

# Initial and final intonation cues of Czech yes-no questions

Andrea Pešková<sup>1</sup>, Laura Colantoni<sup>2</sup>, Trudel Meisenburg<sup>1</sup>

<sup>1</sup>University of Osnabrück, Germany

<sup>2</sup>University of Toronto, Canada

apeskova@uos.de, laura.colantoni@utoronto.ca, tmeisenb@uos.de

## Abstract

In this paper, we explore prenuclear and nuclear fundamental frequency (F0) patterns and durational cues in Czech neutral yes-no questions and compare them with (neutral) statements. The data were obtained in a production experiment with 21 native speakers and later described phonetically and modeled within the Autosegmental Metrical (AM) framework. Despite of the fact that the final rise distinguishes Czech polar questions from statements, we found additional significant differences in prenuclear positions: The initial accentual phrases have a larger pitch excursion and longer duration in statements than in questions. These findings thus support the claim that prenuclear tonal patterns should be taken into account in the analysis of sentence modality.

**Index Terms:** Czech intonation, yes-no questions, initial cues, nuclear configurations.

## 1. Introduction

From a cross-linguistic perspective, the use of rising intonation in questions and especially yes-no questions was earlier suggested to be universal ([1], [2]). More recently, many studies have found that yes-no questions exhibit a high variation in nuclear configurations (NC) cross-linguistically, as well as within languages (see, e.g., [3], [4], [5]). Additionally, it was shown that initial cues (especially peak alignment) may be important for the interpretation of sentence modality (see, e.g., [6] for German, [7] for Castilian Spanish). Languages may also use further strategies (or combination of these) to express yes-no questions, such as particles, verbal morphology, speech rate ([8]) or word order. According to the World Atlas of Language Structures ([9]), Czech belongs to the group of languages with interrogative word order. Albeit it is true that the inflected verb usually stands at the beginning of the utterance in unmarked yes-no questions (e.g., *Koupila Marie noviny?* lit. ‘Bought Mary newspaper?’; see also [10]), Czech does not allow an identical intonation pattern to be used for statements and questions (see, e.g., [11]), independently if the subject is inverted or not (see Section 2).

The aim of this paper is twofold: First, we seek to describe the intonational patterns of yes-no questions in Czech (West-Slavic language), which is understudied within the Autosegmental-metrical model ([12]). Second, we hope to contribute to the typological characterization of languages regarding tonal patterns and intonational strategies for the expression of yes-no questions.

## 2. Statements vs. yes-no questions

Typologically, we consider Czech a phrase language (in terms of [13]). It has fixed lexical stress (on the first syllable), and it

assigns phrasal tones in a purely demarcative way. Its prosody is left-headed and the accentual phrase (AP) can be defined as a rhythmic unit with a (mostly) rising pitch from one \*σ to the next (Fig. 1). Interestingly, similar intonation contours are also observed in other phrase languages with lexical stress on the first syllable (see, e.g., [14] for Bengali, [15] for Hindi):

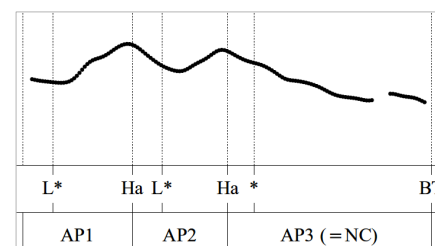


Figure 1: The default tonal pattern of the AP in broad focus SVO declarative (from [16]).

The low F0 portion on the first syllable of the AP is analyzed here as a low pitch accent (L\*) and the high F0 portion of the rising contour as an AP final boundary tone (Ha); an initial high tone (Hi) at the beginning of an utterance is also possible. The work on Czech intonation by [17] contemplates additional tonal patterns in the AP (in her terminology *mluvní takt*, ‘stress group’): LH (rising tone), HL (falling tone), H= (sustained high tone) or L= (low plateau), LHL (rising-falling tone) (see also the inventory of pitch accents proposed by [11], [18] within the AM). This variation could be attributed to the number of syllables, expressivity or stylistics. We will test whether such realizations vary across sentence types.

As for the final contours, they are typically falling in neutral statements (Fig. 1). Previous research (see, e.g., [19], [20], [21]) describes statements with a fall (‘cadence’) and questions with a rise (‘anticadence’). Essential works by [17] and [22] on Czech intonation take into account six main contours for unmarked declaratives and questions, using Pike’s ([23]) notation of four (F0) levels (with 1 being the highest and 4 the lowest level):

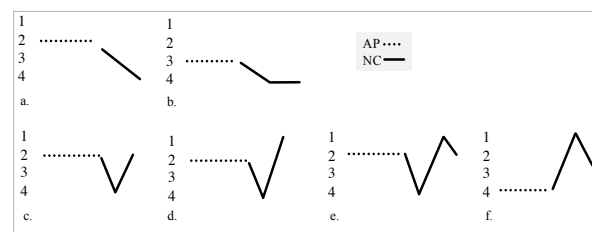


Figure 2: Intonation of statements (a, b) and questions (c, d, e, f) (modified with a schematic F0).

According to [17], the interrogative rise can be either on the last syllable or on the second syllable, when the AP has three or more syllables. Following the AM “translation” of the intonation patterns (in Fig. 2) proposed by [11], we assume two main contours for Czech yes-no questions: L\* H% (Fig. 2c, 2d); L\*+H !H% (Fig. 2e). Additionally, there is a “Prague” colloquial pattern, labeled as a H\* !H% (Fig. 2f). (Instead of M% proposed by [11], we only use the label !H%). [22] assumes that the rising intonation is typical for Standard Czech yes-no questions, whereas the “rising-falling intonation implies at least a slight degree of emotion (expressiveness or emphasis)” (p. 146). In addition, the variation is also described to be diatopic: the Moravian (Fig. 2c, d) vs. the Bohemian pattern (Fig. 2e, f) [17]. We will discuss this point later.

Up to now, less attention has been paid to the prenuclear position. It is thus not clear whether there are any systematic changes in initial cues in statements vs. questions: Prenuclear material (the first AP) shows no particular pitch excursion and starts at the same level 2 in Fig. 2 (with the exception of statement b, and question f). For the reason that prenuclear position as well as initial pitch of an utterance (see, e.g., [6], [7], [24]) can provide information on the sentence modality in different languages, we conducted a small pilot experiment with two speakers and observed the three following differences, which will serve as hypotheses for our study:

- (1) nuclear configurations have a rising pattern in questions (see, e.g. [17]) and longer duration than in statements;
- (2) initial accentual phrases show a smaller F0 excursion in questions than in statements;
- (3) initial accentual phrases are shorter in questions than in statements (consistent with observations in [8]).

This indicates that albeit the final rise is still an important cue for distinguishing statements from yes-no questions in Czech, the initial cues may differ and thus impact on pragmatic meaning too. Furthermore, we will examine utterance medial APs and describe all tonal contours in AM terms.

### 3. Methods and data

We conducted a production experiment (reading task) with 21 Czech native speakers (12F, 9M), all of who were naïve to the purpose of the study. The material included eight simple pair constructions (statement/yes-no question) composed by two (or three) APs. Since Czech is a pro-drop language, we selected sentences with an unexpressed pronominal subject, so that the word order remains the same:<sup>1</sup>

- (1) Unmarked broad focus statements (S)

- a. *Jedeme na chatu.* ‘We are going to a cottage.’
- b. *Jedeme na výlet.* ‘We are going on a trip.’
- c. *Jedeme na Moravu.* ‘We are going to Moravia.’
- d. *Zítřka jedeme na Moravu.* ‘Tomorrow we are going to M.’

- (2) Unmarked information-seeking yes-no questions (Q)

- a. *Jedeme na chatu?* ‘Are we going to a cottage?’
- b. *Jedeme na výlet?* ‘Are we going on a trip?’
- c. *Jedeme na Moravu?* ‘Are we going to Moravia?’

<sup>1</sup> The only exception is the question (2d), in which the topic *zítřka* (‘tomorrow’) is inverted (cf. 1d), since its initial position was leading to marked reading (e.g., echo question) in the pilot experiment.

d. *Jedeme zítřka na Moravu?* ‘Are we going to M. tomorrow?’

We chose for the NC only APs with three (or four) syllables so there would be enough tone-bearing units for the final rise in questions. We are aware that intonation contours may differ according to the number of syllables (see, e.g., [11], [17], [21], [22] for a discussion), but we believe that such variation is phonetic, and not phonological in nature.

After transcribing and segmenting the files by performing an acoustic analysis of all tokens in Praat ([25]), we labeled the tonal events, using the ToBI (Tone and Break Indices) system. So far there is no standardized Czech ToBI, although a preliminary proposal has been put forward (see [16]; for AM modeling see, e.g., [11]). Then, we measured: (1) the duration of all prenuclear accentual phrases (AP) and nuclear configurations (NC), and (2) the pitch height at three time points in the rhythmic group (AP: F0<sub>1</sub>, F0<sub>2</sub>, F0<sub>3</sub>, and NC: (F0<sub>3</sub>), F0<sub>4</sub>, F0<sub>5</sub>, F0<sub>6</sub>). Figures 3 and 4 illustrate an example of our analysis of one sentence pair produced by the same (female) speaker, who comes from Southeast Moravia:

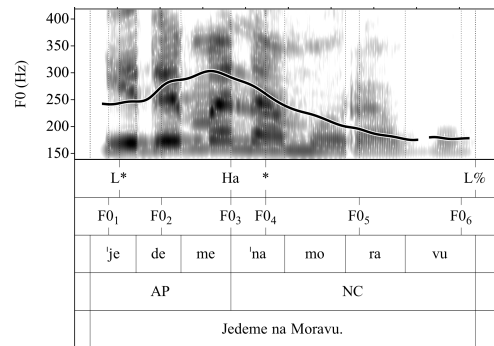


Figure 3: Spectrogram and F0 trace for the statement “Jedeme na Moravu” (speaker6-F).

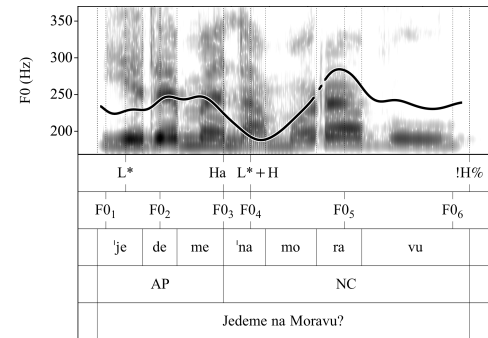


Figure 4: Spectrogram and F0 trace for the yes-no question “Jedeme na Moravu?” (speaker6-F).

Measurements were extracted with Praat scripts ([26], [27]) and afterwards corrected manually (some data were discarded due to the presence of creaky voice, especially in unstressed phrase-final positions in the production of several speakers).

As for the tonal analysis, the last \*σ has a high realization in statements due to a falling interpolation from the Ha to the L% (Fig. 3). In contrast, the \*σ in questions has a L\*+H, a low tone with a sharp post-tonic rise with the highest peak on the second syllable or – if the AP has more than three syllables – on the third syllable (Fig. 4). As for the realization of the first AP in this example, we find a rising (LH) pattern in the

statement (Fig. 3) and a moderate rising-falling pattern (LHL) in the question (Fig. 4). Notice that the AP in the statement has a larger pitch excursion and a higher initial pitch (F0: 233Hz) in comparison to the question (F0: 217Hz). The NC is realized here as a (H)\* L% in the statement and L\*+H !H% in the question.

Finally, linear mixed-effect regression models with pitch change and duration as the dependent variables, Sentence (Question / Statement), Dialect (Bohemian / Moravian) and Tonal Event (utterance-initial AP / utterance-medial AP / NC), as fixed effects and Participants as random effect were used to compare the pitch and durational patterns across groups.

#### 4. Results

Starting with final cues, we detected several interrogative realizations (Table 1, Fig. 5). Since the realization of the NC may vary across dialects ([17], [22]), we included “Dialect” as a potential source of the variability in the data. Contrary to our expectations, the L\*+H !H% was the predominant pattern across all varieties (the only exceptions are two speakers from Central Bohemia and two Moravian speakers, who produced questions systematically with a H\* LH% and a L\* H%, respectively).

Table 1: *Tonal inventory of yes-no questions.*

Tonal event	Bohemia (N=36)	Moravia (N=48)
H* LH%	22%	6,5%
L* H%	11%	21%
L*+H !H%	53%	64%
L*+H H%	11%	0%
L*+H LH%	3%	8,5%

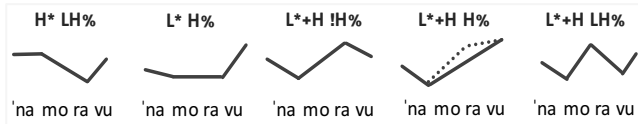


Figure 5: *Schematic representation of F0 patterns in questions (example of NC ‘na Moravu’).*

As for statements, we found two main nuclear contours: (H)\* L% and L\*+H L%. The latter pattern (Fig. 6) has been found in non-neutral declaratives [22] and it is supposed to have a more emphatic reading. In our data, the L\*+H L% was produced (although not systematically) in only 15 (out of 82) cases by eight speakers from different dialects:

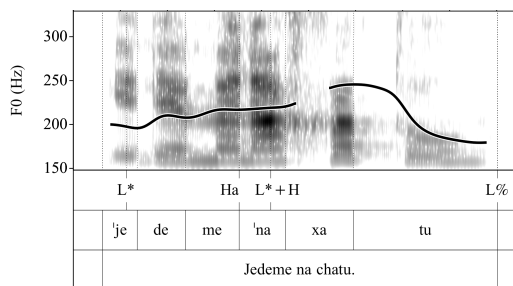


Figure 6: *Spectrogram and F0 trace for the statement ‘Jedeme na chatu’ (speaker13-F).*

Figure 7 illustrates the realizations described above in prenuclear (left) and nuclear (right) positions, as produced by seven representative speakers: a) East Bohemia (F), b) South-East Moravia (M), c) South-East Moravia (M), d) Central Bohemia (F), e) Prague (M), f) Prague (M), g) South-West Moravia (F):

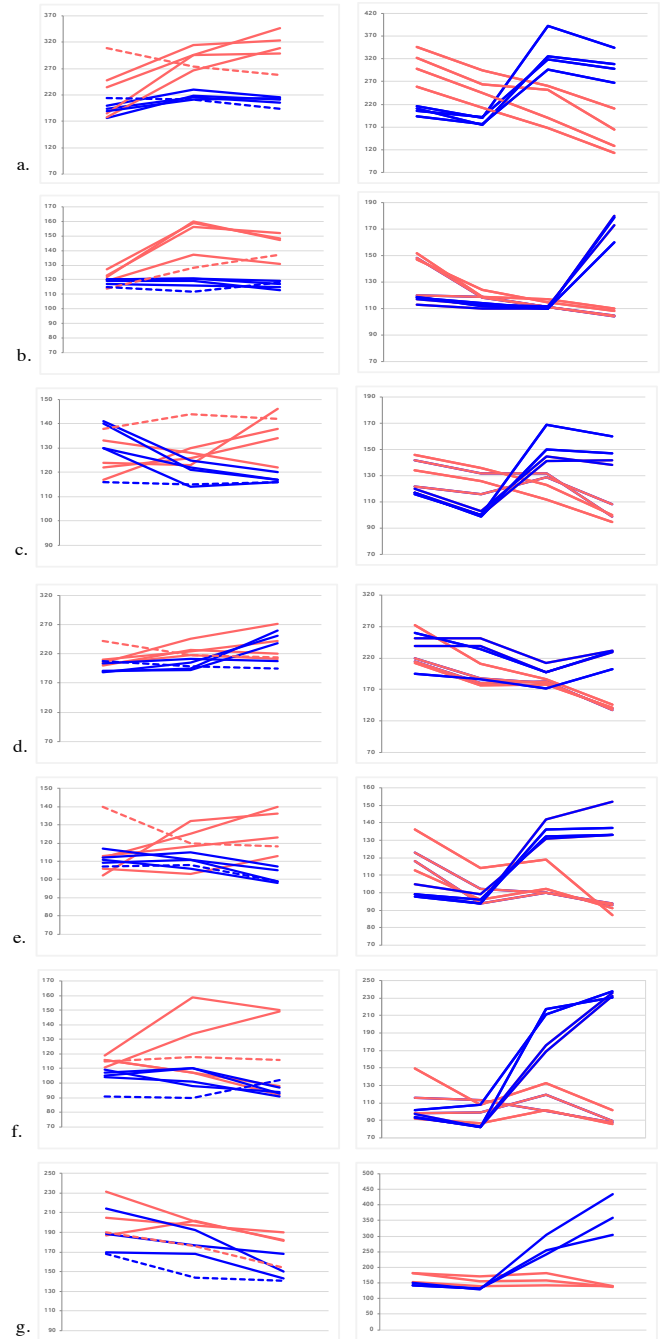


Figure 7: *F0 contours of prenuclear AP (left) and NC (right) in statements (red) and questions (blue). The dashed line represents the utterance medial AP.*

As for the initial prenuclear AP, the most frequent realization was a rising tone (LH) in statements (82%), in addition to other F0 shapes (L, H, HL, HLH). In contrast, initial APs in questions do not appear to be marked by a specific type of

contour. In this position, APs were realized with a low plateau, a rising-falling pattern or just a falling pitch among other L/H combinations. Utterance medial APs were produced at a lower F0 level in questions than in statements; they exhibited four patterns L, H, HL, LH (sustained H or L tones predominate and depend on the previous pitch contours but not on the sentence type).

There is a small difference between statements and questions as for the initial pitch: it is slightly higher in statements than in questions (S: Ø 5.9 ERB(F), 3.7 ERB(M); Q: Ø 5.7 ERB(F), 3.6 ERB(M)). Moreover, in comparison to statements (Fig. 8), the initial AP in questions exhibits a significantly smaller pitch excursion and a tendency for a sustained or falling F0 contour (we measured here only the difference between the initial and final F0 values of the AP) (u-initial AP,  $\beta = -.413$ ;  $t = -5.905$ ;  $p = .000$ ; u-medial AP,  $\beta = .163$ ;  $t = 1.160$ ;  $p = .254$ ).

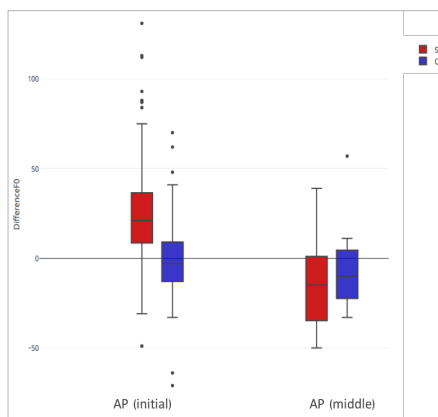


Figure 8: *Pitch change in each prenuclear tonal event in statements (red) and questions (blue).*

Regarding duration cues (Fig. 9), the results show significant differences in speech rates between the two sentence types: In prenuclear position, initial APs in questions are significantly shorter than those in statements (initial AP: median 35% (S) > median 32% (Q); ( $\beta = -.215$ ;  $t = -3.184$ ;  $p = .002$ ); in nuclear positions, we found the opposite trend (NC: median 61.5% (S) < median 65% (Q); ( $\beta = .228$ ;  $T = 2.991$ ;  $p = .003$ )). No significant differences were obtained for the factor *Dialect*, and no differences were found with utterance medial APs.

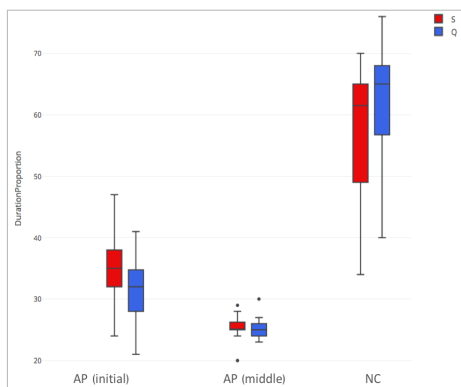


Figure 9: *Durational cues of AP and NC in statements (red) and questions (blue).*

## 5. Discussion and conclusion

In this paper we examined initial and final cues in Czech yes-no questions and we compared them with statements. Besides the expected intonational differences in the realization of nuclear contours in statements (fall) and yes-no questions (rise, rise-fall), we found that APs in statements tend to begin with a higher pitch than in questions. Thus, Czech (a phrase language) appears to differ from languages like Spanish, German or English (intonation languages), which use peak alignment and/or a high F0 peak to mark polar questions. Additionally, utterance-initial (as well as utterance-medial) APs in Czech questions exhibit a smaller pitch excursion than in statements, which is quite the opposite pattern to the one reported for German [6] or Spanish [7]. Moreover, Czech seems to behave as a language with local uses of duration (see [8] for different languages): Initial APs in questions have shorter duration than those in statements; NCs show an opposite trend and are significantly longer in questions than in statements. However, the utterance-medial APs as well as the total duration are not significantly different in questions and statements. This is not surprising, since the relationship between sentence modality and speech rate (in different parts of an utterance) is considered to be language-specific rather than universal (see, e.g., [8], [28], [29] for different languages).

In summary, our results confirm previous (cross-linguistic) research, which concluded that interrogative structures are more complex than declaratives. Indeed, interrogatives are marked by a combination of different strategies, which may range from F0 contours, duration cues, syntactic changes or use of particles, as shown in many European and African languages (see, e.g., [4], [28]).

Finally, our study opens avenues for further studies. First, given the variability observed in our data, it appears to be crucial to conduct more research in order to establish total inventories for different Czech dialects (see [11], [17], [22], [30] for a discussion). The division in Bohemian vs. Moravian dialects is very approximate, since there are probably further differences within these two main dialectal groups. However, shorter duration and/or pitch compression of APs in questions seem to be typical for all varieties of Czech. Second, there remains the question as to whether Czech native speakers/hearers are able to perceive and identify correctly a question before the final rise comes into play.

## 6. Acknowledgment

We would like to thank all the speakers who participated in our experiment.

## 7. References

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