

A Phonetic Study of Stress in Korean

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- **Goal:** to find out if there is stress in Korean and if so, what is the domain and location of stress?

- examine prosodic features (f₀, duration, amplitude) of a word in isolation and in phrase (Accentual Phrase, see below for its definition) initial and medial position.
- examine both production and perception data.

Assumption: since Korean has Accentual phrase (AP) initial lengthening (Jun 1995) and the tonal pattern of AP is LHLH or HHLH, the perception of stress may be due to the phrasal prominence triggered by phrasal H-tone (phrase initial or final syllable) and phrase initial lengthening.

cf. French also has a phrasal stress which is realized on the last full vowel of an Accentual Phrase (Jun and Fougeron 1995, same level as Rhythmic Unit (Hirst & Di Cristo 1984, Di Cristo & Hirst '93) or Intonation Group (Mertens '90, 93))

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Experiment 1 (Production)

Method

- 3 Seoul speakers (two female and one male)
- 16 words of reiterated syllable /ma/ & /ta/
 - 2 to 5 syll; light (CV) or heavy (CVC) initial 2 syllables
 - in isolation and sentence initial & medial position
 - sentences in 3 levels of force: soft, normal and loud

examples: sentence initial & medial position

[mamama mariri manna] 'Mamama meets Mari.'

[mamamama mariri manna] 'Mamamama meets Mari.'

[mamamama mariri manna] 'Mamamama meets Mari.'

[mamamama mariri manna] 'Mamamama meets Mari.'

[ɔɔjaga mamama manna] 'Younga meets Mamama.'

[ɔɔjaga mamamama manna] 'Younga meets Mamama.'

[ɔɔjaga mamamama manna] 'Younga meets Mamamama.'

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Introduction

- Acoustic property of stress has been controversial. But in general, all or some of f₀, duration and intensity integral have been known to be the primary phonetic realizations. (Fry 1959, 1960; Lea; Beckman 1988)
- Stress in Korean (Seoul) has been controversial.
 - the 1st syll. of a word is stressed if it is heavy, otherwise, 2nd syll. (H.B. Lee 1973, 1993)
 - the final syll. of a word (Polivanov, 1936 (in H.Y. Lee 1990)
 - the 1st or 2nd syll. of a morpheme (H.Y. Lee 1990)
 - the 2nd syll. of a phrase (Huh 1985)
 - not stressed, but pitch accented (S.B. Cho 1967)

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Accentual Phrase (AP) of Seoul Korean (Jun 1993)

- AP is a tonally defined prosodic unit. It is larger than a word and smaller than an Intonational phrase (IP).
- The tonal pattern is either LHLH or HHLH depending on the phrase initial segment.
- Each tone is associated with a certain syllable of an AP.
 - initial tone (H or L) ==> the first syll of AP
 - the second tone (H) ==> the second syll of AP
 - the third tone (L) ==> the penult of AP
 - the final tone (H) ==> the final syll of AP.
- The AP final tone (H) is pre-empted by the IP final boundary tone if they are realized on the same syllable (i.e. when the AP is the last AP in an IP). Thus, a word in isolation (citation form) does not end in a H-tone since it forms 'one AP/one IP' with a declarative boundary tone.

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- 3 words of reiterated syllable /na/ (2 to 4 syll; all light) in 16 minimal paired sentences: the target word in Accentual Phrase (Jun 1993) -initial and -medial position

example sentences (AP is in { }; focused word in bold):

{uri} {nanado} {mariri}{manna} 'Our Nana meets Mari too.'

'our' 'nana-also' 'Mari-Acc.' 'to meet'

{uri nanado}{mariri}{manna} 'Our Nana meets Mari too.'

{tʃə}{nanado}{mariri}{manna} 'That Nana meets Mari too.'

{tʃə nanado}{mariri}{manna} 'That Nana meets Mari too.'

- 6 repetitions
- measure fundamental frequency (f₀), duration and average amplitude for each vowel of reiterated syllable.

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Results and Discussion

1. word in citation (/ma/ or /ta/, 2 to 5 syll)

=> In general, the second syll is prosodically stronger in a word of longer than 2 syllables, unless the first syll is heavier and/or has a High tone. For 2-syllable-words, the 1st syll is prosodically stronger (higher f0 and higher intensity).

# of syll	peak f0	peak intensity	longest
2	1st	1st	last
3	2nd (=1st if H tone)	2nd (1st if it's heavier)	last
4	2nd (=1st if H tone)	2nd (1st if heavy & H tone)	last
5	2nd (=1st if H tone)	2nd	last

shown in (Fig.1) (Fig.2) (Fig.3)
 ** The longest duration on the last syll is due to the IP final lengthening. Otherwise, the 2nd syll is the longest.
 ** only light syllables were tested for 2 & 5 syll-words.

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2. Word in Sentence-initial and Sentence-medial AP position; all light sylls in 3 force levels

- sentence initial (one AP):

=> in general, the 2nd or last syll. was prosodically stronger than others for words of longer than 3 sylls. For 2-syll-words, the last syll. was stronger. => Fig. 4 (peak f0), Fig.5 (mean amplitude), & Fig.6 (duration)

- sentence medial (one AP)

=> in general, similar pattern to sentence initial AP but the difference between the 1st and 2nd syll is reduced in the medial AP, especially in duration and amplitude. Fig. 7 (mean amplitude)

- similar patterns across 3 force levels: f0 and amplitude increase as force level increases.
 cf. duration varied the most across words, speakers & force levels.

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3. Amplitude and Syllable Weight

- f0 and amplitude of each vowel in a word *change* depending on its *location within an AP*. This was true for both sentence initial and medial APs.

Fig.8 (syllable weight and mean amplitude, 3 & 4 syll AP)
 3 syll. AP: 2nd is stronger unless the 1st is heavy.
 4 syll. AP: 2nd is stronger in general

Fig.9 **f0**: [tʃə nananado mariri] (subj. ss)

^{that Nanana-also Marii-Acc. to meet'}
 -> 'That Nanana meets Mari too.'

- (a) {tʃə} {nananado} {mariri} {manna} - f0 peak on 2nd /na/
- (b) {tʃə} {nananado} {mariri} {manna} - f0 peak on 1st /na/

Fig.10. **amplitude**: same sentences as above (subj. sk)
 : amplitude peak changes as in f0 change above.

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4. Summary of Production Data

- a certain syllable is prosodically stronger (higher f0 and greater amplitude) than others. Thus, we can say there is 'stress' in Seoul Korean.
- But, the prosodically strong ('stressed') syll of a word changes depending on its position within an AP. Thus, stress is the property of the Accentual Phrase, not of the word.
- : the 1st syll. of AP is 'stressed' in a 2 syll. AP.
 the 2nd syll. of AP is 'stressed' in a 3 or more syll. AP.
- if a syll has a High tone, then the syll often has a high amplitude, i.e. 'stressed'. (but not necessarily longer duration)

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Experiment 2 (Perception)

Method

- 3 Seoul speakers (2 female (S1, S2), 1 male, S3)
- 22 listeners (early 20s - early 40s; speakers of different languages - English (17), French (1), Chinese (2), Japanese (1), Italian (1)).
- tape (12 min.) contains 28 real words (single N; ten 2-syll words, nine 3-syll words, and nine 4-syll words) in isolation read by all three speakers and additional 27 words (modifier+N) in citation read by S2.
 (The modifier (Adj./Det/Poss. ProN) is either 1 or 2 sylls. so that the whole mod+N forms one Accentual Phrase)
- listeners were asked to circle any prominent syllable(s) if there is any.

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Results and Discussion

1. In general, the syllable perceived prominent was on the same position as in the production result.
 - i.e. the 2nd syll was most often perceived as prominent. In addition, for all speakers, stress tended to shift to the 1st syll if that syll is heavier than the 2nd syll and has a H-tone.
2. two response patterns among 3 speakers (Fig. 11)
 - the most common stressed syll was 2nd for S1 & S2 when the word/phrase was of 3 to 6 sylls. For 2 syll. word, the most common stress was on the 1st.
 - the most common stressed syll was final for S3 in words/phrases of less than 3 syll. and 2nd & final for 4 to 6 syll words/phrases.

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3. Two response patterns for three speakers. Why?

: speakers S1 and S2 used a low boundary intonation pattern (L%) while S3 used a falling boundary intonation pattern (HL%) expecting the following word in the list (like a continuation rise boundary tone).
As found in production data, a syll. of higher f0 also has stronger amplitude in Seoul Korean, thus perceived as 'stressed'.

Fig. 12. waveform and f0 tracks : example words

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4. Same word in AP initial vs. AP medial position => stress moves to the 2nd syll of an AP regardless of the location of the word stress in isolation.

Figure 13. 'σ' refers to a stressed syllable.

- (a) when 2 syll nouns (1st syll stressed) are preceded by a modifier within the same AP, stress changes depending on the number of syllables of the modifier and the weight of the syllable:
- (i) when Modifier is 1 syll and heavy, stress moved to the modifier, i.e., AP initial syllable
- (ii) when Modifier is two sylls, stress moves to the 2nd syll of the Modifier, i.e., AP second syllable
- (iii) when Modifier is 1 syll, stress remains on the 1 syll of the Noun, i.e., AP second syllable

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(b) when 3 syll nouns (2nd syll stressed) are preceded by a monosyll modifier within the same AP:
-> stress moved to the 1st syll of the noun.
i.e. the 2nd syll. of the AP.

(c) when 4 syll nouns (1st syll stressed) are preceded by 2 syll modifier within the same AP:
-> stress moves to the 2nd syll of the modifier,
i.e., the 2nd syll of the AP.

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5. Summary of Perception Data

- As shown in the production data, the second syllable of an AP is perceived as the most prominent for two out of three speakers.
- As shown in the production data, the prominence of a syllable is influenced by the weight and tone of the syllable. Heavy syll and High tone syll are perceived as prominent.
- Different patterns of perception response for speaker S3 confirm that high f0 (and possibly greater intensity) triggers prosodic prominence in Korean.

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Conclusion

Both production and perception data support that

- there is stress in Seoul Korean but it is not a property of the word but of the phrase, Accentual Phrase.
- the most common location of stress in a 2 syll or longer AP is the second syllable of the AP.
- the most common location of stress in a two syllable AP is the first syllable of the AP.
- stress tends to shift to the first syll of an AP if the first syll begins with a H tone and/or is heavy.

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Fig. 1 F0 of a word in citation form

▽ /na/ syllable
○ /ta/ syllable

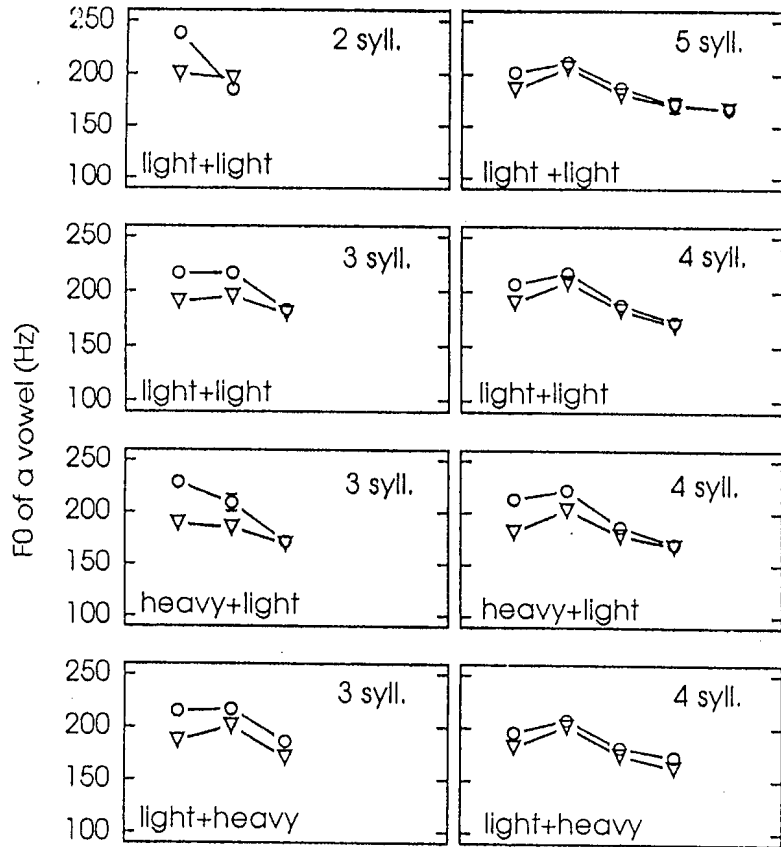


Fig. 2

Amplitude of a word in citation form

▽ /na/ syllable
○ /ta/ syllable

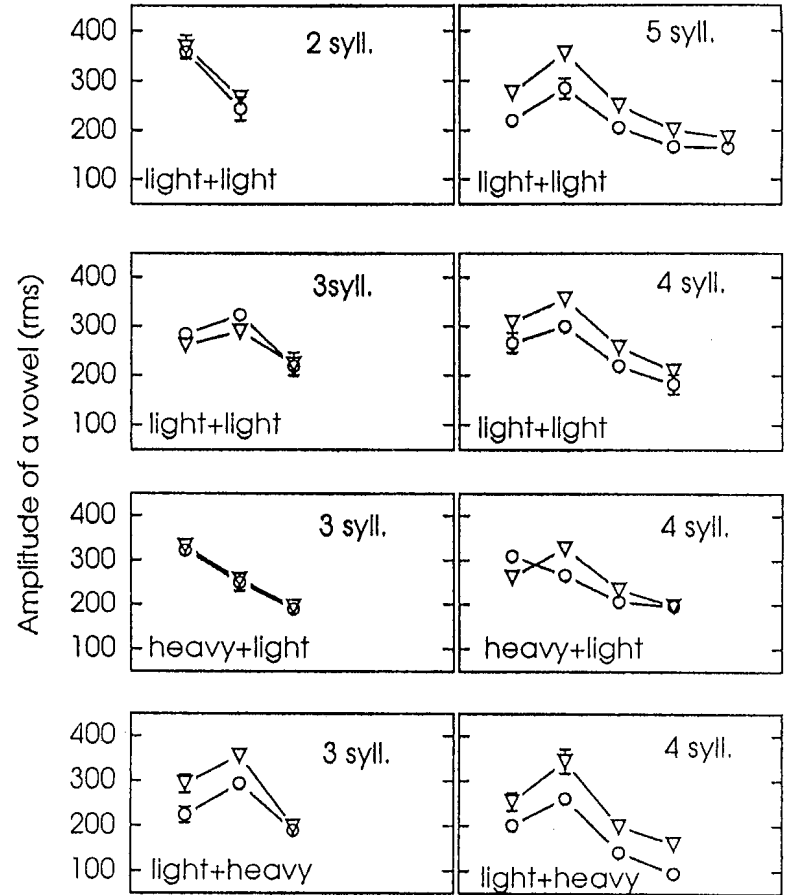


Fig. 3

Duration of a word in citation form

○ /ta/ syllable (all light)

▽ /na/ syllable (all light)

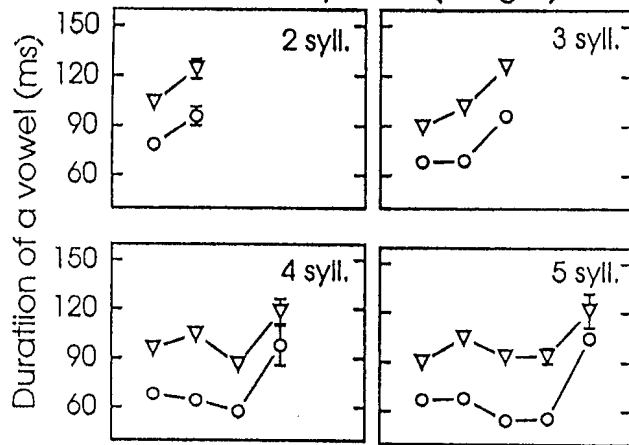


Fig. 4

Initial AP - f0 values

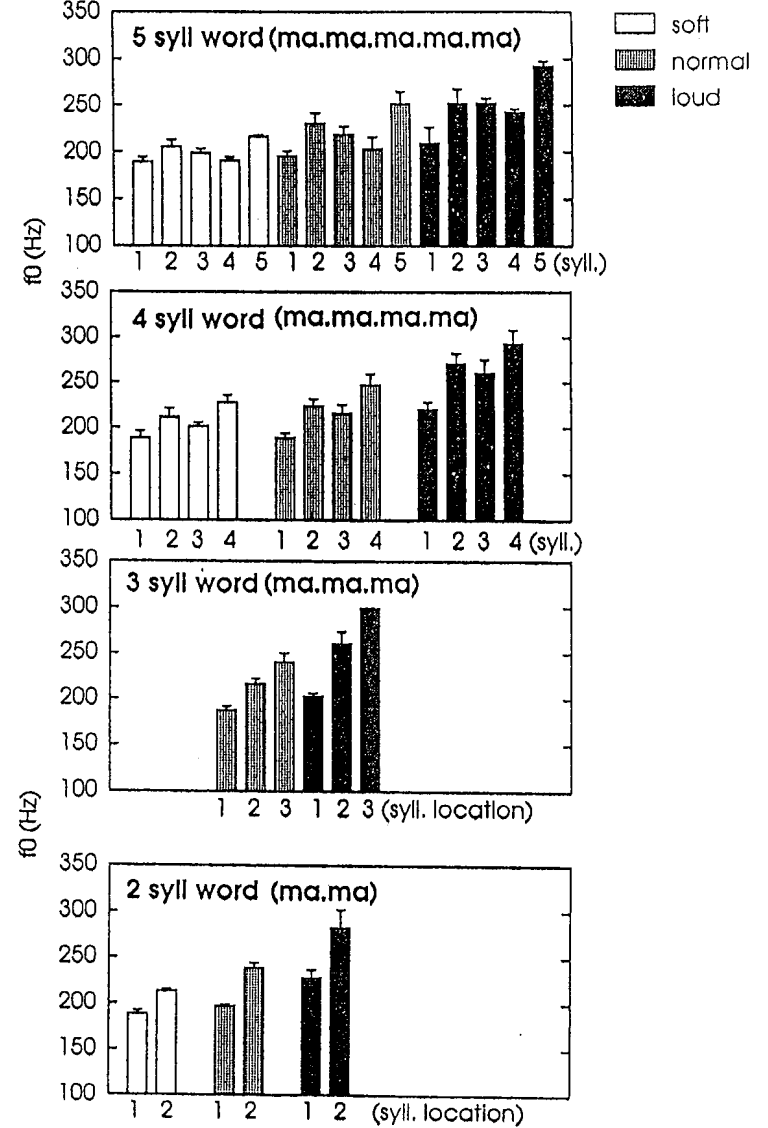


Fig. 5

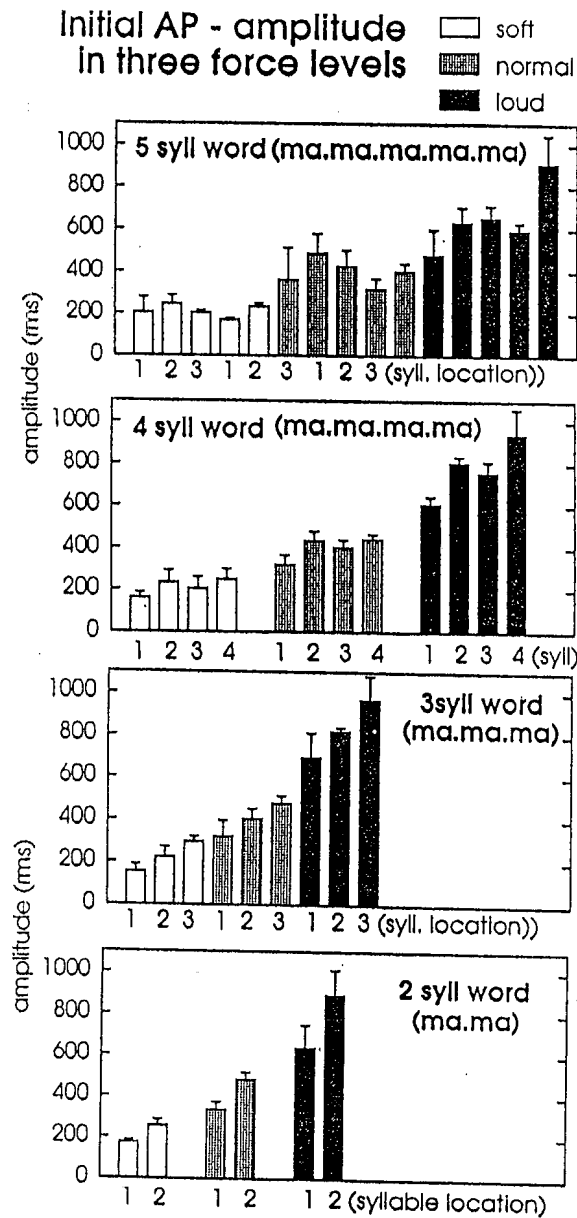


Fig. 6

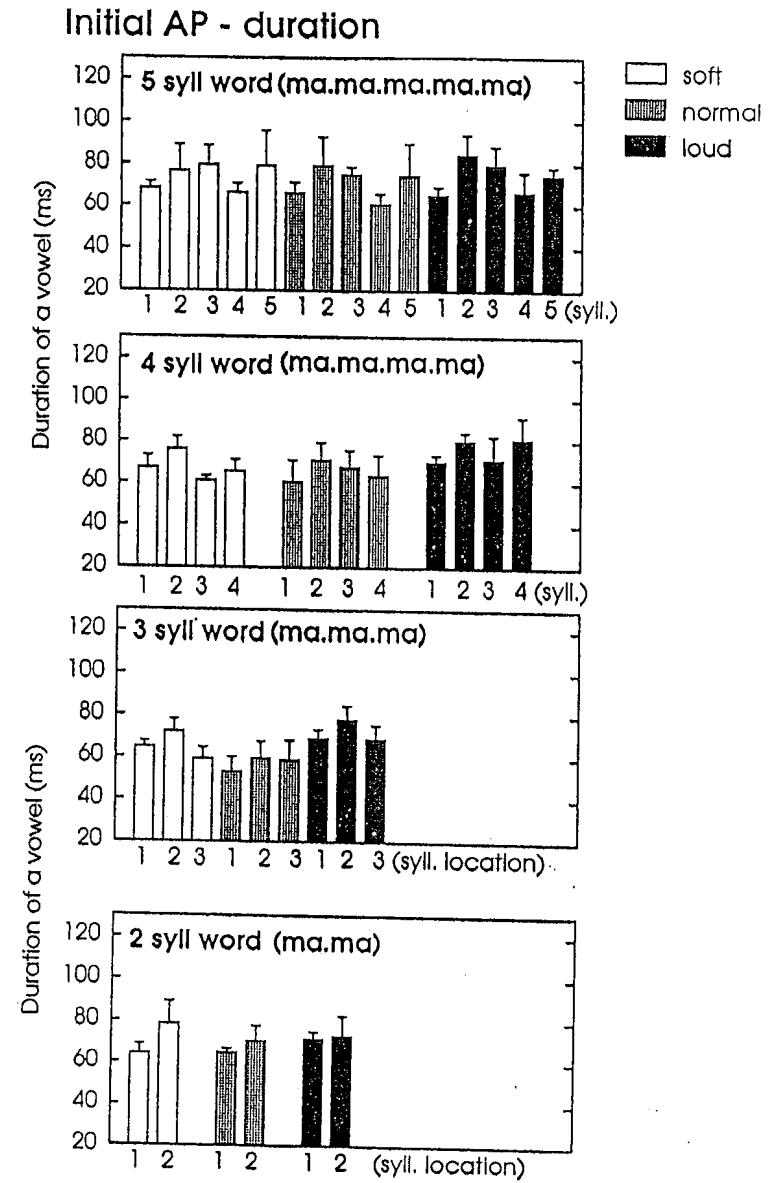


Fig. 7

Sentence
Medial AP - amplitude

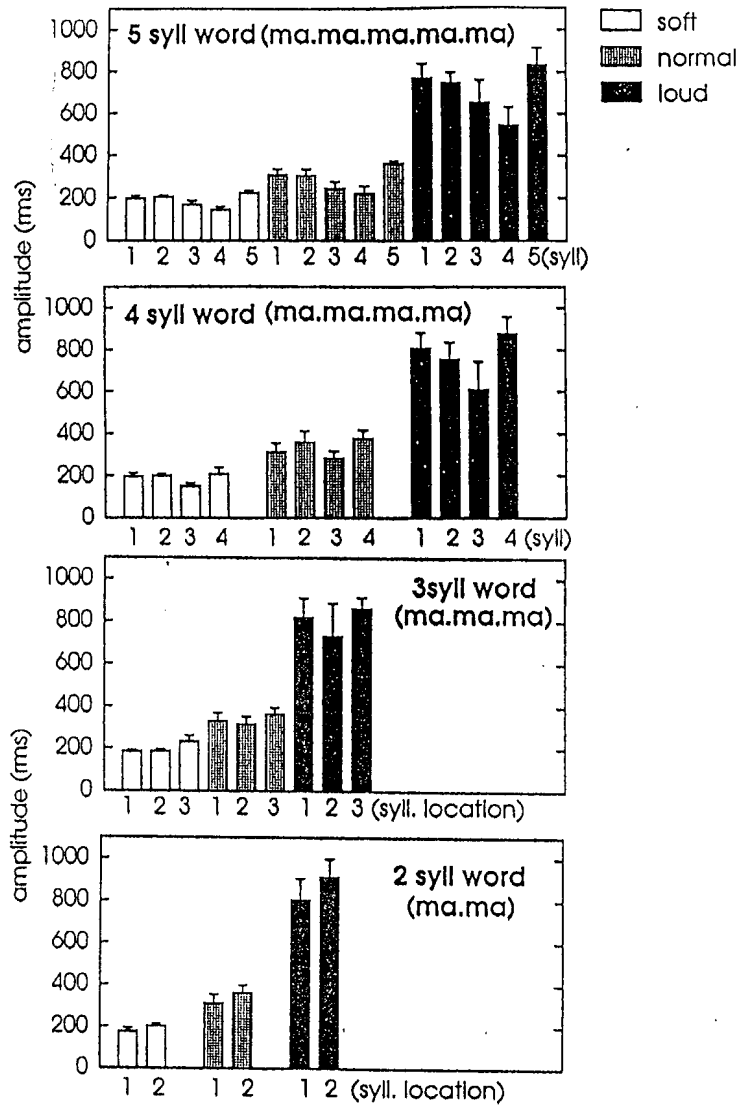
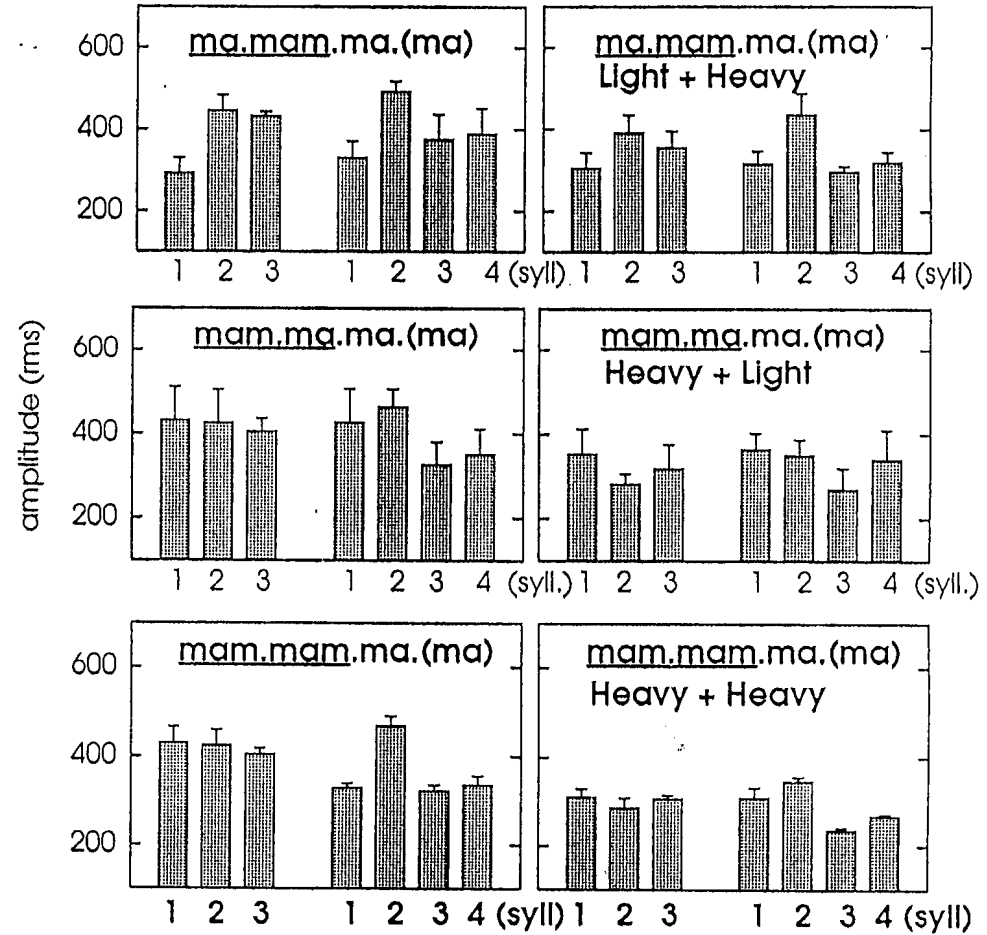
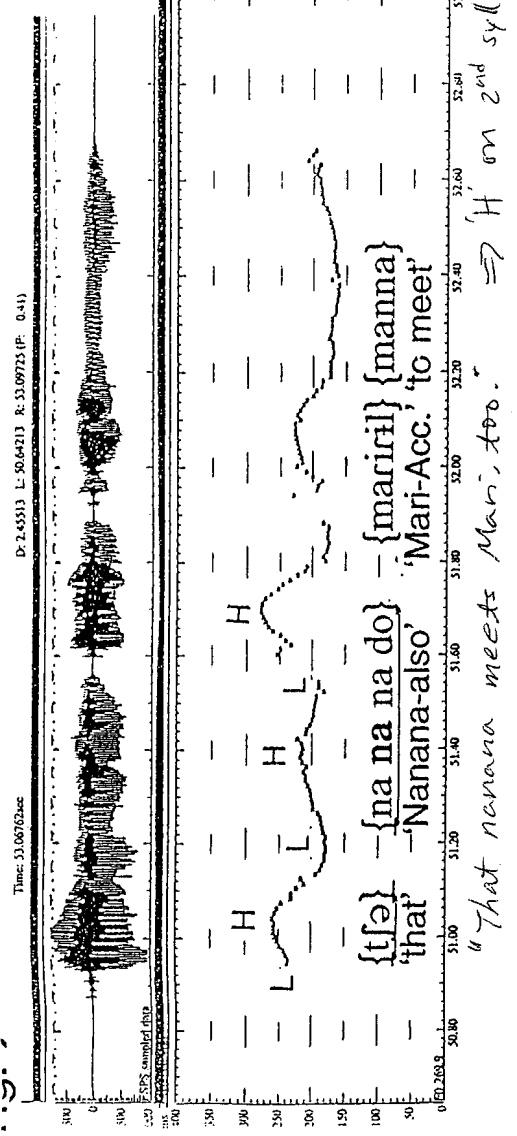
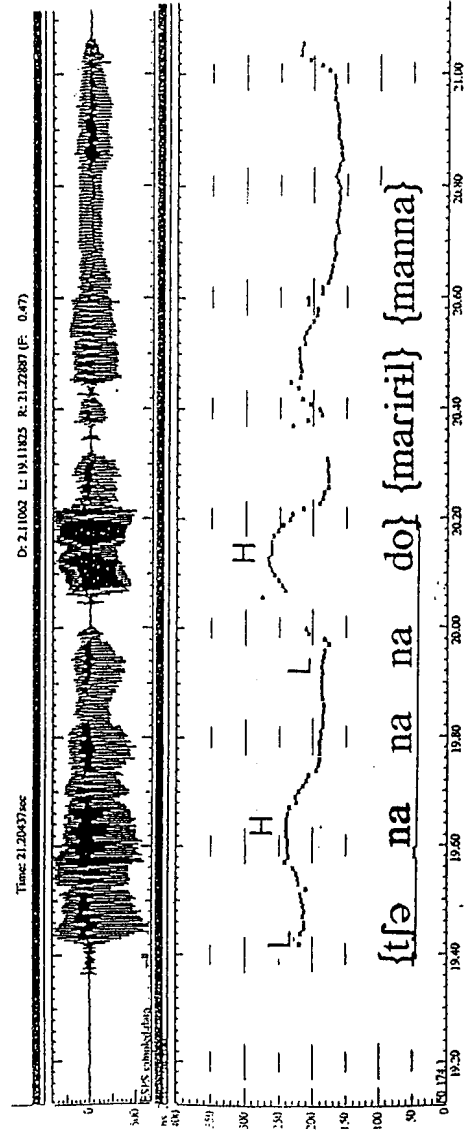


Fig. 8 Amplitude and syll weight
Initial AP (normal) 3 syll and 4 syll word
Medial AP (normal) 3 syll and 4 syll word





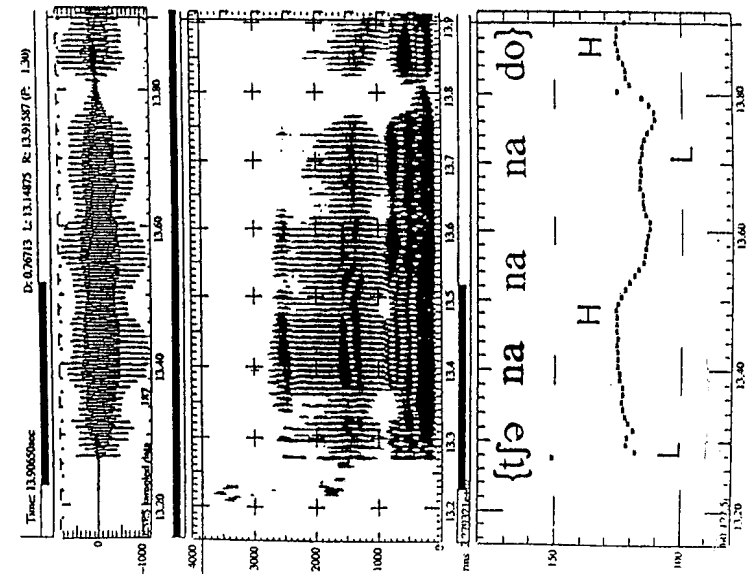
⇒ Fig 10 (b)



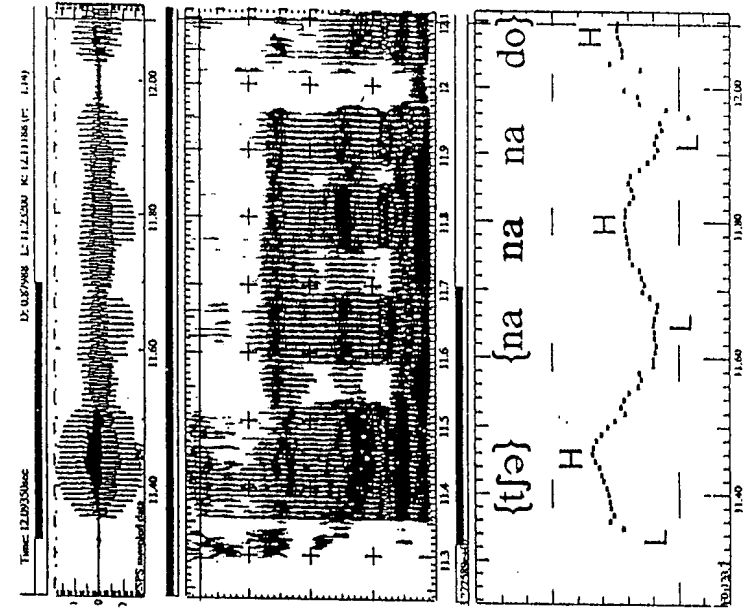
⇒ Fig 10 (a)

Fig. 10

(a) AP Medial



(b) AP Initial

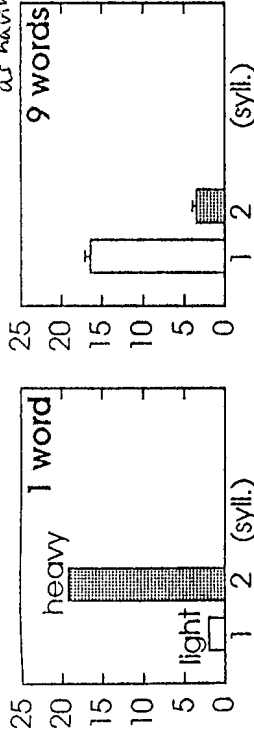


(see spectrogram)

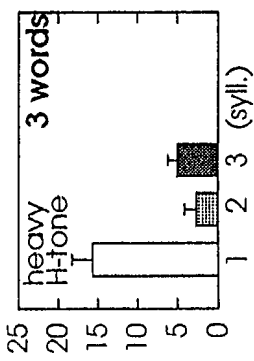
Fig. 11

is perceived as having stress on 2nd syll.

2 syllable word (10 words): only one word as having stress on 2nd syll.



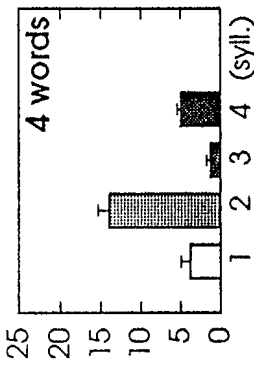
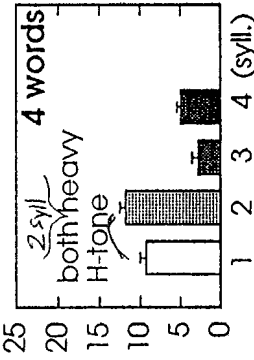
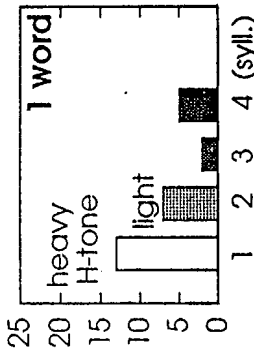
3 syllable word (9 words)



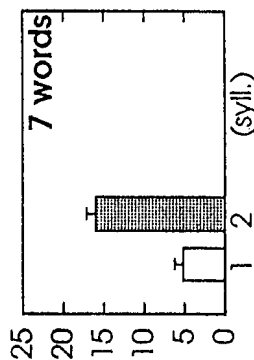
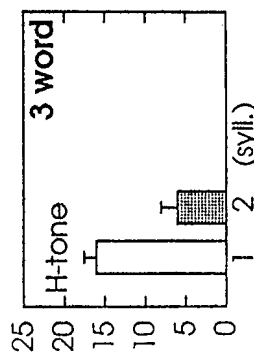
Speaker 2

stressed syll. =>
2nd in 3 or more
syll. words;
1st in 2 syll words.

4 syllable word (9 words)



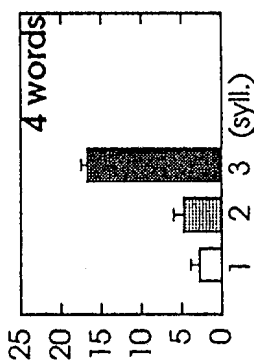
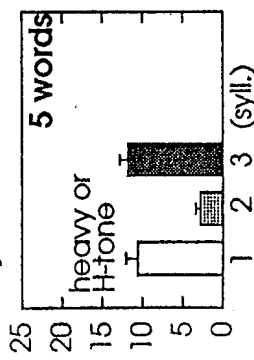
2 syllable word (10 words)



Speaker 3

stressed syll.
=> last syll. or
heavy/H-tone
initial syll.

3 syllable word (9 words)



4 syllable word (9 words)

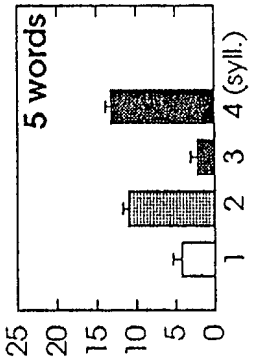
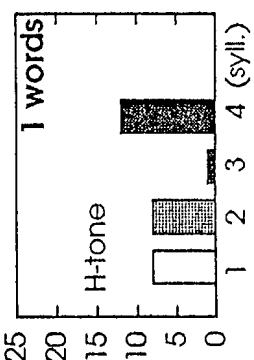
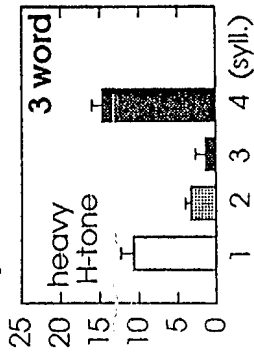
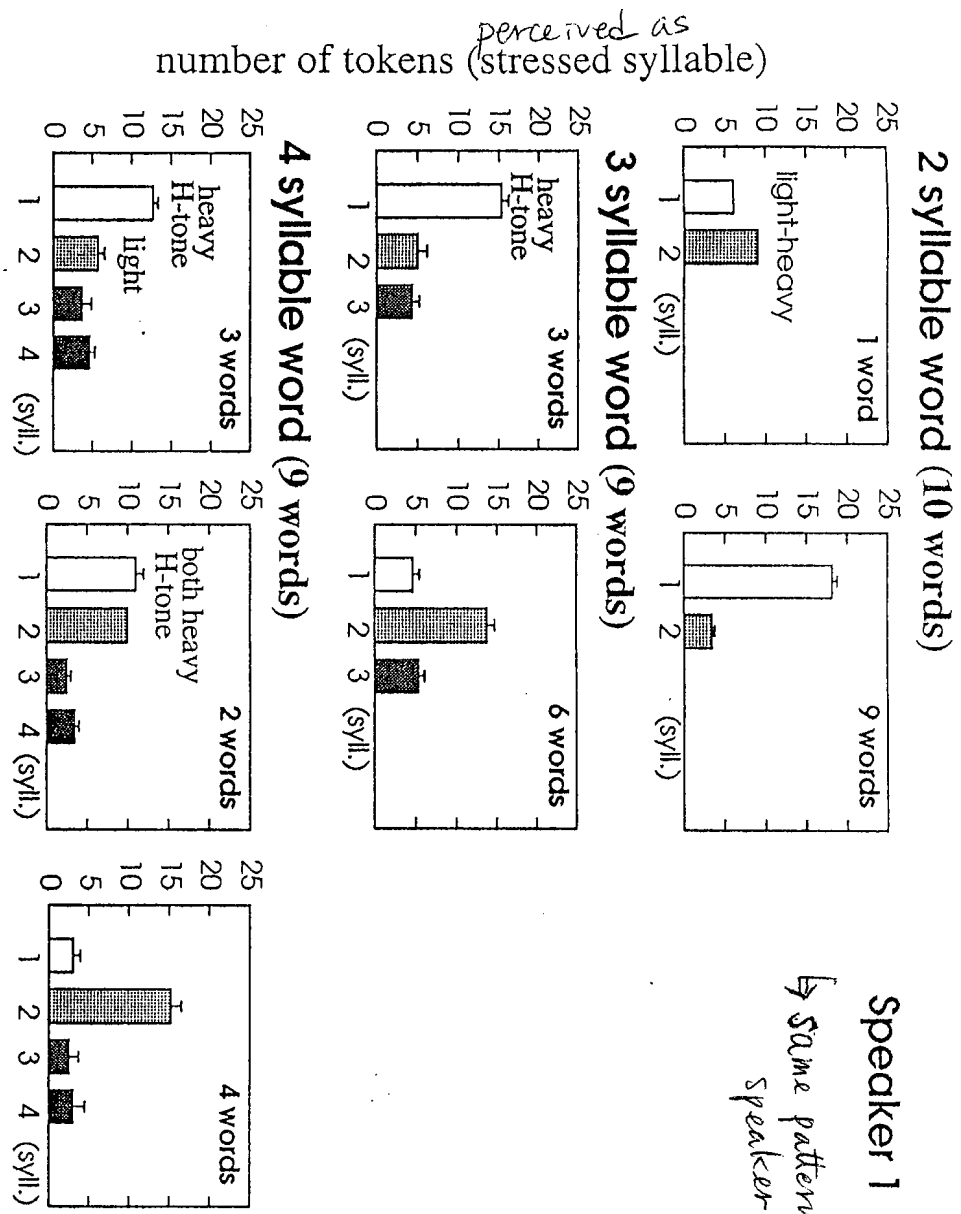
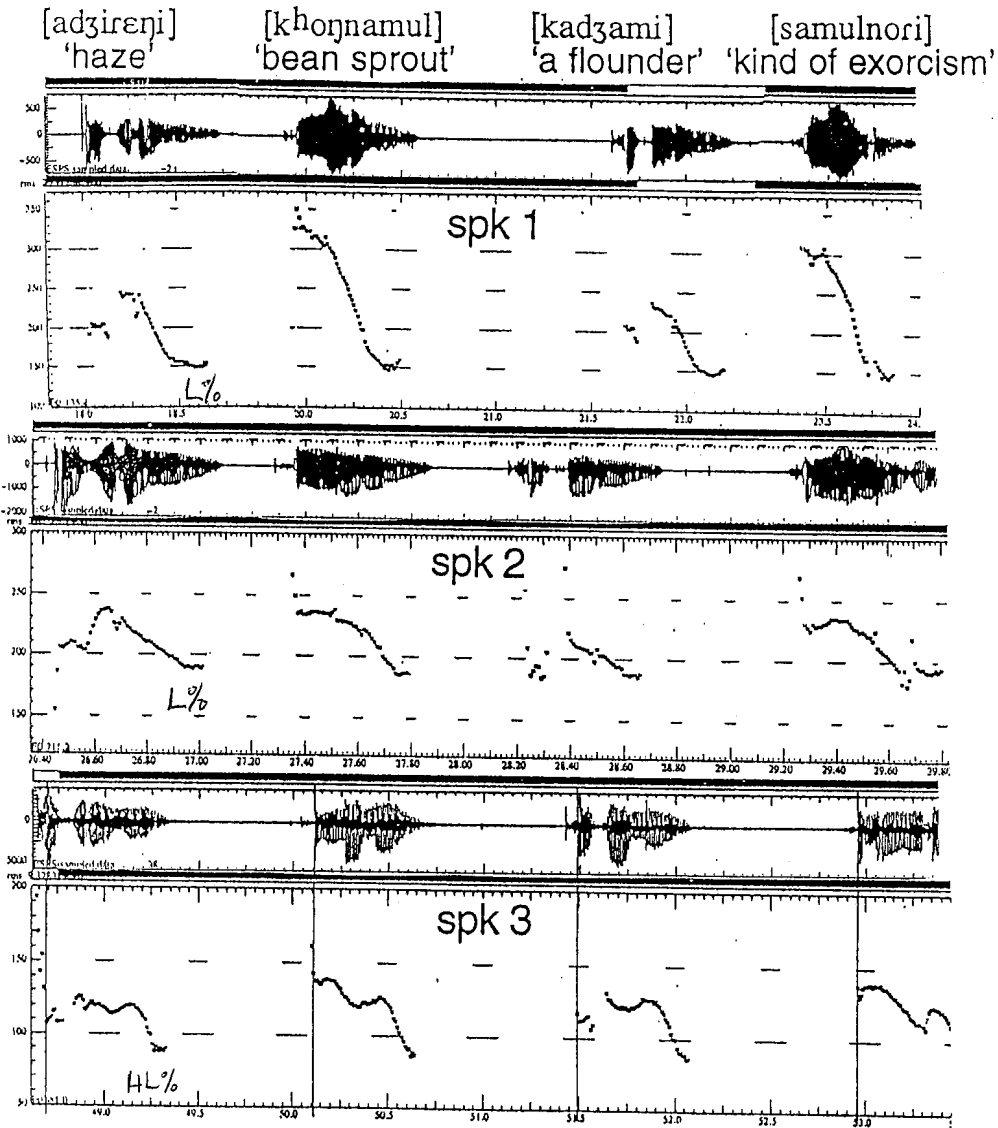


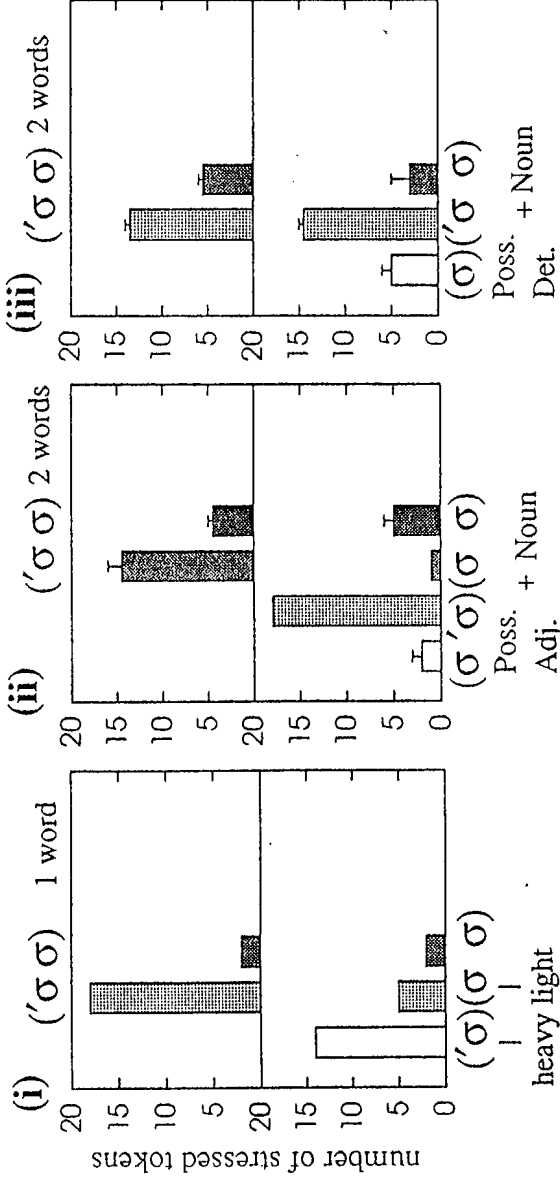
Fig. 12



Ⓐ same word in AP initial vs. AP medial position

=> stress moves to the 2nd syll of an AP regardless of the location of the word stress in isolation.

Fig. 13. (a) 2 syllable word AP (upper) vs. 2nd word in AP (down)
 (= 2 syll-word in isolation) (modifier + 2 syll-word)



in isolation

(b) 3 syll-word and (c) 4 syll-word in isolation (upper) vs. the same word in AP medial position (down)

