

# ACOUSTIC CORRELATES OF PERSIAN IN-SITU-WH-QUESTIONS

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## ABSTRACT

This experiment was designed to investigate whether the acoustic correlates of prosody of the pre-wh-part of the sentence differentiate in-situ-wh-questions from declaratives in Persian. To accomplish the purpose of this research 115 declaratives and 115 in-situ-wh-questions were constructed. These sentences were elicited from eight Persian native speakers in a sentence elicitation task. The contrast between the prosody of the pre-wh-part of the sentence in declaratives and in-situ-wh-questions appears to have clear acoustic correlates, which can be captured in terms of a higher pitch level and shorter duration of the pre-wh-part in wh-questions and a larger pitch excursion size of the word immediately preceding the wh-word. This finding provides evidence for the claim [14] that questions universally differ from statements in that the former have some element of high pitch that is absent in the latter. In addition, the result implies that the in-situ-wh-questions can potentially be distinguished from declaratives based on the prosody of the pre-wh-part of the sentence.

**Keywords:** in-situ-wh-questions, pitch, duration.

## 1. INTRODUCTION

Wh-questions are expressions that use wh-words to enquire about desired information. There are two types of wh-questions: fronted wh-questions and in-situ wh-questions. In fronted wh-questions (cf. example 1b), which occur in languages such as English [5, 6], the syntactic structure enables the listener to discern the sentence type once he/she hears the first word of the sentence. In other words, the fronted wh-element signals the clause type at the very beginning of the sentence. However, in the case of wh-in-situ questions (cf. 2b), which are used in Persian [1, 16, 17, 18, 20, 22], the syntactic structure does not provide a cue to the clause type at the beginning of the sentence, since the wh-element does not occur sentence initially. This raises the question if prosody of the pre-wh-part of the sentence is indicative of in-situ-wh-questions.

- (1) a. Mary carries a book.  
b. What does Mary carry?

- (2) a. Maryam diruz kitab xarid.  
Maryam yesterday book buy.PAST.3SG.  
“Maryam bought a book yesterday.”  
b. Maryam diruz chi xarid?  
Maryam yesterday what buy.PAST.3SG.  
“What did Maryam buy yesterday?”

## 2. BACKGROUND

This part presents the literature on the acoustic features of interrogatives in different languages and the background on the prosody of wh-questions in Persian in two separate sections.

### 2.1. Interrogatives in different languages

Research on the acoustic features of the prosody of questions in different languages mainly concentrates on yes-no questions and declaratives questions [3, 8, 9, 11, 12, 13, 15, 27, 28, 29]. Very little work has been done on the acoustic correlates of the prosody of fronted and in-situ-wh-question [11, 19, 25].

[14] argued that interrogatives are universally marked by the presence of a high element somewhere in the sentence. This high pitch may manifest itself both locally, e.g. in the initial, medial or final portion of the sentence [9, 11, 12, 13, 19, 25, 27, 28] and globally, either in the guise of raised register or the absence of F0 downtrend [3, 8, 13, 15, 27]. According to [12, 13, 27, 28] interrogatives can be distinguished from declaratives by the presence of a terminal rise in American English, Swedish, Danish. [3, 8, 11, 15, 27]’s studies revealed that absence of f0 downtrend and higher pitch register differentiate interrogatives from declaratives in Danish, Hausa, Dutch and American English. Higher pitch at sentence initial position and a terminal rise mark Dutch interrogatives [11]. [19] showed that Mandarin Chinese wh-questions are marked by a higher pitch at sentence initial position and [25] argued for a more expanded pitch range at final position in wh-questions in Mandarin Chinese.

The results of the studies on durational differences between questions and statements in Dutch, Manado Malay and Orkney English [29] and a Neapolitan regional variety of Italian [4] revealed that questions have decreased duration in comparison to declaratives. They found that this

durational difference can have local as well as global manifestations.

## 2.2. Wh-questions in Persian

Previous studies on Persian wh-questions investigate phonological aspects of the prosody of wh-questions [7, 21, 23, 26, 29]. None of these researches examine acoustic correlates of Persian in-situ-wh-questions or made a comparison between the phonological aspects or acoustic correlates of the prosody of Persian declaratives and wh-in-situ-questions.

The first study in this field was conducted by [23]. Mahootian identified five types of intonation patterns for Persian: rising-falling, mid-rising, low-rising, mid-falling and high-falling. High-falling intonation is typical of wh-questions. It starts at a high level, and falls at the end of the question. According to Mahootian, the intonation peak in wh-questions is on the wh-word, because the wh-word is the focus of the sentence.

Mahjani [21] and Tehrani [29] applied the auto-segmental-metrical (AM) framework and Esposito and Parjam [7] used ToBI (Tone and Break Indices; [26]) labeling conventions to study the prosody of different types of Persian sentences including declaratives and wh-questions. They suggested that wh-questions are similar to declaratives in that the IP of both sentence types contains a series of APs and ends with a L% boundary tone. According to them, deaccentuation of the part of the sentence after the wh-word in wh-questions differentiates wh-questions from declaratives. They argued that the wh-word in wh-questions attracts the nuclear pitch accent of the sentence which causes the remaining part of the sentence to be deaccented.

## 3. RESEARCH QUESTIONS, PREDICTIONS AND APPROACH

Do acoustic correlates of the prosody of the pre-wh-part of the sentence differentiate Persian in-situ-wh-questions from declaratives in the absence of the wh-word at the beginning of the sentence? To answer these questions a sentence elicitation task was designed in which 115 declaratives and 115 in-situ-wh-questions were elicited from 8 Persian native speakers. According to [14], presence of a high element somewhere in the sentence marks interrogatives universally. This high pitch manifests itself in the initial part of the sentence [9, 11, 25] in American English, Dutch and Mandarin Chinese. Therefore, we expect the pitch level of the pre-wh-part to be higher in wh-questions.

Our second prediction is that the pre-wh-part in wh-questions has a shorter duration than in declaratives. This prediction is based on the results of [29, 4]'s studies who found that questions have decreased duration in comparison to declaratives and this durational difference can manifest itself locally.

## 4. METHOD

### 4.1. Subjects

Eight native speakers of standard Persian (4 males and 4 females) between the age of 24 and 42 participated in the production experiment. All of them were university students or university lecturers.

### 4.2. Materials

The materials of this experiment represent two main conditions: declaratives and in-situ-wh-questions. We composed a corpus of 115 sentences for each condition. The structure of the declaratives and wh-questions elicited in this experiment are presented in (3) and (4) respectively. In order to arrive at 115 sentences in each condition we varied the words used as the Subj<sup>i</sup>, DO, AdjT, AdjM, AdjP and the verbs.

- |          |     |                      |      |
|----------|-----|----------------------|------|
| (3) Subj | Adv | DO/ AdjT/ AdjM/ AdjP | Verb |
| (4) Subj | Adv | Wh-word              | Verb |

The sentences in both conditions were structured so as to be minimally different in order to provide the best comparison across conditions. Moreover, the sentences were composed of the same number of words and syllables in both conditions.

### 4.3. Procedure

Participants were recorded using a high quality microphone (Sennheiser PC 141 Headset) and a digital recorder (M-Audio MicroTrack II) in a quiet room. Each participant was presented with a different randomized orders of the sentences. The target sentences were elicited from participants in a sentence elicitation task. Prior to conducting the main experiment, the participants took part in a practice session. They were instructed that they would see a question and three main constituents of the target sentence (1: subject, 2: direct object or adverb of time, place, or manner, or wh-word, and 3: the root of the verb) on the computer screen. Simultaneously they heard the question (also shown on the computer screen) read to them by the researcher. The participants were asked to produce a sentence (either a declarative or a wh-question) in response to the question they heard, using the given

constituents. All of the declaratives were elicited in response to the question “what happened?”. An example of the basic form of the questions used to make participants produce wh-questions is given in (5).

- (5) a. You know that Mohammadreza threw something yesterday. In order to know what he threw what would you ask?

The participants were required to produce all of the sentences in simple past tense. Furthermore, they were instructed to use the adverb /diruz/ (yesterday) after the subject in all of the sentences. The test items (each stimulus accompanied by the word constituents) were presented one at a time. The entire session took about thirty five minutes for each participant and they were given a five minutes break in the middle of their session. Fig. 1 presents a screenshot of what the participant saw on the computer screen during the production experiment.

Figure 1. A screenshot of what the participant saw on the computer screen during the production experiment. The English translation of the question and the constituents is added here for illustrative purposes.

101w.

What Happened? چه اتفاقی افتاد؟

<صحبت کردن> <بی پروا> <امیر محمد>

<to talk> <fearlessly> <Amir Mohammad>

#### 4.4. Data Analysis

Sentences were analyzed and segmented in Praat Version 5.3.69 [2]. The pre-wh-part of the sentence was separated from the remaining part in all utterances. The pre-wh-part was further segmented into a subject and an adverb in both declaratives and wh-questions as these two constituents form the pre-wh-part of the sentence in both sentence types.

According to the findings of the literature on interrogatives in several languages [4, 11, 19, 28 ] and based on our research question, a script was run in Praat to extract the following values: f0 onset, f0 minimum, f0 mean, duration of the pre-wh-part of the sentence, and excursion size of the pitch accents realized on the subject (SpeSubj) and the adverb (SpeAdv).

## 5. RESULTS

A one-way repeated measures analysis of variance (RM ANOVA) was conducted with sentence type as

the independent variable and f0 onset, f0 minimum, f0 mean, duration, SpeSubj and SpeAdv as dependent variables. According to the multivariate test there was a significant effect of sentence type [ $F(4,4) = 18.100, p < .05$ ; Wilk's A = .018,  $\eta^2 = .982$ ]. Univariate tests for individual variables indicated a significant effect of sentence type on f0 mean, f0 minimum, SpeAdv and duration. However, the difference between declaratives and wh-questions with respect to F0 onset and SpeSubj was shown to be non-significant. Table 1 gives the results of the univariate tests.

Table 2. Result of univariate tests for the acoustic correlates of the pre-wh-part of the sentence.

	F	df	p	$\eta^2$	N
F0 mean	10.02	1,7	.016*	0.589	8
F0 onset	0.82	1,7	.393	0.106	8
F0 minimum	12.75	1,7	.009**	.646	8
SpeSubj	4.47	1,7	.072	.390	8
SpeAdv	6.12	1,7	.043*	.467	8
Duration	5.80	1,7	.047*	0.453	8

Note. Decl = declaratives; Wh-q = in-situ-wh-questions; SpeSubj = excursion size of the subject; SpeAdv = excursion size of the adverb. \* $p < .05$ . \*\* $p < .01$ .

Comparing the mean of the f0 minimum, f0 mean and SpeAdv (see Table 2) in wh-questions and declaratives indicated that the pitch level of the pre-wh-part is higher in in-situ-wh-questions. The mean of the duration suggests that the pre-wh-part is longer in declaratives (see Table 2).

Table 2. Descriptive statistics (mean and sd) for the acoustic correlates of the pre-wh-part of the sentence.

	M SD (Decl)	M SD (Wh-q)	N (Decl)	N (Wh-q)
F0 mean	5.144 1.300	5.258 1.366	920	920
F0 onset	5.336 1.426	5.277 1.489	920	920
F0 minimum	4.719 1.242	4.818 1.283	920	920
SpeSubj	1.285 0.584	1.691 0.812	920	920
SpeAdv	0.914 0.650	1.268 0.679	920	920
Duration	0.981 0.181	0.953 0.173	920	920

Note. Decl = declaratives; Wh-q = in-situ-wh-questions; SpeSubj = excursion size of the subject; SpeAdv = excursion size of the adverb. All f0 measures are expressed in ERB and the duration is expressed in seconds.

## 5. DISCUSSION

The results of the current study confirm the expectation that the pre-wh-part in in-situ-wh-questions is uttered at a higher pitch level than the corresponding part in declaratives. This higher level is reflected in the pitch mean and f0 minimum of the pre-wh-part and a larger excursion size of the word immediately preceding the wh-word (adverb). This result agrees with the findings reported earlier on the differences between declaratives and interrogatives

in different languages [9, 11, 12, 13, 19, 25, 27, 28]. Moreover, it supports the general claim that greater pitch height in questions can be regarded as a universal property of language [14].

The second prediction of this research was ratified as well. The pre-wh-part is shorter in in-situ-wh-questions. This result is in line with [3] and [28] who showed that questions are shorter than declaratives and the decreased duration of questions can be local.

Based on the contrast between the acoustic correlates of prosody of the pre-wh-part in declaratives and wh-in-situ-questions, it can be inferred that the prosody of the pre-wh-part of the sentence signals in-situ-wh-questions in the absence of the wh-word at the beginning of the sentence. This suggests that wh-in-situ-questions can be identified based on the prosody of the pre-wh-part of the sentence before the wh-word is heard.

## 6. CONCLUSION

The goal of the current experiment was to tackle the question whether prosodic characteristics of the pre-wh-part can signal Persian in-situ-wh-questions in the absence of the wh-word at the beginning of the sentence. Therefore, acoustic features of the pre-wh-part in Persian wh-in-situ-questions and their declarative counterparts were investigated.

The general conclusion of this research is that prosody does mark in-situ-wh-questions in Persian. This markedness is captured in f0 minimum, f0 mean, duration of the pre-wh-part and excursion size of the pre-wh-word in wh-questions. The pitch level of the pre-wh-part is higher in wh-questions and the pitch accent of the adverb (the word immediately preceding the wh-word) has a larger excursion size in wh-questions. As for the duration, the pre-wh-part is shorter in wh-questions. This result provides the ground for further research; whether Persian native speakers can distinguish in-situ-wh-questions from declaratives relying on the prosody of the pre-wh-part of the sentence.

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<sup>i</sup> Subject is abbreviated as Subj, adverb as Adv, direct object as DO, adjunct of time as AdjT, adjunct of manner as AdjM and adjunct of place as AdjP.