarised with the words (only the words, not the meanings) prior to this learning. Under these latter conditions most of the cognitive processes and structures associated with establishing visual and acoustic representations will have been completed by the time that learning of the words and meanings as units is undertaken. Accordingly, this prior exposure to, and familiarisation with, the lexical part of the word-meaning combinations were manipulated as a between-subjects factor (henceforth the Exposure factor).

Homophones provide a means by which we may investigate the visual form of a word and the development of its internal representation. This can be done by comparing the learning of a homophone and its meaning under conditions of Exposure with learning under ordinary, no exposure, conditions. The usefulness of a homophone for this purpose lies in the fact that it is only discriminable from its counterpart by its visual form, and so investigating the development of the visual representation requires that both members of the homophone pair be learned. This provides a source of interference which can only be avoided by relying on the visual representation.

Homophones as a class of words vary considerably in the degree to which they are similar. For example, <u>team</u> and <u>teem</u> are clearly more similar than, say, <u>sight</u> and <u>site</u> (visually similar that is, leaving aside the part that grammatical form class plays in the notion of similarity). We might expect on the basis of this kind of difference that the degree of interference between homophones might vary with the degree of visual similarity. In view of this, this experiment uses nine different homophone spellings that occur in the language (e.g. <u>ee</u> and <u>ea</u> as in <u>teem</u> and <u>team</u>; <u>ight</u> and <u>ite</u> as in <u>sight</u> and <u>site</u>). Apart from providing the basis for investigating the effects of visual similarity the use of these different types will also lend the experimental conclusions generality.

Two of the nine types of homophone spellings differed from the others in that the members of these pairs differed morphemically as well visually. That is, one member of each pair was singular (e.g. fipse, hex) while the other was plural (e.g. fips, hecks). The reasoning behind introducing these items is that if the internal representation of the plural member of each pair is of its singular form (e.g. fip and not fips is represented) then, as the two representations are not homophonous, the degree of interference should be less than that between comparable items whose homophony is not based on the plural morpheme.

If subjects are presented with items in which the word pairs are such that the members of each pair differ both visually and acoustically then we expect their performance to be better than the subjects dealing with homophone pairs. Subjects in the latter condition have to rely on only visual representations while those in the former condition can use both the visual and the acoustic representations. A comparison between these two conditions should then reveal the importance of the acoustic representations of the words, i.e. the extra information that the acoustic representation contributes. If we look at it from a slightly different point of view, performance in the homophone condition may be considered to reflect the contribution of the visual representation of the items in the normal condition.

With a logic parallel to that used for the homophone pairs, we would expect that a comparison of Exposure and No Exposure conditions using these normal pairs would isolate the learning component associated with establishing visual and acoustic representations in the mental lexicon. Accordingly, these normal pairs were presented to subjects in each of the Exposure and the No Exposure conditions. Notice that we would not expect to find a difference in performance between the homophone and the normal condition under conditions of prior exposure as the acoustic representation provides no information above that which the visual representation provides. This is because the visual representation in this Exposure condition has been fully established and so provides sufficient information for the homophones to be discriminated.

Subjects Twenty male and twenty female first year psychology undergraudates participated in this experiment to fulfil course requirements.

Materials There are certain kinds of orthographic correspondences that seem regularly to form, or have the potential to form, the basis of a homophonic relationship between words. Nine of these correspondences were used in this experiment: ee - ea (e.g. been - bean), oe - ow (e.g. toe - tow), ue - ew (e.g. flue - flew), ight - ite (e.g. sight - site), o-e - oa (mote - moat), a-e - ai (e.g. bate - bait), t-tt (e.g. but - butt), ps - pse (e.g. laps - lapse), cks - x (e.g. lacks - lax). For each one of the nine correspondence types ten pairs of nonsense, but orthographically legal, homophone pairs were generated, e.g. cheel - cheal, heen - hean, neem - neam, etc. As a matter of terminology, one member of each pair will be referred to as $w_1$ (the $w_1$ word), and the other as $w_2$. The $w_1$ word for each correspondence type is the same in each pair, e.g. cheel, heen, neem, etc. Subjects receiving homophone pairs will be referred to as being in the Rv condition (mnemonic: Relationship visual).

For each correspondence type ten further nonsense words were generated (referred to as $w_2$ words in the Rva conditon for reasons that will become clear). These were generated from the $w_2$ words in the Rv condition (i.e. from the homophones just described) by changing one letter (the same letter for each correspondence type) so that the sound of the resulting word was different from the source word, producing for example cherl, hern, nerm, etc. (The word type designated $w_1$ for each correspondence type was selected so that this transformation was as easy as possible - this was merely a procedural convenience). Subjects receiving $w_1$ words and these $w_2$ words will be referred to as being in the Rva condition (mnemonic: Relationship visual and acoustic).

All the words used are to be found in Appendix 2.2.1.

Eighteen definitions or statements of meaning were used in this experiment. The meanings used in the last experiment served as a basis for this with a few minor alterations being made in some instances and with new items being generated according to the same general principles. They were all definitions of concrete nouns with one or more adjectival qualifiers. These are presented in full in Appendix 2.2.1.

One member of each of the two types -<u>cks</u>/-<u>x</u> and -<u>ps</u>/-<u>pse</u> require that their definitions be plural. Accordingly, the definitions that were paired with these words were suitably tailored as the occasion demanded. For example, the definition "a turkish bracelet" may have appeared in the learning phase with the word <u>fipse</u>. When, during the test phase it occurred with <u>fips</u> it would have been tailored to "turkish bracelets".

<u>Randomisation Procedures and Experimental Design</u>

Consider one subject from the Rv (homophonic pairs) condition. One $w_1$ word was drawn at random from each of the nine sets of $w_1$ words and paired with a meaning, also drawn at random and without replacement. The selection of the $w_1$ word in each case determined the $w_2$ word that had to be selected (e.g. if <u>cheel</u> had been selected then <u>cheal</u> would have had to have been selected) and each of these $w_2$ words was randomly paired with one of the remaining nine meanings. The result of this was a total of nine $w_1$ and nine $w_2$ words randomly paired with one of the eighteen meanings. This basic procedure was repeated another nine times so that the end result was a group of ten subjects, each with a set of nine pairs of homophones specific to him and with each word randomly paired with one of the eighteen meanings. Word-meaning combinations will be referred to as $w_1 - m_1$ or $w_2 - m_2$ as appropriate (the subscript on the $m_1$ is for reasons of identification that will soon become clear).

Now there were two groups of ten subjects in the Rv condition and we shall refer to them as ERv and NERv as they received slightly different treatments. They did not differ however, in the sets of word-meaning combinations they received and each subject in ERv was paired with a subject in NERv in this respect.

Corresponding to these two groups of ten subjects in the Rv condition were two groups of ten subjects in the Rva condition, ERva and NERva. The only difference between a subject in either of these two groups and his counterpart in Rv was that the $w_2$ words he received were not homophones but their Rva counterparts. Thus for example, rather than receiving cheel with $m_1$ and cheal with $m_2$ he received cheel with $m_1$ and cherl with $m_2$.

The difference between E subjects (either ERv or ERva) and NE subjects (either NERv or NERva) was that E subjects were exposed to the $w_1$ words (only, without meanings) in their set prior to the main experiment. NE subjects did not receive this prior exposure.

The recognition tests presented to subjects consisted in all cases of thirty six printed word-meaning statements. For each subject, each of his nine $w_1$ words appeared once (correctly) with its meaning (e.g. $w_1$ with $m_1$) and once (incorrectly) with its corresponding $w_2$ meaning (e.g. $w_1$ with $m_2$). Similarly, each of his $w_2$ words appeared once correctly with $m_2$ and once incorrectly with its corresponding $m_1$. As we shall see, each subject was given several tests and only one of these differed from the format described (referred to as Td (mnemonic: Tdifferent)). The other tests will be referred to as $T_1$,$T_2$,$T_3$ and Ts (mnemonic: T same); they are all the same for a particular subject with the minor difference of the items being in a different random order).

The difference in the Td test was that the $w_2$ words were substituted by their counterparts from the other condition; that is, $w_2$ words in Rv were replaced by the $w_2$ words from Rva, and vice-versa. For example, a subject in Rv who in the three normal tests received, say, <u>cheel</u> with $m_1$, and <u>cheal</u> with $m_2$, would have then received <u>cheel</u> with $m_1$ (as before) but <u>cherl</u> with $m_2$.

The essential features of the experimental design are presented in figure 1.

| NERv | | | NERva | | |
|---|---|---|---|---|---|
| $S_1$ | $w_{11} - m_1$ | $w_{21} - m_2$ | $S_{21}$ | $w_{11} - m_1$ | $^1w_{21} - m_2$ |
| $S_2$ | $w_{12} - m_1$ | $w_{22} - m_2$ | $S_{22}$ | $w_{12} - m_1$ | $^1w_{22} - m_2$ |
| | ⋮ | ⋮ | | ⋮ | ⋮ |
| $S_{10}$ | $w_{110} - m_1$ | $w_{210} - m_2$ | $S_{30}$ | $w_{110} - m_1$ | $^1w_{210} - m_2$ |
| **ERv** | | | **ERva** | | |
| $S_{11}$ | $w_{11} - m_1$ | $w_{21} - m_2$ | $S_{31}$ | $w_{11} - m_1$ | $^1w_{21} - m_2$ |
| $S_{12}$ | $w_{12} - m_1$ | $w_{22} - m_2$ | $S_{32}$ | $w_{12} - m_1$ | $^1w_{22} - m_2$ |
| | ⋮ | ⋮ | | ⋮ | ⋮ |
| $S_{20}$ | $w_{110} - m_1$ | $w_{210} - m_2$ | $S_{40}$ | $w_{110} - m_1$ | $^1w_{210} - m_2$ |

<u>Figure 1</u>

Represented is the experimental design for <u>one</u> of the word types. The four conditions, NERv, NERva, ERv, ERva, are between-subjects conditions. Notice that $S_1$, $S_{11}$, $S_{21}$ and $S_{31}$ (say) receive the same $w_1$-$m_1$ combinations but that the $w_2$ words received in combination with $m_2$ meanings differ (marked $w_2$ and $^1w_2$ for convenience). Thus NERv and ERv receive the homophone of $w_1$ while NERva and ERva receive the visually and acoustically discriminable item.

Procedure

Exposure Conditions (ERv and ERva). Subjects received spoken instructions that they were required to learn a set of nine words over ten trials. At the end of this they would be required to write down as many of the words as they could recall. On each trial they looked at each $w_1$ word printed in upper case on a card (13cms x 8cms) for five seconds (indicated by a metronome) and turned it face down immediately afterwards. At the end of the trial they shuffled the cards for about fifteen seconds and then began the next trial. At the end of the ten trials they wrote down as many of the words as they could remember. They were allowed as long as they wished to do this, within reason. Having finished the task they moved on to the main experiment.

All Conditions Subjects were instructed as to the kind of materials they would be required to learn, the kind of recognition test to expect and the necessary procedural details to perform the task. Subjects began by reading a text (Harper Lee - "To kill a mockingbird") for a period of two minutes, having been led to believe that they would be asked questions about the text at the end of the experiment. At the end of two minutes they were given the eighteen word-meaning combinations to learn. These were printed in upper case on index cards. They looked at each for five seconds as indicated by a metronome and turned the card face down at the end of this period. Having looked at all the cards they gave these to the experimenter, who shuffled them thoroughly, and returned to reading the text at the point they had left it. After two minutes of reading they were presented with the first recognition test, for which a theoretically unlimited time was available but over which subjects had been cautioned not to spend too much time. (They had also been instructed to work down the items in order and not to look back to earlier items.) This read-learn-read-test procedure was repeated another twice, with one difference concerning the presentation of the items to be learned:

on the first trial the cards had been ordered so that all the $w_1 - m_1$ combinations were seen before the $w_2 - m_2$ combinations, whereas on the second and third trials the order was random. The idea of this was to mimic the manner in which we come across words (homophones particularly), first one, then the other and thereafter in "random" order.

At the end of the third recognition test subjects were told that they would be given a further two tests. One of these (Ts) would be the same as the other three they had received but the other (Td) would be different. They were told that it was different in that some of the words that they had learned had been replaced by other words and that the statements in which these items occurred were of course wrong. (Subjects did not seem to have any difficulties with these rather vague instructions.) The order in which these two tests were presented was balanced across subjects.

The instructions given to subjects are presented in Appendix 2.2.2.

## RESULTS

### Principal Results

In the first analysis two scores were calculated for each subject for each of the first three recognition tests (i.e. $T_1$, $T_2$, $T_3$). The first was the sum of correct responses to seven of the nine $w_1$ words (the maximum score possible is 14 since each $w_1$ word appeared with its correct meaning and with an incorrect meaning). The second was the corresponding score to the seven $w_2$ words. (The two correspondence types omitted from this analysis were those involving the plural morpheme, cks - x and pse - ps. These are omitted from the following analyses unless otherwise stated as they embody a morphemic as well as a phonemic difference).

These scores were put into an ANOVA that dealt with the following factors: the effect of previous exposure to $w_1$ words (E vs NE); the effect of the structural relationship between the pairs of words, e.g. the homophonic pairs (Rv) vs the "mixed" pairs (Rva); the effect of the number of learning trials ($T_1$ vs $T_2$ vs $T_3$); and the difference between $w_1$ words and $w_2$ words. The results of this ANOVA are presented in full in Appendix 2.2.3.

There was a significant effect of previous exposure, which had the effect of improving performance (means: E = 11.29 (81%), NE = 9.91 (71% correct); F = 11,8; d.f. = 1,36; $p<.001$). This result, together with the fact that this Exposure factor did not interact with any other factors, means that the effects of previous exposure go beyond an improvement on $w_1$ words, which were the words actually seen previously, to $w_2$ words. This indicates that these items are not independent in this task and, either at the learning stage, or during test, or both, they were "yoked", (means: $NEw_1$ = 10.08; $Ew_1$ = 11.55; $NEw_2$ = 9.73, $Ew_2$ = 11.03).

There was no significant effect of structural relationship (means: Rv = 10.75 (77%), Rva = 10.44 (75%); F = 0.62; d.f. = 1,36). This factor did not interact with the Exposure factor (F = 0.56; d.f. = 1,36) indicating that the effect of Exposure was the same in both conditions. It did however interact with other factors and we shall return to these interactions shortly.

Performance improved significantly over trials (means: $T_1$ = 8.63 (62%), $T_2$ = 10.94 (78%), $T_3$ = 12.24 (87%); F = 115.84; d.f. = 2.72; $p<.001$). This result simply attests to the effects of learning. This factor also interacts with other factors.

There was a significant difference between performance on $w_1$ words and performance on $w_2$ words (means: $w_1$ = 10.82, $w_2$ = 10.38; F = 5.06; d.f. = 1,36; $p<.03$). There seems no reason why this should be the case other than that on the first learning trial $w_1$ words were presented separately from, and before, $w_2$ words. (This was done with a view to mimicking the manner in which we normally come across new words: first one, then the second, and thereafter in random order (assuming other factors like frequency to be constant). In retrospect, the minimal gain in ecological validity seems outweighed by the qualifications this procedure necessitates).

There were three significant interactions. The first was that of trials and pair member ($F = 3.2183$; d.f. = 2,72; $p<.05$). The means are presented in Table 1.

| | | Trials | | |
|---|---|---|---|---|
| | | $T_1$ | $T_2$ | $T_3$ |
| Pair | $w_1$ | 9.2 | 11.1 | 12.2 |
| member | $w_2$ | 8.1 | 10.8 | 12.3 |

Table 1

Presented in Table 1 are the appropriate means for the significant interaction between trials and pair member.

As can be seen from Table 1 there is a difference between $w_1$ words and $w_2$ words, with performance on $w_1$ being superior. This superiority is lost over the three trials. This however, is not the sum total of what is occurring, for pair member also interacted with the structural relationship factor ($F = 8.15$; d.f. = 1,36; $p<.01$). These means are presented in Table 2.

| | | Pair Member | |
|---|---|---|---|
| | | $w_1$ | $w_2$ |
| Structural | Ry | 11.25 | 10.27 |
| Relationship | Rya | 10.38 | 10.50 |

Table 2

Mean number of correct responses in conditions defined by the interaction of pair member and structural relationship.

This result indicates that the difference between $w_1$ and $w_2$ is confined to the Rv condition.

The third significant interaction ties these results together. There was a significant interaction between pair member, trials, and structural relationship. ($F = 15.17$; d.f. = 2, 72; $p<.03$). These means are presented in Table 3.

| Structural Relationship | | Pair member | Trials $T_1$ | $T_2$ | $T_3$ |
|---|---|---|---|---|---|
| | Rv | $w_1$ | 9.75 | 11.45 | 12.55 |
| | | $w_2$ | 7.50 | 11.15 | 12.15 |
| | Rva | $w_1$ | 8.55 | 10.75 | 11.85 |
| | | $w_2$ | 8.70 | 10.40 | 12.40 |

Table 3

Mean number of correct responses in conditions defined by the interaction of Trials, Structural Relationship and Pair Member.

This interaction indicates that not only is the difference between $w_1$ and $w_2$ confined to the Rv condition, and that it decreases with learning, but that it is also confined to the first trial. In other words, all these results put together mean that there was a difference between $w_1$ and $w_2$ on the first trial in the Rv condition only. This was due to the difference in presentation procedures on the first trial and one might speculate as to the reasons for this differential effect on Rv and Rva: on the first trial in the Rv condition, subjects had read all the $w_1$ words when they came across the first of the homophonic $w_2$ words. Given that they recognised the homophony of $w_2$ words, and that the homophony was a source of interference, it is reasonable to suppose that the $w_1$ words, having come first, would have been more securely established (or even that subjects adopted the strategy of specifically concentrating on the $w_1$ words). The difference with the Rva condition is that the relationship between the $w_1$ and $w_2$ words is not so evident and so the interference was not asymmetric (i.e. subjects were not concentrating on the $w_1$ words at the expense of the $w_2$ words). Support for this notion of the differential allocation of capacity or attention comes from the fact that even though the difference between $w_1$ and $w_2$ varied depending on the condition (Rv vs Rva), the mean of $w_1$ and $w_2$ words combined was the same in each condition (8.65 in both Rv and Rva).

One of the main results of this analysis is that previous exposure to $w_1$ words improves performance and that this improvement does not depend on other factors (i.e. no significant interactions). In particular, this means that the difference in performance between the Exposure and No Exposure conditions does not decrease with learning, which seems to indicate that discrimination between words in the No Exposure condition was not improving over the three trials. This follows from the fact that this difference was hypothesized to reflect a difference in discriminability. However, while it is the case that there is no significant interaction, there is a decrease in the difference between Exposure and No Exposure conditions over trials. Performance in the Exposure condition (percent correct): $T_1$ = 69%, $T_2$ = 83%, $T_3$ = 91%. Performance in the No Exposure condition was (percent correct): $T_1$ = 55%, $T_2$ = 74%, $T_3$ = 84%. A reason why the improvement is not greater also highlights an inadequacy in the argument, assuming of course that the assumption that discrimination in the Exposure condition is at asymptote holds. The assumption that the difference between the Exposure and No Exposure condition is only one of discrimination might not hold in that it seems plausible that subjects in the Exposure condition would be able to allocate some of their cognitive capacity (that which would normally be devoted to learning the points of discrimination between the words), to learning features of the items other than their points of discrimination. This would account for the non-significance of the decrease.

Another major result was that there was no significant difference between the Rv condition and the Rva condition (other than the interactions previously discussed). This result means that there is no more interference between homphonic pairs than between pairs of words which have both a visual and an acoustic difference (means: Rv = 10.75; Rva = 10.44). This in turn means that the development of visual codes does occur, and at a rate and of a standard such that an acoustic code adds no extra information.

The third major result was that performance improved over the three learning trials. It is not clear however at what point performance was significantly above chance, and whether this occurred sooner in the Exposure condition, as one might expect, given the results obtained so far. Accordingly, performance levels on each trial and in each of the four major conditions (ERv, ERva, NERv, NERva) were compared against chance levels using the Kolmogorov-Smirnov test. The assumption using this test was that on each of the fourteen items in the recognition test the probability of getting it right by chance was 0.5. (It could be argued that subjects with no knowledge of the items at all could adopt some strategy or have some bias such that this assumption was not justified. In the first place however, there is no a priori reason to suppose that in the long run behaviour on each item would not be describable by this assessment of chance levels of performance, and in the second place there seems no way to assess any particular strategies or biases that might occur under these conditions of ignorance.) The results of these tests are presented in Table 4.

As can be seen from Table 4, performance in all conditions is significantly above chance by trial 2. It can also be seen from Table 4 that the enhancing effects of Exposure are once again evident. The effect

| | | | $T_1$ | $T_2$ | $T_3$ |
|---|---|---|---|---|---|
| NE | Rv | $w_1$ | 0.05 | 0.01 | 0.01 |
| | | $w_2$ | - | 0.01 | 0.01 |
| | Rva | $w_1$ | - | 0.01 | 0.01 |
| | | $w_2$ | - | 0.01 | 0.01 |
| E | Rv | $w_1$ | 0.01 | 0.01 | 0.01 |
| | | $w_2$ | - | 0.01 | 0.01 |
| | Rva | $w_1$ | 0.01 | 0.01 | 0.01 |
| | | $w_2$ | 0.01 | 0.01 | 0.01 |

<u>Table 4</u>

Results of Kilmogorov-Smirnov tests giving significance levels. Tested were performance levels relative to chance on $w_1$ and $w_2$ in the four major conditions and over the three trials.

of exposure was a level of performance significantly above chance on the first trial. These results indicate that by the second trial in all cases visual codes have begun to be established in the mental lexicon, to a degree such that an above chance level of performance is possible.

There has been some evidence to suggest that subjects in the Rv conditon may have been directing their attention in ways not found in the Rva condition. Indeed, it seems very plausible that subjects, confronted with homophones to be discriminated, might have paid attention to the visual aspects of these words to a greater extent than they perhaps normally would have done. This can be tested. Recall that subjects in the Rva condition were presented with two recognition tests after the three learning trials and that while one of these two tests was no different from those previously administered, the other one (Td) was. Td replaced the $w_2$ words with $w_2$ words from the Rv condition (e.g. <u>cherl</u> was replaced by <u>cheal</u>). i.e. This test presented them with homophones where they had previously had similar sounding, but not homophonic, items. Similarly, the Td test in the Rv condition contained words substituted from the Rva condition. The scores from the Ts and Td tests were analysed in the same way that the scores from $T_1$, $T_2$ and $T_3$ were analysed. The results of this ANOVA are presented in Appendix 2.2.4.

There was a significant difference between $w_1$ and $w_2$ words (means: $w_1$ = 11.89 (85%), $w_2$ = 12.70 (91%); $F = 16.82$, d.f. = 1,36; $p<.001$). Two further results however, suggest that this difference was confined to the No Exposure condition (see Table 5(a) for means), and to the Td recognition test (see Table 5(b)). The two relevant significances are the interaction of Exposure with Pair member ($F = 4.34$; d.f. = 1,36; $p<.05$) and that of Test (i.e. Ts, Td) with Pair member ($F = 19.87$; d.f. = 1,36; $p<.001$).

a)

| NE | | E | |
|---|---|---|---|
| $w_1$ | $w_2$ | $w_1$ | $w_2$ |
| 11.50 | 12.73 | 12.73 | 12.68 |

b)

| Ts | | Td | |
|---|---|---|---|
| $w_1$ | $w_2$ | $w_1$ | $w_2$ |
| 11.83 | 11.80 | 11.95 | 13.60 |

Table 5

5(a) Presented are the mean number of correct responses (maximum 14) in conditions defined by the interaction of Exposure and Pair member.

5(b) Presented are the mean number of correct responses in conditions defined by the interaction of Test type and Pair member.

There was also a significant difference between Ts and Td (means: Ts = 11.81 (84%), Td = 12.78 (91%); $F = 14.85$; d.f. = 1,36; $p<.001$). However, as we can see from Table 5(b) this was very largely confined to $w_2$ words.

Put together, these results indicate that the effect of substituting words into the recognition test (in the No Exposure condition) was to enhance performance on those items. This enhancement was both relative to themselves as they were before substitution (i.e. $w_2$ in Ts vs $w_2$ in Td) and relative to the unsubstituted items (i.e. $w_2$ vs $w_1$, both in Td). Specifically, when homophones such as cheal were suddenly substituted for words such as cherl, which were both visually and acoustically discriminable from their pair member cheel, performance not only did not deteriorate, it improved. This means that subjects who had had no specific reason to pay special attention to the visual characteristics of the words they were learning had nevertheless built up visual codes of these words in the mental lexicon.

There is another factor that was very nearly significant and which interacted with no other factors. There was a difference between Rv conditions and Rva conditions (means: Rv = 12.69 (91%), Rva = 11.90 (85%); $F = 3.55$; d.f. = 1,36; $p = .065$). This result suggests that performance in the homophone conditions was in general superior to that in the Rva conditions. This is counter-intuitive in that it suggests that a difference between pairs that was purely visual led to better discrimination than a difference that was both visual and acoustic. This result is anomalous not only because it is counter-intuitive but also because the earlier analysis (i.e. performance over the learning phase) indicated no significant difference between Rv and Rva. The anomaly is partly resolved if we hypothesize that subjects in the Rv condition were paying special attention to discriminating between the pairs of homophones. It is not clear however why this difference was not evident during the learning trials. (Notice incidentally, that this hypothesis does not affect the conclusion of the immediately preceding result.)

The scores used in these analyses were obtained by combining the correct responses made to the seven types of word. It is possible however, given this pooling, that the conclusions do not apply to all the seven types but are a product of only a few of them. To check this scores were obtained by pooling over subjects rather than over words and the two ANOVAS just discussed repeated using these scores. The results of these ANOVAS completely substantiated those of the main ANOVAS, indicating very clearly that these results and conclusions apply to all the seven word types.

Individual Word Types

Even though all the seven word types behaved in the same way, it may still be asked whether there were any differences between the different types. Accordingly, for each subject the $w_1$ and $w_2$ scores for each pair were added together and summed over the three learning trials (maximum score 12) and the resulting seven sets of observations were tested for a difference between them. This was done for each of the four conditions, ERv, ERva, NERv, NERva. There were no significant differences between the seven types in any of these four conditions (Friedman two-way ANOVAS: $\chi^2$ERv = 1.63; $\chi^2$ERva = 9.73; $\chi^2$NERv = 4.9; $\chi^2$NERva = 9.04; d.f. = 6).

The seven word types seem to vary in the degree to which the members of each pair are visually similar (in the Rv condition), or are both visually similar and acoustically similar (Rva condition), and it is not clear to what extent these similarities can predict performance. For example, a pair of words based on ee and ea are very similar and seem likely to cause more confusion than a pair of words based on ight and ite.

Each of the ten sets of Rv words and each of the ten sets of Rva words were given to one of thirty judges. Those judges that received a set of Rv words had to rate each homophone pair for visual similarity; similarly, ten judges rated the pairs of Rva words for visual similarity while the remaining ten judges rated the pairs of Rva words for acoustic similarity. They all used a five point scale: 1 - very dissimilar; 2 - dissimilar; 3 - neutral; 4 - similar; 5 - very similar. From these ratings the mean similarity rating for each type (acoustic and/or visual similarity as appropriate) was calculated.

For each subject in the Rv conditions a correlation coefficient was calculated (Spearman's Rho). This was the correlation between his performance scores on the seven word types and the mean visual similarity ratings for these types. For each subject in the Rva conditions two correlation coefficients were calculated. One was that for performance and visual similarity and the other for performance and acoustic similarity. In both conditions the performance score was calculated by summing the $w_1$ and $w_2$ scores for each type over the three trials. The mean values of these six correlations are presented in Table 6.

| | NERv | ERv | NERva | ERva |
|---|---|---|---|---|
| Visual similarity | +0.14<br>6 | +0.18<br>7 | -0.08<br>5 | +0.22<br>7 |
| Acoustic similarity | - | - | +0.01<br>5 | -0.06<br>5 |

Table 6

Presented are the mean correlation coefficients, obtained from ten subjects in each case, between performance on the seven word types and ratings of the visual and acoustic similarity of pairs of words. Also presented are the number of positive correlations obtained from the ten subjects in each condition.

The mean coefficient has in each case been calculated from the ten coefficients obtained from the ten subjects in that condition. A simple test of whether there is a significant correlation in each case is simply whether a significant number of subjects (significant on the sign test) produced a positive (or negative) correlation. Table 6 also presents the number of subjects who, in each case, produced a positive correlation. (A positive correlation indicates that the more similar a pair of items, the higher the performance score. If visual or acoustic similarity predict performance in the way we have discussed then we expect to find negative correlations). None of the correlations is significant, or indeed substantial enough to be interesting.

The results of the similarity ratings are presented in Appendix 2.2.5. Briefly, Friedman two-way ANOVAS revealed an overall significant difference between the seven types of homophone ($\chi^2 = 13.5$; d.f. = 6; $p<.05$) with respect to visual similarity (ee - ea and (v)ps-(v)pse were adjudged the most similar and ue - ew, the least similar). There was no such overall difference between the seven types in the Rva condition ($\chi^2 = 6.99$; d.f. = 6). Recall that these had been generated with a view to keeping the visual similarity between a pair the same as that between the equivalent homophone pair. The seven Rva types did however differ significantly with respect to acoustic similarity ratings ($\chi^2 = 13.84$; $p<.05$), with t - tt judged the most similar and ue - em judged the least similar. There was a negative, but not significant, correlation (-.42) between the two sets of visual similarity judgements. This is contrary to expectation and the reasons for this are not clear.

The results of this section indicate that there are no significant differences between the seven word types analysed, in any of the conditions. Also, visual and acoustic similarity ratings do not predict performance on the seven types.

## Types of Error

The analyses so far have dealt with the number of correct responses. This however, has obscured the fact that two kinds of errors can be made. One is an incorrect rejection (IR) which is when a correct item (e.g. $w_1 - m_1$) is marked as being wrong. The second is a false alarm (FA) which is when an incorrect item (e.g. $m_1 - w_2$) is marked correct. For each subject, the number of IRs and FAs on each trial was calculated (maximum 14 in each case) and used as the scores in an ANOVA that varied Exposure, Structural Relationship (Rv/Rva), and Trials.

There was a significant difference between the number of IRs (mean 2.52) and the number of FAs (mean 4.10) ($F = 59.46$, d.f. = 1,36; $p<.001$). One way of interpreting this is simply in terms of a greater bias towards responding "correct" but I wish to interpret it in a more complex fashion. Each word - meaning combination presumably occupies an address in the mental lexicon, and when the subject comes across a correct item (e.g. $w_1 - m_1$), both the word and the meaning converge on the same address. However, when an incorrect item is being read (e.g. $w_1 - m_2$) the word and the meaning lead to different lexical addresses. It seems likely that in the first case when all the information is converging and when only a confirmatory response is required the probability of error will be less than the second case when the information is diverging and when the response that has to be made is to the effect that something is not the case.

Type of error did not interact with any other factor.

<u>"Morphemic" Homophones</u>

All these results have been concerned with seven of the nine word types. The two that have been omitted depended (in the Rv condition) on the plural morpheme for their homophony, i.e. -<u>cks</u>/-<u>x</u>; -<u>ps</u>/-<u>pse</u>. The question with these items is how they behave relative to the other items.

For each subject the number of correct responses to the eight items in the recognition test dealing with these two types was calculated. The comparable score for the other seven types would be based on twenty eight recognition items. The reason for comparing these two <u>sets</u> of items rather than the two morphemic types with specific controls is that it is not really clear what the controls should be. Accordingly, the most conservative solution is to compare mean performance on the two morphemic types with mean performance on the other seven types. To make the two sets of scores comparable and to permit use of the arc sine transformation, each score was reduced to a proportion of 1. Thus the morphemic scores were divided by 8 and the "normal" scores by 28. The resulting scores were transformed (arc sine transformation) and analysed by an ANOVA with the Exposure, the Structural Relationship and the Trials ($T_1$,$T_2$,$T_3$) factors. The arc sine transformation was applied because performance on trial 3 in all conditions is beginning to reach a ceiling (84% to 99% correct).

There was an overall significant difference between the two types of item (Percent correct scores: morphemic type = 87%, normal type = 76%; $F = 71.59$; d.f. = 1,36; $p<.001$). There was also a significant interaction with the Rv/Rva factor, with the advantage of the morphemic type being less in the Rv conditions (83% correct vs 77% correct) than in the Rva conditions (89% correct vs 75% correct) ($F = 6.58$; d.f. = 1,36; $p<.02$). These results indicate that the plural morpheme is in some way marked, and that it thereby provided an additional source of information for purposes of discrimination. It is not clear why this morphemic difference should interact with the acoustic difference (i.e. the significant interaction). One could speculate that the representations of acoustic and morphemic information are related in some way but I would not wish to make such a claim. I would not wish to make such a claim because some of the scores in this analysis are very near ceiling, and while the use of the arc sine transformation ameliorates the effects of this, there is nevertheless an element of unreliability. The significance of the general factor seems more secure in that the effect is a substantial one (i.e. $F = 71.59$). (The same ANOVA was carried out on untransformed scores and in this, while the main morphemic factor was still significant ($F = 49$), the interaction was not ($F = 2.8$) ).

A similar analysis of the Ts and Td scores would be less secure as all these scores are near ceiling (again, greater than 80%), not just those on one of three trials. Accordingly, while the same processes of reduction were carried out on Ts and Td scores they were not analysed using an ANOVA. Presented in Table 7 are the mean numbers of correct responses in each condition, expressed as a percentage, for clarity.

| | Ts | | Td | |
|---|---|---|---|---|
| | Norm. | Morphemic | Norm. | Morphemic |
| | | Rv | | |
| NE | 82% | 90% | 93% | 91% |
| E | 89% | 98% | 95% | 98% |
| | | Rva | | |
| NE | 81% | 94% | 88% | 83% |
| E | 82% | 96% | 90% | 91% |

Table 7

Presented are the mean percent correct responses for normal and morphemic types in each of the major conditions.

Take the Ts scores first. The four sets of means all indicate an advantage for the morphemic condition and a sign test on all the observations in these four conditions confirmed that this difference was significant (sign test: proportion = 31/36 observations; $p<.001$). However, four separate sign tests revealed that the difference was not significant for observations in the NERv condition, while it was significant in the other three conditions ($p<.05$). It is not clear how much importance to attach to these fluctuations from condition to condition given the ceiling problem and the limited number of values (0 to 8) that scores in the morphemic condition can take. Accordingly I will deal only with major effects. In this case the overall significant difference between the two types substantiates the conclusion arrived at in the last analysis, namely, that the plural morpheme is in some sense marked.

With respect to the Td scores, the four sets of means suggest no consistent difference between the morphemic and normal types. An overall sign test was not significant (the proportion of morphemic scores greater than normal scores was 15/34). (If we break these observations down into those in the Rv conditions and those in the Rva conditions the result still holds.) This indicates that the morphemic difference is of no advantage when the new words are substituted.

At least part of the reason why the advantage is lost is that the normal items improve from Ts to Td (see the means in Table 7 and note the relevant earlier analysis). This improvement certainly accounts for the lack of advantage of morphemic types in the Rv condition in that firstly we can see that the normal types improve (82% to 93% and 89% to 95%) and secondly we can see that the morphemic types do not improve (90% to 91%, and 98% to 98%). A sign test was not significant, only one observation out of four showed an improvement, with sixteen items tied). The improvement of the normal types with respect to the Rva condition is a partial explanation, but it is clear from Table 7 that performance on the morphemic types deteriorates when homophones are substituted (10 out of 11 items show this deterioration; sign test: $p<.01$). This result indicates that the acoustic difference between the members of a morphemic pair in the Rva condition was a source of discrimination and that when this source was removed and subjects had to rely on the morphemic and visual differences, performance deteriorated. It is not clear why the morphemic and normal types differed in this respect.

The results of this section are not as clear as they might be. There is clear evidence that the morphemic component of some pairs is a factor in discrimination and that it is a contributor to (better) performance. The effect of substituting new words in the Td test is not however very clear in the case of these morphemic types. Perhaps the least speculative conclusion in this case is that subjects have two, and sometimes three, sources of discrimination (visual, morphemic, acoustic) and that they rely on these to different degrees depending on the conditions.

Questions

Subjects were asked a series of questions at the end of the task.

Subjects were asked to pronounce all the words they had learned. This was to check that homophones were pronounced as such. Seven subjects out of forty mispronounced items, only two of these mispronouncing more than one. One subject specifically said that he mispronounced one member of each homophone pair in order to aid discrimination between them.

All forty subjects said they had noticed the similarity between words, this was in both Rv and Rva conditions.

Fourteen subjects said that the reading had interfered with their learning of the items, twenty three said it had not. (Numbers in these questions do not always add up to forty as subjects did not always reply.)

Subjects in the Exposure conditions (20 of them) largely felt that prior exposure to the $w_1$ words had aided subsequent learning (15 subjects). Three subjects said that prior exposure had not helped and two said it had been detrimental.

Subjects had been asked whether they had seen any of the words before. Only six cited one item each and even on these they were not really sure.

Finally, and most interestingly, subjects were asked how they had gone about learning the words. These replies are presented in Table 8. The category labelled "Association" covers those responses suggesting that subjects were using a real word to form a link between the novel word and the meaning. The category labelled "Discrimination" deals with responses where subjects said they were paying particular attention to discriminating the members of each pair. Notice that these occur almost exclusively in the homophone condition - substantiating the earlier hypothesis of an attention strategy. (A Fisher exact probability test revealed that the distribution of learning strategies (Discrimination and Association) was significantly different from chance, $p<.04$). Finally, the "other" category covers responses dealing with rote and particular idiosyncratic strategies.

| | Association | Discrimination | Other |
|---|---|---|---|
| Rv | 7 | 7 | 6 |
| Rva | 10 | 1 | 9 |

Table 8

Presented above are the major categories of response to questioning concerned with how subjects learned the words partitioned according to condition (Rv vs Rva).

Subjects in the Exposure conditions had had to write down as many of the ten words they had learned as they could remember. There was no significant difference between the two groups (mean: Rv = 8.3, Rva = 7.8).

## CONCLUSIONS

Performance in this experiment improved rapidly with learning, growing from about 60% on trial one (it varied with condition) to around 85% on trial three, with a level that was significantly above chance by trial two in all conditions.

The purpose of manipulating Exposure was to determine the growth of visual and acoustic representations in the mental lexicon. This aspect of the experiment was not as informative as it might have been, showing only that familiarity with the words by themselves did confer an advantage (a difference of about 10%) on later learning of the words and their meanings.

Interestingly, there was no overall difference between the learning of homophones and the learning of words differing both visually and acoustically. This indicated that visual representations are so securely established that no information is added by an acoustic representation. However, there was evidence that strategy differences were present in the two conditions. The strategy in the homophone condition was simply that subjects were giving particular attention to discriminating between the pairs of homophones, something they were not doing in the Rva condition. On the other hand, even though this strategy difference was present, the results of the two post-learning recognition tests (Ts and Td) clearly showed that subjects in the Rva condition, those specifically <u>not</u> using this strategy, had nevertheless established visual representations.

The fact that there were no significant differences between the different types of word pair in both the homophone and the normal conditions was disappointing, for even though this lends the conclusions generality it was hoped that differences between the types may have formed the basis of statements concerning the organization of the mental lexicon. For example, that visually similar items were "close together" and visually less similar items further apart.

Finally, there was evidence to suggest that morphemic differences (specifically plurality) are marked in some way, as the morphemic items produced performance that was superior to the normal items. This result is potentially the most interesting as a number of interactions between morphemic, visual and acoustic representations seem to be occurring, the exact nature of which are unclear in this experiment.

# CHAPTER THREE

## 3. GENERAL INTRODUCTION (2)

The experiments described so far have used monosyllabic words and, where necessary, simple meanings. Now even though one can certainly argue that the use of such a restricted set limits the generality of experimental results involving their use, there is no reason to suppose that such results are invalid. However, the use of such a set of words is symptomatic of a generally impoverished conception of the structure of the language and what the psychological correlates of this structure might be. Briefly, what underlies these experiments is the general notion that a word is at one level, a sound pattern and a visual pattern and at another level a meaning; that the first two are connected by spelling rules and that the assignment of these forms of a word to its meaning is essentially arbitrary, phenomena such as onamatopoeia aside. Thus there is no reason why the sound of <u>bus</u> and not that of say, <u>pen</u>, should refer to "vehicle". Psychologically, this conception holds that learning is a process whereby the connection between a form and a meaning is made and where the bonded pair is stored in an elaborate filing system called memory. Now whether such a conception is correct or not is an empirical matter. What is at issue here is not that such a conception is wrong but that it fails to take sufficient account of the structure of the language and as a consequence, while it may provide a valid and valuable skeletal framework, is likely to generate hypotheses that are impoverished.

Now it is certainly the case that, with some exceptions, the particular pairing of the form and the meaning of a word is arbitrary. However, in English the basis exists for complex and non-arbitrary connections (or mappings) between form and meaning, and this basis is the morpheme. Its role in the relationship between words is illustrated on the one hand by the general coherence of the group <u>generation</u>, <u>generated</u> and <u>generate</u>, and on the other by the link between the items <u>generation</u>, <u>mediation</u>, <u>veneration</u>, and so on. Now while there are a number of relationships that may exist between words - for example as in the phenomena of synonymy, hyponomy and homophony, these phenomena have in common the fact that the relationship exists either at the semantic level, or at the level of form, but not both. The relationship resulting from the morphemic structure of words however, is at both levels. To illustrate: synonyms such as nearly and almost are semantically but not phonologically or orthographically related; homophones such as bear and bare, on the other hand, are phonologically but not semantically related; boy and boys or generation and mediation however, are semantically connected to varying degrees and this relationship is reflected in their phonological and orthographic forms.

The notions "word" and "morpheme" have in common the feature that they are both linguistic signs, the essence of a sign being that it is at the same time a significate, possessing semantic and syntactic value, and a significant, possessing a form. A word takes its identity from its role in the syntax of the language and from its decomposability into morphemes (Mathews, 1974). This follows from the general idea that a morpheme is a minimal grammatical element and that words are composed of morphemes. This latter assertion is not always true in that words are frequently composed of a single morpheme, e.g. bear, ocean. Words are positionally mobile or permutable with respect to other words but at the same time are internally stable or cohesive in that the morphemes of which they are composed are uninterruptable and have a fixed order. To illustrate: murderer is a single word composed of a free morpheme (murder) and a bound morpheme (-er). The notion of uninterruptability is illustrated by the fact that we cannot say "murder-the-er"; that of fixed order by the fact that we cannot say ermurder. A word however, is permutable (albeit to a limited degree), as is illustrated by the acceptability of the sentences "... the murderer ...." and ".... murderer, the ...".

Seemingly then, we have in the morpheme an excellent basis for a system of relationships between words in the language. This is perhaps most clearly seen in a semi-formal characterisation. A word would have the structure ($m_1$+$m_2$), or some other such combination, where $m_1$ and $m_2$ are morphemes with the phonetic/orthographic forms $p_1$ and $p_2$ respectively and the semantic/syntactic values $s_1$ and $s_2$. The form and meaning of ($m_1$+$m_2$) would be predictable from its components according to some set of rules. The relationship between ($m_1$+$m_2$) and ($m_1$+$m_3$), ($m_4$+$m_2$), ($m_1$+$m_2$+$m_5$), and so on, would similarly be regular and evident. It is in the regularity of such a system that its psychological value lies. However, before considering this psychological value let us consider some of the complexities of the realization of this basic system in the English language.

Traditionally, word structure is dealt with in the fields of inflectional and lexical morphology. Inflected words are of the type (stem + inflection) where the inflection is a morpheme such as the plural morpheme. Thus the letters s and es in the words bikes, cars, and buses are orthographic realizations (allomorphs) of the plural morpheme -s, while the sounds |s|, |z| and |iz| are the phonological realizations of the same morpheme. The crucial feature of an inflected morpheme (and the difference between inflectional and lexical morphemes) is that it is a grammatical element. That is, inflections fulfil grammatical requirements, and as such are determined by the syntactic structure of the sentence or phrase in which they appear. The corollary of this is that the inflection adds no new lexical information to the stem, it is lexically redundant and it is fully productive. Conversely, lexical morphology is concerned with the derivation and the compounding of words (e.g. Canadian is a derivative of Canada while steamboat is a compound of steam and boat), and the morphemes and morphemic processes that are the concern of lexical morphology are not grammatically determined in that they are not required by the syntactic structure. Furthermore, the radical (source) and the derivative are lexically distinct items. Thus for example, boy and the inflected boys are considered to be the same lexical item (lexeme) while Canada and Canadian are not. The following examples will serve to illustrate the reason why. In the sentence:

"The boys are going home"

whatever the noun that could appear in the place of boys, it is grammatically constrained to be plural. That is, plurality is grammatically determined. On the other hand, in:

"The Canadian flew home"

there is no grammatical requirement that the noun be a derivative; a monomorphemic word such as bird would be equally acceptable grammatically. It is because inflections are grammatically determined and do not contribute to lexical distinction that we shall not be concerned with them any further. However, two points should be noted in connection with the distinction between lexical and inflected words. Firstly, the distinction is not as clear cut as has been suggested (the comparatives, e.g. hot, hotter, hottest, are controversial with respect to categorization) (Mathews, 1974). Secondly, the distinction is a linguistic distinction, which is not to say that it is necessarily a psychological one. However, it is useful as a first approximation.

The distinction made between derivatives and compounds is that the former consist of one bound and one free morpheme while the latter consist of two free morphemes. Contrast for example Canadian and baker with steamboat and blackboard. We shall not discuss compounds any further, largely because of their rather limited productivity. For example, the proliferation of the morpheme -boat is considerably less than that of -er (an agent-forming suffix), and the scope for the former to be used in the formation of new words is similarly considerably less (beyond steamboat, houseboat, tugboat and lifeboat, the examples and possibilities are limited).

In English, derivatives fall into the two classes of prefixed and suffixed words. The former are affixed at the beginning of a word while the latter are affixed at the end. Thus undo and untie are prefixed (in un-), while acceptable, agreeable and changeable are suffixed in -able). Double derivations occur of course, e.g. unacceptable, disagreeable.

Two kinds of relationship seem to exist as a result of derivational processes. There is the regular alternation between the radical (the source) and the derivative that is found in, for example, accept: acceptable, change: changeable or do: undo and tie: untie. There is also the link by common element in words like undo, untie, unhitch and unhorse or in acceptable, changeable, and comparable. The psychological implications of these relationships rest on the constancy of form and meaning of the affix and on the potential for characterising the relationship between the members of an alternation such as do: undo by rules of composition and decomposition. Unfortunately, this regularity is a somewhat idealized characterisation, and the true state of affairs is one of varying degrees of regularity and various sources of anomaly. However, whether the degree of regularity to be found in any particular derivational structure is sufficient to be psychologically useful is an empirical matter and one that has been tested here for three prefixes, the results of which will be presented later.

One source of the irregularity that is often found in a radical/derivative alternation is the polysemous nature of some words. One manifestation of this is in items which have specialised meanings, for which the derivational process breaks down. For example: "he tied his shoelace" and "they tied the match" are both acceptable, but while "he untied his shoelace" is acceptable, "they untied the match" is not. Similarly, "Jesus Christ was divine" and "that meal was divine" are equally acceptable, but while we can say "the divinity of Jesus Christ", we cannot say "the divinity of the meal". Another instance of the general effect of polysemy is in the derivational relationship between <u>import</u> and <u>importance</u>. The construal of the meaning of the latter (by someone who did not know the meaning but did know the derivational rule) would depend on which meaning of <u>import</u> they began with ("to bring into" or "signify"). In the same vein, the identity of the stem of a derivative can also be misleading if it bears a spurious resemblance to a known word. For example, <u>impale</u> and <u>impeach</u> are in no way related to "pallid" (<u>pale</u>) and "fruit" (<u>peach</u>). (Even though they are equally misleading to most people however, the connection between the stem and the derivative is not in fact the same in each case: the <u>peach</u> in <u>impeach</u> is fortuitous in its resemblance to <u>peach</u> (fruit) but the <u>pale</u> in <u>impale</u> is an archaic word meaning "a sharp stick").

The stem of the derivative is by no means always a word in its own right and so there is no alternation of radical and derivative. This certainly has the effect of reducing the amount of redundant information in the derivative in that there is no information in the stem. This is not to say that the redundancy is reduced to zero, for the meaning of the item is still partially predictable from the affix. Compare for example the degree to which the meanings of <u>preview</u>, <u>precursor</u> and a totally unstructured item like <u>fish</u> are predictable from the component morphemes. The reasons for the structure of these radical-less items are historical. They are imports from Latin, either directly or by way of French, and the radical was either not also imported or was and became archaic (<u>immaculate</u> for example, comes from <u>maculate</u> meaning "spotted"). A particularly large class of this type of word is that consisting of some of the verbs ending in -<u>ate</u> (e.g. <u>elevate</u>, <u>donate</u>, <u>hibernate</u>, but not <u>hyphenate</u>, which has a radical). A more detailed discussion of the historical processes underlying the derivation of items of this (and indeed other) kind is to be found in Marchand (1969), the point to be made here is that the existence of these items introduces a source of uncertainty where we have assumed regularity, and it is probably the case that the degree of uncertainty introduced will vary depending on the affix.

Another source of irregularity is a slightly different class of derivative, which is also the result of historical processes. The class consist of items with a morphemic structure that is completely "moribund" (Garret, 1975) in that the meaning is not predictable to any apparent degree from the component morphemes, e.g. permit, submit, emit; subject, reject, object, abject. As can be seen from these examples, while in some cases the affix is not moribund when it occurs in other words (e.g. sub- in submerged), and while the same stem occurs in several words, implying some connection (e.g. subject, abject, reject), the morphemic structure of these words makes no contribution to their meaning. (Notice that if we are prepared to speak of degrees of "moribundity" then this notion can be used to speak of some of the other types of word we have discussed. Thus, while permit is perhaps totally moribund, donate and precursor would be less so, and preview would be least moribund).

Multiple meanings of an affix introduce another source of uncertainty with respect to the predictability of the meaning of a derivative from that of its components. For example, the suffix -er forms the comparative form of an item (bigger, longer, wider) as well as forming agent nouns (baker, murderer). Notice however that (in this case at any rate) the ambiguity is systematic: when -er is added to (certain) adjectives it forms the comparative while it forms agent nouns when added to (certain) verbs.

All these factors discussed reduce regularity at the semantic level, i.e. the degree to which an item is semantically redundant is reduced by these sources of variation. Another source of uncertainty lies in the fact that the spelling and the sound of a morpheme (its orthographic and phonological forms) are not always invariant. Furthermore, the phonological and orthographic forms of a multimorphemic word might also not reflect its morphemic structure in a simple and unambiguous way.

A simple example of how the spelling and sound of a morpheme is not constant is to be found in the plural morpheme. Depending on the phonemic context the plural can be realized as /z/ (trees), /s/ (books) or /iz/ (fishes), while the spelling can be s (trees, books) or -es (fishes), again depending on context. An example involving derived, as opposed to inflectional, morphemes is the various forms that the prefix in- can take: before m, b, and p it takes the form im- while before r and l it becomes ir- and il- respectively. Both these examples illustrate the fact that the forms of a morpheme are not always invariant, but they also illustrate the fact that these variations seem always to be context dependent and predictable.

Sometimes when a derivative is being formed the process involves more than simple concatenation of the morphemes. A phonological and orthographic adjustment might also occur. An example of this is the occurrence of palatalization when the suffix -ion is added to verbs to form nouns of condition or action. Palatalization occurs when one of the dentals, |s|, |z|, |t|, |d|, followed by the glide |j|, and an unstressed vowel, become palatalized to the sounds |ʃ|, |ʒ|, |tʃ|, |dʒ|, respectively (Venezky, 1970). When -ion is added to some radicals these conditions are fulfilled and palatalization occurs: thus we have promote, complicate, inhibit and abort going to promotion, complication, inhibition and abortion. Similarly, the |d| in divide and erode becomes palatalized in the derivatives division and erosion, but note the additional orthographic change. Again, the |s| or |z| in revise and immerse become palatalized in the derivatives revision and immersion, the voicing determining whether the palatalized form is |ʒ| or |ʃ|. The situation concerning derivatives in -ion is considerably more complex than this brief discussion suggests and is beyond the scope of this chapter, but it does illustrate the point that derivational processes may involve considerably more than concatenation.

One of the features of the phonology of words is the location of the different levels of stress. The factors governing stress assignment and the rules of stress assignment are discussed in Chomsky and Halle (1968). For present purposes we note that morphemic structure is one of the factors governing stress assignment. Stress, according to Chomsky and Halle, is assigned to a word by the cyclical application of rules, which may or may not be blocked at various stages by an intra-word morpheme boundary. There are three types of such boundary. The first is a word-boundary, signified by #, and this boundary is one across which stress assignment rules do not normally operate. This boundary marks both a phonological word, by definition, and a lexical word (embedded), and is to be found in items like pre#conceive and stupid#ly. Notice in these examples that the stress pattern of conceive and stupid is not affected by the addition of the affix. A second type of intra-word morpheme boundary is the formative boundary, signified by +. This boundary does not play any special part in stress assignment in that it does not block the application of rules. It is found in words like stupid+ity and definit+ive, where the stress pattern of the root is affected by affixation. Finally, there is a third type of (unchristened) boundary, signified by =, which is like a word boundary in only one respect: it can block the application of a stress assignment rule. It is otherwise a normal formative boundary. It is found in 'moribund' words like permit which, as verbs, should be stressed on the penultimate syllable but which are not because the = boundary blocks the movement of stress. It does not however, block the stress rule that is sensitive to form class and which places primary stress on the first syllable when the word is a noun.

Morphemic structure can also affect the phonemic structure of the root word. In word pairs like sane-sanity and profane-profanity, the vowel sound spelt by the a changes as a result of affixation. This change however is regular and predictable. In some more complex instances, both vowel alternation and stress change occur as a consequence of affixation (e.g. brutal - brutality), but again these changes are predictable.

This discussion of phenomena such as palatalization and vowel alternation makes several points: that morphemic structure and morphemic processes affect the phonology of a word; that the effects on phonology are far from simple but that they are also very often regular and predictable; and that the orthography tends, in cases where the effects are regular, to reflect the morphemic rather than the phonemic structure of a word.

The tendency of English orthography to reflect the more abstract morpho-phonemic structure rather than simply phonemic structure is the basis of the claim by Chomsky and Halle (1968) that English orthography is near optimal. It is near optimal because it more nearly represents the underlying representation of a word than it does its surface (phonemic) form, which is related (in the majority of cases) to the underlying representation in a systematic way. As a consequence of this, relationships between related items are reflected more clearly in the current orthography than they would be in a purely phonemic orthography. For example, the conventional spellings of sanity and distortion reflect their derivational ties with sane and distort more clearly than do the phonetic spellings sannity and distorshun. It can in fact be argued that English orthography does not go far enough in representing the underlying rather than the surface form. Klima (1972) has pointed out that English orthography only marks major word boundaries (with spaces), and does not mark intra-word morpheme boundaries. Thus it does not mark the fact that untie, resell, contentment and stupidly are morphemically complex, with boundaries between the root and the affix, and with derivational relationships to tie, sell, content and stupid respectively. The value of marking morpheme boundaries is perhaps more clearly seen in pairs like nation-elation and $resign_1$ ("quit") - $resign_2$ (sign again). The second members of each pair are related to their roots, elate and sign, whereas the first are not (in the case of nation the root by itself is meaningless; in the case of $resign_1$ the relationship is only etymological and not at all obvious). This difference between the two types could usefully be marked: say, nation - elat'ion, resign - re'sign. A number of sophistications would follow, and Klima suggests what at least some of them would be, but this would be the principle.

Derivational processes then, are not as simple, or as regular, as we initially supposed. However, while there are certainly irregularities, there are also instances where the irregularity is only an apparent one and where there is in fact an underlying regularity. Psychologically, even though the degree of redundancy in a particular derivational structure may not be as large as it might be, there is nevertheless the possibility that it might be of value. How might this redundancy be psychologically manifest? We turn now to a discussion of this issue, beginning with some notions of the relationship between morpheme structure and the mental lexicon.

One of the earliest conceptions of morphological relationships (Lees, 1960), holds that word formation is essentially a component of more general transformational processes. Root morphemes and affixes are stored in a lexicon and, depending on the semantic and syntactic demands of the sentence being generated, are retrieved and concatenated as appropriate by transformational processes. Thus morphologically complex words are generated as part of sentence production. The principal objection to this notion is that, as we have seen, the processes of word formation are simply not sufficiently regular for them to be practicably a part of sentence generation (transformationally or otherwise based).

While the objection to the transformationalist notion holds for derivational processes it does not apply (nearly so strongly) to inflections. Chomsky (1970) has proposed that inflectional processes may be grammatically (transformationally) based, but that derivational processes are a lexical matter, i.e. confined to the mental lexicon. This lexicalist theory has two principal variations, but before discussing these it is worth digressing briefly to point out a general feature of Chomskyan (lexical) theory. A principle of this is that wherever the structure of the language permits, generalities or predictable features are represented as such, i.e. by rules, and are not a part of the representation of each and every relevant lexical entry.

The partial entry theory (Jackendoff, 1975) holds that the radical or root of a family of derived words is the principal entry of that family in the mental lexicon, e.g. _generate_ would be the principal entry of the set _generate_, _generation_, _generative_ etc. Part of the information contained in this entry would be a set of pointers, pointing to derivational rules and to the entries of the derivatives. The important point here is that the redundant information associated with a derivative is to be found in the entry of the radical and in the derivational rule(s); the idiosyncracies of the derivative are the only information to be found in its lexical entry. Psychologically, this mode of representation certainly takes care of the kind of redundancy we have discussed, in a neat and economical fashion. It does, however, mean that the information concerning a particular morphologically complex derivative requires access to three lexical entries and a subsequent integration of these three sources of information. In short, the gain in lexical economy may be offset by processing complexity. The other problem with this notion of partial entry is to do with the representation and subsequent processing of semi-moribund items like generate and precursor and of moribund items like permit and subject. Are non words like gener and cursor to be given lexical status (more relevantly, are they to be given a psychological existence that is "independent" of the words in which they occur)? The problems are compounded for permit and subject, for even though these items are morphologically complex and subject to morphemically sensitive phonological rules (Chomsky and Halle, 1968), their meaning is in no sense predictable from their parts.

The full entry theory (Jackendoff, op.cit.) holds that each lexical item is fully represented. All the information relevant to that item, redundant or otherwise, is represented. This does not preclude the existence of derivational rules (or more generally "lexical redundancy" rules) in the lexicon, nor does it preclude the separate storage of affixes; it simply means that they are no longer necessary to the understanding of an item. The essence of the full entry theory is that a good deal of the information present in the lexicon is redundant; in contrast, the partial entry theory capitalizes on the redundancy in the language to eliminate (or at least reduce) redundancy in the lexicon. The objection to the full entry theory is based on the lack of lexical economy that it entails. It is also however just this feature that is it's strength in that a redundant lexicon is one that can meet a range of psychological requirements with flexibility and with the facilities for ease of processing. For example, it seems reasonable to suppose that the best kind of lexical entry for the demands of fluent reading would be a full entry, as the partial entry notion would require the synthesis of information from a number of sources. On the other hand, the existence of a lexical redundancy rule could be argued to characterise an intuition that a particular radical and its derivative were related in a regular manner. Equally, such a rule could even be used to generate new items, or construe the meaning of a novel item, in context. For example, the word petrifiedly recently occurred in the essay of a school child.

The specific topic of word formation is dealt with by Aronoff (1976). Aronoff's thesis is that there are roughly two classes of lexical redundancy rule: there are those that capture only partial regularities and such rules are susceptible to the kinds of exceptions discussed; and there are those that deal with regularities of sufficient quality to sustain the generation of new words from the radical, or indeed from another derivative. The latter kind of rule, a word formation rule, operates at the level of the word rather than at the level of the morpheme in that the base (or root) on which the rule operates is always a word, and never a bound morpheme. Thus, other factors aside, prewrite could be generated because write is a word, but preaggress could not be generated because aggress is not a word but a bound morpheme. Aronoff proposes the interesting thesis that morphemes are best considered as only phonological units and not as semantic units. Thus they contribute to phonological processes such as stress assignment but not to the generation of novel semantic units. For example, according to Chomsky and Halle, the morphemic identity of per and mit contribute to the assignment of stress in the item permit. Aronoff would claim that this observation, together with the observation that they make no contribution to the meaning of permit, substantiates the idea that morphemes should be redefined as only phonological units which have no part to play in word formation. The occasions that morphemes do make a semantic contribution are so irregular that they can only, at most, contribute to the redundancy of the lexicon (the first kind of redundancy rule referred to). Aronoff's concern then, is with regularities of sufficient quality to sustain word formation (notice incidentally, that those affixes that would be required as a part of a word formation "library" are presumably exempt from the restrictive definition of a morpheme in purely phonological terms). His tendency to relegate partial regularities to the uninteresting is perhaps misguided as, psychologically, they may also prove to be interesting. For example, an individual who spontaneously generates new words using say, un- or -ly, as the child who generated pretrifiedly did, is certainly interesting in that he is demonstrating an ability to use a solid regularity in the language. He may be said to possess a word formation rule for forming adverbs in -ly and he may even be able to use the same lexical redundancy in perception, as well as production: he might be able to derive the meaning of a new -ly adverb if he knows the root, or at the very least deduce from the -ly that it is probably an adverb. However, his inability to do this with the less regular -ate does not indicate that he is completely ignorant of the kinds of relationships and processes that the suffix enters into. Similarly for, say, -ion. He might for example, be able to learn a noun ending in -ion (this is a nominal suffix) quicker than an otherwise comparable unsuffixed noun. He might also, when confronted with several possibilities as to the meaning of a word ending in -ion, be able to select the correct meaning with a probability above that expected by chance. In both these cases the facilitation may not necessarily be a product of the application of lexical redundancy rules in an active, conscious manner but may be, for example, the product of a lexicon that is loosely organised on the basis of affixial identity; such an organization would provide the information (obtained by comparison with known words) that words ending in -ion also tend to be nouns (e.g. nation) or it may, in some instances, provide the more detailed information that they tend to be abstract nouns derived from verbs (e.g. distortion).

Partial redundancies then, psychologically, may prove to be far from trivial. The degree to which a particular morphological regularity is psychologically manifest is, of course, an empirical matter and is one which we shall be investigating in the next chapter.

We turn now to a number of empirical studies dealing with some of the issues discussed.

Taft and Forster (1975) found, in a lexical decision task, that the stems of prefixed words (e.g. the juvenate in rejuvenate) took longer to classify than the "stems" of non-prefixed words (e.g. the pertoire in repertoire). The same was true of relative classification times for 'compounds' like dejuvenate and depertoire. On the basis of these results they concluded firstly that it is the stems of prefixed words that are represented in the mental lexicon and that access to the stem and to the appropriate prefix is dependent on prior morphological decomposition. These conclusions were supported in a later study by Taft (1979) who found that lexical decision time to both inflected and prefixed words was predicted by the frequency of the stems when the frequency of the whole word was held constant. However, if the frequency of the stem was held constant then decision time was also affected by the frequency of the whole word. Taft interpreted these results in terms of an independently motivated two-stage model of lexical access (Forster, 1976). What is important for present purposes is that Taft concluded that the morphologically complex items were fully represented in a master file of lexical memory and that their stems were separately represented in an access file. Access to the former was subsequent to and dependent on the latter, which in turn was dependent on morphological decomposition. Thus approach and reproach would both be represented and would both be accessed through proach, stored in an access file.

Stanners, Neiser and Painton (1979) have investigated the representation of prefixed words in a series of priming experiments. They found firstly that prefixed words do have a unitary representation in memory, in that priming with the stem (be it a free or bound stem) did not have the same effect as priming with the word itself. Secondly, they found evidence for morphological decomposition in that a prefixed word with a free stem (e.g. resell) was as good a prime for the stem (sell) as the stem itself. Finally, they found that the representations of prefixed words could, for both free and bound stems, be accessed by the stem. Thus -treme primed extreme, though not as effectively as extreme primed itself.

Stanners, Neiser, Hernon and Hall (1979), continued to use the priming paradigm to investigate inflections (e.g. likes), irregular inflections (e.g. hung), and derivatives (e.g. descriptive). On comparing priming of the root by the root (e.g. like by like) with priming of the root by the complex form (e.g. like by likes), they found that there was no difference for inflections but that there was a difference for the irregular inflections and for the derivatives. They interpreted these results as meaning that inflections have a single representation (e.g. likes, liked and liking are all represented as like with the inflection separately represented) while the other forms have two separate, but connected, representations (e.g. hang and hung). (The last deduction was made on the basis of the fact that some priming was occurring in these cases).

These results indicate that derived forms do have a separate unitary representation, in which respect they do not differ from monomorphemic items. Where they differ is that firstly there is evidence for morphological decomposition and secondly there is evidence that the representations of the root and the derivative are connected. In cases where the stem is not a real word it nevertheless seems to have some lexical status and appears to be an effective access code. The second Stanner s study also indicates that inflections and derivatives differ in the degree to which the stem and affix are bound. The affix in the case of inflections seems less an integral part of the word than it is in the case of derivatives.

Two experiments by Morton attest to the decomposability of inflected words. Murrell and Morton (1974) found that pre-exposure to a word containing the same root morpheme as another inflection facilitated subsequent recognition of that inflection. For example, pre-exposure to seen facilitated recognition of sees, relative to a visually and phonemically similar control, seed. (This is essentially the priming paradigm.) Van de Molen and Morton (1979) presented subjects with a list of words for serial recall. They found that if one of the items in the list was plural then this plurality tended to 'drift' and attach itself to some other item. For example, if cats and pot occurred on the learned list, cat and pots might be recalled. The fact that the drifting morpheme usually retained its phonemic form suggested that it was coded in short term memory phonologically, and not in some abstract morphological form, e.g. the drifting |s| from cats did not usually become |z| or |iz| , but remained as |s| and attached itself to a phonologically suitable root, such as pot.

Speech errors (e.g. Fromkin, 1971, Garrett 1975) are a rich source of data on morphemic decomposition and in general provide "natural" evidence for the psychological reality of a number of linguistic units. As a general phenomenon, morphemes are involved in all the major categories of speech error: misordering of units, omission of units and addition of units (Boomer and Laver,1968, Noteboom, 1969). However, these errors are far from unsystematic and their systematicity has been the concern of

Fromkin and Garrett.

Fromkin found in her corpus that the transposition, omission and addition of morphemes manifested the distinction between root morphemes and affixes: they never, for example, substituted for each other in that affixes replaced affixes and roots replaced roots, affixes rarely replaced roots or vice-versa. More relevant to the present discussion was the occurrence of errors such as nationalness (target: naturalness), groupment (grouping), concludement (conclusion) and infinitive (infinity). The first and last of these could be construed as incorrect retrieval from the mental lexicon but the remaining two suggest the existence of a vocabulary of stems and affixes and of word formation rules that put these together during the generation of speech.

Garret's analysis of speech errors was conducted within the context of sentence production, which he hypothesizes to consist of a number of stages: semantic, syntactic, lexical and phonological. The morphemic error he was primarily concerned with was the morpheme exchange, occurring when the stems of two morphemically complex items exchanged locations. For example, instead of the target "busting pushers", the error "pushing busters" was produced; or, "trunked two packs" was produced instead of the target "packed two trunks". There are several features of these errors that are of interest. Firstly, it is the stems that are permuted while the affixes are left stranded, grammatically in the correct place. Secondly, the affixes that are involved are syntactically active morphemes of tense, number, possession, comparison (i.e. -er) and nominalization (-ing). Of 46 errors, 33 involved these affixes, 6 involved items where the affix was morbund (the sub in subject for example), and 7 were 'residual' errors. Thirdly, the permuted elements, the stems, were always free morphemes. That is, they exist as words in their own right. Finally, on the rare occasions that derivational morphemes were involved in these exchanges they were involved in conjunction with a syntactically active morpheme, e.g. in pushing busters and in intelephoning stalls (installing telephones), the derivational affixes are -er and in- respectively while the inflections are -ing and -s, in both cases. These results support the notion that inflected forms are generated from their component parts by rules and processes that are grammatically based. Derivatives on the other hand do not seem to be the product of such generative processes.

Further support for this general conclusion comes from the speech deficiencies of Broca's aphasics. Until recently, the agrammatical nature of the speech of Broca's aphasics has been held to be the product of a general grammatical deficiency (e.g. Goodglass et al., 1972). Thus for example, Broca's aphasics tend to omit function words and inflectional morphemes such as -ed, the comparative -er, and the plural -s, (e.g. Goodglass and Berko, 1960). The omission of inflectional morphemes, with seemingly no comparable omission of derivational morphemes, would constitute good evidence for the kind of distinction between the two we are seeking to make but for a recent challenge to the accepted view by Kean (1977a). Kean holds that the agrammatism of Broca's aphasics is a phonological deficit and not a grammatical (i.e. syntactic) one. The debate between Kean and her critics (Kolk, 1978; Klosek, 1979) need not concern us unduly for while it concerns whether the deficit is a phonological or a syntactic one, and while the outcome might have consequences for the basis of the psychological distinction between inflected and derived forms, we can suspend judgement and refer only to the empirical differences between the two. It is Kean's challenge of these that is important. It seems however that this challenge is without force. Firstly, she presents no data to the effect that Broca's aphasics omit traditionally derivational morphemes like -ness and -able, which according to her argument should be omitted. Secondly, the only "derivational" morpheme that is omitted is the plural morpheme (i.e. -s). Her argument then, that these morphemic omissions cut across the derivational/inflectional distinction, rests on the claim that the plural morpheme is a derivational morpheme - a unique claim which seems to have no linguistic basis (see Kolk, 1978). The evidence from Broca's aphasics then, supports the general notion of a psychological distinction between derived and inflected forms.

The morphemic decomposability of inflected forms, and by implication the generative nature of their formation, is indicated by all the studies considered: lexical priming, short term recall and recognition, and speech errors. The situation for derivatives however seems much less clear. I do not intend to attempt a resolution of the complexities and anomalies but will make two observations. Firstly, it may not be sufficient to merely distinguish between inflections and derivations; we may need to distinguish between those derivatives that involve affixes that are productive (and which incidentally are separated from the stem by a word boundary), and those affixes that are not productive. It is the former that seems to betray generative origins. For example, -ment, -ness and the nominalizing -ing are the derivational affixes involved in the speech error data of Fromkin and Garret; they also appear to be among the most productive in the language. Secondly, the experiments of Stanners et al., Taft et al., and Mackay (to be discussed) may not demonstrate that derivational processes are part of the normal process of language use but only demonstrate that these are linguistic resources that an individual may call upon when the situation demands. The most conservative conclusion to be drawn from these experiments is that they support the full entry theory if for no other reason than that it has not been refuted and can accommodate all the results while the partial entry theory, for example, cannot deal easily with the evidence for unitary representation of complex items.

Mackay (1976, 1978), has been concerned with the oral production of derivatives and inflections from their roots. Latency to utterance onset and errors were the measures. In the earlier experiment (1976), subjects were presented with regular and irregular verbs and had to produce their past tense form. He found that latency was a function of the number of phonological rules that specified the difference between the root and the inflected form. Thus producing felt from feel took longer than producing tapped from tap because of the vowel alternation in the former pair. This difference could not be ascribed to the regular/irregular factor because there was a similar difference between two irregular types: dig to dug and hide to hid; they both involve vowel alternation but the latter also involves glide deletion. The errors made also suggested the operation of phonological rules. For example, the application of some, but not all the necessary rules was suggested by errors like maig (going from make to made), and cat (going from catch to caught). In both these cases, MacKay argues, one more phonological rule needs to be applied, a consonant change and a vowel change respectively. Another kind of error suggested that the wrong rules were being applied. For example, the misapplication of the "common" rule to produce maked from make, rather than the correct and more specific rule(s) to produce the irregular made. In the later study (1978) Mackay applied the same logic to the production of nominal forms from their verbal base, with similar results and conclusions. For example, the production of conclusion from conclude took longer than that of government from govern (latency to utterance onset was the measure). This was because the phonological adjustments needed to produce government from govern are less (nil) than those required to produce conclusion from conclude (involving the phonologically complex operation of palatalization). MacKay concluded that these results were evidence for the independent storage of affixes and for the operation of stem modifying (phonological adjustment) rules. He does not however rule out the possibility that morphologically complex words are also represented as whole, independent, phonetic units. It is not clear from MacKay's discussion whether his remarks are confined to the phonology of morphemic processes or whether they are intended to extend to the semantic domain. In any event, the minimal claim is for the existence of phonological redundancy rules.

A study by Myerson (1978) was also concerned with the oral production of derivatives, but with children (ages 8 to 17). These children were presented with nonce words, from which they had to produce the (nominalizing) derivative. Myerson looked at three phonologically regular derivations: palatalization (e.g. distort to distortion), vowel shift (e.g. sane to sanity), and stress and vowel shift (e.g. moral to morality). Ability varied with age, but in general no child produced the correct version of the vowel shift derivative (sanity); less than 35% of children produced the vowel and stress shift derivative correctly (morality); and between 20% and 50% palatalized successfully. These results seem to support the notion of the application of phonological rules. However, there seems to be a peculiar feature of these results, namely, that the children seem more successful with the more complex palatalization than with the relatively simple vowel shift. This suggests that we should be alert, when speaking of rules, to the Glushko issue: that the ability to produce these words may reflect only the ability to call on the resemblance to similarly structured real words. This would not be trivialising the ability to produce these words, for it would depend on a cognizance of the relationship between the root of the model (e.g. distort) and the derivative (e.g. distortion), an issue that is of interest.

Stress is a phonological feature that is not directly represented in English orthography and the assignment of stress is claimed by Chomsky and Halle to be describable by a number of ordered rules (phonological redundancy rules). The ability of students to assign stress to nonce words in a way predicted by these rules has been investigated by Baker and Smith (1976) and Smith and Baker (1976). They found that stress assignment was governed by a number of factors in a manner that generally supported Chomsky and Halle. Phonemic structure, such as whether the second vowel of a bisyllabic word was lax or tense affected stress assignment; spelling patterns such as doubling of medial consonants and silent final e also affected stress assignment; and finally, form class worked in conjunction with perceived morphemic structure to influence stress assignment. Apart from further substantiating the general notion that subjects are capitalising on a general knowledge of certain phonological redundancies (presumably rule based, but again we are alert to the Glushko issue), these results also show that subjects are alert to phonemic, orthographic, morphemic and syntactic information generally, and that they are capable of integrating this information in a complex fashion.

In this discussion we began by considering the complexities and irregularities of derivational relationships, we then considered some of the ways in which the orthographic, the phonological and the morphemic forms of a word co-varied, and touched on the notion of an optimal orthography. The notion of "derivational redundancy" was then discussed with reference to the mental lexicon and then we considered empirical studies that were concerned with the psychological reality of morphemic structure and of phonological redundancy. The experiments to be reported in the next chapter should be considered in this general context of the psychological reality of linguistic, specifically derivational morphemic, structure.

# CHAPTER FOUR

## 4. Introduction.0

The five experiments to be reported in this chapter are designed to assess the psychological reality of three prefixes: be-, im- and pre-. The selection of pre- was on the basis of the productivity of pre- and the intuition that it is one of the better known prefixes. Im- is interesting in that it has two clearly different senses: one is a negative sense as is found in improbable, while the other is a prepositional sense as is found in import or immigrate. The intuition concerning im- was that in its negative sense it is (in the author's vocabulary, in the first instance) reasonably salient and reasonably well known even though overshadowed by un- (to which it has given way with respect to productivity - Marchand, 1969). In its prepositional sense it is neither of these. Be-, again in my vocabulary, only seems to be evident as a prefix in a very few words like belittle and belabour and even in these few items it is not really very clear what sense is conveyed by the prefix. The intuition was therefore that be- was likely to be little known as a prefix.

The major theme of these experiments is that there are certain features of orthographic form, phonological form and meaning that co-occur in various ways to signal to different degrees whether an item is prefixed or not. The question is whether subjects are sensitive to these features and their patterns of co-occurrence.

There are, accordingly, several aspects of the orthographic and phonological forms as well as of the meaning of these three prefixes that merit consideration. These will be referenced as the experiments to which they are relevant demand: for the present we will briefly discuss some general observations, drawn partly from Marchand (1969) but mainly from and on the basis of entries in the Concise Oxford English Dictionary.

Pre-. This prefix is Latinate in origin and a number of the words of which it is a part are hence possessive of stems that are not words in their own right (e.g. preliminary). It is chiefly a verbal and substantival prefix though adjectives are not scarce. It lends to the item a general sense of "before" which may, according to the Concise Oxford English Dictionary, be realized in several forms: with respect to time (e.g. preconceive, precedent); to place (e.g. preposition, prefix); to order (e.g. preface) and to rank (e.g. preside, prefect). A general point that some of these items exemplify is that the sense of the prefix (in this case of pre- the sense of priority) varies, depending on the part of speech of the item. This variation is however redundant in that it is presumably predictable from the systematic and intrinsic differences between the different parts of speech in general. More seriously, this classification is somewhat idealized in that the categorization of any particular item is often not beyond dispute (for example preface could be referenced to either of time or place). Indeed, whether or not an item conveys the sense of priority at all is often arguable: consider for example the senses in pretext, pretend, or precipice, all of which are prefixed by the etymological criteria of the C.O.E.D. or Marchand. There seem to be at least two general senses of pre- that are found in a number of words and that cut through this fuzziness of meaning and the problems it presents. These two senses are used in some of the experiments to follow. One is found in substantives such as prelude, preliminary, preview and preface and is a sense of an initial "something" that occurs before "something else". The second sense is also found in substantives like presentiment, prejudice and preventive, and is one of "something" that has reference (is some kind of harbinger) to some future "something".

Im-. This prefix is also Latinate in origin and is one of the assimilated forms of the prefix in-, occurring before b, m, and p. It has two main senses. Firstly, it has a negative sense in which form it is a predominantly adjectival prefix (with a sense of "not" as in immoral) but does also occur in substantives (with the sense "lacking, want of", as in _imbalance_). An observation whose psychological status will be tested later is that the status of these negatively sensed adjectival items is very often signalled by an adjectival suffix, especially _-able_ (e.g. _impeccable_, _impossible_, _impecunious_). They also tend to be trisyllabic or longer, in contrast to the _im-_ words with a prepositional sense which tend to be trisyllabic or shorter. In these latter items _im-_ can convey one of several sub senses: a sense of "in"; a sense of "on"; a sense of "towards" and a sense of "against". The sense of "in" is found in various shades. For example, those in _imprison_, _implicit_ and _import_ seem to be subtly different. The sense of "on" is similarly found in different shades but to a possibly greater and more idiosyncratic extent (e.g. _imprint_, _impose_, _impress_, _improve_). Examples of the senses of "towards" and "against" are hard to come by but are found in _impel_ and _impede_ respectively. One of the features of these _im-_ words with a prepositional sense is an alternation of stress with part of speech: thus _import_, _imprint_ and _impulse_ are all nouns and as such receive first syllable primary stress; when they or other such _im-_ words are verbs they receive primary stress on the non-initial (e.g. second) syllable. This will be discussed in greater detail later; for now we only note that the co-occurrence of short _im-_ words, non-initial primary stress, verbs, and a sense of "in" is used in the experiments that follow.

_Be-_. This is a native prefix (i.e. Old English) and is historically a form of the particle "by". It has formed chiefly transitive verbs, but also some intransitive verbs (e.g. _belong_) and some reflexive verbs (e.g. _behave_). There is a small coherent set of _be-_ words that are not verbs and which embody the prepositional sense of the prefix: _before_, _behind_, _below_, _beside_, _between_. Among the verbs, the meaning that the prefix conveys is both imprecise and variable, for historical reasons. The original locative sense (e.g. _beset_, _beslaver_) was mixed to a greater or lesser degree with a sense of intensification (e.g. besmear, bedrug, bes eech, bedeck). In other words the sense of intensification became one of privation (e.g. behead, bereave), while in still others the prefixed words came "adrift" from the root, which sometimes fell into disuse (e.g. begin, believe, betray and become). When the root of the verb is a noun (e.g. becloud, begirdle) the sense is one of "to cover with, to treat in the manner of" while when it is an adjective the sense is one of "to make" (e.g. befoul, becalm). The sense then, of be- is not one that is precisely specifiable. However, some generalities do hold for a majority of the items: they tend to be predominantly verbs; there is a sense of excess or intensification and a sense that the action of the verb causes a change in the object. (As an example of these generalities, one of the nonsense be- words used later is given a meaning "to drench; to soak thoroughly").

There are some generalizations that seem to hold for all prefixes and the psychological validity of these will be tested. One of these is that monosyllabic words are not prefixed (e.g. best, preen and imp). Also not prefixed are polysyllabic words where the "stem" is not an orthographically legal string (thus words like better and presbyter are never prefixed). On the other hand, words where the stem is a known word in its own right are likely to be prefixed, provided that the meanings of the stem and the whole word are connected (thus preconceive is prefixed but bedad is not).

The first experiment asked subjects a series of questions about prefixes. They were asked to define a prefix; to state whether the letter strings pre-, be- and im- were prefixes and if so to give their meanings, and finally to provide prefixed and non-prefixed examples for each of these prefixes. The purpose of this final question was to get some idea of the kinds of words that were and were not regarded as prefixed.

This theme was pursued in the second experiment where subjects were presented with sets of words beginning with be-, im- and pre-. The sets were heterogeneous in character with respect to structure and meaning and subjects were required to rate each one for its likelihood of being prefixed. The question here is whether the factors that govern subjects' responses are those that determine, or correlate, with the status of these words.

The third experiment investigated the degree to which subjects were sensitive to those elements of the orthographic and phonological structure of words that relate to their prefixed status. This was done by presenting subjects with nonsense words (i.e. divorced from meaning) which were generated specifically to embody these elements (e.g. number of syllables, stress pattern), and by requiring subjects to rate each one for the likelihood of being prefixed.

The fourth experiment involved a forced choice task. Each member of a subset of the nonsense words used in the last experiment was presented with two meanings and the subject was required to state which of the two meanings best fitted the word. One of the meanings contained the component associated with the prefix on the item while the other was a control meaning. Subjects who knew what the prefix meant would have been able to have picked the correct meaning significantly more often than the control meaning.

The final experiment pursued this question of whether subjects knew and were able to use the knowledge of what a prefix meant. This was tested by comparing their ability to learn prefixed word/prefixed meaning paired associates relative to control pairs.

# 4. EXPERIMENT.1

## INTRODUCTION

The first experiment consisted of a number of questions. These are to be found in Appendix 4.1.1. Subjects were first asked to define a prefix as comprehensively as they could, the point of this being to get an idea of the state of subjects' formal knowledge. The next question prompted them with the information that un- was a prefix and encouraged them to add to the answer they had given in question one. This prompting was directed at those subjects who perhaps knew what a prefix was but did not know that prefix was the name for it.

The third and fourth questions required subjects, respectively, to list as many prefixes as they could within five minutes and to give the meanings of these where they could. Answers to these questions provide information firstly as to the state of explicit knowledge and secondly as to the relative psychological status of the various prefixes, i.e.: how many subjects cite pre- relative to be-; for which prefixes do they know the meaning; is knowledge of the meaning synonymous with knowledge of prefix status?

The fifth question pursued these questions of explicit knowledge and ranking by requiring subjects to say which of three prefixes (pre-, be- and im-) and three distractors (tre-, fe- and am-) were prefixes and to give the meanings of the positive instances. The sixth question sought to determine the criteria used to answer question five by asking subjects to list the words they had thought of, both positive and negative instances, when deciding the status and meaning of each of the prefix strings.

Question seven was merely an exhortation to subjects to write down all the words they had thought of when answering question five.

Before question eight subjects were given a brief definition of a prefix and, citing un- as an example, the point made that there were no clear cut distinctions between prefixed and un-prefixed words. Accordingly, in question eight they were asked to generate six words for each of the categories "prefixed", "don't know" and "not prefixed", for each of be-, pre- and im- . These were, they were told, theoretically prefixes. The point of this task was to get an idea of the kinds of principles underlying subjects' partitioning of these sections of their vocabulary according to a criterion of "prefixedness".

## METHOD

### Subjects

Twenty subjects, 10 male and 10 female, participated in the experiment to fulfil first year psychology course requirements. Nineteen subjects had done English to at least 'O' level and five had done Latin to 'O' level.

### Procedure

The booklet of questions given to each subject (see Appendix 4.1.1) was self-explanatory but subjects were encouraged to seek clarification of any question they found ambiguous.

### Glossary of Terms Used

(p + S. known): This refers to prefixed words where the stem is a known English word and where the meaning of the whole is related to the parts. E.g. improbable, belittle, preconceive.

(p + S. ety): This type consists of all those words that are prefixed according to an etymological criterion (source: Concise Oxford English Dictionary). E.g. prevent, begin, immune.

($\overline{\text{prefix}}$): This refers to all other words beginning with the prefixed letters. E.g. press, beggar, imp.

## RESULTS

Questions 1 and 2

90% of subjects considered a prefix to be a verbal element occurring at the beginning of a word; 60% further considered it to qualify the meaning of a word. After prompting with un- this latter percentage rose to 85%. These results indicate that first year university students have a sound definitional knowledge of prefixes.

Questions 3 and 4

Presented in Table 1 are the results of these questions, for the three prefixes of direct concern: pre-, be- and im-. Details concerning the other prefixes generated are to be found in Appendix 4.1.2.

| Prefix | Frequency: citations | Rank Order | Frequency: correct meaning |
|---|---|---|---|
| pre- | 12 | 2 | 12 ("before") |
| im- | 9 | 4 | 4 ("not") |
| be- | 2 | 32 | 1 ("to make") |

Table 1

Frequency of citations of pre-, be- and im- as prefixes (max. 20 subjects), rank ordering on the basis of these frequencies (data concerning other letter strings cited are in the Appendix 4.1.2), and the frequency of correct meanings given.

These results indicate that pre- and im- are among the best known prefixes (only un- is cited more frequently than pre-) while be- seems little known. ("To make" is taken to be an approximately correct meaning of be-.)

Question 5

The results obtained from free generation (table 1) were substantiated when subjects were required to state whether or not they considered pre-, im- and be- to be prefixes and to state their meaning(s), these items being presented with the distractors tre-, fe- and am- . (In fact mis- and o- were also presented as requiring responses for reasons which we shall not go into here - they will not be discussed further). Table 2 presents the data concerning these six letter - strings.

| Prefix letters | Frequency: positive responses | Frequency: meaning |
|---|---|---|
| pre- | 20 | 7 ("before") |
| im- | 18 | 11 ("not") |
| be- | 7 | 2 ("to make") |
| tre- | 1 | 1 ("three"(!)) |
| am- | 5 | 2 ("not"(!)) |
| fe- | 0 | 0 |

Table 2

Frequency of positive responses with respect to prefixation for each of three prefixes and three distractors. Frequency of meanings given for these letter strings and, in brackets, the meanings given (max. possible for each string is 20).

The number of positive citations of am- indicates that the number of citations may not be a reliable index as to the degree to which a letter string is known as a prefix. The frequencies with which the correct meanings are given are reliable. Notice also that there are no instances of the second meaning of im- being given (im = in).

Question 6

There is only a limited amount of data concerning the kind of words subjects were thinking of when they were answering the last question because many subjects left this question unanswered. However, some information is available.

(a) be- Four subjects who regarded be- as a prefix provided data, citing as positive examples items such as belittle, behead and bewitch as well as before and behind. Four subjects said that be- was not a prefix and produced negative instances such as before, begin, because and become. A tentative characterisation of these results is that verbs of the form (p + S.known) are regarded as positive instances while other words are of an indeterminate or negative status.

(b) im- Eighteen subjects provided data for this prefix. These break down as follows. One subject did not regard im- as a prefix and his decision was seemingly based on implement. One other subject regarded im- as a prefix and had based his decision on immolate and impersonate. Four subjects produced idiosynchratic responses. For example, one said that im- meant "lasting forever" and cited immortal as an example. The most interesting group consisted of the remaining 12 subjects: ten of these had said that im- meant "not" and all twelve produced items such as impossible and impolite as examples. The characterization proposed for be- words seems appropriate here too - that is, words of the form (p + S.known), in this case with the meaning "not", are regarded as positive instances of the prefix im-.

(c) pre-. Data were obtained from 18 subjects, fifteen of whom had said that pre- meant "before". Three of these eighteen had only produced the item prefix; we disregard these as this particular single item seems an insufficient basis for interpretation. Of the remaining 15 subjects, 8 produced positive examples of the variety presuppose, prehistoric and prerequisite (all had given the meaning of pre- as "before"). The remaining 7 subjects produced items that were either only of the type precursor and previous (4 subjects) or were a mixture of the two types. These subjects show some indication that their conception of pre- as a prefix extends to items of the form (p + S.ety). The most secure generalization however, is again that items of the form (p + S.known) are considered examples of the prefix pre-.

Question 8

We turn now to a consideration of the data produced by subjects required to generate im-, be- and pre- words for each of the three categories "prefixed", "don't know" and "not prefixed".

(a) be- Table 3 presents the number of items generated according to class ("prefixed" etc.) and word type (e.g. (p + S.known)). The partition into the word types found in Table 3 is partly on the basis of the results obtained in the previous section and partly on the emergence of these types as a result of the kind of structural and etymological considerations discussed at length in the Introduction to these experiments.

We see from Table 3 that the majority of items in the "prefixed" category are of the (p + S.known) type, (64%). Thus here we find items such as belittle and begrime. The remaining items in this category are of no interpretive significance in that they also occur in large numbers in other categories. However, even these (p + S.known) words occur in other categories in large numbers. Thus while 60% of them occur in the "prefixed" category, 32% also occur in the "don't know" category. These results indicate that "prefixedness" and words of the (p + S.known) type are only loosely equated for the prefix be-.

The other word type of interest in Table 3 is the $(\overline{\text{prefix}})$ type. They account for 70% of the items in the "not prefixed" category and 90% of them occur in this category. These results indicate that words such as bear and better are not regarded as being prefixed.

These results are a little misleading in that they tend to gloss over individual differences, particularly those of a group of five subjects. The combined results of these five subjects are in be-

| | "prefixed" | "don't know" | "not prefixed" |
|---|---|---|---|
| a) Verbs with the structure (p + S.known). eg. belittle. The meaning is related to both morphemes. | 30 (20) | 16 (2) | 4 (1) |
| b) Prefixed words with a prepositional sense. e.g. before, behind. | 10 (0) | 17 (4) | 7 (1) |
| c) Verbs with the structure (p + S.ety) and derivatives. e.g. bestow, behave, belong. | 5 (1) | 20 (6) | 15 (3) |
| d) Non-prefixed words $(\overline{\text{prefix}})$. e.g. monosyllables such as bear; beggar, begorra. | 2 (0) | 8 (3) | 76 (15) |

Table 3

Frequency of be- words generated in each of three categories: "prefixed", "don't know" and "not prefixed". Also classified according to word type, e.g. (p + S. known). The figures in brackets are the frequencies for five subjects whose notions of what exemplars are seem particularly clear (see text for further details).

brackets in table 3. Of particular interest is that these five subjects' results account for 20 of the 30 items of the type (p + S.known) in the "prefixed" category. For these subjects the category "prefixed" consists almost only of this type (95%) and this type occurs almost exclusively in this category (85%). Similarly the category "not prefixed" for these subjects consists largely of items of the type $(\overline{\text{prefix}})$ (75%) and these items are confined largely to this category (83%). These subjects then, have a clear idea of what items they regard as prefixed ((p + S.known)) and what as not prefixed ($(\overline{\text{prefix}})$).

Removal of these subjects' data leaves a residue that indicates that the remaining subject do not regard (p + S.known) items as being prefixed with any reliability.

(b) im-: Table 4 presents the number of im- words generated, partitioned according to category and word type in a manner similar to that of be- words.

The majority of items in the prefixed category are of the type (p + S.known) with a negative sense (i.e. "not") (78%). Examples are improbable, immature and impolite. Also, these items are almost completely restricted to this category, 95% of them occurring here. These results indicate that items such as immature and impolite are reliably regarded as prefixed. The remaining items in the "prefixed" category do not form a coherent group. Notably, words where the stem is a known word but where the meaning is not "not" but "in" or "on" (e.g. impress, imprint) are not restricted to this category. The same generalization applies to etymologically prefixed items with a negative meaning, e.g. immune, immediate and immense.

The other type of word that falls clearly into a category is the $(\overline{\text{prefix}})$ type, such as imp, imagine and imitate. These items, some of which are both structurally and etymologically precluded from being prefixed, occur almost exclusively in the "not prefixed" class (93%). Subjects can reliably identify these words as not being prefixed.

All other word types in Table 4 occur in the "don't know" and "not prefixed" categories.

There are five subjects to whom these generalizations do not apply. Three of these subjects account for 13 of the 19 "deviant" words occurring in the "prefixed" category (i.e. they account for 13 of the words im-

| | "prefixed" | "don't know" | "not prefixed" |
|---|---|---|---|
| a) Words meaning "not" and with the structure (p + S.known), e.g. impolite, imbalance. | 69 | 3 | 1 |
| b) Words meaning "not", with the structure (p + S.ety), e.g. impeccable, immune. | 2 | 11 | 15 |
| c) Words meaning "in, on, into, towards, against" with the structure (p + S.known), e.g. impress, and with the structure (p + S.ety), e.g. immerse. | | | |
| (p + S.known) | 4 | 4 | 1 |
| (p + S.ety) | 11 | 25 | 30 |
| d) Non-prefixed words (prefix). e.g. imp, imagine. | 2 | 0 | 26 |

Table 4

Frequencies of im- words generated in each of three categories: "prefixed", "don't know" and "not prefixed". Also classified according to word type.

not of the (p + S.known) (with negative meaning) variety.) Thus the words occurring in the "prefixed" category of these subjects were a mixture of several types and are not amenable to generalization (all of the three had said earlier that im- was a prefix but only one had given the correct meaning - one of the others had given an incorrect meaning and the third no meaning at all). The other two subjects gave reason to believe that they had little idea of what examples of prefixed im- words might be: each had generated a total of only three items for both the "prefixed" and "don't know" categories. One had said earlier that im- was not a prefix while the other had said that it meant "lasting forever" and had produced the words immortal and immemorable as examples.

Only one subject showed that his notion of the _im-_ prefix might extend beyond items of the (p + S.known) type (with negative meaning). He also cited _import_, with a special note that this was to be distinguished from the other examples.

(c) _pre-_. Table 5 presents the data for _pre-_ words. In the "prefixed" category, 60% of the words generated are of the (p + S.known) variety, e.g. _presuppose_ and _prefabricate_. Also, these

| _pre-_ | "prefixed" | "don't know" | "not prefixed" |
|---|---|---|---|
| a) Words with the structure (p + S.known). e.g. _presuppose_, _preview_. | 55 | 3 | 0 |
| b) Words with the structure (p + S.ety) e.g. _predict_, _prevent_, _preliminary_. | 39 | 43 | 51 |
| c) Non-prefixed words (prefix), e.g. _press_, _pretty_, _precarious_. | 0 | 0 | 25 |

Table 5

Frequencies of _pre-_ words generated in each of the classes "prefixed", "don't know" and "not prefixed". Also classified according to word type.

words rarely occur in any other category (95% occur in the "prefixed" class) indicating that they are reliably regarded as prefixed.

The remaining items in the "prefixed" category are of the (p + S.ety) variety, e.g. _predict_, _prelude_ and _prevail_. This type also occurs in the "don't know" and "not prefixed" categories and no attempt to break this class down into sub-groups and thence arrive at a generalization was successful.

All of the unprefixed words (type: $(\overline{\text{prefix}})$) occur in the "not prefixed" category, indicating that these subjects can reliably identify non-prefixed words.

## SUMMARY

First year University students had a good definitional knowledge of the notion "prefix". From both their free generation of prefixes and their meanings, and from their responses to explicit questions it was evident that pre- was well known to them, im- (with its negative meaning) slightly less so and be- hardly at all. Im, with its prepositional sense, e.g. "in", "on" etc., was not known to them at all - this also emerged from the other analyses. An analysis of the kind of words subjects were thinking of when making decisions as to the prefix status of these strings revealed that in all these cases the existence of words with a structure (p + S.known) was the basis for a positive response. An analysis of words generated by subjects for each of these prefixes in the categories "prefixed", "don't know" and "not prefixed" revealed that for pre- and im- (in its negative sense and for fifteen subjects) words of the type (p + S.known) were reliably regarded as being prefixed while words of the type $(\overline{\text{prefix}})$ were reliably regarded as not being prefixed. This also was the case for be- but only with respect to five subjects.

## 4. EXPERIMENT 2

### INTRODUCTION

The last experiment suggested that words consisting of a prefix and a known word as a stem were regarded by subjects as being prefixed. Similarly, words that are not prefixed, such as monosyllabic words, were regarded as not being prefixed. The experiment however, relied on subjects generating words and because of this there remained a number of questions, some of which the present experiment seeks to answer.

The experiment consisted of presenting subjects with a number of words beginning with im-, be-, pre- and o-. The words in each set varied with respect to prefix status, form class, and meaning, among other factors, and subjects were required to state whether they regarded each word as being prefixed or not.

A necessary but not sufficient condition for a word to be prefixed is that it begins with particular letters such as im-, pre- and be-, letters which are traditionally (i.e. etymologically) prefix letters. (In this experiment as well as in those to follow the criterion of prefixed status is an etymological one with the Oxford English Dictionary as authority.) Thus words beginning with o- are not prefixed.

An easily identifiable subset of non-prefixed words that begin with prefix letters consists of monosyllabic words (e.g. press, imp , best). A second subset of such items is that consisting of polysyllabic words with a "stem" that is an orthographically illegal string (e.g. better = be + tter; pretzel = pre + tzel). Both of these subsets, and other items that are not prefixed, have in common the feature that they do not possess the semantic component associated with the relevant prefix (e.g. they do not mean "before", if pre- words). All these words should be identified as being not prefixed if subjects are sensitive to these factors.

Even though prefixed words should all possess the relative semantic component we have seen that this is not always the case and so it is likely that subjects' responses to prefixed words will not be uniformly positive (assuming meaning to be a determining factor in the response).

A prefix such as im- has two senses, one that conveys the negative (e.g. imbalance) and one that conveys the prepositional (e.g. immigrate). The words with a negative sense seem to form a coherent group while those with the prepositional sense are further subdivided into those meaning "in", those meaning "on", those meaning "towards" and those meaning "against". In view of this it is not clear whether prefixed im- words will all receive equally positive responses.

Those prefixed words with a known word as stem seem particularly salient and indeed the last experiment substantiated this intuition. It is not clear however whether subjects would regard all such items as being prefixed or whether their positive responses would be more discriminating in being restricted to items where the relationship between the stem and the word was clearly derivational, rather than non-existent (e.g. immeasurable and prevent respectively (vent and prevent are not related) ).

We would expect on the basis of the last experiment that words with a stem that is not a known (related) word (e.g. preclude, bereave and immune) would arouse more uncertainty than those words where the stem is a known (related) word. This is not to say though that these (former) words would not be regarded positively.

Finally, there is reason to suspect that the stress pattern of a word might affect the response it receives. In general, the prefix in a prefixed word does not receive primary stress (Marchand, 1969) and so words like impotent and impious might be regarded more negatively than comparable words like impure and immoral.

## METHOD

### Subjects

Ten male and ten female psychology first year undergraduate students took part in this experiment to fulfil course requirements. All had done English to "O" level, eight German, and two Latin.

### Materials

Each subject was presented with a list of 233 words. These fell into four groups: 67 beginning with pre;; 73 beginning with im-; 63 beginning with be- and 30 beginning with o-.

The words in each group had been selected with several factors in mind: their (etymological) prefix status; their syllabic structure (mono-, bi-, etc.); their stress pattern (prefix stressed, prefix unstressed); their form class (noun, verb); their derivational status (e.g. suffixed); their morphemic salience (e.g. stem a known word) and their meaning (im- in the negative sense and in a prepositional sense). In short, they were selected according to any variable that it was felt might affect their prefix status. The full list of words is presented in Appendix 4.2.1.

### Procedure

Subjects were presented with a list of the words, randomised and typed in upper case. Attached to each list was a set of instructions.

Subjects were told that the experimenter was concerned with their intuitions about prefixes. A prefix was defined and un- cited as an example. They were told that the dictionary was an unreliable source as to whether a word was psychologically prefixed or not because of a number of historical processes. Accordingly, their opinions on a number of words were being canvassed. They were asked to rate each word on a six point scale (1 - definitely not prefixed; 2 - probably not prefixed; 3 - more no than yes; 4 - more yes than no; 5 - probably prefixed; 6 - definitely prefixed), and having marked each word, to underline the prefix letters in those instances where their response had been positive. If a word was not known to them they were asked to mark it (these were omitted from the analysis). Finally, they were asked their age, their sex and whether they had done any or all of English, Latin, and German, to "O" level.

At the end of the experiment they were asked what meanings each of pre-, im-, be- and o- had for them. They were then debriefed.

The full instructions are in Appendix 4.2.2.

## RESULTS

Subjects rated each word on a six point scale and so a measure of the degree to which their responses were positive or negative is whether a significant number of subjects made a response that was greater than or equal to a particular value. For example, if fifteen subjects or more out of twenty (significant on the sign test at 0.05, which provides the critical number in all cases) rated a word with a score of 5 or more then we interpret this to mean that a significant number of subjects considered the word "probably prefixed" (this being the verbal label corresponding to 5). Another example, if a significant number of subjects did not make responses more than or equal to 4 (the least certain positive response), or less than or equal to 3 (the least certain negative response), then this set of responses was classified as uncertain. This measure was used for individual words as well as for the overall response to a set of words. In this latter case the mean for those words was computed for each subject and the number of these occurring above or below a certain number used. Finally, in the results that follow reference to a response being positive or negative implies significantly positive or negative - the qualification "significantly" is not always used.

All words used in this experiment are to be found in Appendix 4.2.1, together with mean response rating scores, the critical number above or below which a significant number of responses occurred, and for pre- words the mean priority rating (we shall deal with this shortly).

Presented in Table 1 are the mean response rating scores for all the sub-groups of words referred to.

Pre-. Pre- words that are not prefixed, such as press and prehensile, elicited an overall response that was significantly negative ($\leqslant 2$). The overall mean for these words was 1.7.

There is a set of prefixed words that have a sense of "before" that refers to rank. Examples are prefer and prefect. These words have been separated from otherwise comparable items because of the intuition that these fairly easily identifiable items have a rather specialised sense of "before", a sense of dominance, that is not found in other pre- words. The seven words used elicited an overall response that was uncertain. Individually, five of the seven elicited various degrees of negative response with two eliciting uncertain responses. The overall mean was 2.4.

There is a set of prefixed words that do not have a known word as a stem and that convey the sense of "before" to varying degrees (those with the special sense referring to rank are part of this set but have been dealt with separately and are not included here). Thirty two of these words (e.g. precursor, preclude, predict, precinct) elicited an overall response that was uncertain. Individually, this was also the case with seventeen of the words, with the remaining fifteen

| pre- | im- (negative sense) | im- (prepositional sense) | be- |
|---|---|---|---|
| Not prefixed 1.7 | Not prefixed 1.62 | | Not prefixed 1) monosyllabic 1.03 2) illegal "stem" 1.11 3) wrong stress 1.13 |
| Prefixed. Stem not a known and related word 1) general meaning 2.8 2) "rank" meaning 2.4 | Prefixed. Stem not a known and related word 1) general meaning 3.3 | Prefixed. Stem not a known and related word. 1) Meaning: "in" or "on" 2.91 2) Meaning: other 2.69 | Prefixed. Stem not a known and related word. 1) General meaning 2.30 |
| | | | Prefixed. Prepositions. 2.86 Prefixed. Stem is a known but not related word. 2.80 |
| Prefixed. Stem is a known and related word. 4.60 | Prefixed. Stem is a known and related word. 5.10 | Prefixed. Stem is a known and related word. 4.06 | Prefixed. Stem is a known and related word. 4.20 |

Table 1

Mean response ratings for sub-groups of pre-, im- and be- words. (Further details in the text.)

eliciting varying degrees of negative response. The overall mean was 2.8. We shall return to these words shortly.

Words that are prefixed and that have a stem that is a known word related in meaning to the prefixed word elicited an overall response that was significantly positive (scores $\geqslant 4$). Responses to all but one of the fourteen words (e.g. premature, presentiment) were also positive to different degrees. The overall mean for these words was 4.6.

Prefixed pre- words with a stem that is not a known related word (e.g. precursor, precinct) vary in the degree to which they convey the sense of "before". This, taken together with the observations that they do not seem to vary in any other systematic way and that they elicited responses ranging from 1.35 to 3.75 suggested that their meaning might be an important component in the responses. Accordingly all the pre- words used were given to five judges with instructions that they were to rate each word on a four point scale for the degree to which it conveyed the sense of "before". They were told to rate as four, words like press and prehensile which do not convey the sense of "before", and to rate as one, words like prehistoric and preview (noun) which convey the sense of "before" with considerable clarity. The mean "priority rating" for each of these thirty two words was correlated with the mean response rating for each word (Spearman's rank order correlation). The value of the correlation coefficient was -0.67 which is significant ($t = 4.91$; d.f. = 30; $p < .001$, 2-tailed). This result indicates that the meaning of these pre- words is a component in their prefixedness ratings: the greater the degree to which these words mean "before", the more likely it is that they will be perceived as being prefixed.

The degree to which a word means "before" was also clearly influential in determining the responses that other groups of pre- words dealt with received, though the size of this influence is difficult to assess because other factors were also varying in these groups. However, we note that the non-prefixed words (mean response rating 1.7) received a mean priority rating of 4.0; those prefixed words with a sense referring to rank (mean response rating 2.4) received a mean priority rating of 3.76; those prefixed words with a known related word as stem (mean response rating 4.6) received a mean priority rating of 1.43; and those prefixed words with a stem that is not a known related word (the words just discussed, with a mean response rating of 2.8) received a mean priority rating of 2.8. These results then, seem to support the notion that meaning and prefixed response co-vary.

A small number of words were not included in any of these groups and have been put into a residual group.

A comparison of some interest is that between pre- words which have a known and related word as stem and those where the stem is not a known word. The question here is what difference the identity of the stem makes. Nine words of each kind, selected to form pairs matched as far as possible for features like part of speech and meaning (using the priority ratings), were compared. For each subject the means for the nine words of each kind were calculated and compared in a Wilcoxon matched pairs test. Responses to known-word-stem items was significantly more positive than to the other items (Means: 4.38 and 3.65 respectively; Wilcoxon, $p < .05$, 2-tailed). (Mean priority ratings for the two sets were identical, 1.4 (i.e. the meaning "before" was evident in these words to a high degree) ).

Another comparison of interest is whether radicals (e.g. predict) and derivatives (e.g. prediction) are rated as being equally prefixed. Nine radicals and their derivatives were compared for the responses they elicited. The mean of each set of nine for each subject was calculated and compared using the Wilcoxon. There was no significant difference between the radicals and their derivatives (Means: 2.95 and 2.92 respectively). The mean priority ratings for radicals was 2.7 and that for derivatives was 2.8).

The set of prefixed words with a sense referring to rank (e.g. prefect) produced responses that were uncertain in nature (see earlier) but in fact they were only narrowly not significantly less than or equal to 3 (14 of the 20 subjects produced an overall response that was less than or equal to 3). It may then be questioned whether the responses to these words were significantly more positive than responses to non-prefixed words. Mean scores for each of these sets for each subject were compared and were found to be significantly different (sign test: $p < .01$) (recall that means for each groups were 1.7 (unprefixed) and 2.4 ('rank' prefixed) ).

These results with pre- words indicate that non-prefixed words are identified as such and that prefixed words with a known and related word as stem are also correctly identified. The other categories of pre- words elicit "don't know" responses. The significant correlation between the meaning of an item and the response it received indicates that the degree to which a word contains the meaning "before" is a component in the response.

Im- 1) Negative sense.

Im- words with a negative sense and with a known, related word as stem elicited an overall response that was significantly positive (scores $\geqslant 5$). Of the fifteen words used (e.g. impious, impure, imbalance) all individually also elicited positive responses, of different degrees. The overall mean for these words was 5.1.

Im- prefixed words with a stem that is not a known related word (e.g. immaculate, impudent, immediate and impecunious) do not always have a sense that is clearly negative. The overall response to the eight words used was uncertain (neither significantly positive nor significantly negative). Individually, only one of the eight elicited a response that was not uncertain. This one, impecunious, elicited a negative response. The overall mean for these words was 3.3.

A direct comparison of these two groups revealed that the first set (e.g. imbalance) produced responses that were significantly more positive than those of the second (e.g. immediate). (Sign test: $p < .01$).

Words like _impotent_ and _impious_ are (unusually) stressed on the prefix, in contrast to otherwise comparable words like _immoral_ and _impatient_. When the ratings for these pairs were combined and the two types compared, responses for the latter type (e.g. _immoral_) were significantly more positive than those for the former (means: 4.9 (_impotent_ and _impious_), 5.79 (_immoral_ and _impatient_). Wilcoxon: $p < .02$, 2-tailed).

These results indicate that _im-_ words with a negative sense and with a stem that is a known and related word elicit positive responses. Prefixed words with a stem that is not a known, related word are not regarded in either a positive or a negative way. They also suggest that stress is a factor affecting responses though it is a possibility that this "stress result" might be some function of the degree to which _impotent_ and _impious_ (especially the latter) are less familiar to subjects than _immoral_ or _impatient_. (Words that subjects did not know the meaning of were eliminated from these analyses so the issue is one of familiarity, not ignorance.)

2) Prepositional sense.

_Im-_ prefixed words with a prepositional sense can have several meanings: "in", "on", "towards", "against". However, it is only with "in", and to a lesser extent "on" that the meaning is clear in a reasonable number of words. For example, _impede_ and _impair_ more or less account for those words with a meaning of "against". Accordingly, most of the words in this section are treated as falling into one of two categories, one consisting of "in" and "on" words and one consisting of the rest.

A group of six verbs meaning "in" (4 words) or "on" (2 words) with a stem that is a known and related word elicited an overall response that was uncertain. The overall mean was 4.06. However, individually the words elicited different responses: implant, imperil, imprison and imprint elicited positive responses; import elicited uncertain responses and impress elicited a negative response (note that impress has a metaphorical sense which is the most common and in which the sense of "on" is not really clear).

A group of seven prefixed verbs meaning "in" (5 words) and "on" (2 words) with a stem that is not a known and related word (e.g. imbibe, implicate, impinge) elicited an overall response that was uncertain. This held also for the individual words with the exception of one, (implement), which elicited a negative response (scores $\leqslant$ 3). The overall mean was 2.91.

A third group of prefixed verbs combined two words meaning "against" (impair, impede) with two meaning "towards" (impel, imply) and two where the special meaning is not clear (impeach, implore). These words are comparable with the preceding group in all features but meaning. These words elicited an overall response that was uncertain, a result that also held for the words individually. The overall mean was 2.69. A direct comparison of this group with the preceding group revealed no significant difference (Wilcoxon) and so we may conclude that the difference in meaning between these groups makes no difference to the responses elicited.

The groups considered so far have been prefixed verbs which, etymologically, are the radicals. Six verb-noun pairs of words were compared to test whether the part of speech of these items made a difference. There was no significant difference between them (means: verbs 3.12; nouns 2.96; Wilcoxon). Examples of pairs are import: import, immerse: immersion. (A check revealed that there was no difference between pairs where the form of the noun and verb are the same (import) and between pairs where they are different (immerse) ).

There is rather a large group of residual items. They are somewhat heterogeneous in character and as such do not form sub-groups large enough to sustain generalizations.

The final group of im- words consists of a small group that is not prefixed. The overall response to this group of eight words (e.g. impish, image, imagination) was significantly negative (scores $\leqslant$ 2). Individually, all the words elicited negative responses of various degrees. The overall mean was 1.62.

These results indicate that among im- words with a prepositional sense only a very few are regarded positively. Non-prefixed words were all correctly identified as such by subjects.

Be- . Some words that are not prefixed are monosyllabic (e.g. bear, best). The overall response to these words was significantly negative (scores = 1), as were the responses to each of the six words used. The overall mean was 1.03.

Words such as beckon and better are not prefixed and are identifiable by the fact that the letter string after the initial be- is orthographically legal (e.g. -tter and -ckon). These six words elicited an overall response that was significantly negative (scores $\leqslant$ 2). Individually, all six words also elicited negative responses (scores = 1). The overall mean for these words was 1.11.

A third group of non-prefixed words is identifiable by the fact that its members are not verbs and by the fact that even though the letter string after the be- is not illegal the first syllable is stressed (e.g. beaver, beverage and benefit). The five words in this group elicited an overall response that was negative (scores $\leqslant$ 2). In keeping with this, all five items individually also elicited negative responses (scores = 1). The overall mean for these words was 1.13.

Moving on to prefixed words. There is a group of five prepositions consisting of between, behind, before, below and beside that elicited an overall response that was uncertain in nature. This also held for all but one of the words (between) considered individually, which elicited a negative response (scores $\leqslant$ 2). The overall mean was 2.86.

There is a set of prefixed verbs with a stem that is not a known related word (e.g. bereave, begin, beseech). These six words elicited an overall response that was significantly negative (scores $\leqslant$ 3). Four of the six words elicited negative responses of varying degrees and two elicited uncertain responses. The overall mean was 2.3.

A similar group (of prefixed verbs) have the distinguishing feature that the stem is a known word. However, this word is not clearly related to the whole item (e.g. berate, betray and betide (in this last item there is a connection between tide ("fortune") and betide but it is not as clear as that which exists in the next group, from which we wish to distinguish these words) ). The overall response to these items was an uncertain one, a result that also occurred with eight of the eleven words individually. The remaining three elicited negative responses. The overall mean was 2.8.

The last set of be- prefixed words are also verbs but the stem is both a known and a related word (e.g. becalm, bewail, bemuse). These also elicited an overall response that was uncertain. Individually, eight of the words elicited positive responses (scores $\geqslant$ 4) while those to the remaining seven items were uncertain. (There seems no factor that is responsible for this split.) The overall mean was 4.2.

The nature of the stem in these prefixed verbal words seems to make a difference to the responses. A specific check of this revealed that those words with a known and related word as stem (e.g. becalm) elicited significantly more positive responses than (a) those words with a known but irrelevant word as stem (e.g. berate) and than (b) those words with a stem that is not a known word (e.g. bereave) (sign tests: $p < .02$). There was also a significant difference between these latter two types, with the betray type eliciting more positive responses than the bereave type (sign test: $p < .02$). These comparisons suggest that both the identity per se of the stem as a known word and the relatedness of this stem to the whole item are factors that influence responses.

These results indicate that be- words that are not prefixed are recognised as such by subjects and that this applies to all of three sub-types of these words. Responses to prefixed be- words tend to be in varying shades of uncertainty: some elicited responses that were marginally (but significantly) negative while at the other end of the scale a few elicited responses that were marginally (but significantly) positive. The identity of the stem as well as its relatedness to the whole word partially determine the response elicited.

O- Words beginning with o- are not prefixed and were included in the experiment as distractors. All o- words elicited significantly negative responses ($\leqslant 2$).

In each of the four sets of prefixed words dealt with, the subset most likely to elicit a positive response consisted of items with a stem that is a known and related word (e.g. becalm, imperil, immature and premature). Recall that of the four, pre- and im- (with a negative sense) elicited overall responses that were significantly positive while be- and im- (with a prepositional sense) elicited overall responses that were uncertain. The mean response ratings for each group suggested a rank ordering of im- (negative sense) (mean 5.1); pre- (mean 4.6); be- (mean 4.2) and im- (prepositional sense) (mean 4.06). This ordering was tested using a Page's trend test, with slight adjustment. Tables for

Page's trend test are only available for up to twelve subjects while in this experiment twenty subjects were run. Accordingly, the sum of the ranks for each of the four conditions was computed as normal and then halved, as if produced by ten subjects. These rank sums were then used to compute L in the normal way (i.e. $\Sigma(tcxc)$ where tc = rank total for condition c and c = predicted rank of condition). There was a significant trend (L = 277; critical value at .01 = 272).

Subjects had been presented with the four letter strings (*be-*, *im-*, *pre-* and *0-*) at the end of the experiment and had been asked to state what each one meant. All twenty said that *pre-* meant "before", fifteen said that *im-* meant "not" and three (two the same) said that it meant "into". Eleven said that *be-* meant "to make, to do" and four subjects gave spurious meanings for *0-* (e.g. "after"). These results indicate that the meaning of *pre-* is best known, a finding that does not accord with the rank ordering of prefixes based on response ratings. The reasons for this discrepancy are not clear.

Finally, subjects had been asked to underline the prefix letters of words they had marked as prefixed. All but three subjects did this correctly. Of these three, two subjects marked the *imp* in words beginning with these letters. However, some of these underlinings gave the appearance of being somewhat careless, in addition to which these subjects correctly marked the *im* in words beginning *imb* or *imm*. These two observations, together with the fact that subjects' responses were not unusual suggest that these incorrect underlinings were the result of carelessness. The third subject made clearly incorrect underlinings on *pre-* words where the letter string following the *p* was a known word, e.g. *preference* was underlined *preference* rather than *preference*. Again however the subject's results were not unusual and he gave the correct meaning of *pre*. It seems that this subject's knowledge of the *pre-* prefix was not completely secure.

## CONCLUSIONS

Several generalizations may be proposed on the basis of these results, which substantiate the results of the previous experiment and extend them to a certain degree.

Non-prefixed words are quite clearly regarded as such. At the other end of the scale, prefixed words in pre- and im- (negative sense), with a stem that is a known and related word, are regarded as being prefixed; this is true only for a few be- and im- (prepositional sense) words of the same type. Other words are regarded uncertainly.

The identity of the stem as a word in its own right has the effect of increasing the probability of a positive response. There appear to be two components to this: firstly, the identity as a known word has an effect and secondly, the sometimes consequent relationship in meaning between root and derivative has an effect.

The degree to which a word has the meaning of its prefix also has the effect of increasing the probability of a positive response (for pre- in the first instance). In a similar fashion the correct stress also affects the response but as the data on this are somewhat scant the point will not be pressed. Finally, the identity of an item as root or derivative, and hence corrrelatively its part of speech, does not affect the response.

## 4. EXPERIMENT 3.

### INTRODUCTION

The set of words that are prefixed by a particular element such as pre- is a set that is fuzzy. It is fuzzy because it is not always clear which are the members and which are not. This fuzziness derives from the fact that not all items with the particular prefix possess the same semantic sense to the same degree. For example, the sense "before" is not constant across the items preliminary, prefabricate and presentiment. Further confusion arises from the fact that there are other words that begin with the same letters but which do not and never did possess the required sense and as such are not prefixed. (The criterion for being prefixed continues to be an etymological one with the Concise Oxford English Dictionary as the source.)

In this experiment we are concerned with the perception of the morphemic structure of prefixed words and the identification of prefixes.

The fact that morphemes (e.g. prefixes) are linguistic signs suggests that the morphemic structure of a word must be evident to some degree in its phonological and orthographic forms. The question is what aspects of the phonology and orthography signal, or at least correlate with, the morphemic structure.

In the first instance there are quite simply some letter sequences that are (potentially) prefixes while others are not. The reasons why some initial sequences like pre-, be- and im- are prefixes, while others like tre-, fe- and am- are not, are historical, though in psychological terms it seems likely that the psychological status of a particular string will depend on the degree to which this string is the basis for relating a set of items semantically. One question then is whether people regard the initial strings pre-, im- and be- as potential prefixes while regarding tre-, fe- and am- negatively.

Prefixed words have been formed (and are formed) by the general process of adding the prefix element (the initial letter sequence) to a base word. This process of formation suggests that the morphemic structure may be congruent with the syllabic structure at certain points. It may, however, be the case that this congruence is not as clear as it might be because the item was formed originally in Latin or French. Two predictions follow from this congruence hypothesis.

Firstly, monosyllabic words are not prefixed. This prediction is substantiated by the negative status of words such as <u>press</u>, <u>preen</u>, <u>bear</u>, <u>bend</u> and <u>imp</u>, with no counter-examples except for abbreviations such as <u>prep</u>.

Secondly, the congruence of morphemic and syllable boundaries might mean that the location of a syllable boundary will signal the presence of a morpheme. Thus in words such as <u>predict</u>, <u>precursor</u>, <u>bedight</u>, and <u>berate</u> the syllable boundary corresponds to the morpheme boundary and thus signals prefixation. The existence of items such as <u>benign</u> and <u>begorra</u> however, imply that syllabic structure is an unreliable one for morphemic structure since these items are syllabically identical to <u>predict</u> and <u>precursor</u> but are not prefixed. Where the value of the correspondence lies is not in the syllabic structure signalling what <u>is</u> a prefix but in its signalling of what <u>is not</u> a prefix. Thus in words such as <u>better</u>, <u>beserk</u>, <u>pretty</u> and <u>pretzel</u> (all of which are not prefixed) the syllable boundary cannot lie after the <u>be-</u> or <u>pre-</u>, (notice that this only holds if we rely on the orthography) because removal of <u>be-</u> and <u>pre-</u> leaves illegal letter strings. (If we do not restrict discussion of syllable boundaries to the orthography but try to speak of them with reference to only the phonology of the word the location of these boundaries can be contentious.)

In those items where the syllable boundary is not incongruent with a potential morpheme boundary (e.g. <u>begorra</u>) the degree to which it reliably signals a morpheme boundary will vary with the prefix and with the individual's vocabulary. Thus in items such as bedight and berate on the one hand and benign and begorra on the other, the degree to which the location of the syllable boundary after be- will reliably signal that be- is a prefix will depend on the ratio of the number of prefixed items (e.g. bedight) to the number of unprefixed items (e.g. benign) in the individual's vocabulary (assuming of course, that the prefixed items are related in the individual's vocabulary on the basis of their common morphemic element).

Another cue to whether an item is prefixed or not is whether the stem (i.e. everything but the prefix letters) is a (known) word in its own right. The existence of the stem as an independent word is however, only a reliable cue to whether the word is prefixed if the meanings of the prefix, the stem, and the whole word, are related. Thus in words like becloud, premature and impervious the independent existence of the stems signals the prefixed nature of these words, but note that in words like beton, bedad and betony the independent existence of the stems is misleading - these words are not prefixed and are not of the structure "be- plus known word ".

The stress pattern of an item may also signal its morphemic structure. A general rule for the location of primary stress in a prefixed word is that the prefix does not receive primary stress (Marchand, 1969), e.g. belittle, preliminary, impossible and import. The intricacies of stress assignment are not clear and a more detailed discussion is to be found in Chomsky and Halle (1968). For the present all that needs to be understood is that the rules of stress assignment operate in a cyclical fashion and operate on strings that are bounded by non-formative boundaries (i.e. either #, a word boundary, or =, a special boundary (unchristened in Chomsky and Halle)). The importance of these boundaries is that one or other of them lies between the prefix and the stem. In general when the stem is a word in its own right (e.g. belittle) the boundary # lies thus be#little; when the stem is not a word in its own right but is an etymological root (e.g. the -mit in permit, the -liminary in preliminary) then the boundary = lies thus pre=liminary. Both these boundaries then, specify the domain in which stress assignment rules may operate and the prefix lies outside this domain. This is of course a gross simplification in that there are exceptions, both systematic and idiosyncratic, to these generalizations.

One class of word that provides a number of exceptions is the class consisting of deverbal bisyllabic nouns, e.g. permit, transfer, import, imprint and impact. All these items can be both verbs and nouns. As verbs primary stress is assigned to the second syllable (formative) because the intra-word boundary (# or =, it is not important here) between prefix and stem blocks the normal application of the Main Stress Rule. When the stress pattern of the noun form is being derived it takes the stress pattern of the verb as its beginning (the noun is derived from the verb) and because of a special rule, the Stressed Syllable rule, the location of primary stress is shifted to the left, across the boundary. Thus we find the nouns with first syllable stress (import, permit, imprint). The details of the theory and its motivations need not concern us here, we need only note that form class is a factor in stress assignment (c.f. Smith & Baker, 1976), and that the location of primary stress in words like import and impress depends on their form class.

A second class of word that constitutes an exception consists of certain items with the pre- prefix. They are few in number and examples are precedence, premise, preface and presidency. Empirically these words are distinguished by the quality of the initial vowel (|ɛ|) and the location of primary stress on the prefix. What seems to be happening with these words is similar to that for the class just dealt with. They are all derived from verbs (precede, premise, preface (note this seems to be an idiosyncratic exception) and preside) and either the stressed syllable rule or stress adjustment rules (necessitated by the addition of the suffix) produce the resulting stress pattern.

These two classes of exception illustrate a general problem in this experiment: that we are concerned with the degree to which the stress pattern in a word signals morphemic structure but we find instead that it would be factors like the perceived morphemic structure and perceived form class that would partially determine the stress pattern. To anticipate slightly a full description of this experiment - the solution adopted here was to generate the nonsense words required according to two principles: firstly, to mimic as far as possible the structure of the different types of real words that were of interest, so that our relative ignorance of the factors determining stress would be minimal in its effects; secondly, to manipulate strictly phonological factors in order to attract primary stress to certain parts of the word (factors such as the strength of syllables, which have been shown to have psychological reality (Smith and Baker, 1976) ).

Apart from these general cues that seem to point to morphemic structure there are other cues that are specific to a particular prefix. An example of this is that im- words with a prepositional sense tend to be bi-, or at most tri-syllabic (e.g. import, immerse, immigrate) while im- words with a negative sense tend to have more than two syllables (e.g. impudent, impalpable, impracticable). Another specific cue is that im- prefixed items with a negative sense tend largely to be adjectives and this adjectival status is very often signalled in the suffix, e.g. immeasurable, impeccable, impious, impervious.

The preceding discussion has identified some aspects of the phonological and orthographic structure of words beginning with be-, pre- and im- that signal, to varying degrees, the status of a particular item with respect to prefixation. In some cases the cue is more than just a signal in that it is a necessary condition for prefixation. An example of this is the identity of the initial letters. In other cases there is a very strong relationship between word structure and prefixation. The status of the stem as an independent word is an example of this. Finally, there are weak and peripheral cues such as the number of syllables in im- words.

The question posed in this experiment is whether subjects are sensitive to these kinds of structural features and their relationship to morphemic structure and prefix status.

Accordingly, lists of nonsense words were constructed with these elements of structure in mind and subjects were asked to state whether they considered each of these items to be prefixed or not. The fact that these words are not real words means that subjects have to be alert to their orthographic and phonological structure and use their knowledge of the relationship between this structure and prefix status to make non-random judgements. Their responses enable an assessment of the state of this knowledge to be made.

## METHOD

### Subjects

Seven male and seven female first year psychology undergraduates volunteered for this experiment.

### Construction of Nonsense Words and Glossary of Word Types

Each of the prefix elements be-, pre- and im- was paired with a control set of initial letters fe-, tre- and am- respectively. Given any word beginning with a prefix element (e.g. prelade) the control word was generated by substituting the control element for the prefix element (e.g. trelade). On some occasions an additional change had to be made. For example, bew could not be changed to few and so was changed to bey.

In the descriptions that follow reference will not be made to control items unless their generation from the original was sufficiently unusual to merit special mention.

For each of the three prefix elements fourteen examples of each of several word types were generated, e.g. 14 monosyllabic words beginning with be-. The difference between the word types was kept to a minimum. To illustrate: if the fourteen items in, say, word type (a) for be- were bisyllabic, then, unless the number of syllables was a variable being manipulated, items in the other be- word types were also bisyllabic (this was not always possible however - generating nonsense words of a specified structure often presents practical problems).

In what follows the notation used for each word type is followed by a short description of its referent together with examples of both nonsense and real words of the type. The structure of the words used is generally represented thus: (p+Ssub), where p refers to the prefix, S refers to the stem and sub. is some qualifier concerning the stem.

It has already been mentioned that there is a problem of manipulating the location of primary stress and that a partial solution is to manipulate some of the purely phonological factors that affect the stress pattern (after Smith and Baker, 1976). The longer words present less of a problem, as usually by mimicking their orthographic structure stress assignment is taken care of. The problem arises with the bisyllabic items. Accordingly, in order to attract primary stress away from the prefix (i.e. to the second syllable) the second syllable in these words was made "strong". Strong syllables are those with a tense vowel (i.e. long vowel) followed by any number of consonants or a lax vowel (ie. short) followed by at least two consonants. This device for manipulating stress may not be completely natural in that weak second syllables are often stressed, e.g. besot, begin, but it is not inaccurate in that the phenomenon is common, e.g. besmear, impede.

Even given the success of these efforts to manipulate the stress pattern of the words used it is nevertheless a weakness of this experiment that empirical data concerning the pronunciation of the items was not collected.

1) be-

a) (Mono)be. : Monosyllabic words in be-, e.g. bepse; bend.

b) (p+S.neg)be : Bisyllabic items in be- with an orthographic structure that precludes the occurrence of a syllable boundary after be-, i.e. such a division leaves an illegal stem. The second syllable was "strong" to attract second syllable stress. Examples: bertule, berway; better (real word after semi-colon).

c) (p+S.pos)be : As in (b), with the difference that the occurrence of a syllable boundary after be- does not leave an orthographically illegal stem, e.g. beflune , bewray; beget, bedight.

d) (p+S.known)be : Bisyllabic items in be- with a known word as the stem, the nature of this being such that the resulting item could plausibly be a verb (thus mimicking the class of real such words). Some archaic items were used after five informants had judged that these seemed like English words but that they were not known to them. Examples: begrime, beclothe, bedew; belittle.

2) pre-

a) (Mono)pre : Monosyllabic words in pre. Examples: prell, pream; prey, preen.

b) (p+S.neg(stressed))pre : Polysyllabic items in pre- mimicking the structure of words like pretzel. The occurrence of a syllable boundary after the pre- is precluded because it results in a stem that is orthographically illegal. The initial vowel in these words is |ε| and the first syllable tends to receive primary stress. Examples: pretsolation, prendulent and prensid; pretzel, presbyter and pressure.

c) (p+S.pos(stressed))pre : These are again polysllabic items. They mimic words like prevalent and preference. The occurrence of a syllable boundary after pre- is not precluded, the initial vowel tends to be |ε| and the first syllable tends to receive primary stress. Examples: precelation, prefulent, prepid; preference, premier, prevalent.

d) (p+S.pos)pre : These are polysyllabic items in pre- with the occurrence of the syllable boundary after pre- not being precluded. The initial vowel in these words is not |ε| and the prefix does not receive primary stress. These features are taken care of by the fact that either the items were suffixed or, in the case of bisyllabic items, the second syllable was made strong to attract primary stress. Examples: precalify, prefulgence; prevent, precursor.

e) (p+S.known)pre : This refers to prefixed items with a stem that is an independent word and where the word is such that it allows the addition of the semantic component "before". Thus words such as prelight, prevaporous and precoherence were generated. These words accept the addition of the sense of "before" while words such as prewall, pretea, and presing are implausible (their plausibility however varies with context; for example, "we used to drink water in the pretea days" is certainly comprehensible though perhaps the parasynthetic form pre-tea would be used in the written form).

With all the four preceding types of pre- words, as high a degree of similarity as possible was maintained between the four types. For example, the number of bisyllabic and trisyllabic items in each set was approximately the same and the number and type of suffix in each word type was held constant in that -ion occurred in all types, -ive occurred in all types, and so on.

3) im-

There were no monosyllabic im- words as the number of possibilities is limited (imb is the only one that is orthographically legal). Also, only one monosyllabic word, imp, occurs in the language.

a) (p+S.pos)im/neg. This refers to im- words with a negative sense. As these negatively sensed words tend to be polysyllabic (of three or more syllables), with primary stress not on the prefix, and often with an adjectival suffix such as -able, these words possessed all these features. Examples are immonulative, immunderable and impluvious; impeccable, impecunious.

b) (p+S.known)im/neg. These items were as those above but with a known word as a stem and where this word accepts the sense of negation that the prefix brings. Examples: immimicable, implenteous and impurposive; impossible, immortal.

c) (p+S.pos )im/neg. This type was similar to (p+S.pos)im/neg with the difference that the suffixial endings in those items were replaced by non-suffixial endings. For example, immonulative became immonulaton, immunderable became immunderast, and so on. Words of this type do not exist in the class of im- words and so the sole function of this set was to determine the value of the adjectival suffix.

d) (p+S.pos)im/in. These items were bisyllabic with a strong second syllable to attract stress. They mimic prefixed items in im- with a verbal, prepositional sense (immerse, impinge), which also tend to be bisyllabic. Examples: imbroal, impide and immude; immerse, impinge.

There is an aspect of these word types that merits special attention, particularly in respect of be, fe-, pre, tre. This is that the types can be ordered with respect to the likelihood of being prefixed.

Monosyllabic words are never prefixed. Bisyllabic (more generally polysyllabic) words are sometimes prefixed depending on other factors: words with a preclusive boundary (i.e. the 'stem' is an illegal string) are almost never prefixed (pregnant is the only counter-example) while words with a sympathetic boundary (the stem is not an illegal string) may or may not be prefixed depending on the etymology and meaning. Staying with these latter items, we would expect that those items with the prefix stressed would be less likely to be perceived as prefixed than those with the prefix unstressed (given that prefixes tend to be unstressed (Chomsky and Halle, 1968; Marchand, 1969)). Finally, those items with a known word as stem are most likely to be prefixed.

What characterises this shift in likelihood of prefixation is a general additivity of these features, which may be illustrated thus:

1. monosyllabic
2. polysyllabic + preclusive boundary
3. polysyllabic + sympathetic boundary + stressed prefix
4. polysyllabic + sympathetic boundary + unstressed prefix
5. polysyllabic + sympathetic boundary + unstressed prefix + known root.

The words used in this experiment are presented in full in Appendix 4.3.1.

Procedure

There were five types each of pre- and tre- words and four types of each of be-, fe-, im- and am- words, giving a total of 26 types. For each of these, fourteen examples were generated. Each subject was given a list composed of 26 words, one selected at random from each type without replacement. An additional restriction was that the occurrence on the same list of words with a minimal difference was avoided. For example, if bew was used to generate fey (few with an additional change) then these two did not occur on the same list. Similarly with immonulaton, immonulative, ammonulative and ammonulaton - only one of these appeared on any given list.

Subjects were given a list with a set of instructions. The instructions gave them a brief definition of a prefix, citing un- as an example. They were alerted to the fuzziness of prefixation, this being attributed to historical processes, and were told that their intuitions about prefixation were being canvassed because of this fuzziness. They were asked to judge how likely they thought each word on the list was to be prefixed by rating each word on a six-point scale (1 - definitely not prefixed; 2 - probably not prefixed; 3 - more no than yes; 4 - more yes than no; 5 - probably prefixed; 6 - definitely prefixed). They were also requested to underline the letters they thought to be the prefix letters in instances where they had given a positive response.

After subjects had finished the task, which only took them a few minutes, they were presented with the six prefix letters (i.e. fe-, be-, pre- etc.) and asked what meanings these had.

See Appendix 4.3.2 for the full instructions given to subjects.

## RESULTS

Consider first some general figures concerning "Yes" responses (rating score greater than or equal to 4). We can partition the word types for each initial element into those where a prefix is precluded by the nature of the word (monosyllabic items and items with a preclusive syllable boundary) and those where a prefix is not precluded (other types), referring to these two as the prefix-illegal and prefix-possible conditions respectively.

Table 1 presents the percentage of "Yes" responses in these two conditions for each initial element (we shall refer to the prefixes (e.g. be-) and the prefix letters (e.g. fe) collectively as the initial elements).

| | Prefix-illegal | Prefix-possible |
|---|---|---|
| be | 7% | 64% |
| fe | 7% | 32% |
| pre | 29% | 86% |
| tre | 11% | 50% |
| im | - | 70% |
| am | - | 62% |

Table 1

Percentage of "Yes" responses in conditions where prefix status is and is not precluded by the structure of the word ("Yes" is a score $\geqslant$ 4).

Notice firstly that in general "Yes" responses are higher where they should be (prefix-possible) than where they should not be (prefix-illegal). The proportion of "Yes" responses in the latter category are generally low with the exception of pre- . Secondly, that be- and pre- are higher than their respective controls in the prefix-possible group but that the difference between am- and im- is considerably smaller. Thirdly that a rank ordering of prefix status based on these responses would yield an order of pre-, im-, be-, am-, tre- and fe-. These results convey the general flavour of the more detailed considerations to follow.

The response given to any particular item is a rating that can vary from one (definitely not prefixed) through to six (definitely prefixed). Because of the limited range of this scale and because of the floor and ceiling effects, the use of ANOVAS requires pooling.

Table 2 presents the data for the first analysis. For both be- and its control fe-, scores for the two word types that preclude prefixation were combined as were scores for the two word types that do not preclude prefixation. These scores were put into an ANOVA. Firstly, there is a significant difference between be- and fe- scores ($F = 8.78$; $df = 1,13$; $p<.02$). Secondly, the difference between prefix-illegal and prefix-possible word types is also significant ($F = 45.26$;

df = 1,12; $p<.001$). Finally, the interaction of these two factors is also significant ($F = 8.64$; df = 1,13; $p<.03$).

| | be- | fe- | |
|---|---|---|---|
| prefix-possible | 3.929 | 2.464 | Mean $\bar{x}$ = 3.196 |
| prefix-illegal | 1.571 | 1.679 | Mean $\bar{x}$ = 1.625 |
| Mean $\bar{x}$ | 2.750 | 2.071 | |

Table 2

Mean rating scores for be- and fe- elements, collapsing over word types that preclude and allow prefixation.

These results indicate that be- is considered more of a prefix than fe and that subjects know (not necessarily explicitly) that prefix status is dependent on word structure. They also suggest that subjects know that when certain conditions of structure and identity are met simultaneously the probability of the word being prefixed is increased (or decreased).

The same kind of analysis was performed on pre- and tre- scores. See Table 3 for the means.

| | pre- | tre- | |
|---|---|---|---|
| prefix-possible | 4.729 | 3.371 | Mean $\bar{x}$ = 4.05 |
| prefix-illegal | 2.536 | 1.500 | Mean $\bar{x}$ = 2.02 |
| Mean $\bar{x}$ | 3.632 | 2.436 | |

Table 3

Mean rating scores for pre- and tre- elements, collapsing over word types that preclude and allow prefixation.

The difference between pre- and tre- is significant ($F = 31.02$; df = 1,13; $p<.001$), as is the difference between prefix-illegal and prefix-possible conditions ($F$ = 155.55; df = 1,13; $p < .0001$). There is no significant interaction ($F$ = 0.03; df = 1,13). These results indicate that pre- is considered more of a prefix than tre- and that subjects are again alert to the importance of word structure.

The same kind of analysis cannot be performed on im- and am- words because no types were included that precluded the possibility of these words being prefixed. However, im- scores were compared to am- scores (combining (p + S.pos) im/neg. and (p+S.known) im/neg. scores). There is no significant difference between them (mean im- : 4.75; mean am- : 4.25; F = 0.66; df = 1,13). However, a comparison between them on (p+S.pos) –/in reveals a significant difference between these types on the sign test ($p < .02$; mean im- : 3.86; mean am- : 3.08). These results suggest that any difference between im- and am- might depend on the structure of the word. A direct test of this suggestion was not significant ($\chi^2$ = 0.24; df = 1). The difference between im- and am- for (p+S.pos)-/in then was not significantly greater than that between them for (p+S.pos)-/neg. A conservative conclusion is that there is no reliable difference between im- and am-.

Put together these results generally indicate that subjects are alert to the fact that the identity of the initial letters of a word, the structure of the word and the interaction of these two factors all affect the prefix status of that word.

We turn now to a consideration of the absolute nature of the responses made to each of the different word types. Recall that subjects were rating from "definitely not prefixed" to "definitely prefixed" on a six-point scale.

The degree to which a particular word type is regarded as a prefix can be assessed by the frequency of responses to words in that type that are greater than or less than a particular point on the rating scale. Thus if monosyllabic items in be- receive ratings of 5 or 6 from 11 of the 14 subjects we may regard this word type as possessing the status "probably prefixed" - by virtue of the fact that 11 out of 14 positive responses is significant on the sign test ($p<.05$) (scores $\geq 5$ versus scores $\leq 5$).

Table 4 presents each word type for be- and fe- together with its mean response rating and the point on the rating scale above or below which a significant number of subjects responded. Also presented for each word type is a resulting verbal label describing its status. Thus an entry of "$\geq 4$" indicates that 11 subjects or more responded 4,5 or 6 - the appropriate verbal label being "more likely to be prefixed than not". No entry indicates that scores were spread over the scale.

| Word type | Example | Mean rating | Rating responses | Verbal label for rating responses |
|---|---|---|---|---|
| (mono)be | belk | 1.31 | $\leq 1$ | definitely not prefixed |
| (p+S.neg)be | bertule | 1.86 | $\leq 2$ | probably not prefixed |
| (p+S.pos)be | beflune | 3.24 | - | |
| (p+S.known)be | begird | 4.64 | $\geq 4$ | more prefixed than not |
| (mono)fe | feap | 1.21 | $<1$ | definitely not prefixed |
| (p+S.neg)fe | feldeen | 2.14 | $\leq 3$ | probably not prefixed |
| (p+S.pos)fe | festaim | 2.07 | $\leq 3$ | probably not prefixed |
| (p+S.known)fe | fedim | 2.93 | - | |

Table 4

Responses to be- and fe- word types.
Presented are the mean response ratings (max. 6.0) and the rating score above or below which a statistically significant number of scores occurred. Also presented is a verbal description of what this rating score signifies.

Notice in Table 4 that both monosyllabic be- words and (p+S.neg)be words elicit generally negative responses, as they should (being of a prefix precluding structure). The two prefix-possible types do not elicit negative responses and (p+S.known)be is slightly positive.

Words beginning with fe- should elicit uniformly negative responses if it is clearly known that fe- is not a prefix. This tends to be the case with the exception of the type (p+S.known)fe which does not receive a significantly clear negative response. The negative status of fe- then, is less than clear to these subjects.

Table 5 presents the same information for pre- and tre-.

| Word type | Example | Mean rating | Rating responses | Verbal label for rating responses |
|---|---|---|---|---|
| (mono)pre | preet | 1.79 | ≤2 | probably not prefixed |
| (p+S.neg/ stressed)pre | prendulent | 3.29 | | |
| (p+S.pos/ stressed)pre | prelinous | 4.07 | | |
| (p+S.pos)pre | pretontuous | 5.00 | ≥5 | probably prefixed |
| (p+S.known)pre | preclarify | 4.93 | ≥5 | probably prefixed |
| (mono)tre | treal | 1.14 | ≤1 | definitely not prefixed |
| (p+S.neg/ stressed)tre | trennative | 1.93 | ≤2 | probably not prefixed |
| (p+s.pos/ stressed)tre | trecelation | 2.57 | | |
| (p+S.pos)tre | trecaldive | 2.93 | | |
| (p+S.known)tre | trepunitive | 4.71 | ≥5 | probably prefixed |

Table 5

Responses to pre- and tre- word types. Presented are the mean response ratings and the rating score above or below which a statistically significant number of scores occurred. Also presented is a verbal description of what this rating score signifies.

Of the two prefix-illegal word types in pre- only the monosyllabic items receive a significantly negative response. Of the prefix-possible word types, only those two with the prefix unstressed are regarded positively (i.e. (p+S.pos)pre and (p+S.known)pre ). Seemingly then, the importance given to the syllable boundary with respect to its clearly eliciting negative or non-negative responses depending on its location, is not justified for pre- words. On the other hand it seems to be the case that word types with the prefix unstressed and with an initial vowel that is not |ɛ| (i.e. the initial vowel and stress are not as in preference, but rather as in prevail) elicit positive responses.

With respect to tre- words: there is not the uniform negative response that would signal that tre is clearly regarded as not being a prefix. Indeed the type (p+S.known) tre is positively regarded.

Table 6 presents the same information for im- and am- words.

| Word types | Example | Mean rating | Rating responses | Verbal label for rating responses |
|---|---|---|---|---|
| (p+S.pos)im/in | imbroal | 3.86 | | |
| (p+S.pos*)im/neg | immonulat on | 4.29 | | |
| (p+S.pos)im/neg | immonulative | 4.50 | | |
| (p+S.known)im/neg | immimicable | 4.93 | ⩾5 | probably prefixed |
| (p+S.pos) am/in | ampide | 3.08 | | |
| (p+S.pos*) am/neg | ampunsatil | 3.29 | | |
| (p+S.pos) am/neg | ammoterable | 4.07 | | |
| (p+S.known) am/neg | ampopulous | 4.36 | | |

Table 6

Responses to im- and am- word types. Presented are the mean response ratings and the rating score above or below which a statistically significant number of scores occurred. Also presented is a verbal description of what this rating score signifies.

Of all the im- and am- word types only (p+S.known)im/neg elicits a significantly positive response. Notice also however that none of these types elicit a significantly negative response. The means for these lie in the middle of the scale (between 3.0 and 4.5).

These results may be summarised as follows: Prefix-illegal word types elicit generally negative responses, as their structures indicate they should. The only exception to this is pre- with respect to the type (p+S.neg)pre (mean: 3.29). Prefix-possible types elicit non-negative responses but the degree to which these are actually positive varies ( (p+S.pos)fe is the exception in that it elicits a negative response). In general the degree to which these responses are positive varies with the identity of the initial element and with the word type. Also, the type (p+S.known) elicits responses that are positive, even with one of the control elements, tre-. Finally, the control elements (fe-, tre-, and am-) do not elicit the uniformly negative responses they should if their status was clearly known.

The analyses following explore the differences between word types that differ in only one feature. For example, the difference between the type with a known word as stem and the ('adjacent') type with a stem that is not a known word.

1) be. There is an overall significant difference between the four types of word (Friedman: $\chi^2 = 13.78$; df. = 3; $p<.01$). Finer analysis with the Wilcoxon test reveals a significant difference between (p+S.neg/be and (p+S.pos)be, ($p<.01$) and between the latter and (p+S.known)be ($p<.05$).

2) pre-. There is an overall significant difference between the different types (Friedman: $\chi^2 = 22.6$; df. = 4; $p<.001$). Exploration with the Wilcoxon reveals a significant difference between the (mono)pre and the (p+S.neg) types but between none of the other adjacent pairs ($p<.05$).

3) im-. There is no overall significant difference between

the types (Friedman; $\chi^2 = 4.45$; df. = 3). Notice firstly that this means that the adjectival suffix associated with (p+S.pos)im/neg makes no difference to rating scores. Thus immonulaton did not elicit a response that was significantly different from immonulative. Secondly, this means that im- words with a structure associated with a prepositional meaning (i.e. short words like import) do not differ significantly from those im- words with a structure associated with a negative meaning (i.e. long words like impossible).

4) fe-, tre-, am-. There is an overall significant difference between the word types of both fe- and tre-, but not between those of am- (Friedman: a) fe-. $\chi^2 = 9.06$; df. = 3; $p<.05$; b) tre-. $\chi^2=24.13$; df.=4; $p<.001$; c) am-. $\chi^2=4.05$; df.=3). Also for both fe- and tre- there is a significant difference between (p+S.pos) and (p+S.known) (Wilcoxon $p<.05$).

These results, together with some of those in the previous section dealing with the absolute nature of the responses made, indicate that the identity of the stem as a known word is a factor that influences the response made. Words of this type elicit a positive rating, either in absolute terms (e.g. im-, mean = 4.95), or relative to the other word types (e.g. fe-), or both (e.g. tre-).

It was asserted earlier that the word types in pre- and be- could be ordered in terms of the likelihood of being prefixed (additivity of features). Thus monosyllabic items are less commensurate with prefixation than bisyllabic items; bisyllabic items with a preclusive boundary less than those with a non-preclusive boundary; and so on. While the results just analysed indicate that these "steps" are not always of a size that are statistically significant they do indicate support for the notion of additivity (see the means in tables 4, 5, 6), even with the control elements fe- and tre-. To test this, the correlation between the predicted ordering of word types and the obtained ordering, for each of be-, pre-, tre- and fe-, was computed (Spearman's rank correlation coefficient). This coefficient was computed for each subject and in Table 7 are presented the mean values of the coefficient for each of the four elements. The correlation for each of these four is significantly positive (sign test: $p<.03$).

| | Initial element | | | |
|---|---|---|---|---|
| | be- | fe- | pre- | tre- |
| Mean correlation score | +0.61 | +0.54 | +0.45 | +0.60 |
| Proportion positive correlations | 12/14 | 12/14 | 13/14 | 12/14 |
| Prob. sign test | <.01 | <.01 | <.01 | <.01 |

Table 7

Mean correlation scores for each of the four initial elements (Spearman's rank correlation coefficient). Each is the mean of 14 scores, one from each subject, calculated on the basis of the correlation between predicted and obtained ranking of word types. Also presented are the proportion of these 14 correlations that were positive and the probability associated with these proportions.

These results support the notion of the additivity of features with respect to the likelihood of being prefixed.

Earlier analyses have suggested that in the prefix-possible conditions the size of the non-negative responses varies with the identity of the initial element. Accordingly, the prefix-possible scores for all six elements were compared in a two-way ANOVA (prefix element vs control element; identity of elements i.e. pre/tre vs be/fe vs. im/am). The scores were as calculated for the earlier analysis of prefix-possible scores with the exception of pre- and tre- for which only scores for (p+S.pos) and (p+S.known) were combined, the (p+S.pos/stressed) scores being left out. The reason for this was to bring the prefix-legal scores for these two elements into line with the scores for the other elements.

Figure 1 presents the mean scores for each condition in graph form.

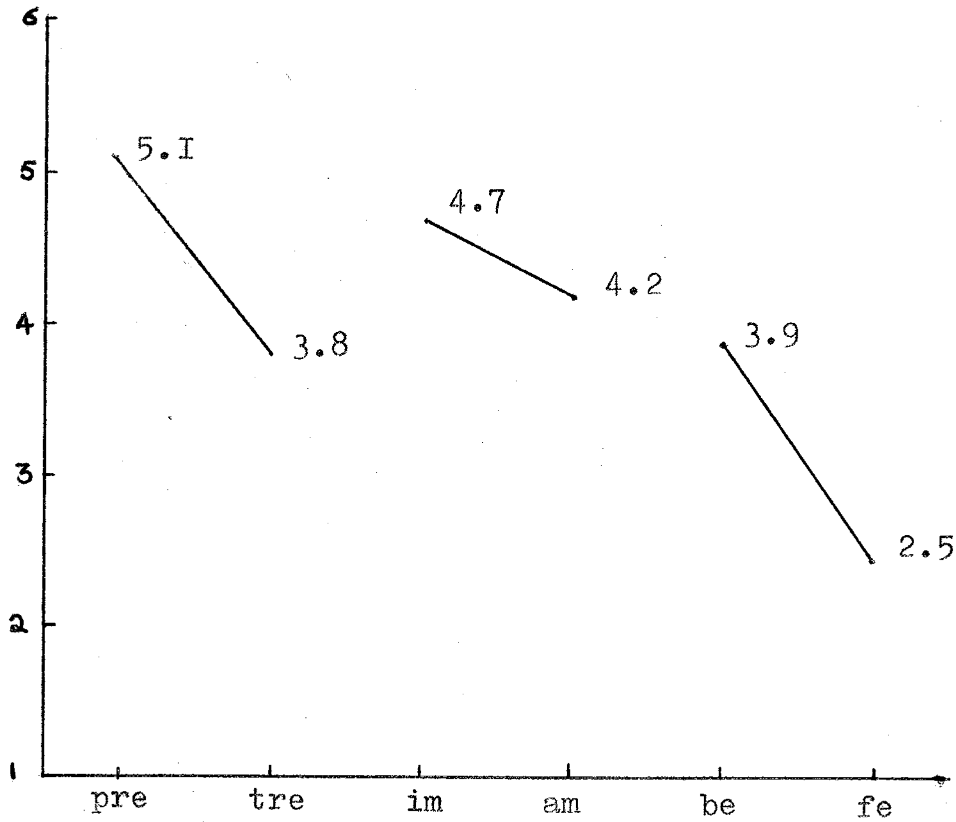


Figure I.

Mean rating scores for prefix elements in the prefix-legal conditions.

There is a significant difference between prefix and control elements ($F = 15.46$; df. = 1,13; $p < .01$) and between the three prefix types (i.e. pre/tre, be/fe and im/am) ($F = 12.22$; df. = 2,26; $p < .001$). The interaction of these factors is not significant ($F = 1.29$; df. = 2,26). These results confirm the notion that the size of the non-negative response varies with the identity of the initial element: prefixes elicit higher ratings than controls; the ordering of the prefixes is pre- (highest rating), im- and be-; and be- elicits responses that are no greater than the controls tre and am-.

Subjects had been asked to underline those letters in a word that they had regarded as being the prefix letters. This was not a request they always, or even often, remembered to comply with, but some data are available.

Be- words were so underlined 17 times, only two of which were deviant: beest and belfond. (Deviant means that the wrong letters were underlined, e.g. bel, or that the right letters were underlined but in a prefix-illegal word, e.g. ferluft below). Fe- was marked eight times, two of which were deviant: ferluft and ferhyme. Pre- produced seven deviant markings out of 38 marked: preal, pream, predlivence, prencitive, prentify, prensimate, prensid. All these subjects marked pre- correctly in other words. Tre- produced one deviant marking in 17: trebelitate. Im- produced one out of 29 underlinings: impude. Am- produced three out of 30: ammodulative, amprolatative (same subject) and ampitulable.

There are two main features of this data: firstly the proportion of deviant markings is small (11%); secondly , 10 of the 12 deviant markings occur in prefix-illegal words, and seven of these 10 are pre- words. This relatively high proportion of pre- words relates to the earlier result that pre- words with a preclusive boundary did not elicit (significantly many) negative responses in the way that their be-, fe- and tre- counterparts did. It is not really clear why subjects should behave in this manner with these pre- items but one possibility is that they were over-generalizing the productivity of pre- as a prefix.

At the end of the experiment subjects had been presented with the six initial elements (e.g. pre-, tre- etc.) and had been asked what meaning(s) these had for them. Table 8 presents these results.

| | pre- | im- | be- | tre- | am- | fe- |
|---|---|---|---|---|---|---|
| All meanings | 14 | 8 | 11 | 5 | 5 | 4 |
| Correct meaning | 13("before") | 7("not") | 5("To make") | - | - | - |

Table 8

Responses to question: "What meaning(s) have these?" for each of the initial elements. Presented are the frequencies of any and all responses given (correct and idiosyncratic) - max. 14. Also presented are the frequencies of the responses that were correct and in brackets the identity of these responses.

These results indicate that the meaning of pre- is best known, with the negative meaning of im- less well known. The meanings given to be- are not precise but five convey the generally correct sense of a verb with a meaning of "to make" or "to do".

The nature of the claim made in this experiment is that subjects have knowledge of the relationship between various features of phonological and orthographic structure and the prefix status of a word. The experiment has provided evidence to support this claim which, while not unequivocal, is substantial. Consider now alternative conceptions of what the experiment was about.

The subject is presented with a list of unknown words (very possibly gobbledy-gook to him); he has been told that prefix words have something in common other than that they have the same initial letters; he has (if he has read the instructions carefully) been alerted to the fact that there is a relationship between the structure of the word and its prefix status and also to the fact that possessing certain initial letters is a necessary but not sufficient condition. Finally, it is also expected of him, but not demanded, that he make a coherent response. I will not defend the position that the pattern of responses is not due to strategies peculiar to the demands made by this task but will argue that any alternative strategy requires just the sort of knowledge that is of concern.

Firstly, there is the simple strategy of making a decision for each word by thinking of a real word like it, deciding whether this is prefixed or not and responding accordingly. This notion is essentially the Glushko (1979) issue; namely that apparent knowledge of rules is no more than the ability to match with known words and respond on the basis of the outcome of this matching. This strategy is a possibility and even though use of this strategy requires that subjects knew something of the relationship between the structure of the real words and prefix status the claim being made here is weakened.

A second simple strategy might be: "Using the words where a letter string is added to a known word (e.g. trecoherence) deduce the 'prefix' letters; when these letters occur in a word where their removal leaves a reasonable looking stem respond "prefix", where not respond "not prefixed" (e.g. tremoltive and trebnuous respectively). Also, when the stem is not a known word respond less certainly (score of 3 or 4) than when it is (score of 6)". Now this simple rule goes a long way to explaining the results, but it needs some additions. The existence of differences between performance on a prefix element and its control requires that the rule be sensitive to the relative status of initial strings. This is particularly the case for example with fe and pre.

In addition to this the significant interaction between initial element (fe- vs. be-) and structure (prefix-illegal and prefix-possible) requires a corollary that "initial letters interact with the nature of the stem". Other results such as the response to monosyllabic words and the incidence of deviant underlinings (pred.....) also require additions to the rule. The point here is that while various additions are very plausible and acceptable, the strategy, initially simple, is becoming more complex in just the kind of ways that are of interest given the kind of claim being made.

## CONCLUSIONS

The Introduction to this experiment suggested that there were several features of word structure that correlated, to varying degrees, with prefix status. The results of this experiment have shown that subjects were alert to a number of these features.

They were alert to the importance of the identity of the initial letters of a string. They were alert to the fact that certain types of orthographic and phonetic structure preclude the possibility of prefixation while other types do not preclude it and are even suggestive of it. Thus they responded negatively to monosyllabes, uncertainly to items with a legal but unknown stem, and positively to items with a known stem. They were also alert to the interaction of the identity of the initial elements and the structure of the word. Finally, there was an "additive" effect of the different features in that as a particular feature such as bisyllabicity was "added" the response became more positive, but not always to a significant degree. This is suggestive of a cluster of features, rather than any one feature, being associated with prefixation.

## 4. EXPERIMENT 4.

### INTRODUCTION

The last experiment was concerned with the phonological and orthographic forms of a word, the degree to which these signal morphemic (prefix) structure and the degree to which they are perceived to do so. However the last experiment did not require subjects to identify the significate of a particular prefix. Thus, for example, they were not required to identify items such as impoat and imbrile as probably meaning "in" or "on", as opposed to items such as imbrolable and impluvious probably meaning "not". In the experiment to be described we are concerned with this identification of the semantic component of a prefix with its form.

There are clearly several ways of approaching the problem of investigating the degree to which a prefix is known. One possibility is to present subjects with a prefixed word together with the alternatives "before", "in", "not" and so forth and require him to select that alternative which is most likely to reflect the semantic component of a prefix. In effect this is merely a variation on what has already been done which was to ask subjects to give the meaning(s) of a particular set of prefix letters. Another possibility is to generate a meaning that embodies the meaning of a prefix and then use the word in a sentence where the meaning of the prefix fits in with the rest of the sentence. The item would be used in several sentences, some compatible with the prefix, some not, and the subject would be required to select the sentence making the most sense. Again there are several variations possible; what is important is the general paradigm. The merit of such a task would be its ecological validity. The source of its weakness lies in the problem of achieving a semantic parity between sentences; that is, keeping constant the degree to which the context of a word implies its meaning.

The experiment to be described steers a path between these alternatives. Briefly, subjects are presented with a nonsense prefixed word, along with two definitions or statements of meaning. One of these is commensurate with the meaning of the prefix, the other not, and the subject is required to indicate which of the two meanings he thinks the most appropriate to the word. To allow for the possibility that one of the two meanings (say that embodying the sense "before" with pre- words) is more likely to be selected for idiosyncratic reasons, a control word for every experimental word is introduced into the experiment and presented with the same pair of definitions. Performance on the prefixed word may then be compared with performance on the control.

In most instances, (pre- is an exception) there are two possibilities as to the kind of structure that the prefixed words in this experiment could possess. On the one hand nonsense words of the general form "prefix letters plus known word" could be used. Examples of this type used in the last experiment are precoherence, immimicable and besoak. Intuition and the results of the last experiment would suggest that words of this type are the most likely to produce high levels of correct responding. The other type of word that could be used is that with a structure "prefix letters plus legal stem", examples from the last experiment being prefulgence, immonulative and bestant. This latter type of word will be used for the reason that its structure and hence its association with or implication of a particular meaning is less evident. Support for this is to be found in the previous experiment where the status of this type of word was equivocal but not definitely negative. Two corollaries of this less-than-evident structure are that if the desired effect occurs with these words then we may reasonably assume that it would occur with the former type; also, the possibility of attributing positive results to some task specific strategy is reduced with the latter type of word. For example, suppose an experimental item was impossible, where the meaning of possible was known and where one of the two meanings was "that which cannot be done". This meaning could be selected without any knowledge as to the meaning of im-; simply by knowledge of the meaning of possible. This strategy would be less likely with an item like impandulable (assuming a pairing of this with appropriate meanings) where the clue to the correct meaning lies in the prefix and not the stem.

The generation of meaning statements that embody the meaning of a particular prefix presents problems of various sorts. The major problem stems from the sometimes nebulous quality of the meaning of a prefix. Consider for example, the realizations of the sense of "priority" associated with pre-. There are words like prefabricate and preconceive ("to do something before ..."); precursor and predecessor, which are subtly different from prelude and preface ("something coming before something else"); prevent and predict ("to do something with reference to a future event"); prefect and predecessor ("priority with respect to rank"). A lesser problem stems from the fact that a particular prefix has several meanings. A prime example of this is im-, which has a negative sense and a prepositional sense. Further, the prepositional sense can be realized as "in", "on", "into", "towards" and "against". Finally, there is the problem posed by the fact that a prefix is often manifest in different parts of speech, this being a function of derivation. Thus prefer, preference and preferential or impress, impressive and impression are all etymologically prefixed but it is quite evident that the meaning of the prefix is not constant across derivations.

The common element in these problems is that they all present alternatives as to what constitutes the meaning or sense of a prefix. One solution is to test them all in the experiment and thus arrive at an answer or ranked set of answers for each prefix. Another solution is the one we adopt here. In the first place the number of alternatives may be reduced by eliminating those meanings which are rarely manifest in the language. For example, consulting the O.E.D. we see that the number of im- words with a sense of "against" or "towards" is small (impede and impel are the only examples that spring readily to mind). Similarly, im-, with a negative sense occurs largely with adjectives and only infrequently with nouns or verbs. So we may justifiably restrict the meanings to adjectives. This process of narrowing down the range of alternatives by eliminating low frequency or idiosyncratic realizations may be supplemented by the rationale that the clearest and most evident realization should be selected for test because if the test of this "best" meaning is empirically validated then there will exist a firm basis for further exploration. If this is not validated then it is unlikely that the more infrequent or idiosyncratic meanings will. The result of these considerations and process of elimination was that a sense of negation within an adjectival context was emergent for some im- words (henceforth im(neg)); for others a sense of "in" or "into" applied to transitive verbs (henceforth (im(in)); a sense of intensity and change of condition within the context of transitive verbs for be-; and a sense of priority within a context of nouns for pre-, firstly realized in the form "something coming before something else" and secondly in the form "something with reference to a future event or action". The reason for using two sets of meanings for pre- was that the realizations of the sense of priority in pre- words are both various and somewhat nebulous in quality and thus using two meanings to some degree mimics these features.

The selection of both the control words and the distractor meanings largely depends on the specificity of the question being asked. This in turn depends on what is hypothesised to be necessary to do the task correctly.

Ideally, the subject will always indicate the meaning embodying the meaning of the prefix as being the correct one. To do this at a level that is significantly above chance the morphemic structure of the word has to be perceived and, in general, the word has to be categorised as being one that might be prefixed. The potential prefix has then to be identified, a process that includes the identification of its meaning or meanings, and a decision made as to which, if any, of the meanings accompanying the word are commensurate with the prefix. It would of course be mistaken to conceive of these operations as being necessarily serially ordered in the manner described. It seems more plausible in fact, that both the word and the two meanings are sources of information contributing to complex and non-serial processes that result in a response. However, the ordering of processes is not really relevant to the point of concern which is that in order to perform this task, knowledge of two kinds has to be stored. Firstly, subjects have to know the kinds of conditions that are necessary, sufficient and indicative of the initial letters in a word being a prefix; secondly they have to have stored information about a prefix concerning its form(s) and semantic value in a manner that enables it to be accessed as an independent piece of information. This independence does not necessarily mean that a particular prefix occupies a separate slot or node in lexical memory, merely that information defining the prefix is accessible independently of the words in which that prefix occurs.

The purpose of this experiment then is to test the degree to which people know and use the kinds of information about prefixes that we have been discussing. In view of this, the control words used are structurally identical to the prefix words, and the distractor meanings similar to the prefix meanings, in every aspect other than the prefix component.

Notice that the choice of control words and distractor meanings constrains the kinds of inferences that can be drawn. Suppose that the prefix meaning is a verb (because most of the words with that prefix are verbs); if the distractor is not also a verb then a correct response may be attributed to the knowledge that words of that type are usually verbs, not necessarily to the knowledge of what the prefix means. Another case: suppose that the control word is selected randomly for each prefix word from a pool of words that are of various types - monosyllabic, polysyllabic, suffixed, not-suffixed and so forth - correct responses here could be attributed again not necessarily to specific knowledge of the prefix but to a general association of a set of features such as polysyllabicity, location of primary stress, identity of initial letters and so on, with a meaning. The controls and distractors used in this experiment restrict the range of inference to the particular prefix element and what it means.

## METHOD

### Subjects

20 male and 20 female 1st year psychology undergraduate volunteers participated in this experiment. All had done English to "O" level and nine had done Latin to "O" level.

### Words and Meanings

The words used in this experiment were drawn from some of the be-, im- and pre- words used in the previous experiment. They were all of the type (p + s.pos). (Those with pre-, for example, as the initial element were of the type whose phonemic form suggested an unstressed first syllable, e.g. prefulgence.) Two types of im- words were used, one to represent those with a prepositional sense ((p + s.pos) im/in) and the second to represent those with a negative sense ((p + s.pos) im/neg). Ten words of each type were drawn at random from the sets of fourteen used in the last experiment, and for each word drawn its control was also drawn. Thus if impoat and prelutation were drawn, so were ampoat and trelutation. Examples then of the words used are prelutation and trelutation; impoat and ampoat; impluvious and ampluvious and benoal and fenoal.

The process of generating definitions is not one that it is readily specified in algorithmic form. However, the definitions were generated with some general factors in mind. To a certain extent uniqueness was a factor in that an attempt was made to produce meanings for which no (common, at any rate) word existed. This consideration prompted the general strategy of taking the meanings from rare words and tailoring them to fit a particular prefix. In some instances there was a rare word with the necessary requirements for which no tailoring had to be carried out. For example, the meaning of "inspirit: to animate, to put life into" was used for one of the im- words (requiring a sense of "in" or "into"). Another factor taken into account was simplicity. Complicated and abstract meanings were avoided. Controls were generated using the same principles. They also had to be as closely matched as possible to the prefix meaning (e.g. substantive, same number of adjectives and even the same words where possible) but with a different theme and of course lacking the particular component attributable to the prefix. An example of a matched pair is:

im-: (a) "to absorb completely"

(b) "to remove fraudulently".

They are both verbal in nature and both clauses contain an adverb. The first definition is the "experimental" meaning because it has the sense "in", "into", while the second does not.

Another example is:

pre-: (a) "an initial skirmish before a battle"

(b) "a massive assault by enemy forces".

Here they are both substantive and both with the construction of a noun qualified by an adjective and an adjectival phrase.

Consider each prefix meaning in turn:

1) pre-. These were all nouns with a general sense of "before". (It is perhaps worth stating at this stage that those pre- words that were suffixed did not possess suffixes that were incompatible with the substantive nature of these meanings. Thus -able, an adjectival suffix, was not attached to any of these pre- words). Two variations on this general sense were employed. Firstly, there was the sense where the "thing" referred to is a precursor of some following "thing" - these meanings are modelled on the meanings of words like prelude and premise. The second sense was of a state or condition referring to some future time - models of this are the meanings of words like preconception and presentiment. In fact the majority (6) of the meanings were of the former variety.

2) im-(in). These were all transitive verbs with a prepositional sense of "in" or "into". Examples would be: "to put life into; to energise" and "to absorb completely".

3) im-(neg). These were all adjectives, mimicking the set of negatively sensed im- adjectives. A problem with these meanings is to do with their form. One alternative is simply to add not to a statement, viz. "possible" would become "not possible" when defining the item impossible. The problem here is that the negation is too salient and

subjects could respond on the basis of this salience rather than any particular knowledge of the negative sense of im-. Accordingly, the negation was blended into the statement with a little more subtlety. For example: "being without compassion or pity"; "discordant and out of phase with"; and so on. Another problem with this set of im- meanings is to do with the type of adjectival suffix on the words; there should not be an incompatibility between the suffix and the meaning. For example, there is a general feeling of incompatibility between the sense conveyed by the -able in impandulable and the meaning statement "weak and without strength of character", while conversely the meaning is compatible with impidulous or immonulative (without labouring the point the remedy adopted here was to simply pair the words in -able (for it was only these (3 of them) that created the problem) with a compatible meaning, the loss resulting from this remedy being a decrease in the randomisation of pairings between word and meaning).

4) be-. These were all transitive verbs. The senses to be captured in these meanings are most imprecise, but generally there is a component of "excess" or "completeness", and the action signified by the verb results in a change of appearance or state of the object. Thus examples are: "to make cloudy and obscure"; "to heap praise on"; and "to cleanse thoroughly and purify".

For each of these four elements ten meanings were generated. Thus for each of the four prefixes (be-, pre-, im(in), im(neg)) there are ten word pairs (a prefixed word and a control in each pair (e.g. benoal, fenoal)) and ten meanings.

Randomisation and the compilation of lists

The allocation of a word pair (prefix and control) to a pair of meanings ("experimental" meaning and "control" meaning) was random. The only exception to this has already been discussed under im-(neg) above.

From the pool of word - meaning pairs described above ten lists were compiled. Each list consisted of eight words, each of which was paired with two statements of meaning (one appropriate or correct, one not). Of these eight, four were prefixed words (be-, im(neg), im(in), pre-) and the other four were controls (fe-, am(neg), am(in), pre-). Selection of items for a particular list was random without replacement, with one constraint on this randomisation: this was simply that both a word and its control would not appear on the same list. So, if on list one we had, say,

impoat: to wrap in; to engulf.
to cast off; to reject.

then we would not also have had:

ampoat: to wrap in; to engulf.
to cast off; to reject.

The ten lists resulting from this procedure (call them ℓa) were then used to generate ten other lists (call them ℓb). The method of producing these lists was simply to replace each word on an ℓa list by its prefix or control counterpart on ℓb. Thus if say ℓa contained the words impoat and ambrile (prefix and control), ℓb would have contained ampoat and imbrile. These two lists enable a comparison of a prefix with its control, each being paired with the same meanings. In order to increase the amount of data collected the twenty word-lists so generated were duplicated and so each list was presented to two subjects (one of each sex to maintain a balance).

The word lists are presented in full in Appendix 4.4.1.

Procedure

Each subject was presented with a list of the type just described, with the following preamble and instructions.

The experiment, they were told, was similar in form to the television game "call my bluff" and to the "Reader's Digest" feature "It pays to increase your word power". They were told to consider each of the two meanings that occurred with a word and tick the meaning they thought the most likely to be the correct one for that word. Having marked one of the two they were also required to rate their answer on a confidence scale (1 - very unconfident; 2 - unconfident; 3 - neutral; 4 - confident; 5 - very confident).

The full instructions are presented in Appendix 4.4.2.

Having completed the task (which never took more than a few minutes ) subjects then answered a few questions. They were required to define a prefix and then state whether or not they considered each of pre-, tre-, be-, fe-, im-, am- to be a prefix and give the meaning(s) wherever they could. (See Appendix 4.4.2 for the questions.)

Experimental Design

The design of this experiment is somewhat complex due largely to a general desire to obtain the maximum of data from the minimum of subjects.

The design is presented in figure 1.

| Word | Prefix | Control | Prefix | Control |
| --- | --- | --- | --- | --- |
| wa | $S_1, S_{11}$ | $S_n, S_{10+n}$ | $S_{20+n}, S_{30+n}$ | $S_{21}, S_{31}$ |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| wf | ⋮ | $S_1, S_{11}$ | $S_{21}, S_{31}$ | ⋮ |
| ⋮ | $S_n, S_{10+n}$ | ⋮ | ⋮ | $S_{20+n}, S_{30+n}$ |
| wj | ⋮ | ⋮ | ⋮ | ⋮ |

Figure 1

Figure 1 deals with one prefix and its control. The ten words are represented by wa, wb .... wj and the columns prefix and control are concerned with the scores for the prefixed (e.g. be-) and control (e.g. fe-) versions of the word respectively. These scores are collected from subjects in a manner illustrated in figure 1.

Each subject, $S_1$ .... $S_{10}$, receives on their list one of the ten words in its prefix version ($S_1$ - wa) and another in its control version ($S_1$ - wf). Each of these subjects is matched with one of the subjects $S_{21} \rightarrow S_{30}$ ($S_1$ to $S_{21}$, $S_2$ to $S_{22}$, and so on), by virtue of the fact that the appearance of prefix word in, say, the list given to $S_1$ is matched by the appearance of its control in the list given to $S_{21}$, and vice-versa (e.g. $S_{21}$ gets wa in control form and wf in prefix form). (Note that another subject, $S_{20+n}$, also receives wa in prefixed form but this time in a context of different words). Finally, to increase the amount of data collected each list is given to two subjects. By virtue of this $S_1$ and $S_{11}$ are matched, as are $S_2$ and $S_{12}$, $S_{21}$ and $S_{31}$, $S_{22}$ and $S_{32}$, and so on. For each subject, for each word on his list a correct or incorrect score is obtained, together with a confidence rating of how correct he thinks the answer is.

RESULTS

In order to compare performance on prefixed words with that on unprefixed words, scores were combined in the following way: scores for $S_1$ and $S_{11}$ on the prefixed item wa were combined with those of $S_{21}$ and $S_{31}$ on the prefixed item wf. The resulting sum, one of correct responses with a maximum value of four, was compared with the sum obtained by combining $S_1$ and $S_{11}$ scores on the unprefixed wf with $S_{21}$ and $S_{31}$ scores on the unprefixed wa. The result of this combining was ten matched pairs for each of the four prefixes. Table 1 presents the mean number of correct scores for each observation in the prefixed and control conditions together with the results of Wilcoxon tests on each set of data.

| Prefix | Prefixed | Not prefixed | Obtained T | N | Critical T ($p<.05$) |
|---|---|---|---|---|---|
| pre- | 3.0 | 2.2 | 2.5 | 6 | 2.0 |
| im(neg) | 2.5 | 2.8 | 28.0 | 9 | 8.0 |
| im(in) | 2.0 | 2.3 | 10.5 | 7 | 4.0 |
| be- | 2.4 | 2.6 | 10.5 | 7 | 4.0 |

Table 1

Mean number of correct responses (maximum 4) to prefixed and control words for each of the four prefixes. Also presented are the values of T and N from Wilcoxon tests (one-tailed) along with the critical value of T at 0.05.

The only data that support the notion that subjects know and use the meaning of a prefix is that for pre-, though this is not statistically significant (T = 2.5; expected T for significance at 0.05 is T = 2.0). The remaining results are both insignificantly different and in a direction contrary to the hypothesis.

In addition to indicating which of the two meanings presented with a word was the correct one, subjects also gave a confidence rating for their response. These can form the basis of a more sensitive measure of the differences between prefix and control than the frequency measure. Observations were pooled in the same way but each observation consisted of the sum of the four confidence rating responses, where the confidence rating for a correct response had a positive sign and that for an incorrect response a negative sign. The score could therefore vary from -20 (four highly confident but incorrect responses) to +20 (four highly confident and correct responses). Table 2 presents the mean of these scores for each of pre-, tre-, be-, etc. and the results of Wilcoxon tests comparing each prefix with its control.

| Prefix | Prefix | Not prefixed | Obtained T | N | Critical T ($p<.05$) |
|---|---|---|---|---|---|
| pre- | 7.1 | 0.3 | 1 * | 8 | 6.0 |
| im(neg) | 4.3 | 3.0 | 20 | 10 | 11.0 |
| im(in) | -0.2 | 1.0 | 23.5 | 10 | 11.0 |
| be- | 2.2 | 3.0 | 21.5 | 9 | 8.0 |

Table 2

Mean confidence rating sums (max: +20, min: -20) for prefixed and control words for each of the four prefixes. Also presented are the values of T and N from Wilcoxon tests (one-tailed) along with the critical value of T at 0.05.
(* significant at .02)

Using this more sensitive confidence rating sum measure the difference between pre- and its control tre- is significant ($p<.02$; one tailed). Of the other three comparisons however, only im- (with a negative sense) is even in the right direction.

These results indicate that the prefix pre- is associated with the sense "before" to a degree that is significantly greater than a control element tre- is.

These results are based on scores obtained by pooling. To recapitulate, an observation for the prefix is composed of (say) $S_1 + S_{11}$ for the word wa and $S_{21} + S_{31}$ for the word wf; the matched observation for the control is composed of $S_1 + S_{11}$ for the word wf and $S_{21} + S_{31}$ for the word wa. Two comparisons are possible by decomposing these scores: a comparison within subjects and a comparison within words.

Comparing first within subjects, subjects receiving identical lists were not separated (i.e. $S_1$ and $S_{11}$, $S_2$ and $S_{12}$, $S_3$ and $S_{13}$ etc.). For each of these pairs performance on a prefixed word on the list was compared with their performance on the control word. This was done for the frequency and the confidence rating sum measure for each of the four prefixes.

These results parallel those obtained with the pooled observations. There is only a significant difference between pre- and its control tre- on the confidence rating sums measure (Wilcoxon, $p<.05$). None of the other comparisons are significant.

The within words comparison involved pooling of results to combine all responses made to a particular word in its prefixed form and similarly to combine all responses to it in its control form. The result of this was to produce ten matched pairs of observations for each of the four prefixes. (Note that these pairs are not independent in that a subject contributing to an observation for the prefixed form of, say, wa, also contributes to the unprefixed form of, say, wf.)

There is a significant difference on both the frequency and the confidence rating sum measures between pre- and tre- (Wilcoxon: $p<.05$). No other comparisons are significant.

These within subject and within word comparisons mean that the positive results obtained for pre- using pooled data are not a function of either a few "good" subjects or a few "good" words; "good" in the sense of producing results that are favourable. (Note that the significance of the within words comparison for pre- also means that positive results are not confined to either of the two slightly different meanings of pre- that were used in this experiment.)

The reason for testing performance on a prefix word against its control was to allow for the possibility that one of the two meanings occurring with a particular word was chosen more frequently than the other for reasons that have nothing to do with the issues that concern us here. Having analysed the data in this manner however, we may test whether, for each prefix, responding to either the prefix or control meaning was significantly above or below chance, where chance is a probability of 0.5 that any given meaning will be selected. Observations in the pooled frequency measure may range from 0 to 4 correct responses, (correct being the selection of the prefix meaning) each with a probability of occurrence specified by the Binomial distribution. The results of a series of Kolmogorov-Smirnov tests carried out for each of the prefix and control sets were negative. This means that subjects were not selecting one meaning over the other in any of the prefix or control sets at a level that was clearly above or below 0.5 probability, i.e. they were not, for example, consistently selecting the "before" meaning with pre- or tre- words in preference to the control meaning (see table 1 for the mean frequencies of selecting the correct or 'prefix' meanings.)

Subjects had been asked at the end of the experiment to define a prefix and to state whether each of pre-, tre- etc. was a prefix and to give the meaning(s) where appropriate. Subjects' formal knowledge of what a prefix was was very good: 37 of them (max. 40) defined it in terms of a verbal element occurring at the beginning of a word and 34 made a statement to the effect that it affected the meaning of the word. Their responses to the second question are presented in Table 3.

From Table 3 we can see that the status and meaning of pre- are known to a large number of subjects. The meaning of im- is known to fewer subjects, this meaning being predominantly the negative meaning.

| | *pre-* | *im-* | *be-* | *tre-* | *am-* | *fe-* |
|---|---|---|---|---|---|---|
| positive response | 38 | 39 | 12 | 5 | 8 | 1 |
| meaning correct | 30 ("before") | 18("neg") 2("in") | 1("to make") | 0 | 0 | 0 |

Table 3

Frequency of positive responses (i.e "X is a prefix") and frequency of correct meanings given to each of the six prefix elements. The meanings given are presented in brackets. (Max. frequency: 40).

## SUMMARY

The results of this experiment indicate that first year university students have a good formal knowledge of what a prefix is: they know that *pre-* means "before" and, in a forced-choice task, show that they associate meanings with a "before" component with unknown words prefixed by *pre-*. They do this with words where the morphemic structure is not as evident as it might be (i.e. words such as *prefulgence* where the stem is not a known word), and where it is signalled by features such as the identity of the initial letters, the location of syllable boundaries and the stress pattern. However, significant results were not obtained for the two meanings of the *im-* prefix and for the *be-* prefix. Among other reasons why significant results were not obtained for these (including of course the possibility that subjects simply do not possess the links between the form and meaning of these prefixes) is that knowledge of too great a degree of specificity was being tested. Thus we were testing for the specific link between say *im-* and a negative sense; more successful might be a test of a link between a cluster of features (such as *im-* as the initial element, polysyllabicity, and an adjectival

suffix) and the meaning. As was stated in the introduction to this experiment the nature of the control word (and meaning) largely determined what is tested.

## 4. EXPERIMENT 5

### INTRODUCTION

This experiment is concerned with the facilitation afforded to the learning of and memory for the meanings of words by the relationship between the form and the meaning of prefixed words. Subjects learned a set of word-meaning items of different types, and were later required to recall the meaning when presented with the word.

The words and meanings used as the materials in this experiment were those used in the previous experiment. To recap, the words were all of the general type (p + S.pos) and the meanings used with each prefix embodied the meaning associated with that particular prefix. For each prefix word and prefix meaning there was a control word and a control meaning.

How might the facilitatory effect referred to come about? The hypothesised basis for the effect is the co-occurrence of features of form, form class and meaning that is found in a prefixed word. The nature of these co-occurrences for the prefixes to be dealt with has been discussed earlier and so will not be repeated here. In the last experiment it was presumed that information concerning the co-occurrence of features, particularly the relationship between the form and the meaning of a prefix, was stored in a form that made it available to processes requiring this information for the purpose of making inferences concerning the probable meaning of an unknown prefixed word. This notion of the use of the redundancy of prefixed words was supported by the results of that experiment (for pre- at least). This experiment continues in the same vein by assuming that this redundancy, this knowledge of the co-occurrence of features, can also be used to facilitate the learning of new members of the prefixed set. One possibility as to how this might occur concerns the notion that the information concerning the prefix, the stem (sometimes), and a collection of appropriate derivational rules might already be stored (see the earlier discussion of lexical redundancy). A second possibility is that the members of a prefixed set might be organised as a group in the mental lexicon. Fay and Cutler (1977) concluded from a consideration of speech errors that aspects such as syllabic structure, form class, sequential phonemic structure and meaning underlie lexical organization. It is just these kinds of features that co-occur in prefixed words. In either case the facilitation to learning would derive from the existence of a lexical apparatus into which the new prefixed words could be readily assimilated.

From this general framework several predictions follow.

Firstly, we would expect the learning and recall of an item consisting of a prefixed word and compatible meaning (henceforth p:m+) to be facilitated relative to a control word and control meaning (c:m-). Recall that the difference between a prefixed word and control word is in the initial letters (e.g. <u>am-</u> vs. <u>im-</u>, <u>pre-</u> vs. <u>tre-</u>, <u>be-</u> vs. <u>fe-</u>) and that the difference between the prefix meaning and control meaning lies in the respective presence or absence of the semantic component specifically associated with that prefix (e.g. "before" for <u>pre-</u>; "not" for <u>im-</u>, and so forth). Thus any difference between these two types of items must be due to the relationship between the form and meaning of the prefix.

Secondly, we would expect performance on (p:m+) to be superior to that on an item consisting of a prefixed word and a control or neutral meaning (p:m-). This latter item corresponds to prefixed words in the language that do not embody the meaning of the prefix; for example, <u>precipitate</u>. The difference between these two items is that information structures in the mental lexicon relating to the prefix will be facilitatory in the case of the first item but not in the second. Indeed, they may be detrimental to the learning and recall of the second kind of item because of an incompatibility between the structure of the word and the meaning.

In the experiment that follows these three types of word-meaning combination, with a fourth (c:m+, control word with a prefix meaning), were presented to groups of subjects for learning and subsequent recall of the meaning. One group (henceforth the "compatible" group) received the two types p:m+ and c:m-; the other group (the "incompatible" group) received the types p:m- and c:m+. Thus they received the same words and the same meanings, it was only the combinations that differed between groups. If subjects did have knowledge of a prefix in the senses discussed then the compatible group should perform better than the incompatible group because such knowledge is facilitatory in the first case but not in the second, where it might even be detrimental.

Subjects 20 male and 20 female subjects participated in this experiment to fulfil course requirements. All had "O" level English and nine "O" level Latin.

Words and Meanings The words and meanings used in this experiment were those used in the previous experiment.

To recap: for each of the four prefix elements (pre-, be-, im(in), im(neg) ) there are ten prefix words (henceforth p) and ten controls (c); each prefix and its control is paired with two meanings, one of which embodies the meaning of the prefix (henceforth m+) while the other is a control (m-).

From this we can see that there are four possible pairings of a word and a meaning: p:m+, p:m-, c:m+, c:m-. Thus p:m+ is the pairing of a prefix with its meaning, p:m- is the same word paired with the control meaning, and so on. In this experiment one set of subjects received the pairings p:m+ and c:m-, in both of which there is an hypothesized psychological compatibility between the structure of the word and the meaning. Another set of subjects received the pairings p:m- and c:m+, in both of which there is an hypothesized psychological incompatibility between the word and the meaning. (Even though there may be disagreement as to whether the pairings in the first set <u>are</u> compatible while those in the second are <u>in</u>compatible it is nevertheless hypothesized that the first is more compatible than the second.) The "compatible" subjects received the combinations p:m+ and c:m- for all the four prefixes while the "incompatible" subjects similarly received the pairings p:m- and c:m+ for all four prefixes.

The full experimental design is presented in Figure 1. This holds for any one of the four prefixes.

| Compatible | | | Incompatible | | |
|---|---|---|---|---|---|
| Subjects | p:m+ | c:m- | Subjects | p:m- | c:m+ |
| $S_1,S_{21}$ | $p_1,m_1$ | $c_2,\bar{m}_2$ | $S_2,S_{22}$ | $p_1,\bar{m}_1$ | $c_2,m_2$ |
| $S_3,S_{23}$ | $p_2,m_2$ | $c_1,\bar{m}_1$ | $S_4,S_{24}$ | $p_2,\bar{m}_2$ | $c_1,m_1$ |
| $S_5,S_{25}$ | $p_3,m_3$ | $c_4,\bar{m}_4$ | $S_6,S_{26}$ | $p_3,\bar{m}_3$ | $c_4,m_4$ |
| $S_7,S_{27}$ | $p_4,m_4$ | $c_3,\bar{m}_3$ | $S_8,S_{28}$ | $p_4,\bar{m}_4$ | $c_3,m_3$ |
| $\vdots$ | $\vdots$ | $\vdots$ | $\vdots$ | $\vdots$ | $\vdots$ |
| $S_{19},S_{39}$ | $p_{10},m_{10}$ | $c_9,\bar{m}_9$ | $S_{20},S_{40}$ | $p_{10},\bar{m}_{10}$ | $c_9,m_9$ |

<u>Figure 1</u>

Experimental Design (for any one of the four prefixes). There are two groups of subjects: the compatible group, receiving the combinations (p:m+) and (c:m-), and the incompatible group, receiving the combinations (p:m-) and (c:m+). Subscripted p's and c's refer to the ten prefixed words and ten control words. Subscripted m's refer to the ten prefix meanings (m) and to the ten control meanings ($\bar{m}$). Finally, each observation was replicated, i.e. $S_1$ and $S_{21}$ did exactly the same task, as did $S_2$ and $S_{22}$, etc.

No subject received both a prefix item (say <u>prelutation</u>) and its control (<u>trelutation</u>) or both a prefix meaning and its control meaning (see Appendix 4.5.1 for the materials used). Thus $S_1$ received $\underline{p}_1$ with $m_1$ and $\underline{c}_2$ with $\overline{m}_2$ (for convenience I shall temporarily reference prefix meanings by $m_{sub}$ and control meanings by $\overline{m}_{sub}$) while $S_3$ received $\underline{p}_2$ with $m_2$ and $\underline{c}_1$ with $\overline{m}_1$.

The compatible and incompatible groups used exactly the same words and meanings but of course the combinations were different. So, for example, $S_2$ received the same prefixed and control words as $S_1$ ($\underline{p}_1$ and $\underline{c}_2$) but whereas $S_1$ received $m_1$ with $\underline{p}_1$ and $\overline{m}_2$ with $\underline{c}_2$, $S_2$ received $\overline{m}_1$ with $\underline{p}_1$ and $m_2$ with $\underline{c}_2$.

Finally, in order to increase the amount of data collected, observations were replicated, i.e. $S_{21}$ and $S_1$ received exactly the same experimental materials, as did $S_2$ and $S_{22}$, and so on.

This design is somewhat complicated but was motivated by the need to collect the maximum of data from the minimum of experimental materials, these being somewhat difficult to produce in large numbers.

<u>Materials</u> Each of the word-meaning combinations for each of the subjects was typed on an index card. Also, the eight words that a subject had received in combination with a meaning were typed, without meanings, on a test sheet that also included instructions for the test phase of the experiment.

<u>Procedure</u> Subjects were informed that the experiment was concerned with the learning of words and meanings and that their task was to learn each word-meaning combination so that if at a later date they were presented with either the word or the meaning they would be able to recall the other. They were instructed as to the procedure that they were to follow in the learning phase of the experiment and told that at the

end of this learning phase they would be given further instructions.

Subjects looked at each card for five seconds, turning it face-down after having seen it. When all eight cards had been seen they began reading a text ("To kill a Mockingbird" - Harper Lee) on which they expected to be tested later. They continued to read this for a period of two minutes. This constituted one trial and was repeated another twice - on each occasion the reading of the text was picked up where it had been left on the previous trial.

At the end of the third trial subjects were given instructions dealing with the test phase. (Instructions given are presented in full in Appendix 4.5.2).

The subject was required to supply the meaning appropriate to each of the eight words with which he was presented - these being the eight he had seen during the learning phase. Subjects were encouraged to guess when recalling the meaning and to write down as much as they could recall of the meaning. They were allowed to respond in any order they wished and there were no time constraints. Finally they were required to give a confidence rating for each response (1 - very unconfident; 2 - unconfident; 3 - neutral; 4 - confident; 5 - very confident).

When subjects had asserted that they were unable to recall any more of the answers they were given a short questionnaire to answer. The first question on this asked them to describe how they went about learning the words. The second asked them to explain what they understood by a prefix. The third question presented them with the letter strings <u>pre</u>-, <u>be</u>-, <u>im</u>-, <u>tre</u>-, <u>fe</u>- and <u>am</u>- and asked them to indicate which of these were prefixes and, where appropriate, what they meant. Finally the fourth question concerned their academic background and personal details.

At the end of the experiment, before debriefing, subjects were asked whether they had been aware of and whether they had used the fact that some of the words had been prefixed. This question was put orally and, of course, the reply noted.

## RESULTS

The recalls produced by the subjects tend to vary in their correctness. For example, compare the subjects' recall "unreliable" with the target "to evade and avoid"; "overwhelming nuclear attack" with "a massive assault by enemy forces" and "stage of foetal development" with "an initial stage of foetal development". In view of the difficulties presented by such variability two judges were recruited to assess the degree to which recalls were correct. The experimenter served as a third judge.

Each recall was rated for correctness on a five point scale where: 1 - wrong; 2 - some aspect of the general sense of the target was recalled; 3 - the core meaning of the target was recalled even though qualifiers may have been omitted or incorrectly recalled; 4 - general sense correct, weak paraphrasing acceptable; 5 - correct and only a good paraphrase acceptable.

All three judges worked blind. That is, they assessed each recall with respect to the target while in ignorance of the experimental condition it was produced under; in ignorance of the word (prefixed or control) it had been produced in response to and, of course, in ignorance of what the other judges had said. Also, the two judges who were recruited were not given examples of what would merit each point on the rating scale. There was complete agreement between the three judges on 44% of the observations. Agreement between two of the three with one judge one point discrepant a further 43% of the time. In fact there was agreement between at least two of the judges 93% of the time. The score finally assigned to each recall (henceforth the recall score) was the mode of the three scores and, in those few cases where the three judges had scored differently, the median score. (Considering those recalls where two judges agreed: the experimenter agreed with judge A (a cognitive psychologist) 53% of the time, with judge B (a non-psychologist) 31% of the time, with these latter two agreeing the remaining 11% of the time.)

Recall that there are two differences that concern us; we wish to assess the relative ease of learning the combination p:m+ over the combination p:m-. Now because this difference might be due to differences in the meanings per se, we need to assess this difference relative to that between c:m+ and c:m-. In fact we find that the expression of concern, namely {(p:m+) - (p:m-)} - {(c:m+) - (c:m-)} can be rewritten as {(p:m+) + (c:m-)} - {(p:m-) + (c:m+)} . This is the difference between what have been labelled the compatible subjects and the incompatible subjects. We also wish to assess the relative ease of learning of p:m+ over c:m-. Now any difference obtained here could be attributed to, on the one hand, a difference between the meanings (m+ vs m-) or to a difference between the words p and c. We assume that any difference obtained is not due to a difference between the learning of p and c per se, and so control only for an effect due to a difference between the meanings. The resulting expression: {(p:m+) - (c:m-)} - {(c:m+) - (p:m-)} can be rewritten as {(p:m+) - (c:m-)} + {(p:m-) - (c:m+)} which is the sum of the difference between prefixed words and control words for the compatible and the incompatible subjects (i.e. a within-subjects difference).

The design of the experiment involved replication and in the analyses to follow the mean of the two scores in each cell of the design has been used.

The first analysis used the frequency of correct responses as its measure (correct responses being all responses that were not completely wrong, i.e. partially correct responses were included). For each subject the maximum number of correct responses that could be obtained to both the prefixed and the control words was 4 (there being four prefixed words and four controls). Table 1 presents the mean number of correct responses per subject in each of the conditions.

| | (p:m+) + (c:m-) | (p:m-) + (c:m+) | F; d.f. | p | (p:m+) + (p:m-) | (c:m-) + (c:m+) | F; d.f. | p |
|---|---|---|---|---|---|---|---|---|
| Correct responses | 2.28 | 1.73 | 5.75;1,18 | <.03 | 1.93 | 2.01 | 0.75;1,18 | - |
| Recall scores | 2.67 | 2.27 | 3.10;1,18 | - | 2.45 | 2.49 | 0.09;1,18 | - |

Table 1

Mean correct responses (max. 4.0) and mean recall scores (max. 5.0) for (1) (p:m+)-(p:m-), with controls and (2) (p:m+)-(c:m-), with controls. Also presented are statistical data for the ANOVA making these comparisons.

Also presented in table 1 are the F scores and probability levels of the two comparisons that concern us (essentially the difference between (p:m+) and (p:m-) and that between (p:m+) and (c:m-) ).

Whereas this first analysis makes no distinction between degrees of correctness, the second analysis used the mean recall scores as a measure of comparison. Thus for each subject the mean recall score for the four prefixed words and that for the four unprefixed words were computed. Table 1 also presents these means together with the results of an ANOVA testing the relevant differences.

These two analyses combined the scores of the four prefixes (and controls) and so the performance on any given prefix is not evident. Accordingly, the recall scores for each prefix were analysed separately.

The appropriate means, together with F scores and probability levels are presented in Table 2.

| | (p:m+) + (c:m-) | (p:m-) + (c:m+) | F; d.f. | p | (p:m+) + (p:m-) | (c:m-) + (c:m+) | F; d.f. | p |
|---|---|---|---|---|---|---|---|---|
| pre- | 3.28 | 2.81 | 1.00;1,16 | - | 3.20 | 2.89 | 0.84;1,16 | - |
| im(neg) | 1.91 | 1.75 | 0.33;1,16 | - | 1.83 | 1.84 | 0.001;1,16 | - |
| im(in) | 2.68 | 2.10 | 2.07;1,16 | - | 2.45 | 2.33 | 0.20;1,16 | - |
| be | 2.80 | 2.41 | 0.74;1,16 | - | 2.31 | 2.90 | 1.76;1,16 | - |

Table 2

Mean recall scores (max. 5.0) for (1) (p:m+)-(p:m-) and (2) (p:m+)-(c:m-) (each with controls), for each of the four prefixes. Also presented are statistical data for the ANOVA making the comparisons.

Put together, these results have implications that are equivocal. There is an overall significant difference between p:m+ and p:m- when frequency of correct response is the measure (I shall speak of the difference as being between p:m+ and p:m- for clarity, it being understood that allowances have been made for the appropriate controls.) This difference is not however significant when the mean recall score is the measure even though there is a very positive trend. The reasons for this discrepancy in the results of these two analyses are not clear. Also, the results for individual prefixes, though in some instances encouraging, are, nonetheless, not significant. The unusual feature of these results is the size of the positive results obtained for the prefix im-, with a sense of "in". It will be recalled that in the previous experiments there was negligible evidence for the psychological reality of this prefix. Whilst this result is potentially interesting it is worth bearing in mind the possibility that it might be artifactual.

It may be the product of a mnemonic constructed by subjects around the phonetic similarity of the im- to the words in or into that were a part of the meaning. (Some subjects reported looking for such mnemonics.)

The results with respect to the difference between performance on p:m+ and c:m- are unequivocal in that there is no significant difference. That is, there is no evidence to suggest that learning a prefixed word with an appropriate meaning is easier than learning an unprefixed word with a control meaning.

There is a suggestion in Table 2 that prefixes might vary both with respect to the difference between p:m+ and p:m- and to that between p:m+ and c:m-. These suggestions were tested directly by computing the value of these expressions (including controls) for each prefix for each pair of matched subjects and then analysing the resulting measures with a Friedman two-way ANOVA. Table 3 presents the mean values of the mean values of the differences for each prefix and the results of the Friedman Analyses. As can be seen there is no significant difference between prefixes for either the measure {(p:m+) - (p:m-)} or {(p:m+) - (c:m-)}.

| | pre- | im(neg) | im(in) | be- | $x^2$; d.f. | p |
|---|---|---|---|---|---|---|
| [(p:m+) + (c:m-)] − [(p:m-) + (c:m+)] | 0.93 | 0.43 | 1.15 | 0.78 | 0.63; 3 | - |
| [(p:m+) + (p:m-)] − [(c:m-) + (c:m+)] | 0.63 | 0.13 | 0.25 | -1.18 | 2.37; 3 | - |

Table 3

Mean recall score differences for: (1) (p:m+)-(p:m-), with controls and (2) (p:m+)-(c:m-), with controls for each prefix. Also presented are the results of Friedman tests comparing the size of these differences across the four prefixes.

Of secondary concern is whether there is any difference between the different types of meanings. In the first place there might be a difference between the ease with which a prefix meaning is learned relative to that with which its control is learned. In the second place there might be a difference in ease of learning between the types of meaning associated with each prefix, e.g. the adjectival meanings associated with im(neg) and its control am(neg) might be easier to learn than the verbs associated with be- and its control fe-.

To test these differences the recall scores for m+ meanings for each prefix/control set were combined, as were the recall scores for m- meanings (e.g. the p:m+ and c:m+ scores for say be- were combined as were the p:m- and c:m- scores). The mean recall scores are presented in table 4.

| | pre-/tre- | im(neg)/am(neg) | im(in)/am(in) | be-/fe- | mean |
|---|---|---|---|---|---|
| prefix meaning (m+) | 3.21 | 1.63 | 2.55 | 2.88 | 2.57 |
| control meaning (m-) | 2.88 | 2.04 | 2.23 | 2.34 | 2.37 |
| mean: | 3.04 | 1.83 | 2.39 | 2.61 | |

Table 4

Mean recall scores for prefix meanings and control meanings for each prefix type (i.e. pre-/tre-, be-/fe-, etc.).

There is no overall significant difference between prefix meanings and control meanings (m+ vs. m-) (F = 1.42; df. = 1,9). There is a significant difference between the different kinds of meaning associated with each prefix/control set (F = 8.71; d.f. = 1,9; p<.001). There is no significant interaction between these factors (F = 1.87; d.f. = 3, 27).

These results indicate that some general types of meaning are easier to learn than others. Easiest is the noun-and-qualifier type used with pre- and tre-. Most difficult is the adjectival phrase used with im(neg) and am(neg). Notice also in table 4 the suggestion that the negative component in the meaning associated with im(neg) might be a source of difficulty for learning in that, in contrast to the other prefix meanings, the prefix meaning for im(neg) produces a lower mean recall score than the control meaning.

The analyses so far have focussed on the degree to which responses have been correct. We turn now to a closer consideration of incorrect responses. These fall into two categories: one where no attempt has been made to recall the meaning and the other where the subject has responded but is incorrect. A sub-category of this latter category consists of confusions and it is this sub-category that is of interest. A confusion is where the meaning B (correctly associated with word B) is incorrectly produced to word A. Now probably because subjects were encouraged to write down anything at all that they could remember, assessment as to whether a confusion had occurred and which items had been confused was not always clear. In view of this difficulty, the task of assessing confusions was given to three judges, one of whom was the experimenter. The judges were presented with the word - recall combinations that had to be judged, and the eight word - meaning combinations that had been learned by that subject. They stated for each word whether or not a confusion had occurred and the sources of the confusion.

There was total agreement by the three judges on 27 out of a total of 51 recalls (53%), two of the three judges agreeing on the remaining 9 (18%). Of the 51, there were a total of 25 confusions in the total agreement class and two in the partial agreement class; by implication there were seven instances (9-2) where only one judge considered that a confusion had occurred (the same judge on six of these seven). The criterion adopted for analysis as a confusion was judgement as such by two judges.

Of the 27 confusions a subset of seven were excluded. These had in common the feature that meaning B was produced to both word A (incorrectly) and to word B (correctly). Furthermore, the confidence rating given to the latter was greater than that given to the former (recall that the confidence rating relates to how confident subjects were that the recall they had given was the correct one). This pattern is interpreted as meaning that the "confusion" is a product of the encouragement given to subjects to guess and to not leave a blank. Subjects were writing down meaning B in response to word A because this strategy offered a better chance of being correct than leaving a blank. In short, these items are not confusions in the same sense that the others are.

The decision to exclude these items is important. This is because they tend to occur in the compatible group (4 subjects, one error each) to a slightly greater degree than in the incompatible group (one subject, three errors), and so their inclusion might neutralize the results of the test (to follow) comparing confusion errors in the two groups were they to be included.

One possible analysis is to simply compare the number of confusion errors in the two groups. However, it will be recalled that the two groups differ significantly with respect to the frequency of correct responses made and so a greater number of confusion errors in the incompatible group (as is in fact the case) might simply be a function of the overall tendency to greater error in this group. Accordingly, the confusion errors made by each subject (or rather pair of replicated subjects) were expressed as a fraction of the total number of errors made by that subject. A comparison of the two groups with a Wilcoxon matched pairs test revealed a significant difference between them ($T = 3$, $p < .05$, one-tailed). There were significantly more errors in the incompatible group than in the compatible group (Mean fraction of confusion errors: compatible = .045; incompatible = .155, Total errors: compatible = 4; incompatible = 16).

The results of this test certainly support the ideas proposed in this experiment, but in fact more specific predictions can be made. We would expect a large proportion of the errors in the incompatible group to occur with the prefixed words and that the recall incorrectly produced would be that associated with the control. For example, we would expect that subjects who had learned that (say) trepold means "an initial stage of foetal development" would be more likely to produce this meaning to a pre- stimulus word than subjects who learned this meaning in connection with prepold would be to produce it to a tre- stimulus word. Table 5 presents the number of confusion errors made in each group for each prefix element.

| | pre- | tre- | im(neg) | am(neg) | im(in) | am(in) | be- | fe- |
|---|---|---|---|---|---|---|---|---|
| compatible group | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| incompatible group | 1 | 3 | 1<br>(1) | 1 | 4<br>(2) | 1 | 4 | 1 |

Table 5

Number of confusion errors for each of the prefix and the control elements in each of the two groups of subjects. Figures in parentheses are the number of confusions specifically between a prefix and its control (only the non-zero values are presented in the table).

From table 5 we see that only for be- and im(in) are the number of confusions higher for the prefix than for the control. (This applies only, of course, to the incompatible group). It is also clear from table 5 that the number of instances where the intrusion (i.e. source of confusion) is from the control is minimal. This result then, cannot be regarded as support for the prediction.

These analyses have not focussed specifically on the recall of that component of each meaning associated with a particular prefix. To a certain extent the degree to which a recall includes the sense "before" or "in" or "not" will be reflected in the recall score given by judges. The redundancy in an analysis that focusses on these components is not absolute however, as we do not know the degree to which their presence or absence influenced the judgement of correctness. Accordingly, each recall was marked correct or incorrect depending on whether the recall included the relevant semantic component. This was done for pre- ("before"), im(neg) ("not") and im(in) ("in") but not for be- because the relevant semantic component in this case is neither specific nor is isolable. Recall of the relevant semantic component was compared for two conditions: recall to the prefixed word when the component had been learned in combination with this word and recall to the control word when the component had earlier been learned in combination with it. Table 6 presents the mean number of times (max. 1.0) that the relevant component was recalled in each condition (per subject). Sign tests were used to make the comparison for each of the three prefixes and table 6 also presents the results of these tests.

Even though these comparisons are not significant they are in the predicted direction and as such support the general notion that the meaning component of a prefix is more closely associated with the prefixed word than with the control.

There was a small set (3) of errors that indicate that recall

| | Component recall (1.0 max) | Sign test proportion | Sign test prob. |
|---|---|---|---|
| pre- | 0.65 | 5/6(pre->tre-) | p=.11 |
| tre- | 0.35 | | |
| im(neg) | 0.40 | 6/8(im->am-) | p=.16 |
| am(neg) | 0.25 | | |
| im(in) | 0.55 | 3/4(im->am-) | - |
| am(in) | 0.35 | | |

Table 6

Mean number of times that the semantic component associated with a prefix (e.g. "before") is recalled when learned with the prefix and when learned with the control. Also presented are the proportions of subjects recalling the component in response to the prefix but not recalling it in response to the control. Finally, the results of sign tests on these proportions are presented.

might be an active process in the sense of being constructive and that this process involves the use of just the kind of information about prefixes that is of interest. These errors were:

a) Trebise - "three something". (The target was completely unrelated to the recall.)

b) Prefadulation (Note: pre-fad-ulation) - "before fashion". (Again the target was not related).

c) Prefadulation - "upset state of emotion before event". (The target was: "emotional state due to an upset of routine".)

Subjects had been asked at the end of the experiment to describe how they had gone about learning the word-meaning combinations. Their responses revealed two major, almost mutually exclusive strategies.

Twenty subjects said that they had used repetition to learn the combinations while fifteen said they had used association as a general strategy. This latter group was comprised of three sub-groups: seven subjects said they had tried to form a link between the word and the meaning using some other word; two subjects said that they had tried to form some link between the sound of the word and the meaning; six subjects said that they had tried to form a link between some part of the word (3 specifically cited the prefix) and the meaning.

Subjects had also been asked to define a prefix and to state whether or not each of the six prefix elements (pre-, be-, im-, tre-, fe- and am-) were prefixes and if so, what they meant. Subjects' knowledge of what a prefix was was good: 36 said that it was a verbal element coming at the beginning of a word and 26 added that it qualified the meaning (max. 40). Their replies concerning the status and meaning of the six elements are presented in Table 7.

| | pre- | im- | be- | tre- | am- | fe- |
|---|---|---|---|---|---|---|
| positive responses | 38 | 31 | 9 | 8 | 7 | 4 |
| Meanings | 35("before") | 22("not")<br>1("in")<br>4(idio) | 2("make") | 5("three")<br>2("very") | 5(idio) | 2(idio) |

Table 7

Frequency of positive responses (max. 40) concerning the prefix status of each prefix element. Also presented are the frequencies of particular meanings (e.g. 35 S's said pre- meant "before"; "idio" = idiosyncratic).

The pattern of results follows those of the previous experiments: most subjects know the status and meaning of pre-; fewer subjects are as familiar with im-, all but one identifying only the negative meaning;

the status of <u>be-</u> is little known and its meaning even lesser known. Finally, in this experiment, subjects were specifically asked whether any prefix had any more than one meaning: only 16 replied to this, seven said "yes" and only two of these cited <u>im-</u> (but did not give any more information).

At the end of the experiment subjects had been asked whether they had been aware of the fact that some words had been prefixed and whether they had used this. Five subjects said that they had been (vaguely) aware of this and only two said they had used it.

## CONCLUSIONS

This experiment has presented weak support for the notion that prefixation facilitates learning. One analysis of combined scores for the four prefixes was significant; an analysis of confusions was supportive; and an analysis of the recall of the meanings specifically associated with the prefixes was encouraging.

The question posed by these results concerns whether they reflect accurately the status of the facilitation afforded to learning by prefixation, or whether some other, more sensitive, test of learning would have elicited more substantial effects. In this, as in the last experiment, the specific relationships between prefix and meaning was under scrutiny (e.g. between <u>im-</u> and "not"), and one possibility is that this test was too fine. A more successful comparison might be between the test items and controls that do not differ only in the specific prefix components, but in a more general way. For example, there might be a facilitation effect on test items when compared to controls that vary (randomly) on other dimensions such as word length, syllabicity, part of speech of the meaning, and so forth. This test would not enable one to make such precise statements about what subjects know about prefixes, but then their knowledge may not be as precise as we expected it to be in this experiment.

# CHAPTER FIVE

# 5. EXPERIMENT 1.

## INTRODUCTION

The research dealt with so far has been concerned with relatively sophisticated subjects and the kind of information they extract from the written word and store in lexical memory. Another source of information as to the nature of representation in lexical memory is the production of both oral and written language. In this chapter we are concerned with the spelling errors produced by ten year old children when the material is of their own choosing.

Originally, it was the spelling errors of undergraduate students (under examination conditions) that was of interest. However, an informal survey of their examination scripts quickly revealed that their spelling errors were of limited interest, both because of their scarcity and because of their limited variety. When they were not clearly slips of the pen they were misspellings involving minor confusions: of the -ance/-ence variety for example, (maintenance/maintenence). In contrast, as we shall see, the errors of the 10-year-old children are both numerous and varied and as a consequence reveal a great deal about their knowledge of the written language.

It is tempting to think that the written form of a word might directly represent the internal representation of that word; that the process of writing a word is merely one of transcription of the internal representation of that word. Such a view has one of its roots in the more general notion that writing is essentially the converse of reading; the same operations performed in reverse with an added motor component. Taking this view we might then reasonably conclude that if we can conceive of that component of reading that is concerned with the identification of words as being a dual process, the visual and the phonological, then we can equally conceive of the spelling process as being similarly dual. Spelling then becomes a process that is some mix of a phonological process, a conversion from sound to print or phoneme to grapheme, and a 'visual' process, the transcription of visually represented letter sequences. The visual component of this process is necessary to account for the correct spelling of words in languages, like English, where the orthography is not reliably phonetic and is full of exceptions and irregularities.

This conception of spelling is one that is in essence held by a number of investigators. Bryant and Bradley (1980) have evidence to suggest that children who are in the very early stages of literacy (7 years old) read by visual processes but spell by phonological processes; that the developmental trend is for both these skills to become increasingly dependent on both visual and phonological processes, and that a failure to develop in this way results in backwardness. Cromer (1980) looked at the spelling errors of normal twelve year old children and those of a number of other language-handicapped groups, including the profoundly deaf. He found that the profoundly deaf compared very favourably with normals in terms of overall number of errors; where they differed was in the proportion of errors that were visually similar to the target word, these being more frequent in deaf subjects. The notion that the deaf are heavily reliant on a visual component in spelling is one that receives general support (e.g. Dodd, 1980). There seems some doubt however as to the degree to which they possess and use a phonological component (Hoeman, 1976; Cromer, 1980; Dodd, 1980).

There are other studies that also hold this general point of view and that go some way to isolating some more of the component processes in spelling. Frith (1980), for example, has isolated a group of children whose peculiarity is that they are normal readers but poor spellers. Her evidence indicates that these children do not lack the phonological component of spelling in that they possess the ability to produce phonetically correct spellings, entailing phoneme-grapheme translation, but do seem to lack knowledge of the idiosyncratic or irregular aspects of English spelling, e.g. that the phoneme |k| can variously be realized as c, k, ck or ch. The spelling problem of these children seems related to their reading strategy which indicates that they are attending only to some and not all aspects of the written word (e.g. not paying attention to the spelling of an unstressed vowel for example). Marsh et al. (1980) produce evidence to suggest that the kind of information individuals use when spelling increases in sophistication with age (8 year olds, 11 year olds and college students). Thus the spelling of jat (requiring simple phoneme-grapheme knowledge) is spelled correctly before the spelling of jate (requiring knowledge of the "silent e" function), is spelled correctly before the spelling of jation (requiring either knowledge of the spelling of the analagous nation or knowledge concerning the spelling of the palatalized syllable).

Hotopf (1980) has compared errors in writing directly with errors in speech. The results begin to identify the respects in which spelling, or more generally writing, and speech are similar and the respects in which they are different. There were some types of error such as the incorrect substitution of similar sounding words (plan for plain; they for their) that occurred in both speech and writing. Also similar in both speech and writing was the estimate of the planning span, based on the number of syllables across which an anticipation occurred $7 \pm 1$). In contrast to these communalities there were also errors that occurred to a significant degree in one but to a negligible degree in the other. Blends (marmelite from marmalade and marmite) and transpositions (all places repart for all parts replaced) occurred only rarely in writing but often in speech. Conversely, omissions, largely of function words and auxiliaries, occurred in writing but rarely in speech. These errors, taken together with others which will not be dealt with here, were taken to indicate that spelling and speech have a common phonological component, the hypothesis that spelling is parasitic on speech being the most plausible. They also indicated that writing was not subject to quite the same time pressure that speech was and that as a result of this, probably ascribable to some short term buffer, writing was more prone to a breakdown in fluency and in the syntactic structure (the result being the loss of function words, auxiliaries and bound morphemes). Equally, writing was more likely to provide for efficient editing in some areas such as the middle of a word.

In a study also concerned with spelling errors Wing and Baddeley (1980) have looked at the distribution of the same. They were concerned almost exclusively with the 'performance' aspects of writing, the roles of short-term memory, attentional mechanisms and so forth, to the neglect of what we might term the 'competence' aspects, or what an individual knows about the spelling of a particular word. For example, they dealt in detail with the high incidence of errors in the middle of a word relative to the ends, ascribing it to the greater likelihood of confusion amongst these letters in a short term (output) buffer.

A shortcoming of all these studies is their failure to take sufficient account of the complexities of English spelling in ways other than to simply label some items as irregular. Accordingly, they fail to allow for the possibility that a failure to spell correctly may be due to an individual either lacking knowledge of some of these complexities, or temporarily failing to take them into account. In other words, an individual's spelling errors might be systematic in that they might reveal particular weaknesses in his knowledge of the rules and generalities that are present in English spelling to a greater degree than is imagined.

In recent years Smith and his colleagues (eg. Smith and Groat, 1979, Smith, 1980) have been among the stoutest defenders of English orthography. They have accumulated evidence that in silent reading as well as in pronouncing tasks university students are sensitive to a range of information that is present in English orthography (graphemic, phonemic, morphemic, syntactic, semantic and even etymological). It also appears that these same factors may also be present in spelling tasks, albeit in more diluted form. Thus for example, in spelling nonsense words presented as verbs or nouns students favoured the silent e spelling of long vowels (e.g. smade, nodude vs. smaid, nodood) more for verbs than for nouns. This is in line with the observation that low frequency verbs come from Latin and Greek which are also the sources of silent e spellings in the language. Nouns do not exhibit this etymological bias. In short, subjects seem to be sensitive to spelling patterns that are etymologically based.

This study then, takes the following standpoint: that English spelling is principally phonetic, and that a good many of its idiosyncracies are not as irregular as might initially seem to be the case and are often describable by rules, generalizations and statistical probabilities; that, as a consequence of this structure, spelling is a process that is principally phonetic in nature and that is supplemented by a knowledge of these various rules and regularities; that when the process breaks down, either in a good speller under, say, stress, or in a poor speller, this breakdown will be systematic; that a careful analysis of spelling errors will reveal particular weaknesses, both those common to a number of spellers and those specific to a particular speller.

## METHOD

### Subjects and Materials

Essays were collected from 56 children attending a local secondary school. The children were from two first year classes, 28 in each class, of about 10 years of age (precise information is not available). One class had written an essay entitled "The haunted house" while the topic of the other class was "The most exciting day of my life".

## RESULTS

Given that spelling is a complex process involving an interaction between stored knowledge and a variety of memory, motor and other processes to implement this knowledge, we are confronted with the problem, when interpreting the significance of a particular error, of deciding whether the error reflects a permanent deficiency in the complex of stored knowledge or whether it is merely a product of that particular psychological moment.

One way around this problem would be to regard a misspelled word that occurs correctly elsewhere as a temporary or performance error and one that is persistently misspelled as a knowledge deficiency or competence error. This solution, of course, depends on more than one occurrence in the text of the misspelled word, a contingency that varies wildly in probability. A preliminary analysis revealed that because the probability of occurrence elsewhere of an error, correct or incorrect, was so variable, it would be a mistake to use such data as a basis for interpretation. Accordingly, the strategy that has been adopted here has been to classify errors on other grounds and only use the occurrence data (in fact very rarely) when it clearly supports or refutes a particular generalization. This strategy will be seen to be justified in the analysis that follows.

General Performance

The mean length of essays was 337 words. This was estimated from the mean number of words per line calculated over five lines per written side of text. The mean number of incorrectly spelled words (repetitions of a particular error were only counted as one) was 10.5. The mean error rate was therefore 3%.

Errors were classified on a preliminary basis into one of five categories. Along with each category of error is presented the percentage of subjects who made an error in that category (%S), the percentage of errors accounted for by that category (%N), and the mean error rate for the category (calculated for only those subjects committing that kind of error) (mean).

a) Inflectional errors: %S = 77; %N = 18; mean = 2.5. These are errors that may plausibly be attributed to the inflection or inflectional processes in inflected words. Excluded are errors that are unrelated to these inflectional processes. Thus for example, remememberd would be included in this category but rembered would not.

b) Derivational errors: %S = 43%; %N = 6%; mean = 1.6. This is a class similar to the inflectional class but for derived words (comparatives are classed here as derivatives). Thus speshily would be included but adventually (eventually) would not.

c) Compound errors: %S = 70%; %N = 15%; mean = 2.2. This class consists partly of items of any type that have been split into two or more words, e.g. down stairs or to gether. Also included here are compounds that have been misspelled (e.g. earings) and where the misspelling is attributable to the compound nature of the word or in fact where attention to the compound nature would remedy the error (ear + ring = earring).

d) Apostrophe S: %S = 68%; %N = 15%; mean = 2.4. In this class is any apostrophed form that occurs incorrectly or any ordinary form that is incorrectly apostrophed.

e) Intra-morphemic errors: %S = 100%; %N = 46%; mean = 4.8. This consists of all items not assigned to any of the other classes.

There is good agreement between the values of error percentages from the two essays on some of the error types. These values are presented in Table 1.

| | | Error Type | | | | |
|---|---|---|---|---|---|---|
| | | Inflectional | Derivational | Compound | Apostrophed | Intra-morphemic |
| %S | (1) | 82 | 57 | 82 | 64 | 100 |
| | (2) | 71 | 29 | 57 | 71 | 100 |
| %N | (1) | 17 | 9 | 16 | 12 | 46 |
| | (2) | 19 | 3 | 14 | 19 | 45 |

Table 1

Error data from the two classes: (1) "Exciting day" and (2) "Haunted house". %S = percent of subjects (N=56) committing errors of various kinds (columns). %N = percent of the total of errors of the various kinds.

As can be seen from Table 1 agreement between the estimates varies according to both error category and the measure of error rates (%S or %N). It is not too clear what the variation is attributable to, though one might plausibly speculate that there are both subject and topic differences.

In what follows the data from the two classes has been pooled.

## Inflectional Errors

As a general rule the inflected form of a word is generated by adding the appropriate morpheme (-ed, -ing, etc.) to the base word which might have to be adjusted in some way. Table 2 gives a list of adjustment rules that are required by some items before addition of the -ed or -ing morphemes. Irregular forms are treated as a special kind of adjustment rule.

Presented in Table 3 are data concerning the categories of inflectional errors and the frequency of their occurrence.

Notice in Table 3 (and in following tables) that the frequencies of subjects in subcategories do not sum to the total numbers in the main category. This is because a subject might have made an error of more than one type and so have been entered in the table several times.

The errors in groups $A_1$ and $A_2$ show very clearly that these children are generating these inflected forms by a simple process - where they are going wrong is in not applying the knowledge (assuming they possess it) that certain forms are irregular and others require an adjustment of one sort (y - i) or another (drop final e). Group $A_3$ is a slightly different proposition because it is not clear what sort of rule is being violated. For items such as cutting and stopped the doubling of the consonant is a phonological requirement to signal the short nature of the vowel. However, in the local dialect stoped (but not cuting) is an entirely appropriate phonetic spelling and so the rule being violated is not a phonological one but an orthographic one.

The errors in groups $B_1$ and $B_2$ are to do with the form of the inflection. In group $B_1$ the -ed has been replaced by a phonetically appropriate letter (laught) or in the case of one subject by an apostrophe (try'd). In group $B_2$ the error is a simple omission of the e in the morpheme and might well be due to some relatively uninteresting

Table 2

The present participle, the past participle and the past tense of regular verbs are all formed by adding the appropriate ending (-ing, -ed and -ed respectively) to the base verb, sometimes after adjustment rules. These are as follows:

1. No adjustment rule: simple concatenation of base and ending (e.g. wait - waiting; shout - shouted).

2. Adjustment rule: final -e. Dropping the final -e from a base that ends in the same before adding the morpheme (e.g. write - writing, amuse - amused). Note (a): with -ed this is tantamount to adding simply -d. Note (b): exceptions when adding -ing: these are when the -e serves either a phonetic marking function (e.g. ageing; singeing - the -e keeps the -g soft) or a lexical marking function (dyeing vs. dying; singeing vs. singing).

3. Adjustment rule: -ie/-y. The rewriting of final -ie as y before adding -ing (e.g. lie - lying).

: -y/-i. The rewriting of final y as -i before adding -ed when the y is preceded by a consonant (e.g. dry - dried) but not when preceded by a vowel (e.g. pray - prayed).

4. Adjustment rule: Doubling. The doubling of the final consonant of the base occurs when the base ends in a single consonant preceded by a single vowel (short vowel) and the syllable is stressed (e.g. permit - permitting). If the syllable is not stressed then doubling most often does not occur (e.g. offer - offering, edit - edited). There are some items where both doubled and undoubled versions are permissible, notably final l (e.g. labelled or labeled; traveling - travelling).

5. Adjustment rule: -ic. For a base ending in -ic, the -ic is rewritten as -ick before the participle is added. (e.g. traffic - trafficking, picnic - picnicked).

6. Irregular forms: -ed participle. There are three types of irregular verbs in English (excluding the verb to be): (a) Type 1. The base, the past tense (p.t) form, and the past particple (p.p.) are all the same form (e.g. put - put - put). (b) Type 2. The base differs from the past tense and past participle which are the same (e.g. bend - bent - bent). (c) Type 3. All three forms are different (drink - drank (p.t.) - drunk (p.p.) ).

Table 2. Rules for the generation of inflected forms in -ed and -ing in English.

TABLE 3

| | Examples error (target) | Frequency: subjects (max.56) | Frequency: items | Frequency: correct occurrences subjects (items) |
|---|---|---|---|---|
| A. Adjustment rule violations | | 17 | 24 | 5 |
| $A_1$ (irregular forms) | sayed (said) | 3 | 4 | 2 (2) |
| $A_2$ (miscellaneous) | partys (parties) | 5 | 8 | 0 |
| $A_3$ (doubling) | cuting (cutting) | 10 | 12 | 3 (3) |
| B. Inflection errors | | 7 | 10 | 7 |
| $B_1$ (incorrect inflection) | laught (laughed) | 4 | 6 | 4 (5) |
| $B_2$ (incomplete inflection) | rememberd (remembered) | 4 | 4 | 3 (3) |
| C. Absence of morphemic structure | | 10 | 11 | 4 |
| $C_1$ (regular target) | blose (blows) | 7 | 7 | 4 (4) |
| $C_2$ (irregular target) | herd (heard) | 4 | 4 | 0 |
| A,B,C, errors (total) | | 22 | 45 | |
| D. Miscellaneous | tolled (told) | 9 | 10 | 2 (2) |
| E. Inflection omissions | walk (walked) | 21 | 24 | 20 (21) |

Table 3 contd.

| | | | | |
|---|---|---|---|---|
| F. Number Agreement violations | I were (I was) | 10 | 16 | 5 (5) |
| G. Confusions (tense /aspect) | | | | |
| $G_1$ (past tense/ past participle | had took(had taken) | 12 | 14 | 0 |
| $G_2$ (past tense/ present tense) | have (had) | 2 | 2 | 0 |

Table 3

Summary of Inflectional Errors. Subscripted capitals ($A_1$,$A_2$ etc.) denote subcategories of main error types (A,B,etc.). Data presented are 1) the frequency of subjects making the error, (2) frequency of errors in that class, and (3) the frequency of subjects who got the rule they violated correct elsewhere. Also included (in brackets) are the frequencies of the correct occurrences of the classes of error.

and peripheral process, especially as the words in which these omissions occur are long words. What these groups have in common is that the items comprising them are phonetically correct spellings and that the form of the base, and thereby some of the morphemic structure, is preserved.

The errors in groups $C_1$ and $C_2$ differ significantly from those in groups A and B in that the error, even though phonetically appropriate, shows no evidence of the morphemic structure of the word. The structure is perhaps less apparent in the correct forms of the items in $C_2$ but it is nevertheless present (hear+d). Further evidence that these items are not produced with inflectional morphemic structure in mind comes from the fact that a number of them are homophones of the inflected word (e.g. herd, past).

The errors in group D consist of rather a rag bag of items which might be a rich source of information but which do not occur with sufficient regularity to warrant interpretation. They will not be discussed further.

Some of the errors dealt with are suggestive of a generative process: the items in groups A and B seem to be the product of generation rather than simple transcription of the internal representation of an inflected form. Evidence for this comes from a class of omission errors (group E), in which we find that the inflection has been omitted: book (for books) and jump (jumped). However, the evidence is equivocal; firstly, if we compare the omission of the -ed and -ing participles with the omission of two or more of the final letters from other words the incidence of the former is significantly greater than that of the latter ($\chi^2 = 5.33$; df = 1, $p<.05$, 10 subjects and 2 subjects respectively); on the other hand the omission of plural s is less than that for the omission of single terminal letters from other words, though not significantly so ($\chi^2 = 1.2$; df = 1, 12 subjects and 18 subjects respectively).

A secondary observation in this data is that the morphemes that are omitted are never the syllabic forms. Thus the |t| and |d| forms of the -ed morpheme are omitted (4 observations of each) but never the |id| form (e.g. waited). Similarly, the |s| and |z| forms of the plural morpheme are omitted (6 and 7 occurrences respectively) but never the |iz| form (fishes). These results may well be argued to be a function of the relative incidence of the forms but they are nevertheless suggestive of a phonetic component in the spelling of these inflected words. These results taken together suggest that the inflection in inflected forms is a product of a generative rather than a transcriptive process and that it is more of an addend than an integral part of the word.

In English there are very few cases where the form of the verb depends on the number (or the person) of the subject. These few instances are summarised in table 4.

| Subject | Present tense | Past tense |
|---|---|---|
| I | am, have, do, know | was |
| he, she, it | is, has, does, knows | was |
| you, we, they | are, have, do, know | were |

Table 4

The instances of subject-verb agreement in English.

From Table 3 we see that a number of subjects (group F) committed errors of number agreement. All of these involved the verb to be. Of the ten children, nine made a total of eleven errors in the grammatical forms there was.... and there were ...., the form of the verb being inappropriate to the subject, which was often complex: e.g. lots of chairs, any loose floorboards. The remaining five of the sixteen errors were instances where the subject came before the verb but where it was again complex: e.g. Aunty and Uncle, one of the doors. These results suggest that children of this age might not be able to identify correctly the subject governing the form of the verb when this subject is in any way complex. For example, children might not be able to distinguish between the singular subject in Either John or George... and the plural subject in Both John and George... Similarly, a mass noun such as music or an irregular plural such as sheep are potential sources of confusion and the complexities of their identity with respect to number have to be mastered before the appearance of the correct form becomes a certainty. These results are also suggestive of a planning span. If a chunk of text awaiting transcription spanned the subject and the verb then, given the existence of a certain amount of background knowledge, errors of agreement would be unlikely. There is some evidence from these errors that this spanning is not occurring. For example, in "one of the doors were" and "Aunty and Uncle was" it is the immediately preceding noun that appears to be determining the form of the verb - the chunk including the verb does not also include the (whole) subject.

There is a sense in which these errors of number agreement and those in the class to be discussed next are not spelling errors - they could and do occur in speech. However, they are informative as to the child's knowledge of the syntax and inflectional morphology of English and as such as of considerable interest.

The last type of error in this inflectional category concerns a confusion of the simple past tense form of a verb with the past participle. In English regular verbs, the past tense and the past participle have the same form: I waited (past tense) and I have/had waited (past participle). This identity of form also occurs with some irregular verbs: bend (bent - bent), put (put - put). However, there is a class of irregular verbs where the two forms differ: drink (drank (past tense) - drunk (past participle) ). It is in this latter set of verbs that a number of children (group G, table 3) have confused the two forms. In using the perfective aspect they have incorrectly used the past tense form to produce errors such as have went and had never saw and in using the simple past tense they have substituted the past participle from the past tense form to produce errors such as I seen and he broken. In contrast to the frequency of these confusions the confusion across tenses is rare. Thus there are only two occurrences of the confusion of past and present forms (have/had, blow/blew) (on the basis of the context in which they occurred I have classified errors such as look (looked) or shape (shaped) as omissions and not as errors of tense confusion). These results indicate that forms that differentiate between tenses are more securely established in the mental lexicon than forms that distinguish between the interaction of tense and aspect, the relationship between these latter being a far from simple one (see for example, Lyons (1968) for a discussion of tense, aspect and mood).

Table 3 also presents the frequency of subjects who, having made an error of a particular kind, have spelled an item of the same class correctly elsewhere in the essay. For example, if the error was laught (laughed) the correct form of a verb of the same class occurred elsewhere (e.g. jumped or picked, ending in |t|, but not called or waited, ending in |d| and |id| respectively). The only result here that seems unequivocal is the high frequency of correct occurrences in group E. This provides further support for the view that these errors are indeed simple omissions rather than ignorance.

Apostrophe s

The apostrophe s ('s) serves two functions: (a) to signal a contraction or omission of letters. This omission often spans more than a single word and so we find items such as thro' (through) and 'till (until) as well as items such as I'll (I will) and won't (will not). Notice that in won't there is more than a simple contraction in that the spelling of the items is not what would be predicted (win't?). The reason for this

anomaly is etymological - the full form being originally wol not.
(b) to signal the genitive or the general quality of possession. The rule for apostrophe s in the genitive is fairly simple: add 's to the possessor and if this is in plural form, where the plural already ends in s, simple add " ' ". Thus we have:

| Singular | Plural |
|---|---|
| boy's | boys' |
| man's | men's |
| lady's | ladies' |

Problems are created by forms such as brother-in-law or a month or two but the rule here is to treat these as units thus: (brother-in-law)'s hat and (month or two)'s time.

Now in spoken language the linguistic information the apostrophe conveys is signalled by the grammar and by the phonological form (the latter being very evident in items like won't or can't but indistinguishable from the plural in items like boy's or girls'). In writing, the apostrophe itself is an additional cue, the correct use of which depends on rules of the kind dealt with above.

Table 5 presents the apostrophe error data. Firstly it should be noted that the relative frequencies of the genitive and contraction errors are not necessarily indicative of their relative difficulty as contraction forms are probably more frequent anyhow. Secondly, all the genitive errors and 80% of the contraction errors are simple omissions of the apostrophe. The data do not permit one to discover whether this is a simple omission or whether it reflects a lack of knowledge concerning the use of the apostrophe. In five of the remaining cases the error was a phonetic spelling of the word, dident or wouldent for example. These latter errors indicate that these children did not know the structure of the items.

| | Category of error | | |
|---|---|---|---|
| | Genitive | Contractions | Wrong use |
| Frequency: subjects | 14 (2) | 29 (9) | 7 (0) |
| Frequency: errors | 16 | 60 | 14 |
| Frequency of type of error | 16 omissions | 48-omissions<br>8-time<br>4-phonetic spelling | 14-used with the plural |
| 38 subjects made an error in at least one category.<br>12 subjects made an error in at least two categories.<br>1 subject made an error in all three categories. | | | |

Table 5

Summary of Apostrophe s data. Presented are frequencies of: (a) the number of subjects making an error in a particular category (e.g. genitive) and the number of these (in brackets) who used the correct form elsewhere, (b) the total frequency of errors in that category and (c) the type of error made - omitting the apostrophe; expressing time (o'clock) wrongly; spelling the form phonetically; or using the apostrophe with the plural.

Derivational Errors

The relationship between a derivative and its root word lacks the simplicity and clarity of the corresponding relationship between inflected forms and their roots. This is due to the irregularities we have discussed at some length in an earlier chapter. This difference between the two types of word is reflected in the data collected in this study, summarised in Table 6.

Firstly we see from table 6 that those errors that can be ascribed to the violation of adjustment rules (group A) are few in number and lack the systematicity of the corresponding inflectional errors. Thus while scarey (failure to drop final e) and snobish (failure to double the b) seem secure as adjustment rule violations it is less clear whether safty and amusments are best construed as rule violations (failure to

| | Error type | Examples error (target) | Frequency: subjects | Frequency: items | Frequency: correct occurrences subjects (items) |
|---|---|---|---|---|---|
| A. | Rule violation | scarey (scary)<br>snobish (snobbish) | 4 | 5 | 0 (0) |
| B. | Suffix wrong | suddenlay (suddenly)<br>nearst (nearest) | 7 | 9 | 2 (2) |
| C. | Phonetic spelling | eventuly (eventually)<br>poisiness (poisonous) | 15 | 24 | 3 (3) |
| | Total: A, B, C errors | | 24 | 38 | |

Table 6

Summary of Derivational Error data. Presented (as in Tables 3 and 5) are frequencies of subjects making the different classes of error (A,B,C); frequency of errors and frequencies of subjects producing the correct version of a class of error elsewhere. Also, in brackets are the frequencies of correct occurrences of the class of error committed. (E.g. for the error suddenlay any correct spelling of -ly is counted).

concatenate) or as simple phonetic spellings.

The errors in group B are straightforward in that they correspond to the inflectional errors. In all these items the suffix is incorrect, a persistent offender being the suffix -ly. This accounts for five of nine items and is found spelled as y (finaly) and -ley (slowley).

The remaining errors (group C) are best construed as simple phonetic spellings with little evidence of the structure of the word. Such evidence as there is, that some of the structure of the word has been preserved (e.g. exactily (exactly), marvalous (marvellous), comiption (competition), is best interpreted as being either a phonetic spelling (the -ily in exactily), or as the realization of knowledge of a particular spelling pattern (the -tion in comiption (competition) and the -ous in marvalous (marvellous).

In summary, an analysis of the misspellings of derived words reveals that phonetic considerations are paramount and that there is little reason to believe that subjects generate the spellings of these items using the knowledge of their morphemic structure.

Compounds

In the data there are a large number of single words that have been written as two separate words. In all these cases at least one of the two components exists in its own right as an English word. Thus one such error was a partment (apartment) and while apart ment could have occurred with equal likelihood the data suggests that we would not find ap artment.

The items that had been splintered in this fashion are a mixture of very evident compounds (downstairs, footprint), less clear cases (alright), and items that are not compounds (again). In view of the problems that defining a compound might have created, the error targets were presented in list form to five independent judges who were asked to state whether they thought a particular item was a compound. A compound, they were told, was a word comprising two (or more) other words that had become joined in the course of time and where the meaning of the result was a function of the parts. Milkman was given as an exemplar.

On the basis of the responses given to these items they were partitioned into two sets: those where three or more of the judges had regarded them as a compound (the compounds), and those where less than three had regarded them so (the quasi-compounds). Subjects committing these errors were also partitioned into three groups: those committing only compound errors, those committing only quasi-compound errors and those committing both. Table 7 summarises these results.

| | Frequency subjects | Frequency items | Frequency correct occurrences. subjects (items) |
|---|---|---|---|
| Compounds only | 15 | 24 | 2 (2) |
| Quasi-compounds only | 6 | 10 | 1 (1) |
| Compounds and quasi-compounds | 14 | 41[1] | 3 (4)[2] |

Superscript 1 - consisting of 22 compounds and 19 quasi-compounds

Superscript 2 - consisting of 2 (3) for compounds and 1 (1) for quasi-compounds.

Table 7

Summary of splits data. Presented are frequencies of subjects committing the error, frequencies of the errors and frequencies of correct occurrences (in terms of the number of subjects and the number of specific items misspelled).

Now firstly, the fact that splitting occurs with items where at least one of the components is a word, and in fact predominantly both are words (17 subjects of the 20 committing quasi-compound errors did so on words where both components were words), suggests that the phenomenon is not trivially peripheral, e.g. a motor error. Secondly, the fact that significantly more subjects committed errors on compounds only than on quasi-compounds only ($\chi^2 = 3.85$; df = 1; $p < .05$. 15 subjects and 6 subjects respectively), taken together with the first observation (that quasi-compounds are split into components, both of which are words), suggests that compounds have a special status. It might be the case that the morphemic structure of at least some compounds is internally represented, a consequence of this being a greater tendency for compounds to split into their components than for quasi-compounds (in which the morpheme boundary is only apparent) to split into theirs.

| Error type | Example error(target) | Frequency: subjects | Frequency: items | Frequency: correct occurrences subjects (items) |
|---|---|---|---|---|
| Splits | down stairs | 35 | 75 | 6(7) |
| Concatenations | abit | 3 | 4 | 0(0) |
| Misspellings | earings | 5 | 5 | 0(0) |

Table 8

Summary of types of compound error. Presented are frequencies of subjects committing the errors, frequencies of errors and frequencies of correct occurrences elsewhere of the specific items and of the subjects producing these correct occurrences.

Table 8 presents the frequency of the splits just discussed together with the frequencies of the other types of compound error. In addition to concatenations, a phenomenon that is the converse of splitting but about which there is little to be said, there is a class of errors which are misspellings and which indicate that the morphemic structure of these items is not a factor governing their spelling. Thus we have items such as earings (earrings), exrays (X-rays) and cubard (cupboard).

Intra-Morphemic Errors

A) Lexical Errors There are a large number of cases where the error is an English word, either identical in sound to the target word or very similar in sound to it. This class divides into subclasses which seem to be the result of different processes. These data are summarised in table 9.

| Error type | Examples | Frequency: subjects | Frequency: items | Frequency: correct occurrences subjects (items) |
|---|---|---|---|---|
| A. Specific confusions | to/too<br>of/off<br>their/there | 26 | 32 | 4(4) |
| B. Homophonic substi-tutions | plain(plane)<br>see (sea) | 15 | 20 | 4(4) |
| C. Semi-homo-phonic sub-stitutions | they (the)<br>flow (flew) | 11 | 15 | 8(9) |

Table 9

Summary of Lexical Errors. Substitutions of target word by an error word that is either identical to or similar in sound to the target. Frequencies of subjects, errors and correct occurrences (in terms of subjects and specific items) for each error type are presented.

Confusions of to and too, there and their and of and off are so frequent as to merit a group of their own, group A in table 9. The confusion in each of these pairs is asymmetrical in that of is substituted for off (11 instances) more often than off for of (1 instance); to is substituted for too (6 instances) more often than too for to (1 instance) and there for their (10 instances) more often than their for there (3 instances). The results of of and off and to and too could be the product of simple omissions of the final letter but the confusion of there and their suggests that these children might not know that the semantic distinction is preserved in the spelling, i.e. they may only have the one spelling.

Group B in table 9 is the more general case of homophonic confusion. In at least five of these cases (those where the correct spelling occurs elsewhere) the children seem simply to be confused as to which spelling is correct to the lexeme being expressed. In the remaining cases the possibility remains that, like their and there, they only know the one spelling for the two lexemes.

Group C in table 9 also consists of errors which sound like the target but where the sound is not identical.. The difference between the target and the error is almost always (2 exceptions) a single letter and either an addition (short(shot)) or a substitution (feel(fell)). Furthermore, seven of the 15 words are simple function words (the, them) and often occur correctly elsewhere. These observations suggest that these errors are not genuine lexical confusions but are the product of some more psychologically peripheral inefficiency.

B) Omission Errors

Terminal omissions: These errors are those comprising group A in table 10. There are several features of this group that merit attention: the items involved are simple words, 20 of the 29 being function words like the (they) and an (and). A number of them, 19 of the 29, occur correctly elsewhere; in all but four cases the error is a word in its own right (the (they), so (sow), go (got), but

| Error type | Examples error (target) | Frequency: subjects | Frequency: items | Frequency: correct occurrences subjects (items) |
|---|---|---|---|---|
| A. Terminal omissions | the (they)<br>a (and) | 19 | 29 | 14 (19) |
| B. Non-terminal omissions | exiting (exciting)<br>happed (happened) | 20 | 32 | 1 (1) |
| C. Unstressed syllable omissions | intresting (interesting) | 7 | 7 | 0 (0) |

Table 10

Summary of omission data. Frequencies of subjects, errors and correct occurrences (subjects and specific items) for each type of omission error are presented.

also looke (looked) ). These features together suggest that these confusions are not confusions at the lexical level. On the other hand the fact that so many of the errors are words in their own right (and this applies also to group C errors in table 9) suggests some lexical influence; a simple slip-of-the-pen type of explanation seems insufficient. One possible explanation is that the wrong item is being retrieved from the mental lexicon. This is a phonetically similar item that is 'near' the desired one - note that this is not a lexical confusion, in that the words are not being confused, but is the product of a "mechanical" error. A second class of explanation is in terms of an editor that operates at a lexical level in that it checks whether a particular string is a word or not; it would provide positive feedback erroneously, after items like the, so, an, and so forth, without taking cognizance of what the intended output was. This latter explanation by itself, however, cannot account for the group C errors in table 9, because the errors are either longer than the target or different from it, but not shorter. The former explanation can account for both types of error.

Non-terminal omissions. These errors, group B in table 10, consist of the omission of letters from non-terminal parts of a word. In 29 of the 32 cases this is a single letter and in 27 of these 29 instances the letter is a consonant. Not included in this category are omissions of vowels which could be construed as errors of vowel correspondence. Thus for example, frind (friend) or herd (heard) are not included in this category.

Unstressed Syllable omissions. These errors, group C in table 10, consist of the omission of the unstressed syllable (a vowel) in words like choc(o)late, diff(e)rent and int(e)resting. These errors might be due to an incorrect phonetic representation, missing the unstressed syllable, rather than to the factor responsible for the other non-terminal omissions.

There seems to be no single factor to which these different kinds of omission are attributable: we have already suggested that there might be a lexical component to the terminal omissions (the (they)) and that the unstressed syllable omissions (diffrent (different)) might be a product of an incorrect phonetic representation. Evidence that non-terminal omissions (remeber (remember)) are a product of confusions in an output short-term memory buffer (c.f. Baddeley and Wing, 1980), while the terminal omissions are not, comes from the observation that the former occur in long words (of a mean length of 8 letters) while the latter occur in short words (of a mean length of 4 letters). This word length difference is significant ($p < .001$, t-test, two-tailed).

C) Consonant Correspondence Errors English spelling has achieved some notoriety, partly because of the multiplicity of correspondences between some consonantal sounds and their spellings. The spelling error data we have here suggests that some correspondences may be particularly troublesome. Table 11 summarises this data.

| Error type | Examples | Frequency: subjects | Frequency: items | Frequency: correct occurrences subjects (items) |
|---|---|---|---|---|
| All | | 19 | 36 | |
| A. \|tʃ\| | stiches (stitches) | 4 | 4 | 1 (1) |
| B. \|k\| | bicke (bike) | 5 | 5 | 2 (2) |
| C. w/wh | wich (which) | 7 | 8 | 2 (3) |
| $D_1$ \|ℓ\| (a) | untill (until) | 4 | 5 | 0 (0) |
| $D_2$ \|ℓ\| (b) | sandle (sandal) | 5 | 5 | 1 (1) |
| E. Marking | agen (again) | 5 | 6 | 0 (0) |
| F. Consonant substitutions | avoin (avoid) | 7 | 8 | 3 (3) |

Table 11

Consonant correspondence errors. Frequencies of subjects, errors and correct occurrences (subjects and specific items) for each of several problematic correspondences. (The sum of the frequencies of subgroups does not equal the total because some correspondences do not appear in any of the subgroups and because some items, classified elsewhere, were imported.)

1) Group A. |tʃ| (as in church and cheese) This sound can be realized either as -tch as in stitch and patch or as -ch as in peach and church. The generalization is that ch is used at the beginning of words, if the preceding vowel is long (peach), or if the vowel is short with a pre-terminal consonant (bench). If the vowel is short then the spelling is probably, but not always, -tch (pitch and latch but which and rich). The errors here are all incorrect productions of -ch in words with short vowels (stich, pich) - a reasonable error given that the rule for

this is probabilistic.

2) Group B. |k| (as in call, christmas and keel). The spelling of this sound is governed by the environment in which it occurs and in these results two generalizations are violated. The first is that |k| is not spelled as c when followed by i or e, rendering ticits (tickets) and histericily (hysterically) incorrect, on at least one count. The second is that following a long vowel the spelling -ck does not occur. Thus bicke (bike) and brocken (broken) are not permissible.

3) Group C. w/wh (as in went and when respectively). The difference between the two sounds represented by w and wh is that the former is aspirated to a lesser degree than the latter (possibly not in all dialects). Contrast the initial sounds in went and when, wales and whales and wile and while. The incidence of these confusions suggests that these phoneme - grapheme correspondences are not secure. (A secondary generalization concerning the distinction between w and wh is that wh occurs often with interrogatives (when, why etc.)).

4) Groups $D_1$ and $D_2$ |ℓ| . There are two allophones of this phoneme and it is their spellings that concern us here.

a) A dark consonanted |ℓ| which occurs in words such as fill and full, i.e. terminal sounds. The children's error is to double the ℓ in polysyllabic words (e.g. untill and beautifull). The generalization concerning the spelling of this terminal dark ℓ is that if the item is monosyllabic then the ℓ is doubled, unless the vowel is long (pill and peel). If the word is polysyllabic then the ℓ is single, even if the word is a compound like careful or beautiful.

b) A dark syllabic |ℓ|. This is the terminal sound in words like apple, pencil, sandal and model. As these examples show, the spelling of this sound can vary and the children's error is to get the wrong spelling (e.g. sandal and handil). (A quick check of "Walker's

Rhyming Dictionary" reveals that the spelling of this |ℓ| is not entirely random: final -al is strongly associated with adjectives (so sandal is the exception rather than the rule), and when the pre-liquid consonant is doubled the realization is most probably -le (e.g. apple, piffle) ).

5) Marking. Group E. Both c and g are "soft" before e and c is soft before i, their pronunciation is hard elsewhere (cellar vs. caller, gem vs. game); g before i is variable. By this token certain spellings are unlikely: guess and biscuit must be spelled with a u to keep the consonant hard; flange and dance are spelled with a final e to keep the consonants soft. The errors in this group of words (group E) indicate that the children are not precluding the spelling of, say, ticket as ticit, and bracelet as braclet, on the basis of the necessity of following the c with a marker to indicate its pronunciation.

6) Group F. Consonant substitutions. This is a small set of errors where substitutions have occurred to produce errors such as wend (went) and bumb (bump). The error and target consonants in all the items in this class differ by only one distinctive feature, nasality (avoin (avoid)) or voicing (bumb (bump)). These errors are evidence for a phoneme - grapheme transcription process in writing that is seemingly oblivious to larger units, i.e. the writing of the sound |b| instead of |p| is occurring without reference to the lexical unit (bump) - if it were then the error would not occur. The claim is not that all spelling operates at this level but simply that this is one component process.

D) Vowel Realization Errors The errors in this section concern the spelling of vowel sounds. They have in common the fact that they are perfectly plausible phonetic spellings - it so happens that they are incorrect. 21 Children made a total of 33 errors of this kind (5 of these were spelled correctly elsewhere).

In a few cases (4) the spellings are incorrect because they are phonetic spellings of the local dialect (oponed (opened), covored (covered), cartin (carton), oporation (operation)). In the remainder of the cases the written realization of the sound is incorrect (e.g. screem (scream), trie (try), promanade (promenade) ). The error in all these cases is a failure to complement the phonetic spelling with graphemic information, i.e. a failure to remember that scream is spelled -ea- and not -ee-, even though both are orthographically legal.

E) Metathesis Eleven children committed 13 errors of metathesis or reversal, three of these thirteen being spelled correctly elsewhere. All but one of the errors involved vowel digraphs and consisted of misspellings such as freind, thier, siad and neice. An interpretation of these errors in terms of some peripheral psychological process may not however be appropriate as nine of 13 errors involved the -ei and -ie digraphs. This preponderance suggests that the correspondences of these digraphs are not secure.

A comprehensive account of the correspondence of ei and ie is to be found in Venezky, what is important here is that the words in which these errors occur tend to be examples of the minor generalizations and so ones in which either spelling would be more or less acceptable. Thus friend could plausibly be spelled freind (by virtue of heifer) and niece and piece spelled neice and peice (by virtue of ceiling). There is some indication then that at least a few of these errors may be due to a breakdown in simple graphemic knowledge of the spelling of certain words.

F) Residue This is the last major category consisting largely of a rag-bag of items which cannot be put into sub-groups of any substantial size. (26 subjects committed 57 errors in this category). There are some items in this category however which together with items that have been classified elsewhere are indicative of problem areas.

Incorrect Phonetic Representations. There is a class of items consisting of errors like expeshily (especially), samviches (sandwiches) and accounter (encounter) which indicate that the children's internal phonetic representations of these items are incorrect (6 subjects committed 6 errors of this kind).

Doubling. Eleven subjects committed 13 errors involving medially occurring doubled consonants, e.g. tommorow (tomorrow), reasured (reassured) and corodor (corridor). These doubling errors did not occur in large enough numbers to determine the degree to which they were systematic.

It could be argued at this point that the foregoing analysis, while possibly interesting, is largely contrived in that the errors can be quite adequately described in terms of a phonetic strategy which has failed because the speller has not remembered various bits of somewhat idiosyncratic information concerning the spelling of certain words. This argument is not without force. However, an analysis of some individual's errors validates just the kind of analysis that has been performed.

Table 12 presents data that shows that certain kinds of errors (e.g. violations of inflectional adjustment rules) occur with greater than average frequency in the scripts of some children. For each of the error types dealt with in this analysis the mean number of errors committed (the mean for the subjects committing them, not the mean over all 56 subjects) was calculated and the criterion for "particular problems with error type X" set at twice this mean. For example, for "compound splits" the mean number of errors was 2.14, twice this is 4.28, so all children with five or more errors are treated as having a special problem in this category. The number of children having problems of a particular kind is in the penultimate column and the scores for these children in the final column. By the same criterion of twice the mean, children with

| | Error type | Example | 2xMean | Frequency: subjects | Frequency: errors for each subject |
|---|---|---|---|---|---|
| 1) | Splits | to gether | 5 | 3 | $6^2, 5^a, 6^6$ |
| 2) | Inflected forms | moveing | 5 | 2 | $7^2, 6^7$ |
| 3) | Number agreement | They was | 3 | 1 | $4^b$ |
| 4) | Derivational suffix misspelled | Suddenley | 3 | 1 | $3^1$ |
| 5) | Derivational phonetic spelling | poisiness | 3 | 2 | $3^1, 3^c$ |
| 6) | Apostrophes all violations | didnt | 5 | 4 | $8^d, 6^e, 9^5, 6^f$ |
| 7) | Terminal omissions | crep(t) | 4 | 1 | $4^4$ |
| 8) | Non-terminal omissions | fu(r)ther | 3 | 2 | $4^1, 5^2$ |
| 9) | Consonant correspondences | stiches | 4 | 2 | $5^2, 6^3$ |
| 10) | Vowel correspondences | screem | 4 | 1 | $4^3$ |
| 11) | Residue | becuas | 5 | 2 | $5^9, 8^3$ |
| | All errors | 1) total number criterion | 21 | 7 | $27^1, 33^2, 27^3, 22^4, 22^5, 24^7, 21^A$ |
| | | 2) percentage criterion | 6% | 8% | $6^2, 8^3, 6^4, 6^6, 10^7, 8^B, 6^C, 10^D$ |

Table 12

Error types that cause some children particular problems, frequencies of children for each type and the number of errors per child. The superscripts are a means of identifying the children. Further details are in the main text.

a general problem were isolated firstly on the basis of the total number of errors they committed and secondly on the basis of the percentage of errors committed. Finally in table 12, the superscript on an error value (e.g. $6^2$) indicates that that score (e.g. 6) belongs to a child (e.g. number 2) for whom data is to be found elsewhere in the table.

Notice firstly that although there is not complete agreement between the sets of subjects selected for having a general problem by the two criteria (total number of errors and percentage of errors), they both indicate that about 13% of children have a general problem. Notice secondly that it would be a mistake to rank order the error types on the basis of the number of subjects they cause problems to, as the relative incidence of the different kinds of words is not known.

From table 12 we see that there are (a) some children who have a general problem and one or more specific difficulties (number superscript), (b) some who have a general problem but no specific difficulty (capital superscript), and (c) some who have a specific difficulty but no general problem. A slightly finer grain analysis of the data in table 12 reveals that in some cases an individual child's spelling profile may be constructed. Consider the following:

a) General problem and specific difficulties:

C1 - (Child 1, table 12). This child has a generally high error rate, a phenomenon that becomes comprehensible if we interpret his spelling of derived words phonetically as being reflective of an over-generalized phonetic strategy, and his tendency to omit medial letters as being reflective of an inefficient memory/attention component (one that is responsible for omitting letters from long words).

C2 - This child's high overall score (33) is accounted for to a substantial degree by his specific difficulties (sum = 23 errors). He tends to split single words into parts and has problems with inflected forms (he tends in fact simply to concatenate the base and the inflection - e.g. smokeing). These suggest a tendency to write "morphemically" and to ignore the integrality of the words (adjustment rules can be construed as serving a binding function in that they reflect factors (graphemic, phonetic) that have the whole word as their domain). He also tends to omit medial letters (the memory/attention deficiency) and to spell consonantal sounds incorrectly (a weakness at the level of phoneme - grapheme correspondences). In short he seems to have a general problem in that he is weak in a number of different areas, each of which reflects a component in the general ability to spell correctly.

C3 - This child has specific difficulties with vowel and consonant correspondences (the "Residue" difficulty is not easy to interpret). That is, this child has problems at a basic phoneme - grapheme correspondence level (one suspects however from the sub-categories, that his problems arise when the correspondences are governed either by phonotactic factors (spelling of |tʃ|) or by convention (scream rather than screem).

C4, C5, C6 and C7 - All these children have a general problem but also tend to peak in one specific area which varies from child to child (see table 12). No more detailed profile than can be drawn from the identity of these specific difficulties is merited here.

b) General problem and no specific difficulty:

No profile of these children is possible at the level of analysis being performed here.

c) Specific difficulties and no general problem.

These children do not have a generally high error rate and so are not, by the criterion used here, bad spellers. They do each have, however, a particular bugbear: Ca tends to split single words into its (apparent) components; Cb uses was irrespective of the number of the subject; Cc has problems with the morphophonemically governed spellings of derived words while Cd, Ce and Cf do not know how to use the apostrophe.

This analysis indicates quite clearly that children may be meaningfully classified into more than just good, average and poor spellers. Any given child may have either a general spelling problem, specific difficulties or both a general deficiency and specific problem area. Of particular psychological interest is that the nature of a child's specific difficulties can be indicative of the psychological structures (e.g. the internal representations of words) and processes (e.g. motor slips) responsible for the majority of his errors.

## CONCLUSIONS

In the Introduction to this analysis of spelling errors I suggested that the errors of these children might be systematic, and that they might reveal particular weaknesses in the childrens' spelling ability. This suggestion has been supported by the data.

Some of the errors made in the spelling of inflected words suggested that they are the result of a generative process that is conditioned by morphemic as well as by phonetic factors. The errors on derived words, on the other hand, gave no such indication that morphemic factors are normally a consideration in their spelling. The tendency of compound words to split at the morpheme boundary suggested that this boundary has representational status and that it is less than secure.

The contribution of lexical factors was indicated: there were instances of misretrieval; of confusions between similar sounding words; and of incorrect phonetic representations in the mental lexicon.

The consonant and vowel correspondence errors were of a type that indicated a failure to take into account phonotactic factors and purely arbitrary conventions when spelling a particular sound. There was also evidence of a short term memory component as well as phoneme-grapheme translation process.

Individually, there were some children with a general spelling problem, some with specific difficulties only, and some with both general and specific difficulties.

This analysis then, has shown that spelling is not merely a question of problem words, nor is it merely a question of a phonetic strategy supplemented by visual information; it is the product of the interaction of several psychological processes and sources of knowledge.

# CHAPTER SIX

# 6. GENERAL CONCLUSIONS. 0.

The experiments described in this thesis have focussed, in turn, on different aspects of a word. We began with an initially simple conception of a word in terms of a sound, a visual form, and a meaning, and it was this conception that underlay the first two experiments. This basic notion rapidly became complicated when we considered in greater detail the structure of the sound of a word and the relationship between sound and spelling. Thus it was soon evident that we could speak of sound structure in any one of a number of units, such as phonemes and syllables; that the relationship of these, one to another, was roughly one of nesting; and that more than a simple concatenation of units was involved. English spelling too, was found to be more than just a simple matter of phoneme-grapheme correspondences, though it was also argued that its reputation for idiosyncrasy was exaggerated in that phonotactic rules and statistical regularities are often found to underlie what initially seems to be an unmotivated spelling. The implications of the discussion of these issues, and evidence bearing on them, were that the acoustic and visual forms of a word might each be represented internally in several forms (e.g. whole-word features, letter-by-letter, and so on), and that also represented internally were a number of other pieces of information concerning lexical matters in general (e.g. spelling rules, a knowledge of permissible sequences in English, statistical regularities of word structure, and so on).

The complexities of word structure multiplied further when we considered the notion of the morphemic structure of words. The implication of this notion was that (multimorphemic) words are composed of semantic, phonological, and orthographic units, and that these three aspects of their composition are related. A more detailed consideration of the realities of morphemic structure and the processes of word derivation suggested that while these were not as regular as a purely linguistic consideration suggested, there might nevertheless be sufficient regularity or redundancy to be psychologically useful. The five experiments reported in chapter four were designed to test the psychological reality of the conception that (some) words are morphemically structured.

In the work of Chomsky and Halle (op.cit.) we find perhaps one of the most complex conceptions of a word: this is in terms of an underlying, abstract, phonological representation that preserves morphemic structure and from which the surface phonological form is generated by the application of rules such as those for stress assignment. According to this conception, English spelling, far from being idiosyncratic, is near optimal in that it is not tied solely to the surface phonological form but often reflects the underlying form when the surface form is predictable. The study of childrens' spelling errors reported in chapter five did not purport to test this optimality claim, but was conducted with a view to analysing these errors from a morphophonemic standpoint.

The first two experiments (Expt. 2.1 and Expt. 2.2) showed quite clearly that some form of visual representation, as well as some form of acoustic representation of a word are established rapidly in the mental lexicon. Subjects in Expt. 2.2 seemed able to use the visual representation of learned words to distinguish between homophones at a level above chance by the end of the second learning trial. However, this rapidity may have been due to an experiment-specific strategy, for the results of Expt. 2.1 suggested that while some form of visual representation was established after three learning trials, subjects were nevertheless tending to mistake homophonic misspellings for the original spellings. Unfortunately, the attempt in Expt. 2.2 to isolate that component of learning responsible for setting up these representations, and to measure the growth of these representations, was in general unsuccessful, even given the absence of strategy effects.

There was also evidence from Expt. 2.1 that visual, as well as acoustic aspects of a word are the basis of lexical organization. The ability to retrieve the meaning of a learned word was impaired when visual or acoustic transformations of it were presented instead of the original and even though the transformed word has been "recognized" as the original.

An attempt in both experiments to specify more precisely in empirical terms what is meant by "visual" and "acoustic" was not successful. Subjects' ratings of the visual and acoustic similarity of confusable items were not of any predictive value. At least part of the reason for this may have been that the range of items used was not large enough to produce either significant differences in performance between the items or significant differences between them on their similarity ratings.

Perhaps the most severe criticism of these results would be based on the evidence that some subjects in these experiments were employing particular strategies. We have already discussed the evidence that subjects were tending to pay particular attention to discriminating between homophones in Expt. 2.2. This strategy effect might affect the kinds of inferences we might wish to make concerning the rapidity with which good quality representations are set up, but (for reasons discussed earlier) it does not affect the validity of the inference that some form of representation is set up rapidly. The more general criticism is that subjects in these experiments might not have been going about learning the items in the same way that they normally go about learning new words when adding to their vocabulary. It seems unlikely, for example, that we normally learn the meaning of a new word by forming a mnemonic or associative chain between the word, its meaning and another word, as some of these subjects did. This must remain as a weakness of these experiments, in that any claim for their ecological validity must confront this criticism.

In interpreting the results of the five "morphemic" experiments reported in chapter four we are advised to bear in mind that these experiments were conducted on students, a population whose literacy is presumably in an advanced state. It is not clear whether similar results would be obtained with people of less formal education. All the five experiments indicated, for example, that subjects had a sound definitional knowledge of a prefix.

The first three experiments all indicated that subjects identified correctly the status of those words that are not, and cannot be for structural reasons, prefixed. Similarly, all three experiments suggested that words with a known word as stem were regarded as being prefixed and that all other words were regarded with uncertainty. The identity of the prefix letters also affected the status of a word: <u>pre</u>- and <u>im</u>- (with a negative sense) were identified as prefixes; <u>be</u>- and <u>im</u>- (with a prepositional sense) were regarded with some uncertainty, while dummy prefixes sometimes evoked positive regard (<u>am</u>-) and sometimes negative regard (<u>fe</u>-).

These results indicate an ability on the part of these subjects to decompose both the words in their vocabulary and words which they have not seen before in a manner compatible with morphemic (prefix) structure, and to make a decision concerning its status on the basis of this decomposition, on the basis of the identity of the "morphemic" components, and on the basis of its meaning. The precise form of the knowledge that this ability calls upon cannot be deduced from these experiments. It might call upon knowledge of a very specific kind: for example, the specific marking of the morphemic structure of some polymorphemic words as well as the separate storage of information concerning morphemes and of information concerning the orthographic structure of prefixed words. On the other hand the ability might be, more simply, the ability to problem solve by calling upon a less organised and systematic store of knowledge: some formal knowledge; bits of information concerning some prefixes; the organization and status of similar items in the vocabulary; and some knowledge of what constitutes orthographic illegality. In any event, it seems that subjects are able to put this knowledge to a more psychologically meaningful use than to simply decide the prefix status of items. The fourth experiment reported showed that subjects were able to deduce the more probable meaning of a word from the identity of its prefix, if only for <u>pre-</u>; and the fifth experiment provided weak evidence that the compatibility of meaning and prefix was a factor in the learning of new items. Both these experiments were testing the ability to use rather specific information, namely the meaning of a prefix, and their limited success might well have been due to the fact that it was a very specific type of knowledge that was being tested.

The final source of data in this thesis came from spelling errors which, in contrast to the other data, are the result of production rather than of "assimilation" processes. The data support the popular view that a principal component of spelling is a phonetic component: errors often suggested a "regression" to a phonetically acceptable, but otherwise incorrect, spelling. There was evidence of both an output buffer and a transcription process, so it is not entirely speculative to suggest that the spelling process is one entailing the retrieval of an acoustic representation of the word, followed by a transcription that calls upon knowledge of phoneme-grapheme correspondences. Such a process would not of course be sufficient; it was suggested earlier that supplementary information of a variety of types would be required if the target of correct spelling was to be achieved. The kinds of errors found have substantiated this view in that they have shown where the system can, and does, break down. The tendency to produce homophonic misspellings (plain for plane), and semi-homophonic misspellings (short for shot), suggest that the role of graphemic representations of these items is important if misretrieval and confusions are to be avoided. In a similar manner, graphemic information is also crucial to the correct spelling of ambiguous vowel sounds such as that in scream, as well as to the correct spelling of idiosyncrasies such as yacht. There were other errors however, that suggest that correct spelling is also a function of statistical regularities and phonotactic rules. Perhaps most interesting were those errors concerned with the misspellings of morphemically complex words. The evidence on inflected and compound words suggests that the morphemic complexity of these items is internally represented. In keeping with the literature the suggestion is that inflected words were often the product of a generative process, entailing the separate representation of the stem and inflection, while the suggestion was similarly true, if less strongly, for compound words. This notion of the marking of the morphemic structure of inflected words (if not actually the separate storage of the components) was also suggested by one of the earlier experiments (Expt. 2.2). In contrast to inflections and compounds, there was no evidence for the morphemic marking of derivatives and it seems likely that the representation of the morphemic structure of these items will be found to depend on such factors as the productivity of the affix, the phonological changes affixation produces and the demands of the task.

In conclusion then, the theoretical literature, the empirical literature, and the experiments reported here are all indicative of a

Lexical Memory or Internal Lexicon whose contents are both heterogeneous and redundant. Such a conception of the Internal Lexicon does not bear close scrutiny when the criteria are elegance and economy, but given the range of demands we make on our language ability, and that each of these demands may be best served by a particular bit of knowledge, this conception makes good psychological sense.

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## APPENDIX 2.1.1

| | Ts | Tv | Ta | Meaning |
|---|---|---|---|---|
| 1. | Flaight | Flate | Flaught | A plant with small purple flowers |
| 2. | Clane | Clain | Clant | A non-alcoholic drink made with pears. |
| 3. | Voar | Vore | Vour | A contagious disease of the bones. |
| 4. | Dawl | Daul | Darl | An amphibious mammal. |
| 5. | Smare | Smair | Smarn | A unit of weight roughly equal to a gram. |
| 6. | Pewn | Pune | Pern | Imitation Victorian lace. |
| 7. | Thoal | Thole | Thoul | Crankshaft of a gas turbine engine. |
| 8. | Meach | Meech | Merch | A legal term for certain kinds of theft. |
| 9. | Slegm | Slemn | Slerm | The ceiling of a thatched house. |
| 10. | Dite | Dight | Dita | An instrument used by surveyors. |
| 11. | Frood | Frude | Froad | A star in a neighbouring galaxy. |
| 12. | Blign | Bline | Blimn | An inert gas. |
| 13. | Noil | Noyle | Noal | One who decorates leather. |
| 14. | Kere | Kear | Kerf | A ball game for two players. |
| 15. | Taid | Tade | Taud | An inert gas. |
| 16. | Hoat | Hote | Hout | An instrument used by surveyors. |
| 17. | Trair | Trare | Traur | A star in a neighbouring galaxy. |
| 18. | Vead | Vede | Veda | One who decorates leather. |
| 19. | Smew | Smue | Smey | Ceiling of a thatched house. |
| 20. | Stry | Strie | Stra | A legal term for certain kinds of theft. |
| 21. | Draist | Draste | Draust | A ball game for two players. |

These are the Words and Meanings used in Experiment 1. The columns marked Ts, Tv and Ta contain words that are untransformed, visually transformed and acoustically transformed respectively. Also presented are the meanings that were presented with the words. Items no. 1-7 comprised List $W_1$, no. 8-14 comprised List $W_2$, and no. 15-21 List $W_3$.

Listed below are the distractor items presented at test. $Td_1$ denotes real word distractors and $Td_2$ the non-word distractors.

$Td_1$: ARM, BANK, CITY, DOLLAR, EYE, FATHER, GIRL, SCHOOL, KING, LADY, MILE, RED, TABLE, WALL.

$Td_2$: COSP, FIEF, JAOC, LALK, ROMB, SAHI, WUX, WRAPH, YOSS, ZORYMB, ISQUE, VROUW, KNOG, QUIV.

## APPENDIX 2.1.2

INSTRUCTIONS GIVEN TO SUBJECTS

### 1) Learning Phase Instructions

This experiment is concerned with how people learn words and their meanings. Printed on each card is a word together with a brief definition of its meaning. The task is to learn the meaning of the word.

Pick up the pack of index cards and look at each card for seven seconds (the interval between beeps on the metronome), and then place it face down on the table. Do this for all the cards.

Having looked at all the cards once pick them up and shuffle them a few times; do this in such a way as to hide the printing on the cards.

Using the same procedure look at all the cards a second time and a third time. Thus at the end you will have looked at all the cards three times.

Instructions for the second part of the experiment will be given in due course.

### 2) Test Phase Instructions

You will now be given a simple test of what you've learned.

Printed on the sheet are all the words you've just learned, together with some you've not seen before and some which are very familiar words. To all these words you must give three replies.

1) In the first column, give your answer to the question: "Have you seen this word before?" Reply, using the following scale:

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Definitely haven't | Think I haven't | Think I have | Definitely have |

2) In the second column, write down the meaning of the word. Even if you only think you know the meaning, put it down. Only if you have no idea what it means, or it's a word you've never seen before write down "no meaning".

3) Your reply in the third column enables me to work out to what extent your reply in the second column was a guess. Using the scale below rate how confident you are that the answer you have given is the correct one.

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Very unconfident | Unconfident | Confident | Very confident |

/contd..

Please note that this scale even applies to words where you've written "no meaning", as you can have various degrees of confidence as to whether the word has a meaning or not.

While in principle you can spend as long as you like on the answers, it's not a good idea to spend too long on each, as your memory for words further down the list will begin to fade.

Finally, please deal with words in turn, giving all three replies to each before moving on to the next word. For the very common words only a very short statement of its meaning is required.

# APPENDIX 2.1.3

Recognition decrement scores and mean judged similarity ratings for transformed-untransformed word pairs, in each of the two word lists ($W_1/W_1$, $W_1/W_3$) and for each type of transformation (Tv and Ta).

## List $W_1/W_2$

| Ts : Tv | Recognition decrement | Visual similarity | Acoustic similarity | Visual + acoustic similarity |
|---|---|---|---|---|
| Frood - Frude | 2.12 | 3.7 | 1.8 | 5.5 |
| Kere - Kear | 2.12 | 2.7 | 2.0 | 4.7 |
| Flaight - Flate | 2.00 | 4.0 | 1.1 | 5.1 |
| Clain - Clane | 2.00 | 2.7 | 1.1 | 3.8 |
| Pewn - Pune | 2.00 | 3.3 | 1.9 | 5.2 |
| Meach - Meech | 1.63 | 2.3 | 1.5 | 3.8 |
| Voar - Vore | 1.25 | 3.0 | 1.9 | 4.9 |
| Slegm - Slemn | 1.25 | 3.1 | 2.6 | 5.7 |
| Blign - Bline | 1.12 | 3.0 | 1.9 | 4.9 |
| Noil - Noyle | 1.00 | 3.9 | 1.7 | 5.6 |
| Dawl - Daul | 0.75 | 2.2 | 2.0 | 4.2 |
| Thoal - Thole | 0.50 | 2.3 | 1.3 | 3.6 |
| Dite - Dight | 0.37 | 3.6 | 1.1 | 4.7 |
| Smare - Smair | - 0.12 | 2.3 | 1.6 | 3.9 |

## List $W_1/W_3$

| Ts : Tv | Recognition decrement | Visual similarity | Acoustic similarity | Visual + acoustic similarity |
|---|---|---|---|---|
| Vead - Vede | 2.12 | 2.6 | 1.6 | 4.2 |
| Stry - Strie | 2.00 | 3.9 | 1.8 | 5.7 |
| Draist - Draste | 1.75 | 3.1 | 1.4 | 4.5 |
| Pewn - Pune | 1.50 | 3.3 | 1.9 | 5.2 |
| Taid - Tade | 1.50 | 2.7 | 1.2 | 3.9 |
| Hoat - Hote | 1.50 | 2.4 | 1.8 | 4.2 |
| Flaight - Flate | 1.38 | 4.0 | 1.1 | 5.1 |
| Trair - Trare | 1.00 | 2.3 | 1.5 | 3.8 |
| Smew - Smue | 1.00 | 3.0 | 1.6 | 4.6 |
| Dawl - Daul | 0.75 | 2.2 | 2.0 | 4.2 |
| Clain - Clane | 0.38 | 2.7 | 1.1 | 3.8 |
| Voar - Vore | 0.13 | 3.0 | 1.9 | 4.9 |
| Thoal - Thole | 0.13 | 2.3 | 1.3 | 3.6 |
| Smair - Smare | - 0.75 | 2.3 | 1.6 | 3.9 |

Appendix 2.1.3 contd.

List $W_1/W_2$

| Ts : Ta | Recognition decrement | Visual similarity | Acoustic similarity | Visual + acoustic similarity |
|---|---|---|---|---|
| Pewn - Pern | 2.50 | 2.9 | 4.4 | 7.3 |
| Sleem - Slerm | 2.50 | 3.2 | 4.2 | 7.4 |
| Noil - Noal | 2.12 | 3.6 | 3.1 | 6.7 |
| Dite - Dita | 2.00 | 3.3 | 4.1 | 7.4 |
| Kere - Kerf | 2.00 | 3.0 | 4.1 | 7.1 |
| Blign - Blimn | 1.87 | 3.8 | 2.5 | 6.3 |
| Dawl - Darl | 1.63 | 3.2 | 3.0 | 6.2 |
| Voar - Vour | 1.37 | 2.4 | 2.4 | 4.8 |
| Smare - Smarn | 1.25 | 3.3 | 3.6 | 6.9 |
| Clane - Clant | 1.00 | 2.6 | 3.9 | 6.5 |
| Meach - Merch | 1.00 | 3.3 | 3.7 | 7.0 |
| Frood - Froad | 1.00 | 3.3 | 3.4 | 6.7 |
| Flaight - Flaught | 0.63 | 1.8 | 3.3 | 5.1 |
| Thoal - Thoul | - 0.12 | 2.5 | 2.4 | 4.9 |

List $W_1/W_3$

| Ts : Ta | Recognition decrement | Visual similarity | Acoustic similarity | Visual + acoustic similarity |
|---|---|---|---|---|
| Clane - Clant | 2.00 | 2.6 | 3.9 | 6.5 |
| Hoat - Hout | 2.00 | 3.5 | 3.0 | 6.5 |
| Stry - Stra | 2.00 | 3.1 | 3.8 | 6.9 |
| Smare - Smarn | 1.88 | 3.3 | 3.6 | 6.9 |
| Vead - Veda | 1.85 | 4.1 | 3.9 | 8.0 |
| Flaight - Flaught | 1.75 | 1.8 | 3.3 | 5.1 |
| Draist - Draust | 1.75 | 3.3 | 3.5 | 6.8 |
| Dawl - Darl | 1.25 | 3.2 | 3.0 | 6.2 |
| Pewn - Pern | 1.25 | 2.9 | 4.4 | 7.3 |
| Thoal - Thoul | 1.25 | 2.5 | 2.4 | 4.9 |
| Trair - Traur | 1.25 | 3.3 | 3.4 | 6.7 |
| Taid - Taud | 0.88 | 3.5 | 4.1 | 7.6 |
| Smew - Smem | 0.38 | 2.6 | 4.0 | 6.6 |

# APPENDIX 2.1.4

## Collection of Similarity Judgements

Each of the 21 words used in this experiment appeared on one of two lists. On the first list each word was paired with its visual transform (e.g. flaight: flate) and on the second list it appeared with its acoustic transform (flaight-flaught). Each list was given to ten subjects (5 male and 5 female) and subjects were asked to rate the pairs on their list for visual and for acoustic similarity on a six-point scale.

Listed below are 21 pairs of words that are homophones, homophones being words that sound the same but are spelled differently. For example see and sea, hare and hair, and so on. Using the six point scale below I want you to rate each pair on two counts.

Firstly, you might not agree that all the pairs do in fact sound the same. Accordingly, I want you to rate them all for how similar they sound. Thus if they sound the same rate them I, if not rate them 2, 3, 4, 5 or 6, depending on how different you think they sound.

Secondly, I want you to rate them on how visually similar you think they are. That is, rate them for how much alike you think they look. For example, male and mole are words that look very alike even though they don't sound the same - rate this I. Use 2, 3, 4, 5, 6, appropriately to express differences in their visual similarity. Ignore the sound of the words when you're rating them for visual similarity.

| I | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| very similar | similar | slightly similar | slightly dissimilar | dissimilar | very dissimilar |

| | Sound Rating | Visual Rating |
|---|---|---|
| Flaight - Flate | | |
| Clane - Clain | | |
| Voar - Vore | | |

| | Sound Rating | Visual Rating |
|---|---|---|
| Dawl - Daul | | |
| Smare - Smair | | |
| Pewn - Pune | | |
| Thoal - Thole | | |
| Meach - Meech | | |
| Slegm - Slemn | | |
| Dite - Dight | | |
| Frood - Frude | | |
| Blign - Bline | | |
| Noil - Noyle | | |
| Kere - Kear | | |
| Taid - Tade | | |
| Hoat - Hote | | |
| Trair - Trare | | |
| Vead - Vede | | |
| Smew - Smue | | |
| Stry - Strie | | |
| Draist - Draste | | |

# APPENDIX 2.2.1

Words used in Experiment 2.

| ee | ea | er | o-e | oa | oi |
|---|---|---|---|---|---|
| cheel | cheal | cherl | swole | swoal | swoil |
| smeel | smeal | smerl | nole | noal | noil |
| leet | leat | lert | trode | troad | troid |
| gleep | gleap | glerp | blome | bloam | bloim |
| dreet | dreat | drert | pone | poan | poin |
| neem | neam | nerm | brone | broan | broin |
| heen | hean | hern | snome | snoam | snoim |
| teep | teap | terp | lote | loat | loit |
| breen | brean | brern | fode | foad | foid |
| pleem | pleam | plerm | sote | soat | soit |

| a-e | ai | ar | ight | ite | ish |
|---|---|---|---|---|---|
| blane | blain | blarn | pright | prite | prish |
| glame | glaim | glarm | cright | crite | crish |
| frane | frain | frarn | dright | drite | drish |
| smale | smail | smarl | stight | stite | stish |
| nate | nait | nart | dright | drite | drish |
| rame | raim | rarm | glight | glite | glish |
| lale | lail | larl | gright | grite | grish |
| nade | naid | nard | snight | snite | snish |
| clade | claid | clard | glight | glite | glish |
| drate | drait | drart | clight | clite | clish |

| ue | ew | em | oe | ow | om |
|---|---|---|---|---|---|
| smue | smew | smem | spoe | spow | spom |
| bue | bew | bem | troe | trow | trom |
| plue | plew | plem | sproe | sprow | sprom |
| bue | bew | bem | smoe | smow | smom |
| snue | snew | snem | cloe | clow | clom |
| smue | smew | smem | droe | drow | drom |
| frue | frew | frem | cloe | clow | clom |
| plue | plew | plem | troe | trow | trom |
| sprue | sprew | sprem | spoe | spow | spom |
| prue | prew | prem | scloe | sclow | sclom |

| (v)t | (v)tt | $(v^1)$tt |
|---|---|---|
| blet | blett | blitt |
| flot | flott | flett |
| plit | plitt | plutt |
| glat | glatt | glett |
| dut | dutt | ditt |
| gret | grett | gratt |
| frat | fratt | frott |
| blet | blett | blitt |
| chot | chott | chutt |
| drit | dritt | drott |

Appendix 2.2.1 contd.

| (v) cks | (v) x | $(v^1)$ x | (v) ps | (v) pse | $(v^1)$ pse |
|---|---|---|---|---|---|
| plocks | plox | plix | brips | bripse | bropse |
| snocks | snox | snix | waps | wapse | wupse |
| glicks | glix | glux | haps | hapse | hepse |
| dracks | drax | drox | stips | stipse | stapse |
| bracks | brax | brox | thops | thopse | thipse |
| hucks | hux | hex | nops | nopse | nupse |
| nucks | nux | nax | dops | dopse | dapse |
| shicks | shix | shex | mups | mupse | mipse |
| frecks | frex | frax | plaps | plapse | plipse |
| hecks | hex | hux | fips | fipse | fupse |

Presented above are the nine sets of words used in this experiment. Each set consists of ten $w_1$ words, ten $w_2$ words in the Rv condition and ten $w_2$ words in the Rva condition. Each list of ten words is headed by the spelling pattern on which the words are based. (Note: (v) refers to a vowel and $(v^1)$ to a different vowel).

APPENDIX 2.2.1 (contd.)

Meanings used in the experiment

An instrument used by surveyors

A bone in the foot

A deep sea fishing boat

A member of a religious sect

A plant with purple flowers

A unit of weight equal to 1.5 grams

A turkish bracelet

A mediaeval stringed instrument

A part of a gas turbine engine

A boil resulting from a lymphatic infection

A military personnel carrier

A vase from the ming dynasty

A section of thatching on a thatched roof

A craftsman who works with metal

A celestial body that orbits a star

A small black mammal

A semi-precious stone

A piece in an oriental board game.

APPENDIX 2.2.2

Instructions: 1) Presented before the major phase of the experiment, i.e. before learning of the word-meaning combinations.

Each trial on the task you are about to do consists of 4 stages.

1) READ: read the text in front of you for two minutes. At the end of this time mark your place with the bookmark. Then:

2) LEARN: on each of the cards in front of you is printed a word and a short definition of its meaning. Your task is to learn the meaning of the word. You will not be asked, at any time, to 'produce' the words and their meanings from memory. Look at each card for the interval between beeps on the metronome, turning it face down on the next beep to look at the next card. Do this for all the cards. Then:

3) READ: continue reading the text (from where you left off) for two minutes. Mark your new place. Then:

4) TEST: you will be given a recognition test of the words and meanings you've learned. This consists of a series of sentences, each of which is an assertion about the meaning of a word. Work your way through the list of sentences, marking each with a 'tick' or a 'cross', depending on whether the assertion is correct or not.

Work you way in order through the list. DON'T LOOK FORWARD OR BACK. This is very important if the experiment is to be meaningful. Don't spend too long on each item as memory for later items will fade.

This then, constitutes the procedure on each trial. Thus the overall structure of the experiment will be:

READ - LEARN - READ - TEST - READ - LEARN - READ - TEST -
READ - LEARN - READ - TEST.

At the end of the experiment you will be asked to give a short summary of the text you have been reading.

# APPENDIX 2.2.2

Instructions: 2) Presented before the final two tests (Ts and Td).

You will now be given two final tests of what you have learned. One is the same as those you have done up to now, the other is very similar but with a slight difference; some of the words you have learned will appear in the same way as in the previous tests: in addition to these some new words will appear with 'old' meanings. These sentences will of course be wrong.

Do these tests in exactly the same way as you did the others.

APPENDIX 2.2.3

Presented below is the source table for the main ANOVA with factors: Exposure, Structural Relationship (Rv vs Rva), Pair members, and Trials.

| SOURCE | D.F. | S.S. | M.S. | F. | Prob. |
|---|---|---|---|---|---|
| Subj | 39 | 476.264 | | | |
| E (Exposure) | 1 | 114.816 | 114.816 | 11.8086 | .0016 |
| R (Rv vs Rva) | 1 | 6.016 | 6.016 | .6187 | .5577 |
| ER | 1 | 5.400 | 5.400 | .5554 | .5328 |
| EER | 36 | 350.031 | 9.723 | | |
| W (Pair member) | 1 | 11.266 | 11.266 | 5.0588 | .0292 |
| WE | 1 | 0.418 | 0.418 | 0.1877 | .6708 |
| WR | 1 | 18.152 | 18.152 | 8.1512 | .0070 |
| WER | 1 | .000 | .000 | .000 | 1.0000 |
| EWER | 36 | 80.170 | 2.227 | | |
| T (Trials) | 2 | 535.674 | 267.837 | 115.8431 | .0000 |
| TE | 2 | 9.859 | 4.930 | 2.1322 | .238 |
| TR | 2 | 5.510 | 2.755 | 1.1915 | .3098 |
| TER | 2 | 1.824 | 0.912 | .3945 | .6808 |
| ETER | 72 | 166.469 | 2.812 | | |
| WT | 2 | 13.010 | 6.505 | 3.2183 | .0447 |
| WTE | 2 | 5.258 | 2.629 | 1.3006 | .2782 |
| WTR | 2 | 15.172 | 7.586 | 3.7531 | .0276 |
| WTER | 2 | 3.027 | 1.514 | 0.7489 | .5194 |
| EWTER | 72 | 145.529 | 2.021 | | |
| WITHIN | 200 | 1011.336 | | | |

TSQ/N = 26966.4004 N = 240 SST = 1487.5996.

APPENDIX 2.2.4

Presented below is the source table for the ANOVA dealing with performance on Ts and Td tests. The factors are: Exposure, Structural Relationship, Pair member and Test (Ts, Td).

| SOURCE | D.F. | S.S. | M.S. | F | Prob. |
|---|---|---|---|---|---|
| Subj | 39 | 281.943 | | | |
| E (Exposure) | 1 | 5.256 | 5.256 | 0.7517 | 0.6041 |
| R (Rv vs Rva) | 1 | 24.807 | 24.807 | 3.5477 | 0.0646 |
| ER | 1 | 0.156 | 0.156 | 0.0223 | 0.8769 |
| Error ER | 36 | 251.725 | 6.992 | | |
| | | | | | |
| W (Pair member) | 1 | 26.406 | 26.406 | 16.8177 | 0.0003 |
| WE | 1 | 6.807 | 6.807 | 4.3350 | 0.0423 |
| WR | 1 | 0.006 | 0.006 | 0.0037 | 0.9501 |
| WER | 1 | 0.006 | 0.006 | 0.0037 | 0.9501 |
| Error WER | 36 | 56.525 | 1.570 | | |
| | | | | | |
| T (Ts, Td) | 1 | 37.057 | 37.057 | 14.8517 | 0.0005 |
| TE | 1 | 0.057 | 0.057 | 0.0227 | 0.8759 |
| TR | 1 | 0.305 | 0.305 | 0.1221 | 0.7285 |
| TER | 1 | 0.508 | 0.508 | 0.2035 | 0.6586 |
| Error TER | 36 | 89.824 | 2.495 | | |
| | | | | | |
| WT | 1 | 28.055 | 28.055 | 19.8710 | 0.0001 |
| WTE | 1 | 0.508 | 0.508 | 0.3597 | 0.5594 |
| WTR | 1 | 0.309 | 0.309 | 0.2186 | 0.6475 |
| WTER | 1 | 0.503 | 0.053 | 0.0374 | 0.8422 |
| Error WTER | 36 | 50.826 | 1.412 | | |
| | | | | | |
| W | 120 | 297.250 | | | |

TSQ/N = 24181.8066 N = 160 SST = 579.1934

APPENDIX 2.2.5

Presented below are the mean similarity ratings for each of the seven types of correspondence used in Experiment 2.2. Visual similarity ratings are presented for both homophone types and for 'normal' types; acoustic similarity ratings are presented for only the latter, it being assumed that homophones would receive the maximum similarity score. Scores can range from one - very dissimilar, to six - very similar.

| | Vis. Sim. | | Vis. Sim. | Acou. Sim. |
|---|---|---|---|---|
| ee - ea | 4.3 | ee - er | 3.5 | 3.1 |
| (v) t - (v) tt | 4.2 | (v) t - ($v^1$)tt | 3.4 | 3.8 |
| oe - ow | 3.8 | oe - om | 3.8 | 3.1 |
| ue - ew | 3.2 | ue - em | 3.3 | 2.4 |
| o-e - oa | 3.9 | o-e - oi | 3.0 | 3.8 |
| a-e - ai | 3.2 | a-e - ar | 3.9 | 3.1 |
| ight - ite | 3.5 | ight - ish | 4.3 | 2.6 |
| (v)ps - (v)pse | 4.4 | (v)ps - ($v^1$)pse | 3.9 | 4.2 |
| (v) cks - (v) x | 3.5 | (v) cks - ($v^1$)x | 2.9 | 4.3 |

Note (v) = vowel

($v^1$) = vowel different from (v)

## APPENDIX 4.1.1

### Instructions and questions given to subjects

The series of questions that follow are designed to tap your psycholinguistic intuitions about prefixes. (Don't worry if you don't know at this stage what I'm talking about!) It is extremely important that you read each question carefully and answer it as fully as you can without spending an excessive time over it. Answer each question in turn - do not look ahead of the question you are working on. You may, if you wish, look back. Don't, however, alter your previous answers.

What is your age:

State your sex:

Did you do English, Latin or German 'O' Level (or the Scottish equivalent?

If so, which?

1. What is a prefix? Define a prefix as comprehensively as you can.

2. Un- is an example of a prefix, e.g. unwise, uncivilised, unfit, unable. Re-answer question (1) if the above information means you can add to or expand on what you have already written. Put these additions in the space below.

3. Write down in no more than five minutes as many different prefixes as you can think of. Number them in the order in which you write them down. Don't worry if you don't know what they mean.

4. Write down those prefixes where you know the meaning(s). State the meaning(s) in each case. You may look back to the answer you gave to Q.3 to remind yourself of the prefixes you wrote down.

5. Which of the following are prefixes? Tick or cross as appropriate and give meaning(s) in each case if you can. Please tick or cross each one even if you have to guess.

   1) mis-
   2) fe-
   3) o-
   4) pre-
   5) be-
   6) am-
   7) tre-
   8) im-

6. In answering the last question you may have thought of one or more words beginning with the given letters and on the basis of these words made your decision as to whether or not the letters constituted a prefix. If this was the way you did the task, write down the words you thought of when making your decision. Only write down the words you thought of at the time. If you did the task some other way describe this below briefly.

7. This is an extension of question 6. Have you written down all the words you thought of when answering question 5; including those which at the time you were doubtful about (as to whether or not they were examples of the letters being used as a prefix), or even ones where you were sure the letters weren't being used as a prefix. If you didn't include these two kinds of words write them below for all the 'prefix' letters - if you did, go back and mark them with a 'd' for doubtful and an 'n' for not prefixed.

8. A prefix is a verbal element that occurs at the beginning of words, adding something constant and thus linking words, which would otherwise be unrelated, into groups or families. I have already given you the example of un-, e.g. unfit, uncivilised, unwise, undo, unable. Consider now however, whether or not the following words are 'un' prefixes: undulate, uncle, under, unit, unction. The point is that it is difficult to categorise words clearly into those that are prefixed and those that are not. The dimension is a continuum rather than being discrete.

   Bearing the above in mind, consider the fact that be-, pre-, and im-, are theoretically, prefixes. On the next page consider each in turn and give: 1) six words which are good examples of these prefixes, 2) six words where you really don't know whether they are prefixes or not, 3) six words where, in your opinion, they definitely are not prefixes. I realise that this is a difficult task and that you might not be able to think of six examples for each category - do the best you can.

| | prefixed | don't know | not prefixed |
|---|---|---|---|
| im- | | | |
| pre- | | | |
| be- | | | |

## APPENDIX 4.1.2

Presented below are the frequency of citations for each letter string being a prefix - the first number. Also presented are the frequency of correct meanings given-the second number (max. possible = 20).

| | | | | | |
|---|---|---|---|---|---|
| un | 19, 17 | extra | 3, 1 | trans | 1, 0 |
| pre | 12, 12 | supra | 3, 0 | retro | 1, 0 |
| dis | 11, 6 | ad | 3, 2 | para | 1, 1 |
| in | 11, 7 | ab | 3, 2 | exo | 1, 1 |
| im | 9, 4 | co | 3, 3 | bis | 1, 0 |
| re | 9, 8 | quasi | 2, 2 | cum | 1, 0 |
| anti | 8, 8 | di | 2, 2 | epi | 1, 0 |
| pro | 8, 6 | suff | 2, 2 | psycho | 1, 1 |
| con | 7, 0 | be | 2, 1 | geo | 1, 1 |
| super | 5, 5 | mis | 2, 1 | per | 1, 0 |
| sub | 5, 5 | infra | 2, 1 | | |
| non | 5, 5 | hypo | 2, 2 | | |
| post | 5, 5 | endo | 2, 1 | | |
| ante | 5, 5 | neo | 2, 2 | | |
| a | 4, 2 | demi | 2, 1 | | |
| ir | 4, 2 | e | 2, 2 | | |
| tri | 4, 4 | under | 1, 1 | | |
| de | 4, 2 | over | 1, 1 | | |
| il | 4, 1 | uni | 1, 0 | | |
| inter | 4, 3 | bio | 1, 1 | | |
| intra | 4, 4 | min | 1, 0 | | |
| hyper | 3, 2 | quin | 1, 1 | | |
| ultra | 3, 3 | fore | 1, 0 | | |
| bi | 3, 3 | as | 1, 0 | | |
| en | 3, 3 | an | 1, 0 | | |
| mono | 3, 2 | on | 1, 0 | | |

# APPENDIX 4.2.1

Presented below are all the words used in this experiment arranged into the sub-groups used in the experiment. In the first column after the word is the critical number above or below which (= 1, <2, <3, >4, >5, = 6) a significant number of responses occurred (sign test: $p < .05$). Blanks in this column indicate an uncertain response. In the second column are the mean response ratings. In the third column (pre- only) are the mean priority ratings.

In the set of pre- words, those used in the known-word-as-stem vs. stem-not-known-word comparison are superscripted 1, and those used in the radical/derivative comparison are superscripted 2. The im- words (with a prepositional sense) used in the radical/derivative comparison are marked with an asterisk.

## Pre-

### Not prefixed

| | | | |
|---|---|---|---|
| preach | 1 | 1.20 | 4 |
| preacher | 1 | 1.15 | 4 |
| precious | 1 | 1.50 | 4 |
| press | 1 | 1.15 | 4 |
| pressure | 1 | 1.45 | 4 |
| predator | 2 | 1.90 | 4 |
| prestige | 2 | 1.55 | 4 |
| prestigious | 2 | 2.00 | 4 |
| precarious | - | 2.45 | 4 |
| prehensile | - | 4.00 | 4 |

### Prefixed: sense of rank

| | | | |
|---|---|---|---|
| premium | 1 | 1.45 | 4.00 |
| president | 2 | 2.00 | 4.00 |
| prefer[2] | 3 | 2.45 | 3.30 |
| preference[2] | 3 | 2.40 | 3.67 |
| prevail[2] | 3 | 2.55 | 3.67 |
| prevalent[2] | - | 3.20 | 4.00 |
| prefect | - | 2.85 | 3.67 |

### Prefixed: known and related stem

| | | | |
|---|---|---|---|
| preview[1] | 6 | 5.40 | 1.0 |
| prehistoric | 6 | 5.70 | 1.0 |
| predetermine[1] | 6 | 5.80 | 1.0 |
| presuppose | 6 | 5.50 | 1.0 |
| preconception[1] | 5 | 5.25 | 1.0 |
| prerequisite[1] | 5 | 4.85 | 1.0 |
| prefabricate[1] | 5 | 5.10 | 2.0 |
| premature[1] | 5 | 4.85 | 1.3 |
| precaution[1] | 5 | 5.15 | 2.0 |
| predestine[1] | 5 | 5.10 | 1.0 |
| predisposition | 5 | 5.50 | 1.3 |
| preposition | 4 | 4.50 | 1.3 |
| prescribe[2] | 4 | 4.00 | 2.3 |

### Prefixed: stem not known and related word

| | | | |
|---|---|---|---|
| pregnant | 1 | 1.35 | 3.0 |
| present (n)[2] | 1 | 1.6 | 4.0 |
| present (v)[2] | 2 | 2.4 | 4.0 |
| precinct | 2 | 2.10 | 3.7 |
| precise | 2 | 2.20 | 4.0 |
| predicament | 2 | 2.20 | 4.0 |
| preservative[2] | 2 | 2.35 | 3.3 |
| present (a) | 2 | 2.10 | 4.0 |
| premise | 3 | 2.30 | 3.3 |
| precocious | 3 | 2.55 | 3.0 |
| prevent[1] | 3 | 2.55 | 2.0 |
| pretend[2] | 3 | 2.40 | 3.7 |
| preserve[2] | 3 | 2.5 | 3.3 |
| pretence[2] | 3 | 2.70 | 3.3 |
| presently | 3 | 2.15 | 2.7 |
| precursor[1] | - | 3.7 | 1.0 |
| predessor[1] | - | 3.7 | 1.0 |
| previous[1] | - | 2.55 | 2.0 |
| premonition[1] | - | 3.40 | 1.7 |
| precedent[2] | - | 3.40 | 1.0 |
| prelude[1] | - | 3.3 | 1.0 |
| preparation[2] | - | 3.2 | 2.0 |
| precede[1,2] | - | 3.7 | 1.0 |
| preliminary | - | 3.0 | 1.7 |
| preclude | - | 3.75 | 1.7 |
| prediction[1,2] | - | 3.50 | 1.3 |
| predict[1,2] | - | 3.6 | 1.0 |
| prepare[2] | - | 3.4 | 2.3 |
| prejudice | - | 3.55 | 2.3 |
| preposterous | - | 2.85 | 4.0 |
| presume | - | 3.25 | 2.3 |
| prescription[2] | - | 3.15 | 3.0 |

Pre- contd.

Prefixed: Residue

| | | | |
|---|---|---|---|
| predominate | 5 | 4.7 | 3.3 |
| preoccupy | 5 | 5.25 | 2.7 |
| preface | - | 3.85 | 1.3 |
| presentiment[1] | - | 4.35 | 2.7 |
| pretext | - | 3.50 | 2.7 |

## Im- (Negative sense)

**Prefixed: known and related stem**

| | | |
|---|---|---|
| imbalance | 6 | 5.7 |
| immoderate | 6 | 5.6 |
| immoral | 6 | 5.85 |
| immovable | 6 | 5.30 |
| impatient | 6 | 5.60 |
| impenetrable | 6 | 5.6 |
| impolite | 6 | 5.6 |
| impossible | 6 | 5.7 |
| impure | 6 | 5.55 |
| impurity | 6 | 5.83 |
| immaterial | 5 | 5.15 |
| immature | 5 | 5.75 |
| impropriety | 5 | 5.19 |
| impotent | 4 | 5.20 |
| impious | 4 | 4.56 |

**Prefixed: stem not a known and related word**

| | | |
|---|---|---|
| impecunious | 4 | 5.22 |
| immaculate | - | 2.89 |
| immediate | - | 2.60 |
| immune | - | 2.90 |
| immunity | - | 3.05 |
| impeccable | - | 4.00 |
| impudent | - | 3.10 |
| impurity | - | 4.00 |

**Residue**

| | | |
|---|---|---|
| impassive | 5 | 5.60 |
| impertinent | 5 | 4.85 |
| immemorial | 4 | 4.50 |

## Im- (prepositional sense)

**Prefixed: known and related stem (verbs)**

| | | |
|---|---|---|
| imprison | 5 | 5.05 |
| imperil | 5 | 4.80 |
| implant* | 4 | 4.20 |
| imprint | 4 | 4.3 |
| import* | - | 3.8 |
| impress | 3 | 2.35 |

**Prefixed: stem not known and related word (verbs, "in" & "on" meanings)**

| | | |
|---|---|---|
| implement* | 3 | 2.10 |
| imbibe | - | 3.14 |
| immerse* | - | 2.90 |
| implode | - | 3.38 |
| implicate | - | 2.75 |
| impose | - | 3.15 |
| impinge | - | 3.16 |

**Prefixed: stem not known and related word (verbs, various meaning)**

| | | |
|---|---|---|
| impair | - | 2.95 |
| impeach | - | 2.80 |
| impede | - | 2.58 |
| impel* | - | 2.65 |
| implore | - | 2.65 |
| imply | - | 2.32 |

**Prefixed: nouns** (compared with *)

| | | |
|---|---|---|
| import | - | 4.10 |
| implant | - | 3.80 |
| implement | - | 2.05 |
| immersion | - | 2.25 |
| improvement | - | 3.00 |
| impulse | - | 2.55 |

Not prefixed

| | | |
|---|---|---|
| image | 1 | 1.2 |
| imagination | 1 | 1.4 |
| imagine | 1 | 1.3 |
| imitate | 2 | 1.65 |
| imitation | 2 | 1.80 |
| imitative | 2 | 1.80 |
| imperial | 2 | 2.15 |
| impish | 2 | 1.58 |

Residue

| | | |
|---|---|---|
| imminent | 2 | 2.26 |
| impact | 2 | 2.15 |
| implicit | | 3.35 |
| important | | 2.55 |
| importance | | 2.60 |
| impostor | | 2.65 |
| impression | | 2.65 |
| impressionable | | 3.00 |
| improve* | | 3.05 |
| impulsion | | 3.05 |
| impulsive | | 2.35 |
| impersonate | | 3.70 |
| impoverish | | 4.26 |
| impregnate | 4 | 4.65 |
| improvable | 4 | 4.85 |

## Be-

### Unprefixed: monosyllabic

| | | |
|---|---|---|
| beach | 1 | 1.05 |
| beam | 1 | 1.00 |
| bear (n) | 1 | 1.00 |
| beat | 1 | 1.00 |
| beef | 1 | 1.00 |
| bear (v) | 1 | 1.00 |

### Unprefixed: first syllable stressed

| | | |
|---|---|---|
| beaver | 1 | 1.0 |
| benefit | 1 | 1.1 |
| beret | 1 | 1.1 |
| bestial | 1 | 1.5 |
| beverage | 1 | 1.3 |

### Prefixed: stem not a known word

| | | |
|---|---|---|
| begin | 2 | 1.75 |
| bequeath | - | 2.80 |
| bereave | 2 | 2.20 |
| beseech | 3 | 2.50 |
| bedraggle | - | 2.90 |
| believe | 2 | 1.40 |

### Prefixed: stem is known and related word

| | | |
|---|---|---|
| bedevil | | 4.15 |
| befall | | 3.70 |
| befog | | 3.80 |
| behead | | 3.90 |
| belittle | | 3.85 |
| bemuse | | 4.05 |
| bewail | | 3.45 |
| becalm | 4 | 4.35 |
| befit | 4 | 4.00 |
| befriend | 4 | 5.00 |
| begrudge | 4 | 4.85 |
| belabour | 4 | 4.80 |
| benumb | 4 | 4.15 |
| beseige | 4 | 4.45 |
| bewitch | 4 | 4.50 |

### Unprefixed: illegal "stem"

| | | |
|---|---|---|
| beckon | 1 | 1.1 |
| bedlam | 1 | 1.1 |
| beggar | 1 | 1.1 |
| bellow | 1 | 1.5 |
| berserk | 1 | 1.2 |
| better | 1 | 1.0 |

### Prefixed: prepositions

| | | |
|---|---|---|
| between | 2 | 1.40 |
| before | - | 3.65 |
| behind | - | 3.10 |
| below | - | 2.95 |
| beside | - | 2.80 |

### Prefixed: stem is known word

| | | |
|---|---|---|
| behave | 2 | 1.85 |
| betray | 3 | 2.30 |
| bewilder | - | 2.80 |
| beget | - | 3.60 |
| behold | - | 3.40 |
| berate | - | 2.90 |
| beset | - | 3.70 |
| betide | - | 3.10 |

### Residue

| | | |
|---|---|---|
| beauty | 1 | 1.05 |
| being | 1 | 1.30 |
| beautify | - | 1.70 |
| benevolent | 2 | 1.65 |
| behalf | 3 | 2.55 |
| beware | - | 2.60 |
| because | - | 2.65 |
| begone | - | 3.60 |
| become | - | 2.85 |
| bestow | - | 3.20 |

# APPENDIX 4.2.2

## Instruction to Subjects

In this experiment I am concerned with your psycholinguistic intuitions about prefixes. A prefix is a verbal element that occurs at the beginning of words and, in theory, adds something constant to the word thus linking words, which would otherwise be unrelated, into groups or families. A common prefix is un-, e.g. uncivilised, unwise, unfit.

One way of finding out whether or not a word is prefixed is to consult the dictionary. However, if we take into account the facts that: 1) the dictionary criterion for a prefix is based on the etymology, or history, of a word, 2) English words have their origins in several languages such as Latin, French and even Hindi, not to mention those words that have been invented, e.g. nylon, plastic, 3) with time the spelling, pronunciation and meaning of a word might drift or change; it becomes evident that while a dictionary classification might be of academic interest it is not of psychological interest in that it tells us nothing of the way people use language. For example, you might like to consider whether or not the following words are prefixed: unease, unearth, misplace, undulate, misrule, miscreant, uncle, mistake, abnormal, abject.

So, to reiterate, I am concerned with your intuitions about prefixes. On the next page is a list of words. Read through them and beside each state, using a six point scale, whether or not you think the word is prefixed. Thus:

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| definitely not prefixed | probably not prefixed | more no than yes | more yes than no | probably prefixed | definitely prefixed |

e.g. thus for nylon you might put 1
for unwise you might put 6

In addition to this would you also underline, if appropriate, the letters that constitute the prefix and mark with a star (*) those words to which you don't know the meaning.

Some of the words overleaf have a letter in brackets after them, this gives you the part of speech of the word in cases where the word could be a noun or verb etc.

To reiterate, for each word give a rating; underline, where appropriate, the prefix letters and mark with a star those words where you don't know the meaning. Give a rating in every case, even if your answer is virtually a guess.

Don't spend too long on each word, primarily because there are a large number of them and you will get so tired and bored that your answers will become virtually random.

There are no right or wrong answers in this experiment, only your intuitions, so don't worry about being doubtful about any or all of the words, though at the same time use the whole scale. For the same reason don't worry if you think all or none of them to be prefixes. In short, whatever your answer it is both valid and interesting.

/contd..

What is your age?

State your sex:

Did you do English, Latin or German 'O' level (or the Scottish equivalent)?

If so, which?

## Appendix 4.3.1

Presented below are the words used in this experiment classified according to prefix and word type and arranged according to those received by each subject (e.g. $S_1$ received all words in the first row of each list).

### be-

| (mono)be | (p+S.neg)be | (p+S.pos)be | (p+S.known)be |
|---|---|---|---|
| beel | bertule | bewray | besmear |
| belk | berway | benoal | begrime |
| beld | berluft | befest | besoak |
| berl | berpald | beclade | beseem |
| bew | belcade | belune | bedim |
| beal | belfond | bemide | bemist |
| benk | betsoal | beflune | beclothe |
| beap | belcand | bestant | bespangle |
| bein | beldeen | berand | bethink |
| beed | betsaim | beglait | begird |
| beng | betsant | bedreen | bedew |
| bease | berdean | bestaim | bedrift |
| beest | bertift | beprald | berhyme |
| bepse | belgoin | bedift | bespeak |

### fe-

| (mono)fe | (p+S.neg)fe | (p+S.pos)fe | (p+S.known)fe |
|---|---|---|---|
| feek | felcade | fewray | femist |
| fenk | ferluft | feglait | fespangle |
| fey | felsoal | felune | fedrift |
| fein | ferway | festant | fesmear |
| feap | ferdean | ferost | fedew |
| fease | felcand | fedrean | fegird |
| felk | fetsant | feclade | fegrime |
| fepse | feldean | fefest | fedew |
| feen | felgoin | festaim | fesoak |
| ferl | ferpald | fedift | feseem |
| feal | fertule | feflund | fethink |
| feld | felfond | fenoal | ferhyme |
| feeb | fetsaim | femide | fedim |
| feng | fertift | feprald | fespeak |

## im-

| (p+S.pos)im/in | (p+S.pos[11])im/neg | (p+S.pos)im/neg | (p+S.known)im/neg |
|---|---|---|---|
| impoat | immunderast | immonulative | immalicious |
| impude | imprantifast | impandulable | immedicable |
| imbroal | immonulaton | imprantious | immeditative |
| imbrue | immoterdend | improcacious | implenteous |
| imprile | improcadom | immedulative | immimicable |
| immapse | impluvimorph | immunderable | imprecocious |
| impape | impitulatib | immicaceous | impugilative |
| imbrale | impunsatil | impunsative | impopulous |
| impide | immicalit | impitulable | imbribable |
| immoil | impandulaton | impidulous | impursuable |
| immeel | improlataroid | imbrolable | immodulative |
| impect | immedularot | improlatative | imprevious |
| immude | imbrolarond | impluvious | impostulable |
| immuld | impiduloid | immoterable | impurposive |

## am-

| (p+S.pos)am/in | (p+S.pos[11])am/neg | (p+S.pos)am/neg | (p+S.known)am/neg |
|---|---|---|---|
| ammuld | ambrolarond | ammedulative | amprecocious |
| ambrale | ammicalit | ammonulative | ampostulable |
| ampude | ammedulasot | ampandulable | ammimicable |
| ampect | ampandulaton | amprolatative | ammodulative |
| amprile | ammonulaton | ampunsative | ambribable |
| ambrue | amprocadom | amprantious | amplenteous |
| ammude | ampluvimorph | amprocacious | ampurposive |
| ampide | amprantifast | ammicaceous | ampugilative |
| ammoil | ampunsatil | ampluvious | ammeditative |
| ammapse | amprolataroid | ambrolable | ammedicable |
| ambroal | ammunderast | ammoterable | ampursuable |
| ampape | ampitulatib | ampidulous | ampopulous |
| ampoat | ampiduloid | ampitulable | amprevious |
| ammeel | ammoteradend | ammunderable | ammalicious |

## pre-

| (mono)pre | (p+S.neg/ stressed)pre | (p+S.pos/ stressed)pre | (p+S.pos)pre | (p+S.known)pre |
|---|---|---|---|---|
| prell | prennative | precify | precalimation | prelight |
| prease | prebnuous | prepid | precalify | presatiate |
| preal | predlivence | precelation | premoltive | prestart |
| preet | prebtal | preminive | prelade | precorrective |
| preld | preblitate | prebil | precaldive | prevaporous |
| prett | prencitive | prefulent | prefulgence | prerotation |
| prent | prempulate | prepitate | preblitate | premovement |
| pream | prendulent | precitive | prefadulent | prelocate |
| prend | prentify | prefidence | prebise | precremate |
| preil | prelson | prenimate | prenift | preclarify |
| pread | prenlon | premilate | pretontuous | prepunitive |
| preft | prensimate | prelin | prepold | preform |
| prein | prensid | premin | premalitate | prefit |
| prelt | pretsolation | prelinous | pretuminate | precoherence |

tre-

| (mono) tre | (p+S.neg/ stressed) tre | (p+S.pos/ stressed) tre | (p+S.pos) tre | (p+S.known) tre |
|---|---|---|---|---|
| treft | trensid | trelin | trelade | treform |
| treld | tredlivence | trecify | tretontuous | trevaporous |
| trenge | trelson | trecitive | trebelitate | trefit |
| trean | trennative | tremilate | tremalitate | treclarify |
| treil | trencitive | trefulent | trepold | tremovement |
| treen | trebtal | trenimate | trebise | trecremate |
| trett | trenlon | trecelation | trecaldive | trecorrective |
| trell | trendulent | trefidence | trenift | trerotation |
| tream | trebnuous | trepid | tremoltive | tresatiate |
| trest | trentify | tremin | tretuminate | trecoherence |
| trelt | trempulate | trebil | trecalimation | trelight |
| treal | treblitate | treminive | trefadudent | trestart |
| trease | tretsolation | trelinous | trefulgence | trepunitive |
| treit | trensimate | trepitate | trecalify | trelocate |

APPENDIX 4.3.2

INSTRUCTIONS TO SUBJECTS (1) Presented before the experiment.

In this experiment I am concerned with your psycholinguistic intuitions about prefixes. A prefix is a verbal element that occurs at the beginning of words and, in theory, it adds something constant to the word and thus links words, which would otherwise be unrelated, into groups or families. A common prefix is un- , e.g. uncivilised, unwise, unfit.

One way of finding out whether or not words are prefixed is to consult the dictionary. However, if we take into account the fact that: 1) The dictionary criterion for a prefix is based on the etymology, or history, of a word; 2) English words have their origins in several languages such as Latin, French and even Hindi, not to mention those words that have been invented, e.g. nylon, plastic; 3) with time the spelling, pronunciation and meaning of a word might drift or change; it becomes evident that while a dictionary classification might be of academic interest it is not of psychological interest in that it tells us nothing of the ways people use language. For example, you might like to consider whether the following words are prefixed: unease, misplace, unearth, undulate, misrule, miscreant, uncle, mistake, abnormal, abject.

So, to reiterate, I am concerned with your intuitions about prefixes. On the next page is a list of archaic English words. Read through the list and beside each word state, using a six point scale, whether or not you think the word is prefixed. Thus:

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| definitely not prefixed | probably not prefixed | more no than yes | more yes than no | probably prefixed | definitely prefixed |

e.g. thus for nylon you might put 1
for unwise you might put 6

It is extremely unlikely that you have seen any of the words before so you will have to rely on your intuitions when doing the task. There are no right or wrong answers so don't worry about being doubtful about any or all of them, though at the same time use the whole scale. For the same reason don't worry if you think they are all prefixes or none of them are prefixes. In short, whatever your answer it is both interesting and valid. Please don't leave any word unanswered.

Finally, in addition to rating each word on the six point scale would you please underline the letters in the word that you think constitute the prefix.

2) This question was presented after the experiment.

What meaning(s) do the following have:

1) <u>be</u>-

2) <u>am</u>-

3) <u>tre</u>-

4) <u>pre</u>-

5) <u>fe</u>-

6) <u>im</u>-

## APPENDIX 4.4.1

Presented below are the lists of word-meanings presented to each subject or rather, to two subjects, i.e. $S_1$ and $S_{11}$, $S_2$ and $S_{12}$, $S_3$ and $S_{13}$, etc.

The lists presented to $S_1$, $S_{11}$ and $S_{21}$, $S_{31}$ are the converse of each other in that where, say, $S_1$ receives festant with the two meanings, $S_{21}$ receives bestant. This applies also to $S_2$, $S_{12}$ and $S_{22}$, $S_{32}$; $S_3$, $S_{13}$ and $S_{23}$, $S_{33}$; and so on.

$S_1$, $S_{11}$

| | |
|---|---|
| festant : | to adorn and cover with finery<br>to wrangle and bargain with |
| trecalimation : | pagan ritual mourning a lost relative<br>religious ceremony requesting a prosperous future |
| impandulable : | logical; subject to reason<br>beyond perception; outwith the senses |
| prefulgence : | an initial stage of foetal development<br>the autumnal shedding of leaves |
| ammonulative: | lacking coordination and balance<br>having judgement and insight |
| benoal : | to fine for a misdemeanour<br>to surround with snares and traps |
| ammoil : | to break apart; to fragment<br>to put life into; to energise |
| impape : | to absorb completely<br>to remove fraudulently |

$S_{21}$, $S_{31}$

bestant : to adorn and cover with finery

precalimation : pagan ritual mourning a lost relative
religious ceremony requesting a prosperous future

ampandulable: logical; subject to reason
beyond perception; outwith the senses

trefulgence: an initial stage of foetal development
the autumnal shedding of leaves

immonulative : lacking coordination and balance
having judgement and insight

fenoal : to fine for a misdemeanour
to surround with snares and traps

immoil : to break apart; to fragment
to put life into; to energise

ampape : to absorb completely
to remove fraudulently

$S_2$, $S_{12}$

ambrale : to damage; to destroy
to breathe into; to blow into

imprile : to cast off; to reject
to wrap in; to engulf

pretuminate : any herbal concoction that wards off illness
any drug with side effects

berand : to reason logically and deduce
to cleanse thoroughly and purify

improcacious : having a mind and gentle nature
being without compassion or pity

feglait : to promote or recommend
to drench or soak

ambrolable : that can easily be pacified
that cannot be appealed against

tremoltent : a part of a complex whole
an indicator of future developments

$S_{22}$, $S_{32}$

| | |
|---|---|
| imbrale : | to damage; to destroy<br>to breathe into; to blow into |
| amprile : | to cast off; to reject<br>to wrap in; to engulf |
| tretuminate : | any herbal concoction that wards off illness<br>any drug with side effects |
| ferand : | to reason logically and deduce<br>to cleanse thoroughly and purify |
| amprocacious : | having a kind and gentle nature<br>being without compassion or pity |
| beglait : | to promote or recommend<br>to drench or soak |
| imbrolable : | that can easily be pacified<br>that cannot be appealed against |
| premoltent : | a part of a complex whole<br>an indicator of future developments |

$S_3$, $S_{13}$

| | |
|---|---|
| beclade : | to dismiss lightly<br>to render insensible |
| prenire : | document issued in advance of general publication<br>secret document concerned with national security |
| ammoterable : | too hard to puncture or perforate<br>easy to destroy or demolish |
| trefadulation : | nervous condition caused by expectation of trouble<br>emotional state due to upset of routine |
| impunsative : | discordant and out of phase with<br>synchronous and in tune with |
| fenoal : | to fine for a misdemeanour<br>to surround with snares and traps |
| impoat : | to make equal in weight<br>to cause to bend inward |
| ammeel : | to cut off with a blade; to sever<br>to put into by drops; to steep |

$S_{23}$, $S_{33}$

feclade : to dismiss lightly
to render insensible

trenire : document issued in advance of general publication
secret document concerned with national security

immoterable : too hard to puncture or perforate
easy to destroy or demolish

prefadulation: nervous condition caused by expectation of trouble
emotional state due to upset of routine

ampunsative : discordant and out of phase with
synchronous and in tune with

benoal : to fine for a misdemeanour
to surround with snares and traps

ampoat : to make equal in weight
to cause to bend inward

immeel : to cut off with a blade; to sever
to put into by drops; to steep

$S_4$, $S_{14}$

trepold : an initial skirmish before a battle
a massive assault by enemy forces

impluvious : beyond redemption; past hope
well behaved; obedient

femide : to make cloudy and obscure
to evade and avoid

amprolatative: symmetrical and well-ordered
formless and ill-defined

bedrean : to converse with
to heap praise on

prefadulation: nervous condition caused by expectation of trouble
emotional state due to an upset of routine

amprile : to wrap in; to engulf
to cast off; to reject

imbrue : to strip the bark off
to insert a tube into

$S_{24}$, $S_{34}$

| | |
|---|---|
| prepold : | an initial skirmish before a battle<br>a massive assault by enemy forces |
| ampluvious : | beyond redemption; past hope<br>well behaved; obedient |
| bemide : | to make cloudy and obscure<br>to evade and avoid |
| improlatative: | symmetrical and well-ordered<br>formless and ill-defined |
| fedrean : | to converse with<br>to heap praise on |
| trefadulation: | nervous condition caused by expectation of trouble<br>emotional state due to an upset of routine |
| imprile : | to wrap in; to engulf<br>to cast off; to reject |
| ambrue : | to strip the bark off<br>to insert a tube into |

$S_5$, $S_{15}$

| | |
|---|---|
| immonulative : | having judgement and insight<br>lacking coordination and balance |
| fedrean : | to heap praise on<br>to converse with |
| ammicaceous : | stagnant and lacking in vigour<br>vibrant and full of energy |
| impide : | to atone for a crime<br>to put into words |
| bemide : | to make cloudy and obscure<br>to evade and avoid |
| ammude : | to mark off<br>to be entrenched in |
| tretuminate : | any herbal concoction that wards off illness<br>any drug with side effects |
| prebise : | the tuning of instruments before a recital<br>the replacing of strings on a musical instrument |

$S_{25}$, $S_{35}$

| | |
|---|---|
| ammonulative : | having judgement and insight<br>lacking coordination and balance |
| bedrean : | to heap praise on<br>to converse with |
| immicaceous : | stagnant and lacking in vigour<br>vibrant and full of energy |
| ampide : | to atone for a crime<br>to put into words |
| femide : | to make cloudy and obscure<br>to evade and avoid |
| immude : | to mark off<br>to be entrenched in |
| pretuminate : | any herbal concoction that wards off illness<br>any drug with side effects |
| trebise : | the tuning of instruments before a recital<br>the replacing of strings on a musical instrument |

$S_6$, $S_{16}$

| | |
|---|---|
| ammuld : | to connect or bring (objects) together<br>to hammer or stamp (a mark) into |
| imbrolable : | that can easily be pacified<br>that cannot be appealed against |
| bestant : | to wrangle and bargain with<br>to adorn and cover with finery |
| ampandulable : | beyond perception; outwith the senses<br>logical; subject to reason |
| prelade : | a satirical piece of prose<br>the first verse of a poem |
| trelutation : | a feeling of impending doom<br>a feeling of emotional tranquility |
| fedift : | to strike lightly, without force<br>to thoroughly corrupt and deprave |
| immeel : | to put into by drops; to steep<br>to cut off with a blade; to sever |

$S_{26}$, $S_{36}$

| | |
|---|---|
| immuld : | to connect or bring (objects) together<br>to hammer or stamp (a mark) into |
| ambrolable : | that can easily be pacified<br>that cannot be appealed against |
| festant : | to wrangle and bargain with<br>to adorn and cover with finery |
| impandulable : | beyond perception; outwith the senses<br>logical; subject to reason |
| trelade : | a satirical piece of prose<br>the first verse of a poem |
| prelutation : | a feeling of impending doom<br>a feeling of emotional tranquility |
| bedift : | to strike lightly, without force<br>to thoroughly corrupt and deprave |
| ammeel : | to put into by drops; to steep<br>to cut off with a blade; to sever |

$S_7$, $S_{17}$

| | |
|---|---|
| immoil : | to break apart; to fragment<br>to put life into; to energise |
| amprocacious : | having a kind and gentle nature<br>being without compassion or pity |
| feclade : | to dismiss lightly<br>to render insensible |
| prepold : | an initial skirmish before a battle<br>a massive assault by enemy forces |
| trenire : | secret document concerned with national security<br>document issued in advance of general publication |
| belune : | to soil; to stain thoroughly<br>to place side by side; to arrange in order |
| ambrue : | to insert a tube into<br>to strip the bark off |
| improlatative : | formless and ill-defined<br>symmetrical and well-ordered |

$S_{27}$, $S_{37}$

| | |
|---|---|
| ammoil : | to break apart; to fragment<br>to put life into; to energise |
| improcacious : | having a kind and gentle nature<br>being without compassion or pity |
| beclade : | to dismiss lightly<br>to render insensible |
| trepold : | an initial skirmish before a battle<br>a massive assult by enemy forces |
| prenire : | secret document concerned with national security<br>document issued in advance of general publication |
| felune : | to soil; to stain thoroughly<br>to place side by side; to arrange in order |
| imbrue : | to insert a tube into<br>to strip the bark off |
| amprolatative : | formless and ill-defined<br>symmetrical and well-ordered |

$S_{8}$, $S_{18}$

| | |
|---|---|
| ampluvious : | beyond redemption; past hope<br>well behaved; obedient |
| precalimation : | religious ceremony requesting a prosperous future<br>pagan ritual mourning a lost relative |
| trebise : | the replacing of strings on a musical instrument<br>the tuning of instruments before a recital |
| ampide : | to atone for a crime<br>to put into words |
| bestaim : | to make a complete fool of<br>to make an excuse for |
| impidulous : | decisive and with a forceful personality<br>weak and without strength of character |
| immude : | to be entrenched in<br>to mark off |
| felune : | to place side by side; to arrange in order<br>to soil; to stain thoroughly |

$S_{28}$, $S_{38}$

| | |
|---|---|
| impluvious : | beyond redemption; past hope<br>well behaved; obedient |
| trecalimation : | religious ceremony requesting a prosperous future<br>pagan ritual mourning a lost relative |
| prebise : | the replacing of strings on a musical instrument<br>the tuning of instruments before a recital |
| impide : | to atone for a crime<br>to put into words |
| festaim : | to make a complete fool of<br>to make an excuse for |
| ampidulous : | decisive and with a forceful personality<br>weak and without strength of character |
| ammude : | to be entrenched in<br>to mark off |
| belune : | to place side by side; to arrange in order<br>to soil; to stain thoroughly |

$S_9$, $S_{19}$

| | |
|---|---|
| trefulgence : | the autumnal shedding of leaves<br>an initial stage of foetal development |
| imbrale : | to breathe into; to blow into<br>to damage; to destroy |
| ferand : | to cleanse thoroughly and purify<br>to reason logically and deduce |
| immicaceous : | vibrant and full of energy<br>stagnant and lacking in vigour |
| ampidulous : | weak and without strength of character<br>decisive and with a forceful personality |
| beglait : | to drench or soak<br>to promote or recommend |
| prelutation : | a feeling of emotional tranquility<br>a feeling of impending doom |
| ampape : | to remove fraudulently<br>to absorb completely |

$S_{29}$, $S_{39}$

| | |
|---|---|
| prefulgence : | the autumnal shedding of leaves<br>an initial stage of foetal development |
| ambrale : | to breathe into; to blow into<br>to damage; to destroy |
| berand : | to cleanse thoroughly and purify<br>to reason logically and deduce |
| ammicaceous : | vibrant and full of energy<br>stagnant and lacking in vigour |
| impidulous : | weak and without strength of character<br>decisive and with a forceful personality |
| feglait : | to drench or soak<br>to promote or recommend |
| trelutation : | a feeling of emotional tranquility<br>a feeling of impending doom |
| impape : | to remove fraudulently<br>to absorb completely |

$S_{10}$, $S_{20}$

| | |
|---|---|
| premoltent : | a part of a complex whole<br>an indicator of future developments |
| bedift : | to strike lightly, without force<br>to thoroughly corrupt and deprave |
| ampoat : | to cause to bend inward<br>to make equal in weight |
| ampunsative : | synchronous and in tune with<br>discordant and out of phase with |
| festaim: | to make a complete fool of<br>to make an excuse for |
| immoterable : | easy to destroy or demolish<br>too hard to puncture or perforate |
| trelade : | the first verse of a poem<br>a satirical piece of prose |
| immuld : | to connect or bring (objects) together<br>to hammer or stamp (a mark) into |

$S_{30}$, $S_{40}$

| | |
|---|---|
| tremoltent : | a part of a complex whole<br>an indicator of future developments |
| fedift : | to strike lightly, without force<br>to thoroughly corrupt and deprave |
| impoat : | to cause to bend inward<br>to make equal in weight |
| impunsative : | synchronous and in tune with<br>discordant and out of phase with |
| bestaim : | to make a complete fool of<br>to make an excuse for |
| ammoterable : | easy to destroy or demolish<br>too hard to puncture or perforate |
| prelade : | the first verse of a poem<br>a satirical piece of prose |
| ammuld : | to connect or bring (objects) together<br>to hammer or stamp (a mark) into |

## APPENDIX 4.4.2

Instructions to Subjects. (1) Presented before the experiment.

You have probably seen the television game "Call my Bluff" or read the "Readers Digest" feature "It pays to increase your word power". I am currently doing a study in the Psychology Department involving a task very similar to these and would appreciate your help by acting as a subject. The task shouldn't take more than a few minutes.

Overleaf is a list of eight words; each is paired with two statements of what it might mean, one being correct and the other incorrect. All I want you to do is to tick (√), for each word, the meaning you think is the correct one and state how confident you are that you've given the correct answer (use the scale below to indicate this). It is essential, if I am to do a statistical analysis of all the results I collect that you give an answer to every word even if your answers are completely random. (Notice that your confidence ratings will enable me to determine whether your answer is a guess or not.)

Since this is a postal type of experiment I regret that I won't be able to give you the answers or explain what the experiment is about. However, I will post an explanation of the experiment on the Psychology notice board towards the end of November.

Use the following scale to indicate your confidence in the correctness of your answer.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| very unconfident | unconfident | neutral | confident | very confident |

Examples: (a) chelifer: a genus of spiders
a sand fly √ 1

(b) heifer: a young cow that has not calved √ 5
a type of elephant

In the first case my answer is a pure guess; in the second I am sure that I'm right.

Instructions to Subjects. (2) Presented after the experiment.

Could you please answer the following questions.

1) Do you know what a prefix is? If so explain briefly what you understand by a prefix. If you don't know don't worry - move on to the next question.

2) Which of the following letters that occur at the beginning of words are prefixes - mark with a tick or cross as appropriate and give the meaning(s) where you can.

im-

fe-

be-

am-

tre-

pre-

3) Could you please state your sex and whether you did Latin or English at 'O' level or the Scottish equivalent.

## APPENDIX 4.5.1

Word-meaning combinations presented to subjects for learning. Each was printed on a card. Odd-numbered subjects are the "compatible" subjects, even-numbered are the "incompatible" subjects. Each set was learned by two subjects.

$S_1$, $S_{21}$

| | | |
|---|---|---|
| prefulgence | : | an initial stage of foetal development |
| trepold | : | a massive assault by enemy forces |
| beclade | : | to render insensible |
| femide | : | to evade and avoid |
| imbrue | : | to insert a tube into |
| ampoat | : | to make equal in weight |
| immonulative | : | lacking co-ordination and balance |
| amprocacious | : | having a kind and gentle nature |

$S_3$, $S_{23}$

| | | |
|---|---|---|
| prepold | : | an initial skirmish before a battle |
| trefulgence: | : | the autumnal shedding of leaves |
| bemide | : | to make cloudy and obscure |
| feclade | : | to dismiss lightly |
| impoat | : | to cause to bend inward |
| ambrue | : | to strip the bark off |
| improcacious | : | being without compassion or pity |
| ammonulative | : | having judgement and insight |

$S_5$, $S_{25}$

| | | |
|---|---|---|
| prefadulation | : | nervous condition caused by expectation of trouble |
| trenire | : | secret document concerned with national security |
| bestant | : | to adorn and cover with finery |
| felune | : | to place side by side, to arrange in order |
| imbrale | : | to breathe into; to blow into |
| ammude | : | to mark off |
| improlatative | : | formless and ill-defined |
| ammicaceous | : | vibrant and full of energy |

$S_7$, $S_{27}$

| | | |
|---|---|---|
| prenire: | : | document issued in advance of general publication |
| trefadulation | : | emotional state due to an upset of routine |
| belune | : | to soil; to stain thoroughly |
| festant | : | to wrangle and bargain with |
| immude | : | to be entrenched in |
| ambrale | : | to damage; to destroy |
| immicaceous | : | stagnant and lacking in vigour |
| amprolatative | : | symmetrical and well ordered |

$\underline{S_9}, \underline{S_{29}}$

| | | |
|---|---|---|
| premoltent | : | an indicator of future development |
| tretuminate | : | any drug with side-effects |
| benoal | : | to surround with snares and traps |
| ferand | : | to reason logically and deduce |
| immoil | : | to put life into; to energise |
| ampide | : | to atone for a crime |
| imbrolable | : | that cannot be appealed against |
| ampunsative | : | sunchronous and in tune with |

$\underline{S_{11}}, \underline{S_{31}}$

| | | |
|---|---|---|
| pretuminate | : | any herbal concoction that wards off illness |
| tremoltent | : | a part of a complex whole |
| berand | : | to cleanse thoroughly and purify |
| fenoal | : | to fine for a misdemeanour |
| impide | : | to put into words |
| ammoil | : | to break apart; to fragment |
| impunsative | : | discordant and out of phase with |
| ambrolable | : | that can easily be pacified |

$\underline{S_{13}}, \underline{S_{33}}$

| | | |
|---|---|---|
| precalimation | : | religious ceremony requesting a prosperous future |
| trelade | : | a satirical piece of prose |
| bedift | : | to thoroughly corrupt and deprave |
| feglait | : | to promote or recommend |
| immuld | : | to hammer or stamp (a mark) into |
| amprile | : | to cast off, to reject |
| immoterable | : | too hard to puncture or perforate |
| ampidulous | : | decisive and with a forceful personality |

$\underline{S_{15}}, \underline{S_{35}}$

| | | |
|---|---|---|
| prelade | : | the first verse of a poem |
| trecalimation | : | pagan ritual mourning a lost relative |
| beglait | : | to drench or soak |
| fedift | : | to strike lightly, without force |
| imprile | : | to wrap in; to engulf |
| ammuld | : | to connect or bring (objects) together |
| impidulous | : | weak and without strength of character |
| ammoterable | : | easy to destroy or demolish |

$\underline{S_{17}}, \underline{S_{37}}$

| | | |
|---|---|---|
| prebise | : | the tuning of instruments before a recital |
| trelutation | : | a feeling of emotional tranquility |
| bestaim | : | to make a complete fool of |
| fedrean | : | to converse with |
| immeel | : | to put into by drops; to steep |
| ampape | : | to remove fraudulently |
| impluvious | : | beyond redemption; past hope |
| ampandulable | : | logical; subject to reason |

$\underline{S_{19}}, \underline{S_{39}}$

| | | |
|---|---|---|
| prelutation | : | a feeling of impending doom |
| trebise | : | the replacing of strings on a musical instrument |
| bedrean | : | to heap praise on |
| festaim | : | to make an excuse for |
| impape | : | to absorb completely |
| ammeel | : | to cut off with a blade; to sever |
| impandulable | : | beyond perception; outwith the senses |
| ampluvious | : | well-behaved; obedient |

$\underline{S_{2}}, \underline{S_{22}}$

| | | |
|---|---|---|
| trepold | : | an initial skirmish before a battle |
| prefulgence | : | the autumnal shedding of leaves |
| femide | : | to make cloudy and obscure |
| beclade | : | to dismiss lightly |
| ampoat | : | to cause to bend inward |
| imbrue | : | to strip the bark off |
| amprocacious | : | being without compassion or pity |
| immonulative | : | having judgement and insight |

$\underline{S_{4}}, \underline{S_{24}}$

| | | |
|---|---|---|
| trefulgence | : | an initial stage of foetal development |
| prepold | : | a massive assault by enemy forces |
| feclade | : | to render insensible |
| bemide | : | to evade and avoid |
| ambrue | : | to insert a tube into |
| impoat | : | to make equal in weight |
| ammonulative | : | lacking co-ordination and balance |
| improcacious | : | having a kind and gentle nature |

$\underline{S_{6}}, \underline{S_{26}}$

| | | |
|---|---|---|
| trenire | : | document issued in advance of general publication |
| prefadulation | : | emotional state due to an upset of routine |
| felune | : | to soil; to stain thoroughly |
| bestant | : | to wrangle and bargain with |
| ammude | : | to be entrenched in |
| imbrale | : | to damage; to destroy |
| ammicaceous | : | stagnant and lacking in vigour |
| improlatative | : | symmetrical and well ordered |

$\underline{S_{8}}, \underline{S_{28}}$

| | | |
|---|---|---|
| trefadulation | : | nervous condition caused by expectation of trouble |
| prenire | : | secret document concerned with national security |
| festant | : | to adorn and cover with finery |
| belune | : | to place side by side, to arrange in order |
| ambrale | : | to breathe into; to blow into |
| immude | : | to mark off |
| amprolatative | : | formless and ill-defined |
| immicaceous | : | vibrant and full of energy |

$S_{10}$, $S_{30}$

| | | |
|---|---|---|
| tretaminate | : | any herbal concoction that wards off illness |
| premoltent | : | a part of a complex whole |
| ferand | : | to cleanse thoroughly and purify |
| benoal | : | to fine for a misdemeanour |
| ampide | : | to put into words |
| immoil | : | to break apart; to fragment |
| ampunsative | : | discordant and out of phase with |
| imbrolable | : | than can easily be pacified |

$S_{12}$, $S_{32}$

| | | |
|---|---|---|
| tremoltent | : | an indicator of future developments |
| pretuminate | : | any drug with side-effects |
| fenoal | : | to surround with snares and traps |
| berand | : | to reason logically and deduce |
| ammoil | : | to put life into; to energise |
| impide | : | to atone for a crime |
| ambrolable | : | that cannot be appealed against |
| impunsative | : | synchronous and in tune with |

$S_{14}$, $S_{34}$

| | | |
|---|---|---|
| trebise | : | the tuning of instruments before a recital |
| prelutation | : | a feeling of emotional tranquility |
| festaim | : | to make a complete fool of |
| bedrean | : | to converse with |
| ammeel | : | to put into by drops, to steep |
| impape | : | to remove fraudulently |
| ampluvious | : | beyond redemption, past hope |
| impandulable | : | logical, subject to reason |

$S_{16}$, $S_{36}$

| | | |
|---|---|---|
| trecalimation | : | religious ceremony requesting a prosperous future |
| prelade | : | a satirical piece of prose |
| fedift | : | to thoroughly corrupt and deprave |
| beglait | : | to promote or recommend |
| ammuld | : | to hammer or stamp (a mark) into |
| imprile | : | to cast off; to reject |
| ammoterable | : | too hard to puncture or perforate |
| impidulous | : | decisive and with a forceful personality |

$S_{18}$, $S_{38}$

| | | |
|---|---|---|
| trelutation | : | a feeling of impending doom |
| prebise | : | the replacement of strings on a musical instrument |
| fedrean | : | to heap praise on |
| bestaim | : | to make an excuse for |
| ampape | : | to absorb completely |
| immeal | : | to cut off with a blade; to sever |
| ampandulable | : | beyond perception; outwith the senses |
| impluvious | : | well behaved; obedient |

$\underline{S_{20}}$, $\underline{S_{40}}$

| | | |
|---|---|---|
| trelade | : | the first verse of a poem |
| precalimation | : | pagan ritual mourning a lost relative |
| feglait | : | to drench or soak |
| bedift | : | to strike lightly, without force |
| amprile | : | to wrap in; to engulf |
| immuld | : | to connect or bring (objects) together |
| ampidulous | : | weak and without strength of character |
| immoterable | : | easy to destroy or demolish |

APPENDIX 4.5.2

Instructions to Subjects. (1) Pre-experiment. These were given to subjects at the beginning of the experiment.

The experiment you are about to do is one of a series in which I am looking at how people learn words. Printed on each card is a word together with a short definition of what it means. For example:

elephant: a large mammal with a trunk

Of course the test stimuli will not be words that you know - they are all archaic english words.

Your task is to learn the meaning associated with each word so that later on if I present you with the word you will be able to give me the meaning or if I present you with the meaning you will be able to give me the word. In short you should approach the task as you normally would when adding a new word to your vocabulary.

The procedure is as follows. There will be a total of three learning trials. On each trial look at each card for five seconds (this is the interval between 'beeps on the metronome), turning it face down (so that you cannot see it) after this time. When you've looked at all eight cards start reading the passage of prose and continue to do so for two minutes (I'll be timing this). Repeat this procedure of looking at the cards and reading another twice, beginning the prose where you left off on the previous trial. I will be asking you some questions about what you've read at the end of the experiment.

So, to summarise, you will have seen the cards three times and spent three two minute periods reading the prose. At the end of these three trials I will give you further instructions.

If any of these instructions are unclear please ask me to clarify.

Instructions to Subjects. (2) Pre-test. These were given to subjects after learning and before testing.

Listed below are the eight words that you have just learned. Beside each one I want you to give as much of the meaning as you can remember. You may only be able to remember part of the meaning - put it down. Guess if you have to; I shall be counting 'blanks' as errors so you have nothing to lose by guessing. Also, after each answer I would like you to state how confident you are that the answer you've given is the correct one; do this by using the following scale:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| very unconfident | unconfident | neutral | confident | very confident |

Example: elephant: a large mammal with a trunk 5

or

elephant: mammal 2

These two answers reflect two possible levels of what I remembered and two degrees of confidence that what I have put down is right.

Don't spend too long on each one and answer them in any order you wish.

imbrue:

femide:

prefulgence:

ampoat:

amprocacious:

immonulative:

beclade:

trepold:

<u>Instructions to Subjects</u>. (3) Post-experiment. Subjects answered these questions after the experiment.

Could you please answer the following questions.

1) Describe, briefly, how you went about learning the words.

2) Do you know what a prefix is? If so, explain briefly. Give an example if possible.

3) Are the following prefixes? If so what meaning do they have for you?

   tre-

   fe-

   be-

   pre-

   im-

   am-

   Do any of them have more than one meaning?

4) Please state your name and sex and whether you did Latin or English at 'O', 'A' level or the Scottish equivalent.