# F0 as the dominant cue to accent location in Persian

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**Abstract**

Two categorical perception studies were conducted in order to test the hypothesis that f0 is dominantly responsible for signaling the position of the accent, earlier known as 'stress', of Persian. We used disyllabic minimal pairs in which the accent was either on the second syllable, the word condition, or on the first, the word-plus-clitic condition. In both experiments, participants were presented with randomized stimuli in which the f0 had been manipulated and were asked to judge whether they heard a word or word-plus-clitic combination. In both cases, we found that the f0 manipulation switched judgement by 100%.

**Key words**: pitch accent, clitic group, phonological word, categorical perception.

## 1.Introduction

The primary purpose of this paper is to investigate the role of f0 in the realization of Persian stress. Stress is a linguistic property of a word that specifies which syllable in the word is stronger than any of the others. However, understanding how prominence at the word level is expressed requires disentangling the effects of stress from those of accent which signals prominence at the utterance level. At this latter level, a speaker presents a word communicatively important by realizing a pitch accent on the prosodic head of that word; that is, the stressed syllable. For this reason, pitch movement has always been advanced as the most important phonetic correlate of linguistic stress ([2, 5]). Huss [5] examined the effect of duration on the perception of stress in English stress minimal pairs ("import" verb versus "import" noun) and found that in the absence of f0 and vowel reduction, listeners could not perceive the location of the stress.

Persian presents minimal stress pairs because clitics are not included in the domain for stress assignment, which attracts a stress on the last syllable. In order to investigate the difference between structures with final and with penultimate stress, we composed a corpus of sentences featuring two minimal pairs contrasting a noun and a noun-plus monosyllabic clitic combination. The two minimal pairs themselves differed only in the voicing of the obstruent at the end of the pre-clitic noun. This latter variable was included in order to assess the effect of voiceless segments in a sensitive f0 location on the perception of the prosodic contrast. These materials in fact form part of a larger corpus in which more segmental conditions are included. Since no obvious quadruplets were available with the segmental condition we wanted to include, one of the four words was a nonsense word: tabeš 'light' vs tab-eš 'toy+his' and tapeš 'nonsense word' vs tap-eš 'tank-top+his'. The members of these minimal pairs were provided with a further monosyllabic clitic and embedded in carrier sentences which varied across three focus conditions, The contrasting stress locations in these sentences are therefore the penultimate (non-cliticized word) and antepenultimate (cliticized word) syllables in the utterance, never the final syllable.

Abolhasani, Gussenhoven & Bijankhan (2011) found that accented vowels were somewhat longer, had marginally greater intensity and were marginally opener in the accented syllables than in the unaccented syllables. Less consistently were similar duration differences found for the consonants. They interpreted these differences as side effects of the occurrence of the pitch accent on the accented syllables, not as effects of an additional underlying difference in stress. This conclusion is supported by the fact that similar small acoustic differences in duration, intensity and vowel formants were found between different focus conditions [1].

## 2. Persian stress

Stress assignment is straightforward. Final syllables of nouns, adjectives, most adverbs and unprefixed verbs have the stress [8, 10]. Prefixed verbs take stress on the prefix. Kahnamuyipour (2003) argued that the uniformity in stress placement in nouns and its variability in verbs follows from a structural difference between these categories and the resulting difference in the way they map onto prosodic structures. Word-level prominent syllables have variably been analyzed as 'accent' or 'stress'. The distinction between these has been sought in the extent to which the prominent syllable is phonetically cued by pitch features alone or alternatively whether other phonetic cues like duration and spectral properties are consistently present. Beckman (1986) termed these prominences 'non-stress accent' and 'stress accent', respectively.

## 3. Clitic Group

A crucial feature of Persian clitics is that they are not accented. The exclusion of right-edge clitics from accent assignment was noted by Lazard (1957: 48) and Shaqaqi (1993: 46). Bijankhan & Nourbakhsh (2007) make stress the main defining feature of the phonological word, pointing out that since clitics remain unstressed, they must lie outside the domain of the phonological word. Because the segmental structures of words and word-clitic combinations are not systematically different on the surface, many examples of minimal pairs can be given, like gol 'flower', which gives (ˈgoli)CG 'one flower' with a clitic and (Goˈli)ω 'proper name', which has a suffix. The fact that the assignment of a pitch accent to final syllables of phonological words skips right-edge clitics, but not suffixes, forms an important, though not the sole motivation for assuming the existence of the clitic group.

## 4. Recording

Two educated native speakers of standard Persian (male) living in Tehran was recorded in the acoustic laboratory at the Linguistics Department in the university of Tehran. A Shure microphone (SM58 Cardiod Dynamic) was used for recordings.

## 5. Perception tests

We here report the results of two perception tests which addressed the question whether f0 alone can have the perceptual effect of the switching the perceived location of the stress. We ran two perception experiments. Each test consisted of an Identification and a Discrimination test. In the Identification test, each stimulus consisted of one utterance and the subjects are asked to recognize the word. In the Discrimination test, each stimulus consisted of two utterances and the subjects should show that what they hear are simillar or different. In each case we used a single source utterance, featuring a noun-plus-clitic (b) in Experiment I and a noun (a) in Experiment II.

a. Phonological word
un **tɒˈbeʃ-e**
*that light-is*

b. Clitic Group
un **ˈtɒb-eʃ-e**

*that swing-his/her-is*

### 5.1 Experiment I

We chose a sentence with neutral, declarative focus and a cliticized target word, Un 'tab-eš-e 'That is his swing', by a male speaker. Using Praat, we provided the first syllable of the target word, [tɒ], with a contour that was the average of the cliticized and non-cliticized words in the sentence pair spoken by that speaker. The shape of the contour was preserved. Nine versions of this speech file were then produced in which the f0 contours in the second syllable of the target word, [beʃ], were 20 Hz apart, again taking five equally spaced points through the contour of [e], with the lowest step starting at 60 Hz and the highest at 220 Hz. These stimuli were presented in random order to a group of 30 female and 21 male listeners aged between 23 to 38 who were asked to indicate if they perceived the word for 'light'([tɒ'beʃ], non-cliticized) or the word for 'swing' (['tɒb], cliticized). These words were shown on a computer screen, on which subjects could click on the word they thought they heard. The results showed a complete perception shift from one condition to the next, with responses of 100% and 0% for at least one stimulus on each side of the switch point (see Fig 1). A logistic regression analysis showed that this point lies at 130 Hz, which is approximately the mid point (130 Hz) in our stimuli continuum (Fig 1&2). The effect of f0 was highly significant ($F(1,7)=4.54$, $p<0.01$). In this test, $R^2=.394$ and $\beta=.938$ [1].

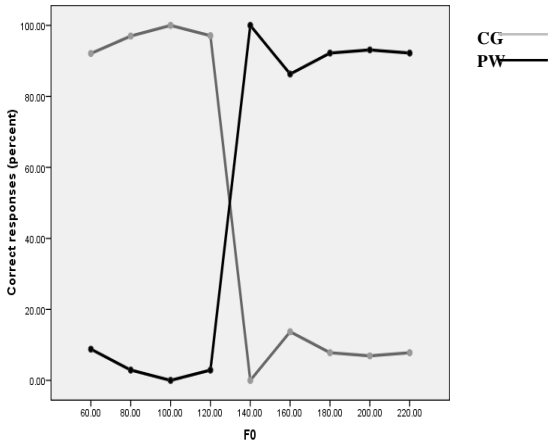


Figure 1: Percentage of perceived nouns and nouns-plus-clitic combinations in the Identification test (Experiment I)

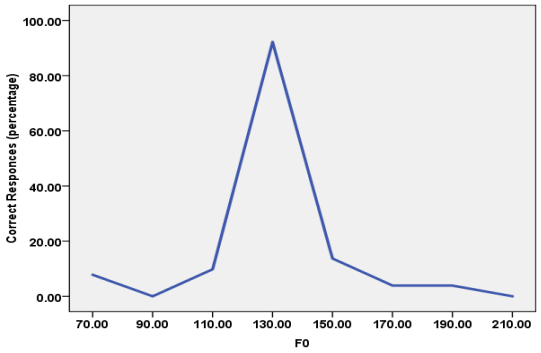


Figure 2: Percentage of perceived nouns and nouns-plus-clitic combinations in the Discrimination test showing at which point two utterances were recognized simillar to each other (Experiment I)

## 5.2 Experiment II

A sentence with neutral, declarative focus and a non-cliticized target word, *Un 'tabeš-e* 'That is light', by a male speaker. Using Praat, the first syllable of the target word, [tɒ] provided with a contour that was the average of the cliticized and non-cliticized words in the sentence pair spoken by that speaker. The shape of the contour was preserved in the first syllable [tɒ]. Nine versions of this speech file were then produced in which the f0 contours in the second syllable of the target word, [beʃ], decreased through nine steps and each step 10 Hz apart, with the highest step starting at 160 Hz and the lowest at 70 Hz ( see Fig 3).

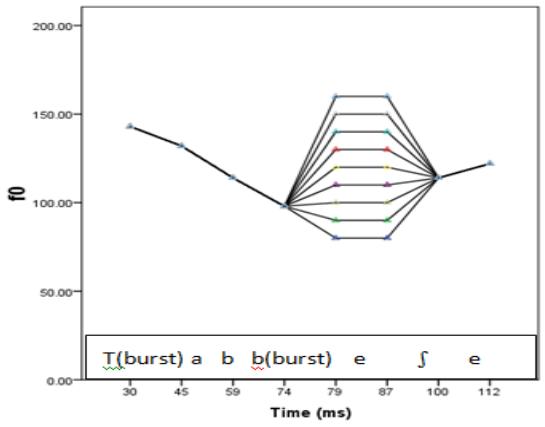


Figure 3: f0 levels in the second syllable of the synthesized utterance (Experiment II)

These stimuli were presented in random order to a group of 18 female and 12 male listeners aged between 19 to 35 who were asked to indicate if they perceived the word for 'light'([tɒ'beʃ], non-cliticized) or the word for 'swing' (['tɒb], cliticized). These words were shown on a computer screen, on which subjects could click on the word they thought they heard. The results showed a complete perception shift from one condition to the next, with responses of 100% and 0% for at least one stimulus on each side of the switch point (see Fig 4&5). A logistic regression analysis showed that this point lies at 125 Hz, which is approximately the midpoint (125Hz) in our stimuli continuum (see Fig 6). The effect of f0 was highly significant ($F(1,7)=8.54$, $p<0.01$) .

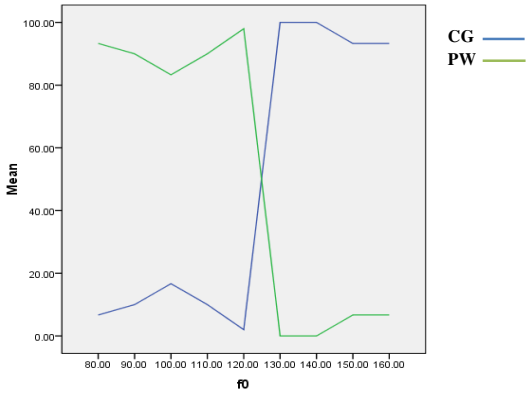


Figure 4: Percentage of perceived nouns and nouns-plus-clitic combinations in the Identification test (experiment2)

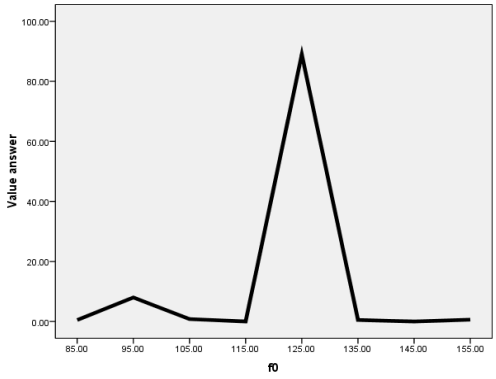


Figure 5: Percentage of perceived nouns and nouns-plus-clitic combinations in the Discrimination test at which point two utterances were recognized simillar bu subjects (experiment II)

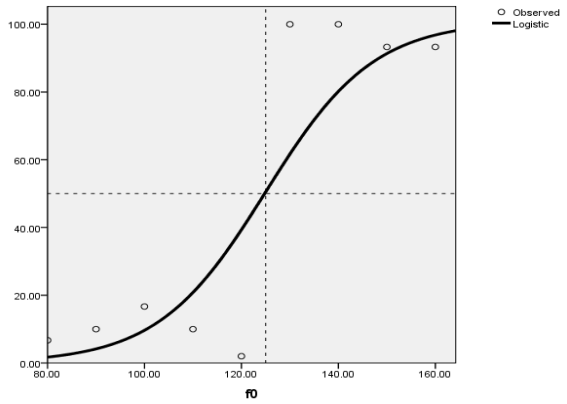


Figure 6: Logistic regression test (experiment II)

### 6.Conclusion

In two Categorical Perception experiments, with f0 as the sole variable it has been shown that a difference in f0 is capable of swing judgements by 100% in the perception of the location of stress in Persian sentences, regardless of the original location of the pitch accent in the source utterance. This strongly suggests that Persian has a pitch accent and that it has no stress in the sense of either a segmentally privileged position, as in English, or a syllable with phonetically enhanced segmental, as in Spanish. Rather, its pitch accent is like that in Japanese, a tone or tone complex that is assigned to some syllable. In the case of Persian, that syllable is structurally defined as the last syllable of the non-cliticized word. Further research is aimed at establishing whether there is a residue of the phonetic differences found by [1]. This will be done by including the source utterance as a variable in the experiment.

### 7. Acknowledgement

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