

Psychological Validity of Phonological Generalizations: A Priming Experiment in Spanish*

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ABSTRACT

This paper describes a psycholinguistic experiment designed to determine if the phonological generalizations which are described by linguists are psychologically significant for Spanish speakers. The experiment consists of a lexical decision task, in which the priming effect which morphemically related words have on each other is measured. In the experiment, morphemically related word-pairs with allomorphy representative of common phonological patterns did not prime better than pairs with uncommon root allomorphy. These findings suggest that the kind of phonological alternation which exists in a word-pair has no bearing on whether the words are considered morphemically related or not by language speakers.

1. INTRODUCTION

Much contemporary phonological research has as its goal to discover and formalize salient phonological and phonetic patterns. Furthermore, the claim is often made that these patterns do not merely exist in a language, but that they are relevant to speakers' cognitive capacities. Of course, not all patterns are considered significant. Certain alternations are considered significant because of their frequency in the language, or because they are easily incorporated into a formal representation of the phonological system of the language. Uncommon alternations, or alternations which are difficult to formalize, are relegated to the domain of suppletion.

It is the hypothetical dichotomy between common and suppletive alternations which lends itself to experimentation. If language speakers are found to treat alternations which are considered significant by linguists differently than they do suppletive alternations, that would constitute evidence that the patterns which linguists account for are psychologically significant. One experiment has already capitalized on this dichotomy.

2. EDDINGTON'S WORD-PAIR EXPERIMENT

Eddington (1993) carried out an experiment patterned after Ohala and Ohala's (1987), but with Spanish as the test language. In this study, test subjects rated word-pairs on a five-point scale, according to how semantically similar they perceived them to be. A score of five was given if the words in the pair had a very similar meaning, a score of one if their meanings were not similar at all. They also rated the pairs of words on a scale of one to five, according to how strongly they felt that the members of the word-pair were derivationally related, that is, whether they had a morpheme in common. Half of the word-pairs contained regular alternations which are common in the phonology of Spanish, and which have received attention in the literature on Spanish phonology (e.g. /kt/~tʃ/ as in *despectivo-despecho* 'scornful-spite'). The remaining pairs contained isolate alternations, which are uncommon in Spanish, and therefore suppletive (e.g. /a/~e/ as in *salvage-selva* 'savage-jungle').

The outcome of this study provides evidence

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that regular alternations are more psychologically salient than suppletive alternations. Word-pairs with regular alternations were perceived as having a morpheme in common to a greater extent than word-pairs with suppletive alternations. The use of derivational relatedness in such a task is not unmotivated. The rules which underlie alternations are designed to account for the different allomorphs of a single morpheme. Therefore, a logical way of testing the significance of an alternation is to determine its role in what words speakers perceive as having a morpheme in common.

The subjects also rated the word-pairs according to semantic similarity. Therefore, their ratings of the derivational relatedness of word-pairs with regular and isolate alternations can be compared at each of the five degrees of semantic similarity. This is illustrated in Table 1. When the test subjects were asked to decide the degree of derivational relatedness of a pair of words, they drew upon their knowledge of what is common and uncommon in their language in making their decision. The regular alternations are alternations which linguists view as significant, and the suppletive alternations are not. Therefore, these results suggest that there is a correspondence between what phonologists consider relevant alternations in Spanish, and those which are psychologically salient for Spanish speakers.

The outcome of the word pair experiment provides initial evidence for this correspondence. The purpose of the present study is to determine if further experimental evidence may be adduced in its favor. The priming effect that morphemically related words exert on each other appears well-suited to such a task. The next section reviews the relevant literature on priming experiments and examines the bearing these experiments have on the present study.

Table 1. Means of Derivational Relatedness Scores.

	Semantic relatedness scores				
	1	2	3	4	5
Regular alternation	1.78	2.84	3.36	3.34	4.39
Isolate alternation	1.59	2.36	3.20	3.04	4.36

3. THE PRIMING EFFECT

The priming effect is observed in experiments which utilize a lexical decision task. In such a task, test subjects are presented strings of letters and asked to decide if the string is a word or a nonword. The time it takes the subject to respond is measured. Although the stimuli are most commonly presented visually, priming effects have been observed with auditorily presented stimuli as well (Fowler, Napps, and Feldman, 1985; Kempley and Morton, 1982; Slowiczek and Pisoni, 1986).

A priming effect is said to occur if the response time to a word is substantially decreased when a related word has been previously responded to. For example, priming occurs if a subject's response time to the word *mouse* is decreased as a result of having seen the word *mouse* on a previous trial. In this instance, the first presentation of *mouse* is called the prime; the second presentation of the word *mouse* is the target. Priming effects have also been found between morphemically related words such as *defend* and *defensive*.

In the present experiment, priming is used as a tool to discover what morphemic relationships Spanish speakers make between words. This assumes that the priming effect is the result of morphemic relationships. There are, however, a number of alternative explanations for the priming effect. Priming may be due to orthographic or phonetic similarity. Phonetic and orthographic relationships are often referred to as formal relationships. Another possibility is that semantic similarity is responsible for the priming effect. Each of these possibilities will be discussed in light of the available experimental evidence. It will be seen that formal and semantic priming are both short-lived. In comparison, morphemic priming is long-lasting. Therefore, an experimental design which factors out formal and semantic priming offers the possibility of shedding light on the morphemic relationships that speakers make between words.

3.1. Formal priming

If phonetic or orthographic similarity is responsible for the priming effect, then words which

are spelled similarly, or which sound similar, should prime for each other even though they are not morphemic relatives. Some evidence for formal priming does exist (Forster, Davis, Schnoknecht and Carter, 1987; Hillinger, 1980; Napps and Fowler, 1987). In these studies, a priming effect is found between formally related words such as *tribe* and *bribe*. There is even some evidence that the first presentation of a nonword can prime for the second presentation of the same nonword (Slowiaczek and Pisoni, 1986).

What these studies demonstrate is the existence of short term formal priming. In all cases, the lag time between the prime and target words was short—1650 msec. or less. In addition, the subjects saw no other test item between the presentation of the prime and the target. However, even under these conditions, not all experiments yielded a short term priming effect (Henderson, Wallis and Knight, 1984; Martin and Jensen, 1988; Slowiaczek and Pisoni, 1986).

In contrast, the ability of formally related words and nonce words to exert a long lasting priming effect has not been established. Experiments by Forbach, Stanners, and Hochhaus (1974), Henderson, Wallis and Knight (1984), Kempley and Morton (1982), Murrell and Morton (1974), Napps and Fowler (1987), all provide negative evidence that formally related words can prime at lags of 2500 msec. and longer. Therefore, the difference between experiments in which formal priming occurred, and those in which it did not occur, appears to depend on the lag time between the presentation of the prime and the target. Formal priming occurs when the lag between prime and target is short, and when no intervening test words separate the prime and target words. Formal priming does not occur at longer lags, or when words intervene between the prime and target.

The short lived nature of formal priming is further supported by Scarborough, Cortese and Scarborough's study (1977:1-4), which found significant priming of both repeated words and repeated nonwords with 0 up to 15 intervening test items. However, the priming effect for real words, as measured by reaction time to the target, did not drop significantly at longer lags. In

contrast, the reaction time to a nonword target increased significantly as the lag between the prime and target increased. In other words, the priming effect of a nonword on itself diminished significantly in a short period of time.

Fowler, Napps and Feldman (1985) hypothesize that the priming effect observed with nonwords cannot reflect repeat access to a lexical item. Instead, they assume that it is episodic in nature. That is, nonwords prime because the test subjects remember having seen the nonword before. Therefore, the priming effect for nonwords weakens with time as the memory of the nonword disappears from short-term memory. In order to demonstrate this, they replicated an experiment by Stanners, Neiser, Hernon and Hall (1979:242-6) using nonwords instead of real words.

In the experiment by Stanners et al., a priming effect between morphological relatives such as *walk* and *walking* was observed. Fowler et al. found that, at an average lag of 9 intervening test items, a nonword such as *flupper* primed for its morphological stem *flup* in a similar manner. However, nonword priming disappeared when the number of intervening test items was increased to an average of 48.

What is important to conclude from these studies is that the priming effect which is observed between formally related words or between nonwords dissipates quickly. Therefore, it can be controlled for by increasing the lag between the presentation of the prime and the presentation of the target.

3.2. Semantic priming

Another argument which could be made is that the priming effect is neither formal nor morphemic, but semantic in nature. If this is the case, then priming should occur between synonyms and other semantically related words. While it is true that semantic priming does exist, like formal priming, it is also short-lived. For example, at lags of 250 to 550 msec., priming was found to occur between synonyms such as *trade* and *swap* (Martin and Jensen, 1988).

Another experimental paradigm which resulted in a semantic priming effect involved presenting two semantically related words at the

same time (Mc Namara and Healy, 1988; Meyer and Schvaneveldt, 1971). In these experiments, subjects responded *yes* if both words were real words, and *no* if one of the items was a nonword. Semantically related pairs such as *nurse-doctor* were responded to much more quickly than semantically unrelated pairs such as *nurse-butter*. This suggests that the recognition of a word is facilitated by the presence of a semantically related word. However, the fact that the two test words are presented concurrently suggests a short-term priming effect. Furthermore, it is unclear if the outcome of a study involving simultaneous presentation of prime and target has any relevance for priming effects obtained through sequential presentation.

The short duration of semantic priming is clearly evident in experiments which vary the lag time between the presentation of the prime and target. Dannenbring and Briand (1982) tested for both word repetition and semantic priming at lags of 0, 1, 5, and 16 intervening items. Word repetition priming remained robust when 16 items intervened between the prime and target. However, semantic priming between word-pairs such as *sea-ocean*, and *mouse-cheese* occurred only with a lag of 0, or about 4 seconds. Henderson, Wallis and Knight (1984) obtained similar results.

Napps (1989) differentiated between two types of semantic relationships: synonyms (e.g. *pillar-column*) and associatively related words (e.g. *tree-leaf*). At lags of 0, 1, 3, and 10 intervening items, synonyms did not prime. Conversely, associatively related words did, and the priming effect did not wane significantly as lag time increased. Although Napps provides some evidence for semantic priming, the evidence taken as a whole suggest that semantic priming is ephemeral when compared to morphemic priming, and may be controlled for in an experimental design which incorporates long lag times.

3.3. Morphemic priming

In contrast to the short-lived priming effects observed between formally and semantically related words, morphemically related words exert longer lasting priming effects on each other. The strongest priming is found in the repetition of a

real word. Forbach, Stanners and Hochhaus (1974) found the priming effect of a real word on itself to last up to 10 minutes. Another experiment revealed that repetition priming of the same real word can last up to 48 hours (Scarborough, Cortese, and Scarborough, 1977:10-12). Strong morphemic priming is not restricted to the priming effect that a real word exerts on itself. Fowler, Napps, and Feldman (1985) observed priming between morphemically related words such as *retain-retained*, *produce-productive*, and *deep-depth*. This occurred when the average number of intervening test items was 48.

The ability of priming to occur among words with different kinds of stem allomorphy is central to the present study. Differences of this sort were initially found by Stanners, Neiser, Herson and Hall (1979). In their study, regular inflections (e.g. *lift-lifting*) primed better than irregular inflections such as *shake-shook*. Regular inflections also primed better than derivations. Derivations with allomorphy in the root (e.g. *describe-descriptive*) primed as well as derivations with no allomorphy (e.g. *select-selective*). These results were obtained with an average lag of 10 items between the prime and the target.

Fowler, Napps, and Feldman (1985) suggest that the experiment by Stanners et al. (1979) may have been influenced by episodic sources. That is, subjects may remember seeing a word or its relative on an earlier trial. Regularly inflected words are more formally similar than inflected words with stem allomorphy. They are also more formally similar than derived forms. Therefore, it is possible that test subjects recall having seen regularly inflected forms more often than inflected words with stem allomorphy or derived words.

In order to eliminate any possible episodic influence, Fowler et al. increased the average lag between prime and target from 9 (as in Stanners et al., 1979) to 48. At an average lag of 9, nonwords such as *flup* primed for inflected nonwords such as *flupping*. This is presumably due to episodic sources. However, at an average lag of 48, no priming occurred between nonwords. At the same time, priming did occur between

derivationally related words, both without allomorphy in the stem (e.g. *lyric-lyrical*), as well as with stem allomorphy, (e.g. *persuade-persuasive*). The same was found for inflectionally related words; *signing* primed for *sign* just as well as *sang* did for *sing*. There were no significant differences between the priming each category of words exhibited. Fowler et al. (1985:251) conclude that since priming occurs with inflectionally and derivationally related words, as well as between related words with stem allomorphy, all words which have a common morpheme are organized together in the lexicon. Similar results were obtained by Napps (1989).

3.4. Differential priming by words with regular and isolate stem allomorphy

The experimental evidence presented so far suggests that all morphemically related forms will exert a priming effect on each other. If this is the case, then it is doubtful that word-pairs with regular phonological alternations will prime differently from word-pairs with suppletive alternations. This appears to be true because in the studies cited so far, the researchers were interested in contrasting related words with stem allomorphy (e.g. *decide-decision*), to related words without stem allomorphy (e.g. *disagree-disagreement*). Whether the allomorphy involved regular or suppletive phonological alternations was not a factor. In contrast, the purpose of the present experiment is to look for priming differences between words with regular alternations and those with suppletive alternations.

Close inspection of the word lists used in priming experiments is revealing. Both Napps (1989) and Fowler et al. (1985) found no difference in priming between words without stem allomorphy and words with stem allomorphy. However, the great majority of the words used in their experiments which display stem allomorphy, involve phonological alternations which are common in English. For example, many words exhibited the common alternation between /d/ and /s/ as in *defend-defensive*. It appears that strong priming occurs between words with no stem allomorphy, as well as between words in which the stem allomorphy involves a well-attested phonological alternation:

The obvious question is whether a long-lasting priming effect is to be observed between words with stem allomorphy involving uncommon phonological alternations. There are two experiments which shed light on this question. Napps (1989) carried out an experiment in order to determine the extent to which suppletive forms, such as *lie-lay* and *strike-struck*, prime. The great majority of the words used in this experiment contained stem allomorphy with uncommon phonological alternations. A priming effect was observed for these words, but only at lags of 0 and 1. At lags of 3 and 10, words with suppletive alternations did not prime.

Similar results were obtained by Kempley and Morton (1982) in an auditory priming experiment. Here again, the majority of the irregularly inflected word-pairs contained uncommon phonological alternations. At lags of 10 to 40 minutes, words such as *man-men* and *tore-tearing* did not exhibit a priming influence.

4. THE PRIMING EXPERIMENT

These results indicate that priming is found between related words with stem allomorphy involving regular phonological alternations. Conversely, enduring priming is not encountered in cases where the stem allomorphy involves uncommon phonological alternations.

In Eddington (1993), it was seen that word-pairs with regular phonological alternations were more likely to be viewed as having a morpheme in common than word-pairs with suppletive alternations. The priming effect presents itself as a method of verifying these results. If words with regular alternations prime better than words with suppletive alternations, then regular alternations play a greater role in the establishment of morphemic relationships than suppletive alternations. The following experiment was carried out to test this hypothesis.

4.1. Subjects

A total of 24 subjects participated in this study. On account of computer problems the data for two subjects were lost leaving 22 test subjects. Twenty subjects were from Spain (13 from Na-

varre), and the remaining two from Argentina. A wide range of ages is found among the subjects, although most were young; there were 11 between the ages of 18 and 27, six between 28 and 37, three between 38 and 47, one 54 year old and one 61 year old. Ten of the subjects were men and the remaining twelve women. Twelve subjects reported having studied formally until the ages of 14 to 17, eight subjects studied until ages 18 to 21, and two until over 22 years of age. Only three subjects reported having studied philology or linguistics, which in Spain usually means having studied prescriptive grammar and literature.

4.2. Stimulus materials

Twenty four suppletive word-pairs and 24 regular word-pairs were originally selected. These 48 word-pairs are a subset of the 72 pairs used in Eddington (1993). The selection of the 48 word-pairs from the list of 72 was based on the judgements of five Spanish speakers who completed a questionnaire as part of a pilot study. They were asked to judge how semantically similar the word-pairs were. The 24 suppletive word-pairs, and the 24 regular word-pairs which were judged highest in semantic similarity constituted the original list. However, one suppletive word-pair was mistakenly assigned to the regular category. The reassignment of that pair into the correct category is responsible for the fact that in Table 2 there are 25 suppletive and only 23 regular word-pairs. Although this was not corrected until after the experiment was run, it was corrected before the statistical analyses were performed, and therefore does not affect the final outcome.

The regular word-pairs were taken from examples found in the literature on Spanish phonology, or are words that could in principle be derived from the same root by the application of the rules set forth in the literature. Thirteen rule-based alternations are represented in the regular word-pair list (see Table 3). In order for an alternation to be considered suppletive it could not have been described in the literature on Spanish phonology. For example, linguists have not considered the alternation between /ð/ and /β/ (e.g. *vida-vivir*) significant. The /a/~e/ alterna-

tion of *rana, renacuajo* is considered a suppletive one even though such an alternation has been described in the literature (e.g. *leche-láctico* 'milk, lactic'). This is because it occurs in a context unrelated to the alternation described

Table 2. Regular and Suppletive Word-Pairs.

	Suppletive pairs
cueva-cavidad	'cave, cavity'
selva-salvaje	'jungle, savage'
dos-ambos	'to, both'
ojo-óptico	'eye, opical'
vida-vivir	'life, to live'
mundo-vagabundo	'world, vagabond'
rana-renacuajo	'frog, polliwog'
herejía-herético	'heresy, heretic'
sangre-sanguíneo	'blood, blood, adj.'
campeón-competencia	'champion, competition'
inglés-anglicano	'English, Anglican'
brazo-braquial	'arm, arm, adj.'
rito-rutinario	'ritual, routine'
llorar-llanto	'to cry, cry'
oro-dorado	'gold, golden'
baño-balneario	'bath, health spa'
correr-carrera	'to run race'
nasal-nariz	'nasal, nose'
gordo-grueso	'fat, thick'
resucitar-resurrección	'to ressurect, ressurection'
amigo-amistad	'friend, friendship'
diez-décimo	'ten, tenth'
revés-reversa	'backwards, reverse'
heredar-herencia	'to inherit, inheritance'
boca-bozal	'mouth, muzzle'
	Regular pairs
saludar-salutación	'to greet, greeting'
dividir-divisor	'to divide, divisor'
presumido-presunción	'conceited, conceit'
vil-villano	'vile, rustic'
lado-lateral	'side, lateral'
huésped-hospital	'guest, hospital'
margen-marginado	'margin, alienated'
despecho-despectivo	'spite, scornful'
igual-equidad	'equal, equity'
eje-axial	'axle, axle, adj.'
génesis-genético	'genesis, genetic'
bien-beneficio	'well, benefit'
suelto-soltero	'unattached, bachelor'
huelga-holgazán	'strike, lazy'
natal-nación	'natal, nation'
inversa-invertir	'reverse, to invest'
reflejo-reflexivo	'reflection, reflexive'
redimir-redentor	'to redeem, redeemer'
relato-relación	'story, relationship'
fondo-fundamental	'bottom, fundamental'
desdén-desdeñoso	'scorn, scornful'
lumen-luminoso	'lumen, bright'
colme-culminación	'limit, culmination'

Table 3. Alternations in Regular Word-Pairs.

- (1) The pairs *saludar-salutación*, and *lado-lateral* are examples of lenition (Harris, 1969:43; Cressey, 1978:91; Pilleux, 1979:58-9).
- (2) The alternation between /ð/ and /s/ in *invertir-inversa*, and *dividir-divisor* may be ascribed to a rule which converts the stem final /ð/ or /t/ of a second or third conjugation verb into /s/ (Harris, 1969:143-54; Martínez-Celdrán, 1975:102; Pilleux, 1979:64-5).
- (3) Harris considers the pair *igual-equidad* to 'share a formative' and sets up a rule which relates /k/ and /ɣw/ (1969:153-7; see also Hooper, 1976:63).
- (4) The questionnaire pair *despecho-despectivo* reflects a rule which relates /kt/ and /č/ (Harris, 1969:168-72; Hooper, 1976:8-20).
- (5) The alternation between /ks/ and /x/ has similarly been described as rule governed (Harris, 1969:168-72; Cressey, 1978:90); *eje-axial*, *reflejo-reflexivo* contain this alternation.
- (6) The pairs *presumido-presunción*, and *redimir-redentor* are examples of nasal assimilation (Harris, 1969:8-18; Harris, 1985a).
- (7) Quite a lot of ink has been spent on the alternation between simple mid-vowels and diphthongs (Harris, 1969:125-6; Harris, 1985b; Hooper, 1976:45-9; Pilleux, 1979:73-6). This alternation is reflected in *huésped-hospital*, *suelto-soltero*, and *bien-beneficio*.
- (8) In *génesis-genético*, nouns ending in /-sis/ correspond to adjectives with /-tik-/ as described by Pilleux (1979:61-62).
- (9) Similarly, nouns ending in /-Cen/ correspond to non-nouns with /-Cin-/ as in *margin-marginado*, and *lumen-luminoso* (Pilleux, 1979:56).
- (10) The fact that /e/ is not found in the root of third conjugation verbs is represented in the pair *redimir-redentor* (Harris, 1977a; Pilleux, 1979:56-7).
- (11) Pilleux considers the alternation between /o/ and /u/ in pairs such as *fondo-fundamental*, and *colmo-culminación* to be a morphologically conditioned alternation (1979:58).
- (12) The alternation in *natal-nación* reflects a rule that transforms /t/ into /s/ (or into /θ/ in the dialect area the data for the present study come from) before a front vowel followed by another vowel (Harris, 1969:142-3).
- (13) The alternation between palatal and nonpalatal consonants of the type seen in *vil-villano*, and *desdén-desdeñoso* has been discussed in terms of rules by Harris (1982), and Contreras (1977).

in the literature. The /e/ < /a/ does not appear before /č/ in *renacuajo*, while it is the existence of /č/ (or at least some precursor of /č/ in a derivation) which triggers the raising of /a/ to /e/ in *leche* and other words which the rule is designed to account for. This is the same rea-

son that two different suppletive pairs with the alternation /a/-/e/ are still considered suppletives; *selva-salvaje*, and *rana-renacuajo* all contain an /a/ that alternates with an /e/. However, one would be hard pressed to find a phonological or morphological context that these three pairs have in common which would allow them to be considered instances of the same rule.

The reason for classifying an alternation as a suppletive one is more often than not a matter of what intuitively looks suppletive. The alternation between /ð/ and /β/ in *vida-vivir* appears to be limited to that one pair of words, but it is entirely possible that some speaker may strongly relate another pair of words with that same alternation and in that same context. Nevertheless, if an alternation seemed to apply exclusively to only one pair of words, in a unique context, it was considered suppletive.

It is worth noting that three suppletive word-pairs contain alternations which are counterexamples to the general rules. Velar softening creates pairs in which a /k/ appears before a back vowel, and which alternates with a /θ/ before a front vowel. In *brazo-braquial* the opposite is true, and in *boca-bozal* a /θ/ appears before a back vowel. Stressless mid-vowels usually alternate with stressed diphthongs, yet there is no diphthong in *décimo* (compare to *diez* 'ten').

The arrangement of these stimulus words in the priming experiment most closely follows that of Fowler et al. (1985). The reason for following the methodology of Fowler et al. is that they found that at an average lag between prime and target of 48 intervening items, derivationally related words primed as well as inflectionally related words. At this lag, they also found that word-pairs in which there was a change in spelling or pronunciation (e.g. *creep-crept*) primed as well as word-pairs which involved no change in the spelling or pronunciation of the root (e.g. *heal-healer*). This is important because the entire purpose of the present study was to compare the effect of priming on two groups of words, all of which are derivationally related, and all of which have roots with spelling and pronunciation changes.

In order to obtain an average lag of 48 intervening items between the prime word and tar-

get word, the test words were assigned to five blocks of 48 items. The items in the blocks were ordered so that the targets in one block were preceded by their corresponding primes in the previous block. Each block contained 24 real words and 24 nonwords. In blocks 2, 3 and 4, there were 6 regular primes, 6 suppletive primes, 6 regular targets, 6 suppletive targets, and 24 nonwords. Block 1 contained 6 regular primes and 6 suppletive primes. However, since it contained no target words, 12 real word fillers were added in order to keep the number of items constant at 48, as well as to balance the ratio of nonwords to real words. Block 5 contained 6 regular targets and 6 suppletive targets. As in block 1, 12 real word fillers were added to block 5 in order to make up for the lack of primes in this last block. The five blocks were preceded by a practice block of 8 real words and 7 nonwords.

Care was taken to avoid selecting real word fillers which were orthographically or semantically similar to any of the test words, and thus could serve as unintentional primes. Nonwords were made by changing one of the letters of existing Spanish words in such a way that the nonword conformed to the orthographic and phonotactic rules of Spanish. Assignment of all words to a specific slot in the block was random. Two different test orders were made in this fashion in order to insure that the results were not dependent on something specific to the order.

The majority of priming studies involve word-pairs that may easily be divided into base words (e.g. *defend*, *null*), and base plus a well-defined affix (e.g. *defensive*, *nullify*). In many instances, word-pairs in this study are instances of a base word, and the base word plus a well-defined affix, as in *saludar-salutación*. There are, however, many instances in which it is not clear which member of the pair is the base and which is the derived form; *gordo* and *grueso* both appear to be bases. In like manner, *huésped* and *hospital* have the same root followed by what could be considered suffixes.

Since it was impossible to determine which member of each word-pair was the base and which the derived form, the division of word-pairs into primes and targets was based on word length. The longest member of the pair served

as the prime and the shortest as the target. This is consistent with the fact that in most priming studies, affixed words are typically used as primes and their unaffixed bases as targets. Where both members of a pair were equal in length (e.g. *nariz-nasal*), the assignment was random.

4.3. Design

At the beginning of the experimental session each subject was assigned to respond to one of the two orders of test words which were created. The independent variables were word type (prime or target), type of alternation (regular or suppletive), and word length. The dependent variable was response time.

It was necessary to include word length as a variable for two reasons. The first is that it was impossible to match regular and suppletive words according to their length. The second reason is that primes were generally longer than targets. Therefore, any decrease in response time to target words could be due, not only to the priming effect, but also to the shorter length of the target words. These two possible effects must be separated in order to preserve the internal validity of the study.

Ideally, another factor to be controlled for is word frequency, since it has been shown to affect the outcome of studies of this nature. Unfortunately, frequency data are not available. The most extensive frequency dictionary of Spanish (Juilland and Chang-Rodríguez, 1964) does not include a significant number of the test words. Therefore, it was impossible to control for this factor.

4.4. Procedure

The subjects were told that the test was designed to explore how words are stored in the mind. Their job was to determine if a word that appeared on the screen was a real Spanish word by answering *sí*, or a nonword by responding *no*. They were also told that 50 percent of the words were real, and the other half were nonwords that had been made by replacing one of the letters in a real word with another letter. It was emphasized that two things were important in the study: accuracy and speed.

All subjects were tested individually on a Toshiba T-1000 computer. Each subject's left index finger was placed on the Z key of the keyboard which had been marked *Sí*, while the right index finger was placed on the slash key which had been marked *No*. All words appeared in the middle of the screen in small letters. As soon as the subject responded the word disappeared. The time between a subject's response, and the appearance of a new word was held constant at 2 seconds.

4.5. Results and discussion

Reaction times of under 400 msec. or over 2500 msec. were considered extreme, and eliminated from the analysis. If a subject incorrectly answered *No* to a test word, it was assumed that the subject was not familiar with that particular word, and as a result, could not have made morphemic associations between it and other words in the mental lexicon. Therefore, a subject's incorrect response to one member of a word-pair was grounds for excluding the subject's response times to both members of the pair from the analysis. This excluded 2 percent of the responses to test items. Incorrect responses to *braquial* and *axial* make up the majority of this two percent which indicates that many speakers are not familiar with these words.

A three-way ANOVA was applied to the resulting test data (Table 4). Among the stimulus words there were no primes words of 3-4 letters, and no targets of 10-12 letters as a result, it was impossible to match prime and target words at all word lengths. For this reason, high order interactions could not be calculated. However, three two-way ANOVAs were run to determine if there were any two-way interactions. As can be seen in Table 5, none were found.

A strong priming effect was obtained in the present experiment. The mean reaction time was

Table 4. Results of the ANOVA.

Source of variation	DF	Sum of squares	F	p =
Prime or target	1	1324807.528	9.410	.002
Regular or suppletive	1	18761.045	.133	.715
Word length	9	1464053.433	10.399	.000

Table 5. Two-Way Interactions.

Two-way interactions	df	Sum of squares	F	p =
Regular/Isolate by Word Length	7	270696.845	1.921	.063
Prime/Target by Regular/Isolate	1	2319.482	.016	.900
Prime/Target by Word Length	4	175833.349	1.250	.288

1135.65 msec. for primes and 956.02 msec. for targets. It is not surprising that word length is such a salient factor in determining reaction time. The real question, however, is whether the priming effect and the word length effect are one and the same. That is, do reaction times depend solely on word length? If such is the case, then it is incorrect to conclude that morphemic priming has occurred at all. If no priming has occurred, and word length is the only factor influencing reaction time, then a prime of a given

Reaction times
in milliseconds

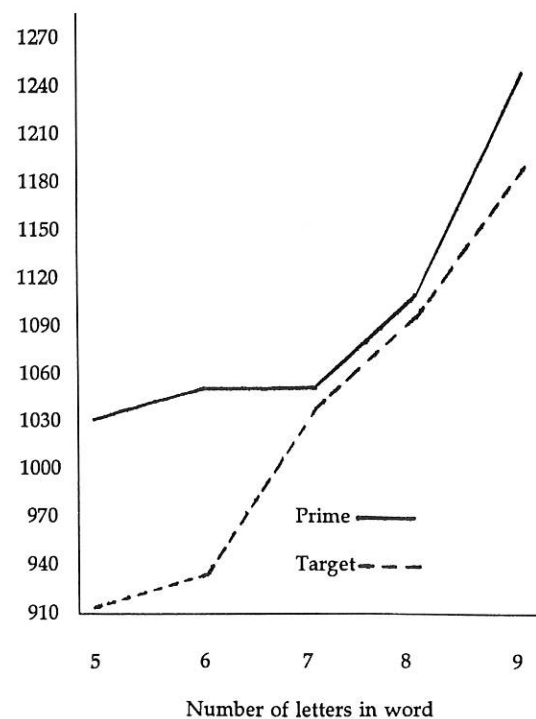


Fig. 1. Mean Reaction Times to Primes and Targets by Word Length.

length and a target of the same length should yield similar mean reaction times. Fortunately, a prime of a given length took longer to respond to than a target of the same length (Table 6). This indicates that the shorter reaction times to targets is a result of the priming effect.

Although a significant priming effect was found, the question which is central to this study is whether speakers make morphemic relationships between words which contain regular phonological alternations to a greater extent than they make morphemic relationships between words which contain suppletive phonological alternations. In this experiment, words with regular alternations primed just as well as words with suppletive alternations. The type of alternation found in a word-pair had no effect on the ability of the prime word to reduce the reaction time to the target word. Therefore, the regular alternations have no special status in establishing derivational relatedness in contrast with the suppletive alternations.

5. CONCLUSIONS

The objective of this study has been to determine if regular alternations are more psychologically salient than the alternations found in suppletive forms. The major premise behind this experiment is that if they are more salient, speakers should treat them differently from suppletive ones. The experiment involved measuring the degree to which the test subjects perceived pairs of words to have a morpheme in common. The use of derivational relatedness in such an attempt is not unmotivated. Regular alternations are involved in accounting for the different phonological forms a single morpheme may assume. Therefore, a logical way of testing their psychological significance is to determine their role in what words speakers perceive as having a morpheme in common.

In this experiment, words with regular alternations, as well as those with suppletive alternations, manifested a significant priming effect. That is, words with regular alternations did not prime any better than those with suppletive alternations. These results imply that all of the

word-pairs were perceived as derivationally related by the test subjects, regardless of the type of alternation the word-pair exhibited. It is interesting to note that similar findings have been reported for Finnish (Niemi, Laine, and Tuominen, forthcoming).

The negative results of the present study contradict the positive results of Eddington's (1993) word-pair experiment, since the outcome of the word-pair experiment suggests that regular alternations are actually more salient. In that study, test subjects perceived word-pairs with regular alternations to share a morpheme to a greater extent than word-pairs with suppletive alternations. Therefore, the subjects used their knowledge of what alternations are common and uncommon in determining questions of derivational relatedness.

The conflicting outcomes of these two experiments should be a clear indication that the subject needs to be explored in more depth. In particular, the utility of the priming effect in exploring questions of morphophonology merits more attention. This is because the present study, in all likelihood, represents the first attempt to test phonological alternations with the priming effect. It may also be the first time that Spanish has served as the test language in a priming experiment.

The results of this experiment are by no means definitive. Central to this experiment is the list of regular and suppletive word-pairs. One thing which would strengthen the validity of the results of these two experiments would be to replicate them with a different set of test words, and different subjects. If similar outcomes are achieved, then the results are less likely to be due to the test material or subjects, and more likely to be dependent on the type of alternation exhibited by each pair of words.

Further research into the question should be undertaken in order to determine why the two experiments yielded different results. The conflicting outcomes may be the result of the different experimental paradigms used. For example, the word-pair experiment involved a conscious decision making task. On the other hand, the priming experiment was designed to measure derivational relatedness on a less conscious

level. Further research may show that regular alternations are psychologically relevant to those situations in which people make a deliberate effort to determine what words are derivationally related. However, outside of this type of task, people may relate all words which are semantically and phonologically similar.

This interpretation is attractive because it would imply that there is a correlation between linguists' characterization of a language, and naive speakers' perceptions of the language, when both parties analyze it in a similar mode. That is, linguists determine what alternations constitute regular alternations by studying the language data in a careful and deliberate manner. Their results correspond to those of naive speakers who, during the word-pair test, similarly study the language material in a careful and deliberate manner.

However, the lack of correspondence between the linguists' characterization, and the naive speakers' perceptions, as evidenced in the priming experiment, could be attributed to the differing nature of the tasks. The outcome of the linguists' conscious analysis of the language may not match the morphemic relationships which exist for speakers on a subconscious level, because conscious and subconscious analyses of morphemic relationships may be fundamentally different.

In any event, it is hoped that this experiment will stimulate others to probe the minds of language speakers in order to discover what kinds of knowledge speakers have about their language. As far as the distinction between regular and suppletive alternations is concerned, once a large body of evidence has been amassed on them, their role in language processing will become more apparent and more definite conclusions may be reached.

REFERENCES

- Contreras, H. (1977). Spanish epenthesis and stress. *University of Washington Working Papers in Linguistics* 3, 9-33.
- Cressey, W. (1978). *Spanish phonology and morphology: A generative view*. Washington DC: Georgetown University Press.
- Dannenbring, G.L., Briand, K. (1982). Semantic priming and the word repetition effect in a lexical decision task. *Canadian Journal of Psychology* 36, 435-444.
- Eddington, D.S. (1993). *Psychological reality and linguistically significant generalizations: Experimental evidence from Spanish*. Dissertation, University of Texas at Austin.
- Forback, G.B., Stanners, R.F., & Hochhaus, L. (1974). Repetition and practice effects in a lexical decision task. *Memory and Cognition* 2, 337-339.
- Forster, K.I., Davis, C., Schnoknecht, C., & Carter, R. (1987). Masked priming with graphemically related forms: Repetition or partial activation? *Quarterly Journal of Experimental Psychology* 39A, 211-251.
- Fowler, C.A., Napps, S.E., & Feldman, L. (1985). Relations among regular and irregular morphologically related words in the lexicon as revealed by repetition priming. *Memory and Cognition* 13, 241-255.
- Harris, J.W. (1969). *Spanish Phonology*. Cambridge, Mass.: MIT.
- Harris, J.W. (1977). Aspects of Spanish verb morphology. In: Hagiwara, M.P. (ed.), *Studies in Romance linguistics*. Rowley, Mass.: Newbury House, 44-60.
- Harris, J.W. (1982). Spanish syllable structure assignment is cyclic. In: Lantolf, J.P., & Stone, G.P. (eds.). *Current research in Romance languages*. Bloomington, Ind.: Indiana Linguistics Club, 71-85.
- Harris, J.W. (1985a). Autosegmental phonology and liquid assimilation in Havana Spanish. In: King, L.D., & Maley, C.A. (eds.), *Selected papers from the XIIIth linguistic symposium on Romance languages*. Amsterdam: John Benjamins, 127-148.
- Harris, J.W. (1985b). Spanish diphthongization and stress: A paradox resolved. *Phonology Yearbook* 2, 31-45.
- Henderson, L., Wallis, J., & Knight, D. (1984). Morpheme structure and lexical access. In: Bouma, H., & Bouwhuis, D.G. (eds.), *Attention and performance X*. Hillsdale, NJ: Lawrence Erlbaum, 211-226.
- Hillinger, M.L. (1980). Priming effects with phonemically similar words: The encoding-bias hypothesis reconsidered. *Memory and Cognition* 8, 115-123.
- Hooper, J.B. (1976). *An introduction to natural generative phonology*. New York: Academic Press.
- Juillard, A., & Chang-Rodríguez, E. (1964). *Frequency dictionary of Spanish words*. The Hague: Mouton.
- Kempey, S.T., & Morton, J. (1982). The effects of priming with regularly and irregularly related words in auditory word recognition. *British Journal of Psychology* 73, 441-454.
- Martin, R.C., & Jensen, C.C. (1988). Phonological priming in the lexical decision task: A failure to replicate. *Memory and Cognition* 16, 505-521.
- Martínez Celdrán, E. (1975). *Sufijos nominalizadores de español con especial atención a su morfología*. Barcelona: Ediciones de la Universidad de Barcelona.
- Mc Namara, T.P., & Healy A.F. (1988). Semantic, phonological, and mediated priming in reading and lexical decisions. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 14, 398-409.
- Meyer, D.E., & Schvaneveldt, R.W. (1971). Facilitation

- in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology* 90, 227-234.
- Murrell, G., & Morton, J. (1974). Word recognition and morphemic structure. *Journal of Experimental Psychology* 102, 963-968.
- Napps, S.E. (1989). Morphemic relationships in the lexicon: Are they distinct from semantic and formal relationships? *Memory and Cognition* 17, 729-739.
- Napps, S.E., & Fowler, C.A. (1987). Formal relationships among words and the organization of the mental lexicon. *Journal of Psycholinguistic Research* 16, 257-272.
- Niemi, J., Laine, M., & Tuominen, J. Cognitive morphology in Finnish: Foundations of a new model. *Language and Cognitive Processes* (to appear).
- Ohala, M., & Ohala, J.J. (1987). Psycholinguistic probes of native speakers' phonological knowledge. In: Dressler, W.U., Luschützky, H.C., Pfeiffer, O., & Rennison, J.R. (eds.), *Phonologica 1984*. Cambridge: Cambridge University Press, 227-233.
- Pilleux, M. (1979). *A Morphophonological functional and semantic analysis of spanish suffixes from a synchronic point-of-view*. Dissertation, University of Pittsburgh.
- Scarborough, D.L., Cortese, C., & Scarborough, H.S. (1977). Frequency and repetition effects in lexical memory. *Journal of Experimental Psychology: Human Perception and Performance* 3, 1-17.
- Slowiaczek, L.M., & Pisoni, D.B. (1986). Effects of phonological similarity on priming in auditory lexical decision. *Memory and Cognition* 14, 230-237.
- Stanners, R.F., Neiser, J.J., Herson, W.P., & Hall, R. (1979). Memory representation for morphologically related words. *Journal of Verbal Learning and Verbal Behavior* 18, 399-412.