JEMEZ TONES AND STRESS*

ALAN BELL

1. INTRODUCTION. This is a first report on ongoing research on Jemez prosody. Jemez, known also as Towa, is an unwritten language spoken in one of the New Mexico pueblo communities about 50 miles north of Albuquerque. Phonological research on Jemez is still in its early stages. The segmental contrasts are known, and Laurel Watkins worked out the surface tone contrasts about two years ago, building on earlier unpublished work by Hale 1957 and Martin 1964. I would like to acknowledge the contributions of Laurel Watkins, with whom I've been working on Jemez. Without her knowledge of the lexicon and structure of Jemez, none of the work reported here could have been done. Thanks are also due to our Jemez consultants.

Part of the background of this report is the difficulty of doing phonetic research when you have limited knowledge of the lexicon, grammar, and of contextual effects of all kinds. Under these circumstances it is hard to find comparable items that bear crucially on phonetic questions. It is also very hard to assess how representative the results may be when your knowledge of the language is limited to the elicited words and sentences of a very few speakers. This data is from only one speaker; we do have some recorded data from two other speakers, which gives us assurance that this data isn't atypical. The data also likely represents a rather formal, maximally explicit style, since it is composed of elicited, and often reelicited, utterances. These caveats notwithstanding, one must start somewhere. The general strategy that I have followed is to focus on the situations and contexts where tones and stress are the clearest impressionistically.

2. PROSODIC ELEMENTS OF JEMEZ. Syllables in Jemez are open (except when the noun suffix *-sh* occurs before a consonant), with either a simple onset or no onset. Syllables are thus predominantly of the shapes CV, CVV, V, and VV. Monomorphemic words are almost all one, two, or three syllables long, with disyllables being by far most frequent lexically. The initial syllable of words plays a special role in Jemez prosody. Short and long vowels contrast, but only in the initial syllable, e.g. *kwą̄nį́* 'pine tree' vs. *kwį̄:nį́* 'wind'. (Nasal vowels are indicated throughout with a hook, and glottalized consonants with an apostrophe, *t', l'* etc.) Noninitial syllables have only the shapes CV or V. (There are no phonological diphthongs, although the labialized and palatalized consonants are realized with extensive vocalic onglides, and some of the vowels may be phonetically outglided.)

There are four contrastive surface tones: High, Falling, Mid, and Low. Initial syllables have either High or Falling tone. The Falling tone never occurs in subsequent syllables, and the High tone only occurs in a noninitial syllable if it is preceded by a High tone. Thus noninitial syllables have either a Mid or Low tone, except in the case where there is a sequence of High tones from the beginning of the word. These constraints are illustrated by the typical tone sequences in the following trisyllabic words.

(1)	*wá:gíshà*	'cow'	H H L
	gínąmų̀	'dove'	H M L
	mą́:shĭl'ŭ	'ball'	H L M
	t'æ:gìlè	'scarecrow'	H L L
	nọ:mų̀tæ	'shovel'	F L M

Finally, in addition to the privileged status of initial syllables with respect to vowel length and High and Falling tones, initial syllables are highly prominent impressionistically.

A few loanwords are exceptions to these restrictions, such as *gûfé* 'coffee' (L H), *gùwáyù* 'horse' (L F L), and *nàrą́:sà* 'orange' (L H L). In these words, it is the second syllable which is prominent, in which a long vowel may appear, and which takes either High or Falling tone. The first syllable always bears Low tone. It is clear that if the first syllable is taken as extraprosodic in these words, then their prosody falls together with the native words. Overall, the main constraint on pitch is that there is never more than one fall from a high pitch in a word.

3. REALIZATION OF JEMEZ TONES. Average pitch contours of the High and Falling tones are shown in Figure 1. High tone is similar to the Mandarin high tone, except that in Jemez it has a characteristic slight rise at the end. The drop of the Falling tone, which in other contexts extends from about the level of the High tone to the middle of the pitch range, i.e. much like the Mandarin falling tone, is greatly abbreviated in short monosyllables. No pitch data is presented here for the Falling tone in long syllables, since the extensive glottalization associated with the tone in a final long position makes routine pitch extraction impossible.

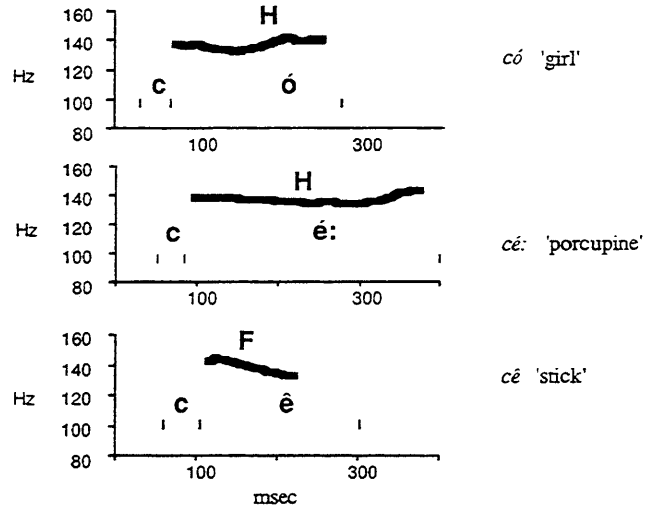

FIGURE 1. High and Falling tone in monosyllables.

Average pitch contours in disyllables are shown in Figure 2. The pitch contour for *gídá* illustrates a High tone in a noninitial syllable following an initial High. The pitch onset for this word is noticably lower than for the other disyllables; in general there seems to be a tendency for voiced consonants to lower the onsets of tones. Notice also the rising tendency of the High tones through the word. The remaining words show initial High and Falling tones followed by either Mid or Low tones.

Even though I cannot yet offer generalizations about the behavior of tones in phrasal and sentential contexts, some examples of average pitch contours of HH nouns in sentences are shown in Figure 3. In these sentences, *dô:* is a demonstrative whose Falling tone is apparently lowered in this context. The sentences end with the verb *mų́* 'see'. In the second sentence the verb is preceded by an agreement prefix with Low tone. Notice that while High tones are lowered after the Falling tone, they do not stay lowered, but recover to the top of pitch range by the end of the sentence.

4. A PROSODIC SKETCH OF JEMEZ. Some of the tonal regularities illustrated above can be captured by assigning either an underlying H or a HL melody to words, with the HL either entirely associated with the initial syllable of words with initial Falling tone or distributed over the first two syllables of other words. In addition, some noninitial syllables must be lexically specified as Mid, even though it is evident that very many Mid tones are derived. (The tonebearing units are syllables, since long vowels do not behave differently with respect to tonal assignment than short

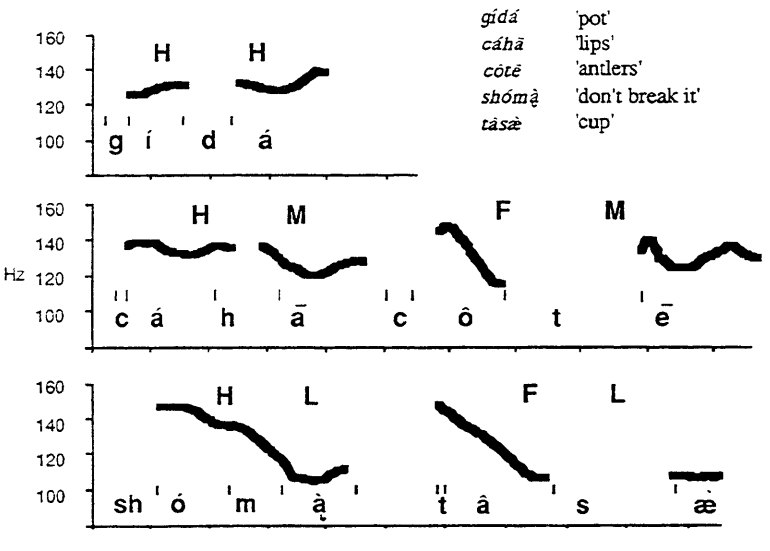

FIGURE 2. Tone sequences in disyllables.

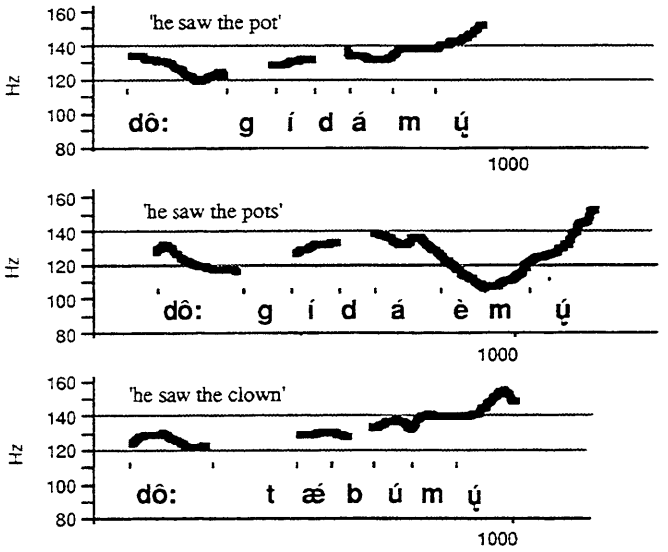

FIGURE 3. HH nouns in sentence context.

vowels.) Metrically, it is clear that the distribution of tones and vowel length establishes initial syllables as strong. But it is not obvious whether or not an independent feature of stress, in addition to tone and length, needs to be posited. This brings us to the main point that I want to examine here, the phonetic realization of initial prominence, since its nature is necessarily an important consideration in deciding whether Jemez initial syllables are stressed.

5. ARE INITIAL SYLLABLES STRESSED? Is the perceived initial prominence simply a consequence of the initial high pitch of the High or Falling tone? Or is there an independent gesture of stress that contributes to initial prominence? To attempt to answer this question, I examined differences in the duration,vowel quality, and pitch of initial and noninitial syllables.

6. DURATION. One gets the strong impression from listening to Jemez speech that noninitial syllables are much shorter than initial ones. This impression is confirmed by instrumental analysis. For our specific purposes, this is not much help. The difficulty is that the relative duration of initial and noninitial syllables is confounded by inherent tonal and segmental durations. By far most noninitial syllables have Low or Mid tones, whereas initial syllables are High or Falling. Since Low and Mid tones could have an intrinsically shorter duration than High and Falling tones (and in fact this seems quite likely, especially for Low tone), the observed duration differences could be a consequence of the tonal differences. The only way to avoid this problem is to compare syllables with High tones, since this is the only tone found on both initial and noninitial syllables. I therefore chose the three sequences of High syllables that are underlined in the following sentences:

(2) *dô: tíjá fǽlá fǫ̨tè* 'The fly chased the bear'
dô: gídá kwâtè 'He hung up the pot'
pǽpú cówá ùvûtè 'Older brother jumped up'

These sequences are all phrase-medial, to avoid phrase-initial and final durational effects that appear to be present, but which are not yet understood. There are certainly intrinsic segmental effects that are not controlled here, but the largest one that I am aware of, the much longer closure of unaspirated stops compared to voiced stops, is avoided, since the stops in these examples are either both voiced or both unaspirated. Since the higher (and hence presumably somewhat shorter) vowels are found in the initial syllables (*có* is phonetically [kju], and *pú* is [pɨ]), a finding of longer duration in initial syllables could not be attributed to vowel duration. The principal remaining concerns are the consonant place differences and the fricative-lateral difference, which are discussed below. The average durations of these three sequences, and the overall average durations, are presented in Figure 4. The differences between initial and noninitial syllables are 22 ms for *fǽlá* (n=9), 38 ms for *gídá* (n=11), 44 ms for *...pú có...* (n=5), and 38 ms overall. In this kind of preliminary study, consistency across items is more important than conventional measures of statistical significance. That these results have some validity is indicated by the fact that the initial syllable was longer than the noninitial syllable in all but one of the 25 pairs measured. It does not appear that the difference can be attributed to differences in intrinsic consonant durations. The *l* in the noninitial syllable of *fǽlá* was actually longer than the initial *f*, as was the labial *p* compared to the palatalized velar *c* in the third sequence. However, initial velar *g* of *gídá* was substantially longer than the *d* in the second syllable. Nevertheless, the vowel duration of the first syllable was longer than that of the second syllable, even though the high vowel *i* in the first syllable would be expected to have a shorter intrinsic duration than the low vowel *a* in the second syllable, so it is not likely that an intrinsic consonant difference can have been the sole cause of the observed syllable difference, although it may have contributed to it.

7. VOWEL QUALITY. Vowels in noninitial Jemez syllables are typically hard to identify and appear to be reduced in comparison with with those in initial syllables. As with duration, one must deal with the same tonal confounding. Ideally, one would want to compare initial and noninitial vowels with the same tone (i.e. High tone) in the same segmental environments. It was possible todo this for the vowel *i*, but for *e* and *a*, some compromises in comparability were required. And we did not have enough tokens of even approximately comparable syllables to compare initial and noninitial *o* and *æ*. (The sixth vowel *u*, which is roughly lowered high central, would not be

Colorado Research in Linguistics, Vol. 12 [1993]

https://scholar.colorado.edu/cril/vol12/iss1/2
DOI: https://doi.org/10.25810/vt8v-3v40

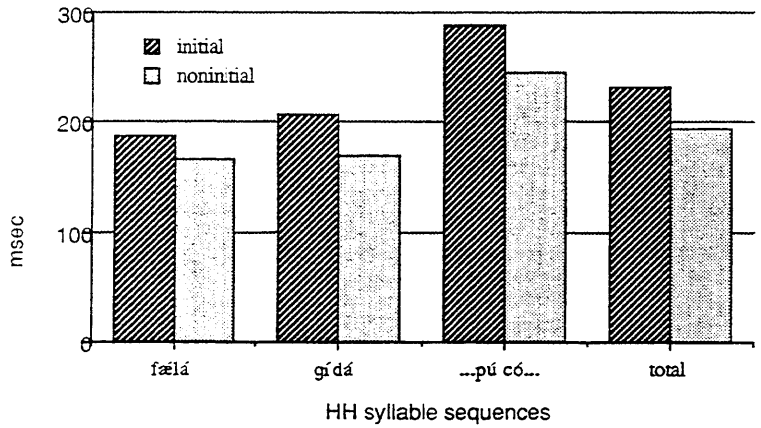

FIGURE 4. Initial vs. noninitial durations.

expected to show much if any reduction. An additional complication with *o* is that it is outglided in some contexts, and this characteristic needs to be better understood before an appropriate measure of reduction can be devised.) For *e*, I was obliged to compare noninitial *lé* with initial *t'é* and *dé*. Although these are all dentals, it is possible that the lateral adds a particular contextual effect, although we are not aware of any from our impressionistic observations. In our lexicon, initial High syllables with *a* are uncommon, and there is no instance of short *a* in an initial High syllable with a neutral segmental context. Consequently, I resorted to the use of High and Falling long *a* and Falling short *a* to estimate the vowel quality of initial *a*. Note that, although the High tone context is probably crucial for noninitial syllables, it is less likely to be a major factor in initial syllables. In particular, Falling syllables do not appear to be substantially longer than High syllables in most contexts. In addition, in two of the words, *a* is either preceded or followed by a labial, which undoubtedly affects the vowel quality of *a*. The effect is, however, apparently a good deal less than the effect of reduction, as we will shortly see. The complete list of words used to compare vowel quality in initial and noninitial syllables, with the number of tokens for each, is given in the Table 1. Where more than one number is given for a word, each number refers to a separate sentential context.

INITIAL SYLLABLES		NONINITIAL SYLLABLES	
gí(dá)	n = 9, 5, 5	*(wá:)gí(shà)*	n = 14
gí(nú)	n = 9	*(k'yæ:)kí*	n = 9
t'é(lé)	n = 9, 9	*(t'é)lé*	n = 5, 5
dé(l'ū)	n = 18	*(shó:)lé*	n = 9
tà(sà)	n = 9	*(gí)dá*	n = 9, 5, 5
k'á:(w'ē)	n = 5	*(tæ)lá)*	n = 9
vâ:(sū)	n = 9	*(kyó:)lá*	n = 9

TABLE 1. Words used to compare vowel quality. n is the number of tokens of each word.

The sets of nine or more tokens include some pronunciations of isolated words. In some instances, the vowel quality of isolated words differed slightly but consistently from that of words

pronounced in a sentence, but the differences were not large enough to be of consequence for present purposes.

Figure 5 shows the vowel quality of *í, ĺ, é* and *á* in initial and noninitial syllables. The plotted values are averages of token values obtained from LPC (linear predictive coding) analyses. For each token, an average LPC formant value over five to 10 4-msec frames was computed, with an analysis window of 16 msec used for each frame. Fewer than 10 frames were used only when it was necessary to avoid initial or final contextual effects. Overall, noninitial vowels are consistently more central than the corresponding initial vowels. The bold reduction arrows show the average extent of reduction for each vowel set. Thus, for instance, the arrows for the a tokens begin at the average vowel quality of *a* in *tàsæ̀*, *k'á:w'ē*, and *vâ:sū* and end at the average vowel quality of final *a* in the words ending in *lá* and *dá*. Note that initial *a* may be somewhat backed after *v*, and that *a* appears to be raised by following *w'ē*. There is virtually no overlap of the initial and noninitial tokens. The individual token values are plotted in the figures in the Appendix.

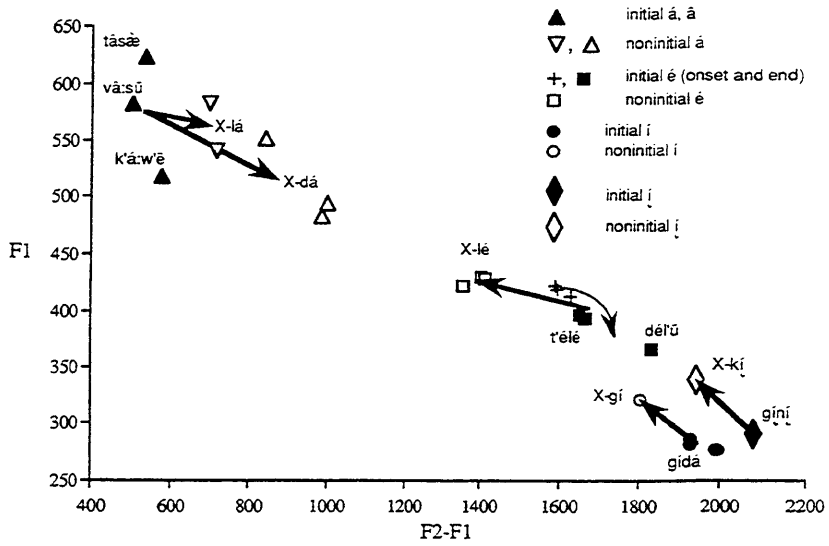

FIGURE 5. Initial and noninitial Jemez vowel quality. The curved arrow indicates the average diphthongal movement for initial *é*. The bold arrows indicate the average reduction of noninitial vowels with respect to the corresponding initial vowels.

8. PITCH. We do not know enough about the contextual effects on tones yet to be able to make meaningful quantitative comparisons. From the examination of a number of sentence examples, I offer the following observations. When sentences end with a High tone, as for example with the verb *mų́* 'saw', there seems to be a general tendency for the Highs in the sentence to be realized on successively higher pitches; see the examples in Figure 3. In such sentences, HH nouns usually have a higher pitch on the second syllable than one the first one; in a few cases the second syllable may still have a lower pitch. When, however, the sentence ends with a Falling tone or a HL or HM sequence, there does not appear to be any global updrift (nor downdrift, either). In all the instances of such sentences that I have observed, the vowel of the second syllable of noninitial HH nouns has a pitch that is slightly lower than the first syllable, and also lower than the following word-initial H or F. (The only sentence initial HH noun in the sentences that I examined

is *pæpú* 'older brother'; the pitch of the first syllable appears to be lower than that of the second one, even when there is no global updrift. This may be an initial edge effect.)

9. SEQUENCES OF INITIAL SYLLABLES. There are two situations in Jemez in which initial syllables lose their prominence. Both are appropriately treated as destressing. the first situation concerns N+N compound nouns and N+V incorporated verbs. In these constructions the initial syllable of the second noun or verb loses its prominence. The H of the initial High or Falling tone is deleted, leaving L or M. Vowel length, if present, is lost.

(3)	*gù'fé*	'coffee'
	'gídá	'pot'
	gù'fégìdà	'coffeepot'

(The few exceptions where H or length is retained, e.g. *sé:k'yā:t'ā* 'eagle feather', from *sé:* 'eagle' and *k'yā:t'ā* 'feather', and *k'yæ:kɻ́* 'lamb', from *k'yæ:* 'sheep' and *-kɻ́* 'relationship term', perhaps related to *kɻ́* 'child', are presumably frozen forms.) While this destressing in compounds is clearly part of lexical phonology, and thus does not bear directly on the realization of prominence, the second situation is clearly part of prosodic, postlexical phonology. In many instances where a monosyllabic noun occurs before another noun, it loses its prominence, but its tone and length are not affected. Thus, in the sentence *dó: có 'cé mɻ́* 'That girl saw the stick', *có* is nonprominent and somewhat reduced. As one would expect, this loss of prominence appears to depend on the speech tempo. The full circumstances under which one of two or more consecutive stressed syllables loses its stress or is reduced in prominence are yet to be discovered. Monosyllabic nouns do not appear to lose their stress before verbs; e.g., *pɻ́* in *'pæpú 'pɻ́: 'shápè* 'older brother shot the deer' retains its full stress. The point that is most important here is that this sort of destressing, when it occurs, provides examples of nonprominent H syllables, and makes any argument that prominence is a property of (perhaps some) H or M tones more difficult to support.

10. INITIAL SYLLABLES ARE STRESSED. Initial syllables of words (including compounds) are metrically strong, since they are the only syllables which require a H tone (either alone or as part of a HL Falling tone), and which permit long vowels. The longer duration, more peripheral vowel quality, and slightly higher pitch of initial High toned syllables compared to noninitial High syllables, to the extent that these preliminary results are not unrepresentative, point to the extra effort of a stress gesture as at least part of the source of the perceived prominence of initial syllables. I conclude from all this that stress is part of the prosody of Jemez, and that initial prominence is not a derivative property of the H and F tones. Adopting this point of view should be helpful in the further study of Jemez prosody.

NOTE

* This is a revised and expanded version of a paper presented to the Acoustical Society of America, May 13, 1992, Salt Lake City.

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APPENDIX

The following Figures show the vowel quality of the individual tokens used to obtain the averages that are presented in Figure 5.

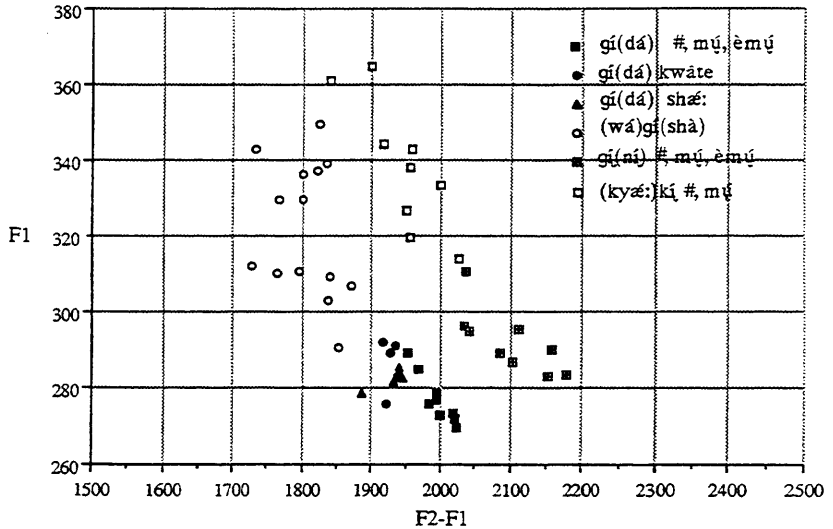

Figure 6. Initial and noninitial *í, ɻ́*.

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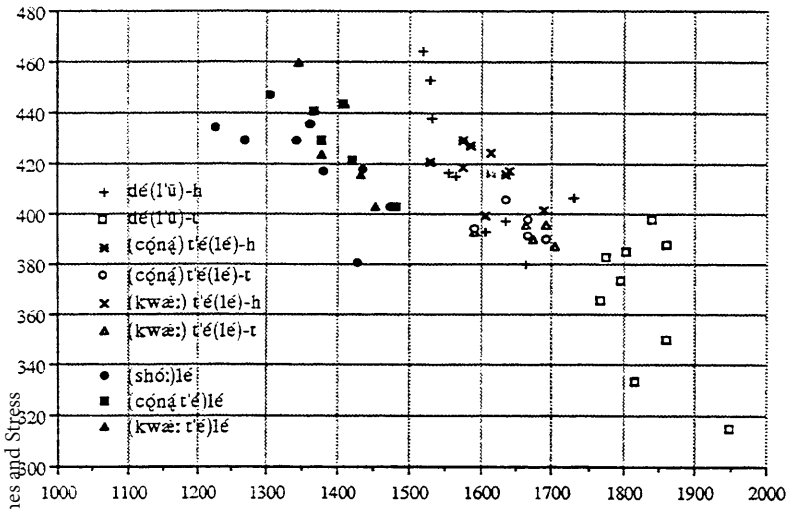

Figure 7. Initial and noninitial *é*.

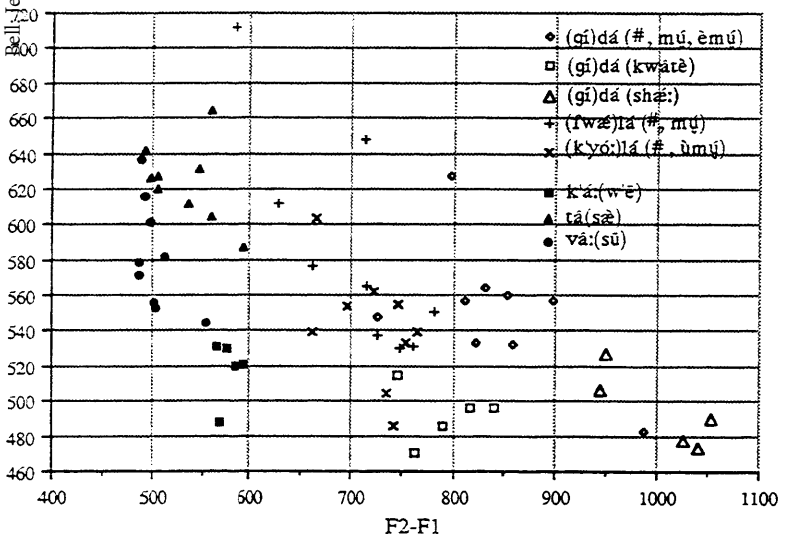

Figure 8. Initial *á, á* and noninitial *á*.

LETTER DETECTION IN GERMAN SILENT READING: SOME LINGUISTIC ISSUES*

CAROLYN BUCK-GENGLER

In a German variant of a letter-detection experiment, native speakers of German read passages in German, searching for the letter *d*, *t*, *n*, or *r* in four passages. Many more instances of the letter *d* in definite articles and in the word *und* were missed than were missed in nouns, verbs, and adjectives. Subjects also missed more syllable-final instances of the letter *d* than syllable-initial *d* or syllable-final *t*. Cluster status and word location of the letter did not affect the results for final *d*. The first finding supports earlier similar findings by Healy (e.g. 1976) for English, and Ferstl 1991 for German, with respect to high frequency words in the language being read in units larger than the letter. The second finding is understood in terms of the German phenomenon of neutralizing the difference in pronunciation between *d* and *t* in syllable-final position. Other preliminary analyses of various linguistic phenomenon were more inconclusive, and point out areas for further research.

1. INTRODUCTION. Lexical access in silent reading has been studied in various ways for many years. One major issue is whether it is mediated by an internal phonological representation or by only the visual representation, or, if indeed both methods are used in a 'dual access' model. In their 1981 review of the reading research to that point, McCusker, Hillinger, & Bias note that along the continuum of necessity for phonological recoding--with it playing no part in reading at the one extreme, and it being absolutely necessary at the other--evidence of varying strengths has been found for every position. Thus they conclude that there is likely a parallel operation of phonological recoding and visual access for most readers. The next question is what factors come into play in determining which route is used for a given word.

One particular paradigm for studying this is the letter detection task, in which a subject reads a passage at normal reading speed, marking every recognized instance of a particular target letter. With this task, psychologists have over the course of many experiments attempted to isolate various factors that influence the choice.

An early letter detection task study was done by Corcoran 1966 in which the letter *e* was missed more often when it was silent in the pronounced word than when it was a pronounced phoneme of the word. Several possible explanations were put forth, including position of the letter in the word, word frequency, inflectional/derivational morpheme versus stem status, and function versus content word status of the test word. This led to several studies by Healy and colleagues (Healy 1976; Drewnowski & Healy 1977; Healy & Drewnowski 1983; Healy, Oliver, & McNamara 1987; Hadley & Healy 1991) which resulted in the formulation of the unitization hypothesis: words with high frequency in the language are more often perceived as a 'unit or chunk rather than in terms of [their] component letters' (Healy 1976:235); thus letters are less likely to be detected in those words than in words occurring less frequently in the language. Some of the experiments in Healy's original study (1976) found that *t* in *the*, one of the most frequent words in English, was missed more often than *t* in other, less frequent, words, especially content words such as nouns. Furthermore, *t* in *the* was missed more often than *t* in *thy*, showing that it was not due only to the different pronunciation of the digraph *th*. In addition, *t* in a frequent word such as *fact* was missed more often than in a rarer word such as *pact*, again showing frequency effects, as well as controlling for word location and showing the effect to occur word-finally as well as word-initially.

Thus one type of unit in facilitating lexical access is the word, but there could well be units within the word, such as the syllable, the stem or root, and even common orthographic combinations such as consonant clusters. It is also possible that there are combinations of words that occur so frequently together that they can be recognized more quickly as a unit, for instance PREPOSITION+ARTICLE in a prepositional phrase. Healy, Conboy, & Drewnowski 1987