

Computer-Aided Comparative Study of Stress in Modern Standard Arabic

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Abstract

This article provides a comprehensive study of the lexical stress for the Arabic language. The study presents the stress rules developed by four linguists who investigated the Arabic stress.

Unlike the English language, the stress in Arabic is mainly indicated by the voice intensity, with the voice pitch and segment duration playing a negligible role on the lexical level. However, the pitch and segment duration can be treated as elements of Arabic speech prosody and this is beyond the scope of this article.

The study measures voice intensity of some example words to validate the stress rules or to show any discrepancies in the results. The measurements were carried out by a personal computer system which has a special speech processing board. The functions of the system are to capture the speech, calculate some speech suprasegmental parameters such as the voice intensity and to give a graphical representation of the speech parameters.

1 — Introduction

The speaker is always in control of the stress of his words according to the information he is trying to convey. So he produces his words or syllables by pushing more or less air out of his lungs.

Stress in Arabic has been neglected by ancient grammarians, because it depends on the speech more than the written language. (Al-Khalifa 1984).

Recent linguists, such as Anis (1961), Hassan (1973) and Al-Ani (1970) investigated the stress in Modern Standard Arabic (MSA) and tried to set some rules for it.

The above three linguists' work was discussed by Abdu (1979) who believed stress rules in Arabic have to be rewritten.

The speech parameters such as loudness, duration or rhythm and pitch can have segmental (small units of speech such as phonemes, parts of syllables or complete syllables) and suprasegmental (utterances or sentences) role. Some of the speech parameters are inclined to behave as indicators for segmental features and others for suprasegmental features of speech. For example, speech loudness or voice intensity is classified as a very weak prosodic feature but it has an important segmental role to play in distinguishing vowels from consonants or stressed syllables from unstressed ones.

Although pitch and rhythm are very strong speech prosody indicators; on the utterance level, they can identify points of major intonational changes, such as pitch rise and fall can convey significant information which is important for producing natural speech.

Our concern in this article is to study the stress on the word level which is primarily showed by the accented and the non-accented syllables. A stress syllable in a word can be showed by the duration of its nucleus vowel and (most important) by the amount of air pushed out of the lungs during its production (Ladefoged 1975: 104) This shows that the most important speech parameters to be used as indicators for stress on the lexical level are intensity and the durations of syllables nuclei within stressed syllables.

The English language stress is different from Arabic. First, on the lexical level a shift of the stressed syllable can change the meaning of an English word and secondly for English all the speech parameters (voice intensity, segment duration and pitch) can play a significant role in determining the stress. The latter point might also be true for Arabic however, because of the current lack of research on this subject we could not include these parameters in this study. Therefore, the orientation of the paper is primarily descriptive and not theoretical in its approach.

In the present study we have conducted comparative study of the stress in MSA, taking into account all the rules which were developed by the above linguists.

We have attempted to quantify our results by some measurements taken on speech energy. In carrying these measurements, we have used a personal computer which has a special speech board. The personal computer is capable of acquiring speech data and doing some real-time analysis on the speech signal such as computation of the signal energy and pitch (Denoix 1984 and El-Imam 1987).

2 - The Structure of the Arabic Syllables

Usually, there is a very strong relationship between the stress and the syllables. In MSA there are six types of syllables, (Mitchell 1952):

- A short syllable which consists of a consonant and a short vowel /CV/ for example, the first syllable of the word //ku/tub// 'books' (see table 1 for the phonetic symbols which are used in this article) is a short syllable of type CV;
- A medium syllable that consists of a short consonant, a short vowel and a short consonant /CVC/. For example, the word //kun/tum// 'you have been' begins and ends with such a syllable;
- A medium syllable that consists of a consonant and a long vowel /CV:/ (after a vowel indicates that it is a long vowel). For example, the word //ca:na// 'he has been' begins with such a syllable;
- A long syllable that consists of a consonant, a long vowel and a closing long consonant /CV:C/. For example, the word //ba:b// is made of such a syllable;
- A long syllable which is composed of a consonant, a short vowel and consonant cluster at the end /CVCC/. For example, the word //kunt// is made of such a syllable. This syllable type does not occur in either classical or modern standard Arabic, except at the end of a word such as //ka/tabt// 'I wrote' or in isolation in monosyllabic words such as //nahr// 'river'; and
- the functional long syllable CV:CC that has a phonetic but no phonemic role. For example, the word //dza:dd// 'keen' is made of such syllable.

3 - Word-Level Stress

On the word level, the stress in Arabic is fixed; i.e., for the same word the stressed syllable is always the same. This is contrary to the English language where for the same word the stress can fall on different syllables depending on the context of the word.

For instance there are two frequent rules in Arabic word stress:

- the stress always falls on the first syllable, if the syllables of the word have the same length and,

- the longest syllable always takes the primary stress.

4 - Sentence-Level Stress

When words combine to form phrases and sentences, some words lose their stress. For example, the words //bint// 'girl' and //sa:/rah// 'a girls name' both have stress on the first syllable (the symbol indicates a primary stress). However when they combine to form the phrase //sa:/rah/ bint// 'Sarah is a girl'; one of the words loses its primary stress depending on what information the speaker wishes to convey. In the above example the speaker may either wish to emphasize the name 'Sarah' or the fact that 'Sarah' is a girl.

5 - Review of the Arabic Stress Rules

In this section we review the stress rules as introduced by four Arab linguists. Namely Tamam Hassan, Ibrahim Anis, Salman Al-Ani and Daud Abdu. When presenting Hassan, Anis's and Abdu's rules we use the same syllable classifications which they have used, i.e., short medium and long as explained in section two.

Al-Ani has used a slightly different classification than the other two. According to him, syllables can be classified as either short or long and either closed or open. Syllable type CV is a short syllable while all others are long. A closed syllable ends with a consonant while an open syllable ends with a vowel.

5.1 - Hassan's Rules

Hassan (1973), presented four rules for stress in Arabic as here;

1. The last syllable in a word is stressed if it is a long syllable. e.g., the last syllable of the word //ʔis/ta/qa:/a// 'he resigned' is a long syllable of type /CVC/ and therefore it receives the stress;
2. The stress falls on the syllable before the last in the following cases;
 - 2.1 - When the syllable before the last is a medium and the last syllable is either a short or medium syllable. For example, the word //ʔax/radz/tu// 'to bring out' has the stress on the syllable/radz/ because it is medium and the last syllable /tu/ is short. The word //Eal/lam// 'taught somebody' has the stress on the syllable /Eal/ because it is word initial and of equal length to the word final syllable.
 - 2.2 - When the syllable before the last is short and word initial; the first syllable receives the primary stress. For example the word //kà /tab// 'he wrote' has the stress on the syllable /kà/.
 - 2.3 - When the syllable before the last is short and preceded by a syllable that contains one consonant that is connected to the previous vowel by a 'Hamzat Wasal'. For example the word //fan/Zù/ru// 'to see' has the

stress on the syllable /Zù/. Another example is the word //Eal/là/ma//, has the stress on the syllable /la/.

2.4 - When the syllable before the last is medium and joined to a previous long syllable by a gemination sign. For example the word //ʔa/tu/Ha:dz/dzù:/ni// 'you argue with me' has the stress on the syllable /dzù:/ because it satisfies this condition.

3. The stress falls on the third syllable from the last when:

3.1 - That syllable is a short syllable followed by two other short syllables. For example, the word //kà/ta/ba// 'he wrote' has the type CV syllable /kà/ as the stressed syllable.

3.2 - That syllable is a short syllable and followed by two short and a medium syllable. For example, the word //kù/tu/bi/him// 'their books' has the short syllable /kù/ as the stressed syllable.

3.3 - That syllable is a medium syllable and followed by two short syllables, e.g., the word //baǵ/tu/ka// 'your home' has the medium syllable /baǵ/ which is of type CVC as the stressed syllable.

3.4 - That syllable is a medium followed by a short and another medium syllable. For example, the word //baǵ/tu/hum// 'their house' has the medium syllable of type CVC /baǵ/ as the stressed syllable.

4. The stress falls on the fourth syllable from the end of the word if the last syllable of the word is a medium syllable and the fourth syllable from the end is short and between two short syllables. For example, the word //bà/qa/ra/tun// 'a cow' has the short syllable /bà/ which is of type CV as the stressed syllable.

5.2 - Anis's Rules

Anis (1961) developed four stressed rules which are described here;

1. The last syllable of a word is stressed when it is a long syllable. For example, the last syllable /Ei:n/ in the word //nas/ta/Ei:n// 'we get help from' is the stressed syllable;
 2. The syllable before the last in a word is stressed when the last syllable is not long and the syllable that precedes it is a medium syllable. For example, the syllable /tà/ in the word //qa:/tà/la// will be stressed;
 3. The third syllable from the end of the word will be stressed if it is not a short syllable which is preceded by another short syllable. For example the word //kà/ta/ba// 'he wrote' has the stress on the syllable /kà/ as it occurs third from the end of the word and is not preceded by a short syllable;
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4. Stress falls on the fourth syllable from the end of the word when the last syllable is not long and is preceded by three short syllables. For example, //hà/ra/ka/tun// 'movement or gesture' has the stress on the syllable /hà/ as it satisfies this condition.

5.3 - Al - Ani's Rules

According to Al-Ani, there are three degrees of stress, i.e., primary, secondary and weak. For every poly-syllabic lexical item there is a syllable that receives the primary stress, other syllables in the lexical item are secondary and weak stresses. Al-Ani (1970), developed three stress rules as described here:

1. When a word is made of a string of CV short syllables, the first syllable receives the primary stress. For example in the word //kà/ta/ba//, the first syllable //kà/ receives the primary stress while the syllables /ta/ and /ba/ receive secondary and weak stresses respectively;
2. When a word contains only one long syllable, the primary stress falls on that syllable. For example, in the word //mu/Eàl/li/ma/hu// 'his teacher' has the stress on the long syllable /Eàl/;
3. When a word contains two long syllables or more, the long syllable nearest to the end of the word receives the primary stress and in most cases the one closest to the beginning receives the secondary stress. For example, in the word //ra/?i:/su/hùn/na// 'their chief' the primary stress falls on the syllable /hùn/.

5.4 - Abdu's Formulation Of Stress Rules

The work of the above three linguists, has been revised by Abdu (1979). Abdu summarized the rules of Arabic stress in three rules which are described below;

1. The stress falls on the last or ultimate syllable of the word if, it is long, i.e, type CV:C or CVCC. For example the word //ka/tàbt// 'I wrote' has stress on its last and long syllable /tàbt/;
2. The stress falls on the syllable before the last or the penultimate syllable if the ultimate syllable is not long and the penultimate is a long or medium syllable. For example the word //ka/tàb/tum// has stress on its medium syllable /tàb/;
3. The stress falls on the first syllable or antepenultimate syllable of the word if the word is made of short syllables or if the last syllable is not long and all other syllables of the word are short. An example of the former case is the word //kà/ta/ba// 'he wrote' which is made of short syllables and therefore has stress on its first syllable. An example of the latter case is the word //Ei/na/bun// 'grapes' which has a medium last syllable and two short syllables, here the stress falls on the first syllable /Ei/.

6 - Computer Results

In measuring Arabic stress, the example words used by each of the three researchers were entered in the computer and the mean square energy or signal intensity for each word is calculated and plotted as function of time. The words have been spoken by a Kuwaiti male, age 28 who spoke MSA with no noticeable dialect.

The energy curves clearly indicated the stressed syllables.

The measurements showed that the stress rules of Hassan are similar to our results except rules 2.3 and 3.2. In the word //fan/Zî/ru//, the syllable /fan/ and not /Zî/ receives the stress as indicated by figure 1. In the word //ku/tu/bi/him//, the syllable /ku/ receives the stress and not the syllable /tu/ as indicated by figure 2.

Rule 2 of Anis needs modification. For example in the word //qà:/ta/la// it is the syllable /qà:/ that receives the stress and not the syllable /ta/ as indicated by figure 3. Anis did not account for the effects of gemination on the stress patterns as Hassan has done.

Al-Ani's formulation of stress rules is similar to ours except his definition of short and long syllables. His stress rules 2 and 3 need modification. According to Al-Ani rule 2, the word //mu/wàd/di/Ea/hu// should have primary stress on its only long syllable /wàd/; in fact the stressed syllable of this word is the short syllable /di/ and this is because of the effects of gemination. This is illustrated by figure 4. In the word //ra/?i:/su/hun/na//, the stress falls on the long syllable /?i:/ and not the syllable /hun/ as shown by figure 5. This is because Al-Ani treated syllables of type CV: and CVC as long syllables of equal weight. In our present finding we treat a syllable of type CV: as a long syllable and a CVC syllable as a medium syllable.

7 - Discussion of the Results and Authors Views on Arabic Stress

Guided by the work of the three linguists and the discrepancies in their findings that show because the measurements on the speech energy, we have attempted to re-formulate the lexical stress rules of the Arabic language. This re-formulation is supported by energy measurements carried out on example words.

In this re-formulation, we have used the same syllabic classification as used in section 2 except that a syllable of type /CV:/ is treated as a long syllable. The change to the classification is prompted by the stress patterns which we were able to measure. Also the effects of gemination were introduced as was first stated by Hassan.

The new formulation of the Arabic stress rules is as follows;

1. When a word ends with a long syllable (CV:, CV:C or CVCC), that syllable receives the stress. This is in line with the findings of the other scholars except a syllable of type CV: is now treated as a long syllable. This is shown by the stress patterns of the word //mun/ti/dzà:// shown in figure 6. The stress is on the syllable /dzà:/;

2. When the last syllable is not long, it is discarded as far as stress assignment is concerned, the rest of the syllables are treated according to the following rules;

2.1 - If all are of type CV then the stress falls on the first of them. This is in line with the findings of all the others.

- 2.2 - If the word is composed of syllables of mixed type without gemination or if the gemination falls at the end of the word, then the stress falls on the syllable which is nearest to the end of the word. For example, the syllable /ʔi:/ of the word //ra/ʔi:/su/hun/na/. The stress is on /ʔi:/ and not /hun/ as was shown by figure 5. In analyzing this word, we looked on the last syllable /na/ which is not long, therefore it is discarded and this way we eliminated the gemination. The rest of the word has a medium syllable of type CVC and a long syllable of type CV:. The CV: syllable will receive the stress. Another example of this rule can be seen by considering the word //sam/Ea/hun/na//; the stress falls on the syllable /hun/ and not the syllable /sam/. This is because after eliminating the last short syllable /na/; the rest of the word has two medium syllables, the syllable /hun/ which is nearest to the end and the syllable /sam/ which is at the beginning. Since the syllables are of equal length, the one nearest to the end will receive the stress.

- 2.3 - If the word contains syllables of mixed type with one or more geminations, then the stress will fall on the first open syllable after the gemination which is nearest to the end of the word. For example, in the word //mu/wad/di/Ea/hu// the stress is on the first open syllable after the gemination /di/ and not on the medium syllable /wad/ as was shown by figure 4.

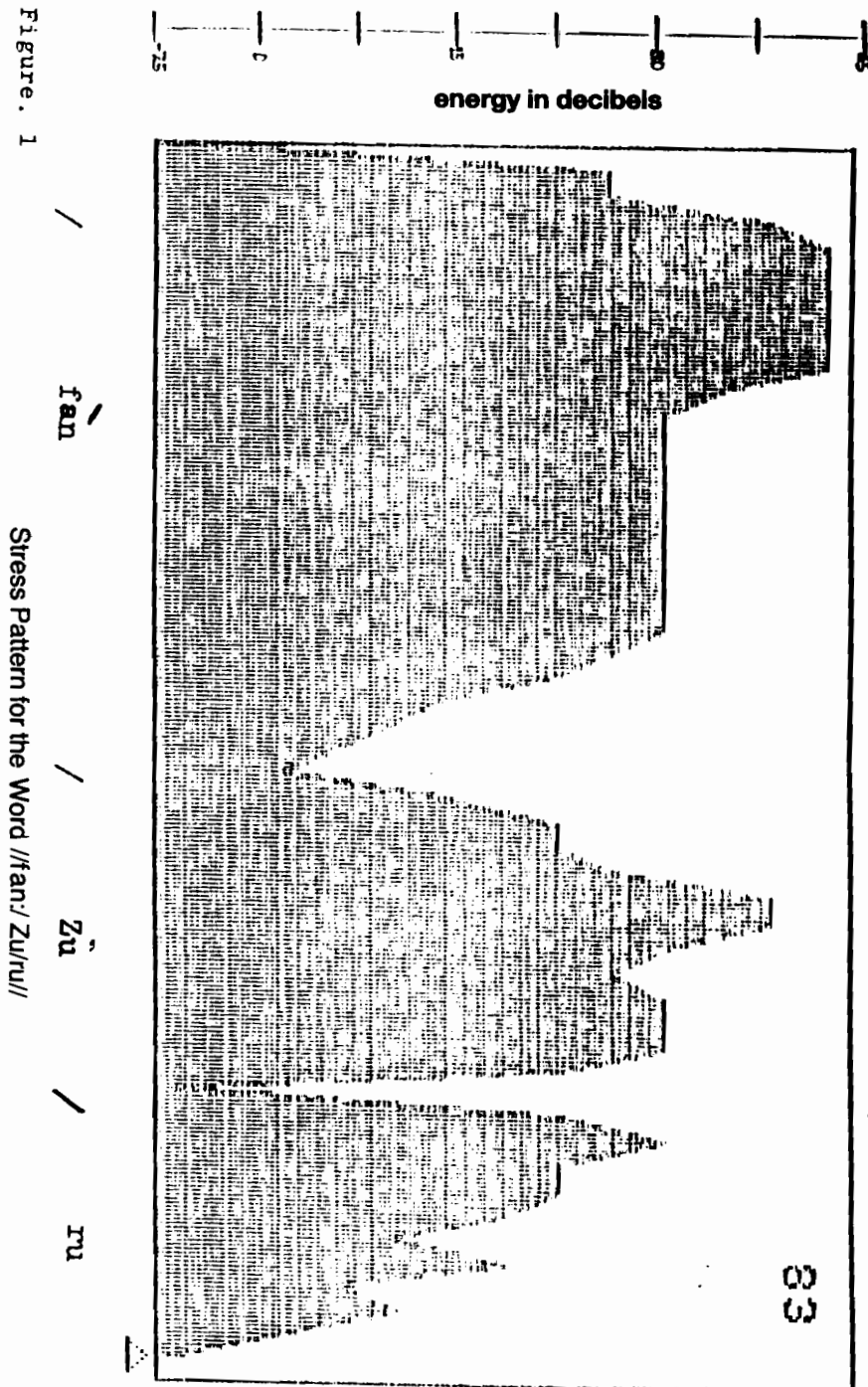
8 - Conclusions

The Arabic stress rules of four linguists have been revised with the help of computerized measurements on the voice intensity. The revision has shown that the stated rules need some modifications which we have attempted to do in this research. However, any differences seen in the stress patterns of MSA can also be due to the different dialects of the speakers.

The present study showed that gemination affects the word stress assignment and that a syllable of type CV: is regarded as a long syllable as far as the Arabic stress is concerned. The effect of gemination on stress was introduced by Hassan whose results were discussed above.

As far as stress rules are concerned, gemination and consonant clusters within the Arabic phonological system operate on the same principle.

Guided by the results of the comprehensive voice intensity measurements, we were able to re-formulate the Arabic stress rules.



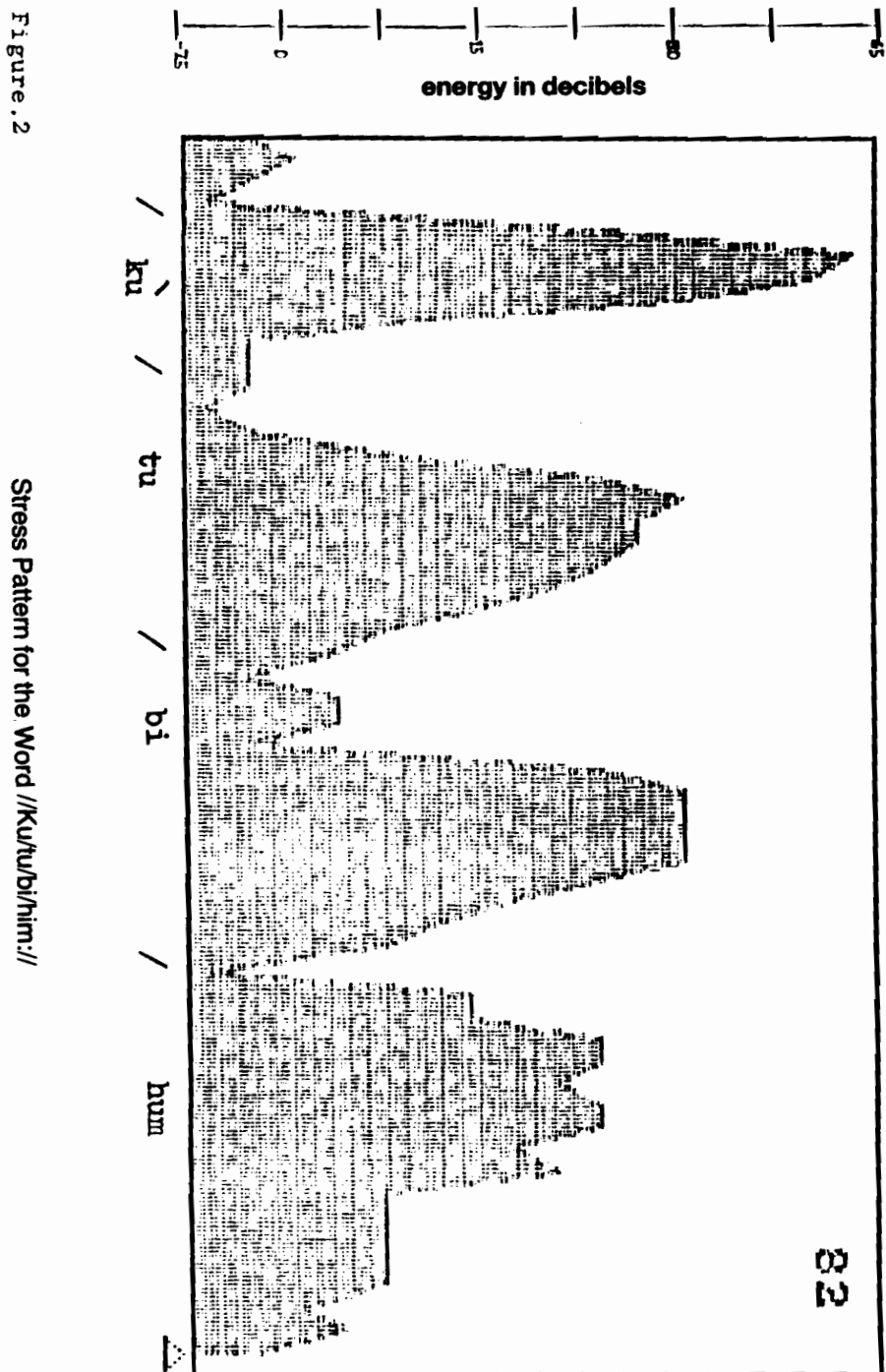


Figure. 2

Stress Pattern for the Word //Ku/tu/bi/him://

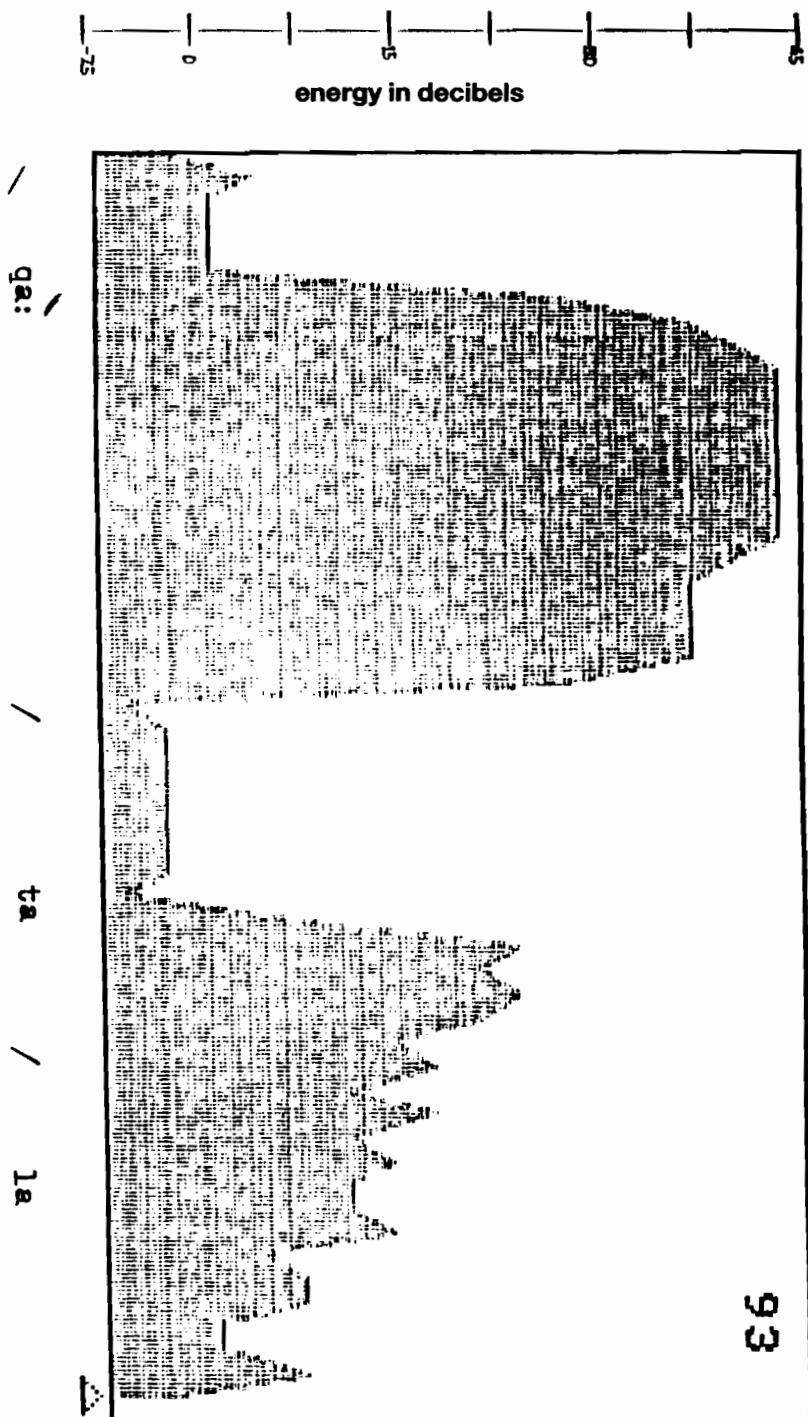
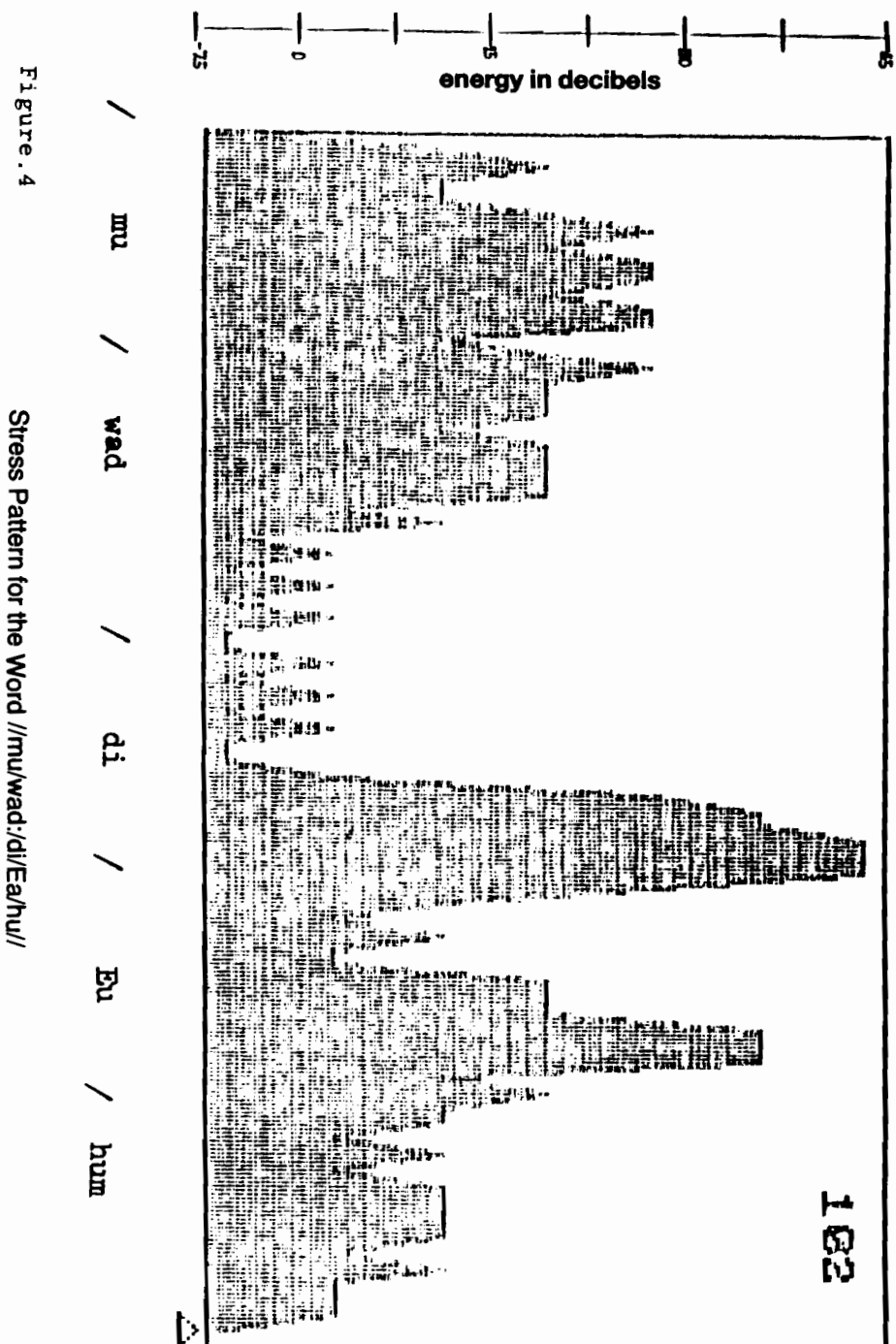


Figure.3

Stress Pattern for the Word//qa:/ta/la//



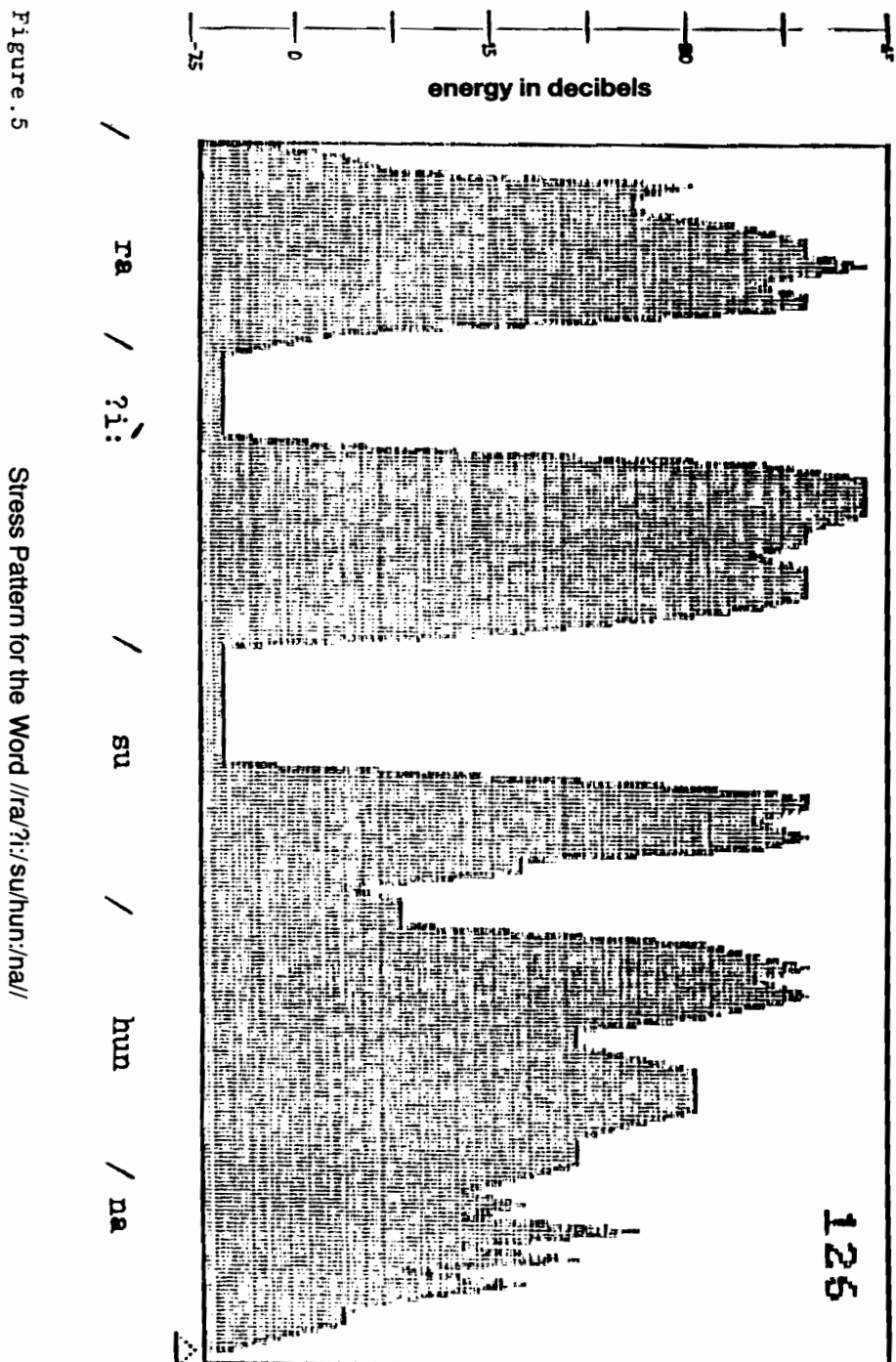
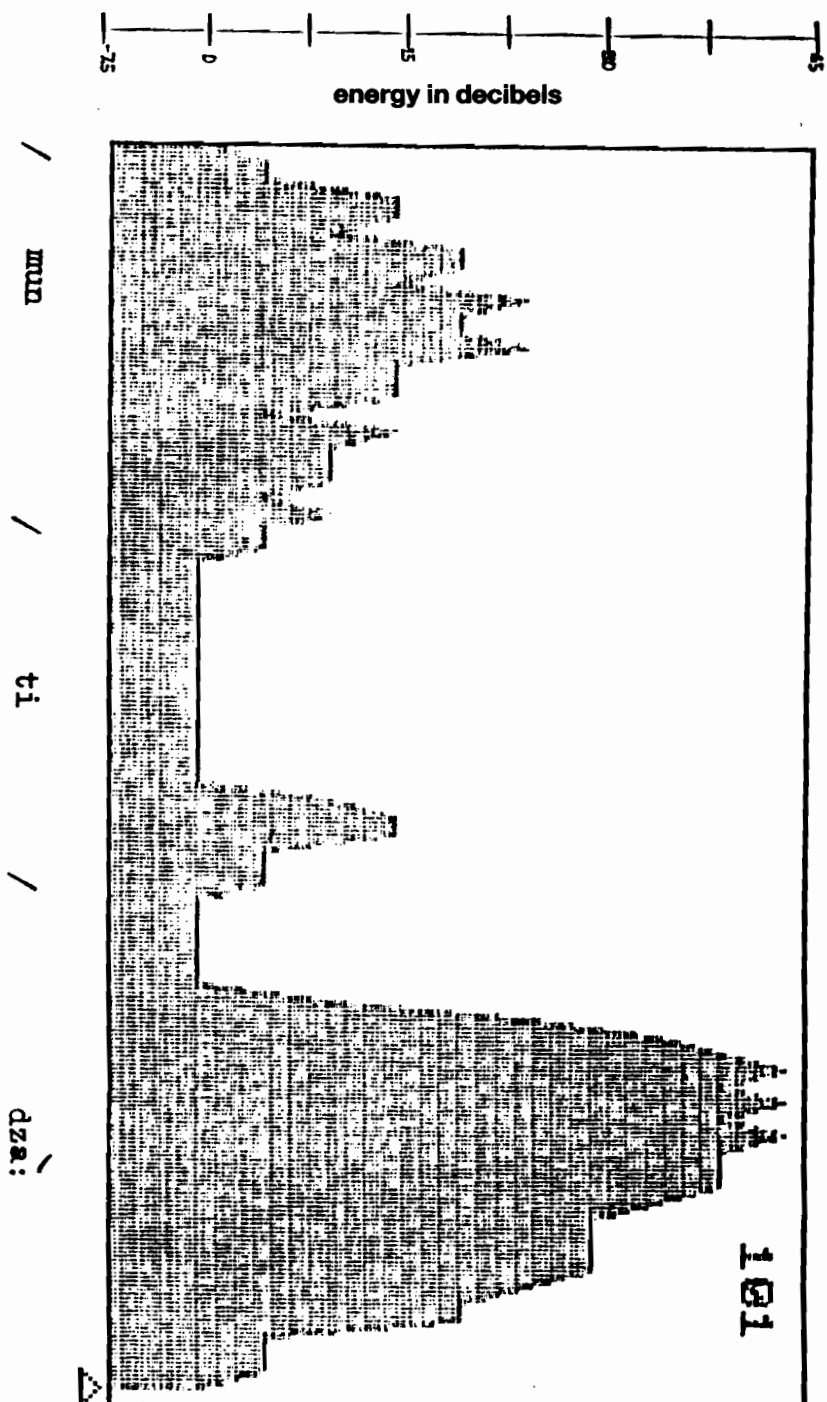


Figure.5

Stress Pattern for the Word //ra/ɪ:/su/hʌn/nə//

Figure .6



Stress Pattern for the Word //mun:ti/dza://

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