SPELLING ERRORS AND PHONOLOGICAL LEVELS OF SPECIFICATION

Richard LILLY
Laboratoire de Recherches Phonétiques,
Lille, France.

ABSTRACT

As shown in an earlier study of a handwritten corpus of American English [1], a large number of spelling errors cannot be explained without reference to phonological representations or operations. In this respect, reduced vowels, which appear to cause spelling errors twice as often as statistically predictable, may provide an indication that neither surface nor underlying representations are fully specified. An experiment designed to elicit spelling errors showed improved performance with words having phonologically informative derivatives. It is hypothesized that the higher level of underlying specification was responsible for lower error rates, an argument in favour of the cognitive value of certain principles of the Underspecification Theory.

INTRODUCTION

In spite of increased attention from psychologists and linguists since the publication of Frith's *Cognitive Processes in Spelling* (1980) [2], the analysis and typology of spelling errors remains a difficult and often confusing subject. One of the reasons for this situation is the fact that no classificatory tool is, so to speak, "theory-neutral". But even within a (traditional) framework, designed for the analysis of dyslexic slips or buffer memory failures, a number of statistical oddities can be discovered, all pointing to a predominantly phonological origin of spelling errors. After a brief presentation of the corpus and a discussion of the traditional typology, I proceed to show that surface representations as well as deeper constructs are involved in spelling errors. Unstressed vowels, which provide the majority of letter substitutions in the corpus, serve the argument that underspecification at the underlying level is responsible for the observed graphic indeterminacy. An experiment confirms this point a contrario by showing that an increase in underlying specification also results in improved spelling performance.

1. ERROR TYPOLOGY

1.1. The corpus

In a previous study [1], I analyzed a corpus of 204 essays, 3 to 4 pages long, written by American students of English as part of their university requirements. The precautions customary with handwritten material were taken to ensure that all collected errors were genuine, even if this meant "losing" a certain number of corrected or ill-written items. This, together with the student population under study, may explain why the corpus yielded proportionally less errors than other comparable bodies of handwritten text [3]. The *American Heritage Dictionary* [4] was used as reference, and all variants therein were considered correct (e.g. *fulfil, fulfill,* etc.). 120 essays turned out to contain one or more misspelled words, giving a total of 324. Even among misspellers, the number of faulty words per student varied a great deal (from 1 to 13, with a mean of 2.7), 23% of the subjects being responsible for 52% of the misspelled words.

1.2 Classification problems

The purpose of the study required that spelling *errors* (rather than misspelled *words*) be identified and quantified. While 3 separate mistakes can easily be isolated in **deffenitly* < *definitely* or **dissalusions* < *disillusions*, the result is less certain in **beurocracy* < *bureaucracy*, and quite impossible to assess in **oprutunities* < *opportunities*. A typology based on hypothesized causes [5] seemed open to criticism because of overlapping categories, and methodological circularity. A widely accepted structural classification (cf. [6], [7], [3]) seemed preferable, at least as a quantifying tool. An error was consequently identified each time a letter had been **Added** (**bothe*), **Deleted** (**athority*), **Changed** (**atrosious*) or **Swapped** (**marraige*). In this system, the word **beurocracy* < *bureaucracy* could be analyzed as containing 1 Addition, 1 Change and 2 Deletions. Unfortunately, this typology can produce diverging results (with obvious quantitative consequences), a fact not reported in previous research. A misspelling like **imganitive* < *imaginative* can thus receive as many as 4 different interpretations :

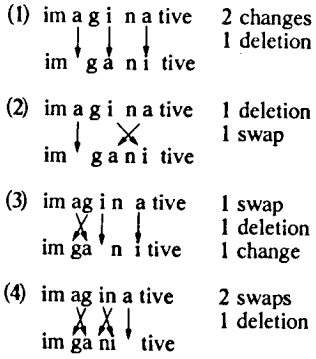

Figure 1. Four structural analyses of **imganitive*.

This difficulty was solved by imposing a certain order on the operations (i.e. Swapping, Change, Deletion, Addition), according to which more complex structural changes took place before simpler ones. Under this protocol, the four categories could function in a mutually exclusive way, yielding one and only one solution per item (solution 4 in the above example). 415 individual errors were thus unambiguously identified in the corpus, falling as follows : Added : 117, Deleted : 126, Changed : 137, Swapped : 36.

2. THE PHONOLOGICAL BASIS OF SPELLING ERRORS

2.1. The problem of units

Such classifications are not free from presuppositions, however. Let us consider errors like **acheive* < *achieve*, **thier* < *their*, etc.. The letter inversion causes them to be identified as Swaps. While factually correct, this solution misses an important point. In effect, out of 650 possible combinations of any two letters, and with a cumulated statistical probability of occurrence of .0055, *e* and *i* were involved in 72% of contiguous Swaps in the corpus... A fact for which no explanation can be offered, unless one ceases to consider letters but *graphemes*. In this respect, *ei* and *ie* happen to be the only English digraphs which are "reversible" without change of phonological value. If letters *e* and *i* have indeed been "swapped" on a superficial level, what the subjects actually did was choose the closest graphic solution to represent a given sound.

Many other statistical oddities argue in favour of considering phonological, rather than graphic representations as the operative units in spelling, leaving a small minority of errors (e.g. **convience* < *convenience*, **opionon* < *opinion*, **previuos* < *previous*, **pyscological* < *psychological*, **tevelvision* < *television*, etc.) to illustrate dyslexic or short-term memory mechanisms ("slips of the pen" proper). The level of such phonological representations remains to be discussed.

2.2. Phonetic spelling

Attempts by subjects to represent their actual pronunciation with some degree of phonetic realism are not infrequent in the corpus (e.g. **close* < *clothes*, **idenity* < *identity*, **goverment* < *government* ; **helpt* < *helped* ; **imformative* < *informative* ; **enviromment* < *environment*, etc.). The suprasegmental tendency of [r] is reflected (**oprutunities* < *opportunities*, **structrured* < *structured*, etc.), as well as the schwa deletion in the C__rV environment (**diffrently* < *differently*, **seprated* < *separated*, etc.). More generally, the frequent choice of plausible, though visually incorrect, strategies (e.g. **extreamly* < *extremely*, **lude* < *lewd*, etc.) argues in favour of surface-level driven operations.

2.3. Underlying forms and rules

The reverse tendency, namely the attempt to represent underlying, prederivational forms is also observed (e.g. **enphisis* < *emphasis* ; *respondsible* < *responsible*, **truely* < *truly*, etc.),

providing evidence that levels of representation other than the obvious surface and graphic levels have some form of psychological reality. It is equally clear that subjects are capable of modifying rule environments to regularize exceptions (e.g. : **bothe* < *both* ; **comming* < *coming*, etc.) or reinforce rule application contexts because they feel the necessity of a strong cluster (e.g. **deffenitly* < *definitely* ; **immitate* < *imitate* ; **pollitics* < *politics*, etc.) or want to avoid intervocalic voicing (**dissallusions* < *disillusions*). The interplay between this more abstract level of operations and the surface phonetic/ graphic levels is well illustrated by the numerous errors found in unstressed position.

3. SPELLING REDUCED VOWELS

3.1. Statistical evidence

The errors grouped under the Change heading present a peculiar behaviour. Out of a total of 137 errors of that type, 98 are vowels (71.5%) and 39 consonants (28.5%). Table 1 below contrasts these figures with the relative frequency of vowels and consonants in the English language (cf. Dewey [8]) as well as with their relative frequency in the corpus. The data shows that vowels are vulnerable to changes to a degree almost double what is statistically predictable.

Table 1 : relative frequency of Vowels and Consonants in Changed corpus.

	Vowels	Consonants	total
number	98	39	137
% total	71.5	28.5	100
% Dewey	38.3	61.7	100
% corpus	40.5	59.5	100

Closer examination of the Changed corpus shows that a high proportion of the Changed vowels belong to *unstressed* syllables (80/98, i.e. 81.6%).

Table 2: relative frequency of Vowels and Reduced Vowels in Changed corpus.

tot. number	98
tot. reduced	80
% Vowels	81.6

On the contrary, the remaining 18 (primary or secondary stressed) vowels were found to be misspelled because a variety of heterogeneous reasons : choice of a plausible digraph (**geered* < *geared*; *weened* < *weaned*; *teenagers* < *teanagers*), greek-style etymological spelling (**styma* < *stigma*) ; non-phononological changes (**relaxition* < *relaxation*, **intellictual* < *intellectual*; **prohibation* < *prohibition*). Clearly, the only class that presents any kind of unity is the one hosting the unstressed, reduced vowels.

3.2. Phonological underspecification

One obvious explanation for this particular vulnerability of unstressed vowels would be that the phonetic cues as to their identity are erased in such an environment. With unspecified articulatory parameters (except for the fact that it is a vowel), schwa would be characterized by *zero articulation* [9]. Now, this situation can only arise in two cases : a) if information has been deleted between the Underlying Representation and the surface (with features such as [high], [low], [back] and [tense] losing their specification) ; or b) if the UR never contained such information. Since spellers have been seen to rely on deep forms when they contain phonological information (cf. § 2.4.), their higher than normal error rate in unstressed position may be an argument in favour of case b. This (cognitive) hypothesis is in accordance with the Underspecification Theory [10] [11] [12], which argues on other grounds in favour of (variable degrees of) underlying underspecification. If we are right in postulating some form of psychological reality to this concept, any increase in feature specification should result in improved spelling performance.

4. LEVELS OF PHONOLOGICAL SPECIFICATION

4.1. The role of alternations

The fact that phonologically informative derivations (e.g. *informal, informality* ; *negative, negate*, etc.) exist in a subject's lexicon should result in such an increase in specification level. This hypothesis was tested with the following experiment. In what was presented to them as a lexical recall task, American university students were asked to supply the missing word in each of 70 unrelated sentences. All 70 target-words were words whose unstressed vowels had been misspelled at least once in the corpus. The first 40 words (part A of the test) were chosen so that derivationally related words, if any, would shed no light as to the underlying form of their reduced vowel(s). The remaining 30 items (part B of the test) were selected for the opposite reason. In this part of the test, the subjects were asked to fill in the blank and write down any "word of the same family" that they could think of.

In part A of the test, the 30 subjects found 68.6 % of the target-words (a total of 823) and made 56 spelling errors in unstressed position. In part B, they found 74.9 % of the target-words (a total of 652), and made 27 errors of that type. The error ratio (weighted by the number of target-words found) was 6.80 % and 4.14 % for parts A and B, respectively, a difference which was found to be significant ($p < .025$).

4.2. Discussion

Though clear, the improvement in performance should not be exaggerated : the subjects involved in the experiment supplied only 60% of the expected related words ; they committed a few spelling errors in spite of their knowledge (and correct spelling) of alternations ; on a few occasions, they spelled the reduced vowel of the initial word correctly, and misspelled the corresponding stressed vowel of the derived word. All in all, however, they improved their performance by 39%, which means that derivational information does help specify underlying representations.

5. CONCLUSION

The degree of indeterminacy which remains does not truly reflect the spellers' actual performance, however. A computer program, designed to simulate the above-described situation [13], still came up with improbable (and unattested) errors, until additional factors were taken into account. Among them, the familiarity of certain affix forms and the strangeness of others was found to raise or lower the probablity of occurrence of a given vowel. Phonological rules themselves bar (or impose) certain underlying vowels, e.g. after velar stops (or their softened transforms), eliminating implausible spelling errors like **eligable* < *eligible* or **nicetine* < *nicotine*. Whether such factors increase the specification of the underlying forms or on the contrary contribute to "streamline" underlying representations remains a matter for theoretical discussion and, possibly, empirical study. In the first case, subjects would use already specified representations as the basis for spelling ; in the second, they would reconstruct underlying forms, spelling so to speak "by rule".

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