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PERCEPTION OF CZECH IN NOISE: ONSET AND CODA IN MONOSYLABIC WORDS

Abstract

The research is focused on the perception of Czech samples in noise. It has been reported earlier that the number of syllables in a word and the quality of a syllable nucleus represented the most stable features in noisy conditions. In this contribution the influence of the structural and articulatory qualities of consonantal parts of syllables on the perception of words is examined. The analysis focuses on the monosyllabic words which enable reliable determination of onset and coda. The data obtained at two highest noise levels were used (10 tested items, evaluated by 300 listeners) and the attention was also paid to the influence of the noise level differences to the resistance of the parameters analyzed. In the analyzed set some tendencies are traced. The open vs. closed dichotomy is recognized with a high probability, especially significant for coda. The determination of the number of consonants in both positions is less successful. As to the analyses of phonemes, the correct identification of onset or coda as a whole is very low. On the contrary, the identification of individual consonants regardless of the whole cluster recognition and regardless of the order of consonants within the cluster is noticeably better and associated with some articulatory qualities relevant for the Czech phonological system. The consonants with tone characteristics (sonorants and voiced obstruents) were recognized with the greatest success. Slightly better results were obtained for consonants in the onset than in the coda. In the future it would be useful to examine polysyllabic words, relevant acoustic parameters and relation to the frequency of consonantal clusters in Czech.

Key words: monosyllabic words, perception of words in noisy conditions, Czech

1. INTRODUCTION

The extensive attention is paid to speech communication in adverse conditions and the examination of perception in noise is accepted as a legitimate source of valuable information in the research of speech material and its features (see e.g. Warren, 1996; Assmann & Summerfield, 2004).

This paper presents the results of a listening test focused on the perception of Czech words masked with noise. Despite the initial objective to evaluate perceptual skills of listeners, the broad range of the collected data provides information about the stability of phoneme inventory.

The number of syllables in a word and the quality of the syllable nucleus represent the most stable features in noisy environments (for more details see Veroňková & Palková, 2009). The results concerning monosyllabic words show an interesting inconsistency in this regard. The identification of monosyllabic words as a whole is less successful than that of polysyllabic words. On the contrary, the vowels forming the nucleus of monosyllabic words are identified better than the vowels in polysyllabic words, both in the initial position (in Czech stressed) and in other positions. The influence of onset and coda is probably the cause of this phenomenon. It may be assumed that the presence of onset and coda stabilizes the transient and supports the identification of a vowel, while the consonants are less resistant in noise and cause the greatest variability in incorrect answers. In this paper the first analysis focuses on the comparison of the consonant features in onset and coda gaining ground in the perception of monosyllabic words.

2. MATERIAL AND THE METHOD

The perceptual test was created in the 1970s and it has been in use until today. For the purpose of this research, judgments of 300 native Czech listeners are presented. Three homogeneous groups (100 listeners in each, students of the Faculty of Arts, Charles University in Prague, aged on average between 19 and 20 years) were chosen from the period of 1979 – 2007. The test was administered in groups of 10 – 20 people in the same sound-treated lecture room via loudspeakers (see Janota & Palková, 1985; Palková & Janota, 1995).

The main part of the test consists of 100 isolated Czech words arranged in five subsets of 20 words at five gradually increasing levels of white noise (L1 – L5, sound-to-noise ratio (SNR) in dB: +9, +6, +3, 0, -3). The task for the listeners was to write the word they hear. All items tested are nouns in the nominative singular and they are balanced according to their frequency (Jelínek et al., 1961) and to the word length in syllables and relatively balanced according to the types and the frequency of syllable structure (Kučera & Monroe, 1968). The speech material was read by a female speaker with standard pronunciation.

For the part of the research focused on the perception of onset and coda, the data of monosyllabic words (W1) obtained at two highest noise levels (L4: SNR – 0 dB, L5: SNR –3 dB) were used. The total of W1 in the set analyzed was 10 items (5 at each noise level), each evaluated by 300 listeners, i.e. the total number of judgments was 3000.

3. ONSET AND CODA IN MONOSYLLABIC WORDS: THE STABILITY FROM THE POINT OF THE PHONEMATIC STRUCTURE

Table 1.   The stability of the phonematic structure in onset and coda in monosyllabic words

Tablica 1.   Stabilnost fonemske strukture u početnom i završnom dijelu sloga u jednosložnim riječima

%		Onset				Coda			
		L4		L5		L4		L5	
		Av.	SD	Av.	SD	Av.	SD	Av.	SD
1	+	100	0.0	100	0.3	97	3.8	98	2.1
2	nC	75	14.0	26	12.0	86	8.6	66	35.4
3	n2C	76	13.9	29	11.0	70*	-	23	1.7
4	n1C					90	3.1	95	1.9
5	id	46	27.6	26	26.8	53	32.3	22	5.6
6	2C-id	38	25.2	27	29.7	68*	-	23	2.5
7	1C-id					50	35.2	22	6.9
8	C	65	17.5	59	15.9	58	33.6	41	24.4
9	2C	54	15.1	58	17.6	84*	-	70	6.5
10	1C					52	34.7	22	8.4

* The value is based on the perception of a single word.
* Vrijednost je temeljena na percepciji jedne riječi.

L4, *L5* – noise levels, *Av.* – average, *SD* – standard deviation, *C* – consonant
L4, L5 – razina buke, Av. – prosjek, SD – standardna devijacija, C – konsonant

Row 1:   the correct identification of the presence (+) of onset and coda
Red 1:   točno prepoznavanje postojanja (+) početnog i završnog dijela sloga
Rows 2 – 4:   the correct identification of the number (n) of consonants in onset and coda
Redovi 2 – 4: točno prepoznavanje broja konsonanata (n) u početnom i završnom dijelu sloga
Rows 5 – 7:   the completely correct identification of onset and coda (id)
Redovi 5 – 7: u cijelosti točno prepoznavanje početnog i završnog dijela sloga (id)
Row 8 – 10:   the correct identification of single consonants in onset and coda
Redovi 8 – 10:točno prepoznavanje pojedinačnih konsonanata u početnom i završnom dijelu sloga

Table 1 presents the global results of the material analyzed. A rather high standard deviation shows significant differences among single tested items. Nevertheless the results imply several hypothetical conclusions.

3.1. Syllable character regarding the open vs. closed syllable dichotomy

The presence of both onset and coda in W1 (Table 1, row 1) is reflected in the perception with a high probability; the difference between the noise levels is not significant. The result implies that the character of a closed syllable is reflected even in noise conditions. The tested W1 are built just by closed syllables. However, the hypothesis about the stability in the recognition of syllable with coda is supported also by the data obtained from the set of di- and trisyllabic words containing both kinds of the syllables. The differences in the perception of open/closed syllables are in all cases statistically significant (test χ^2, $p < 0.01$). The range for disyllabic words is 80 – 90 %; in the material the only lower recognition of syllables as being closed concerns trisyllabic words (53 %) and it is influenced by two frequent exchanges which seem to be morphologically motivated (for the influence of a morphological structure on the perception of words in speech see e.g. Erdeljac & Horga (1999)).

3.2. The identification of the number of consonants in onset and coda

The correct identification of the number of consonants in onset and coda is much lower than the identification of the open/closed character of the syllable (compare rows 1 and 2 in Table 1) being also more noticeably influenced by the noise conditions: The items with polyconsonantal onset or coda reflect the increased level of noise in apparently less successful identification. However, the interpretation of data must include the fact that configurations of syllables are not represented equally in the set of tested W1. There prevail polyconsonantal onsets and conversely, prevailing codas are monoconsonantal. The better results in coda in general are certainly affected by this. If comparing the set of words with binomial onset and binomial coda (row 3), the rate of correct identifications is nearly in level in both, with a slightly better result for the onset.

3.3. The identification of single consonant phonemes in onset and coda

The completely correct identification of onset and coda (including the order of consonants) is even lower than the determination of the number of consonants (Table 1, rows 5 – 7). The worsening of conditions influences the perception: the correct identification decreases between L4 and L5 noise levels both in onset and coda, and even in monomial coda.

Another picture is provided by the share of correctly identified individual consonants in the onset and coda regardless of the recognition of the whole group and regardless of the consonant order within the group (Table 1, rows 8 – 10). In that case the difference in noise levels is perhaps not the factor that affects the result of identification of consonants the most – the quality of the consonants themselves probably plays a role.

4. THE STABILITY OF CONSONANT PHONEMES QUALITY IN ONSET AND CODA

With regard to the structure of tested items (10 tested words, 3000 of judgments) the potential number of consonants is 6300 in the onset and 3900 in the coda. The actual number of analyzed consonants is based on the number and structure of correctly identified words and on the number and structure of incorrectly identified words with correctly determined number of one syllable. The total is 4829 of consonants in the onset and 2657 consonants in the coda. In light of the above-presented results (see 3.3) we merge the results for the noise levels.

The differences in potential stability between the onset and coda are examined on the basis of several parameters representing relevant features in the Czech consonantal system, especially related to the place and manner of articulation (see Table 2).

Table 2.   The correctly identified consonants according to the articulatory characteristics

Tablica 2.   Točnost prepoznavanja konsonanata prema artikulacijskim karakteristikama

	Onset		Coda		Parameter	Onset		Coda	
Parameter	%	n	%	n		%	n	%	n
Labials	37.9	2751	21.0	680	Obstruents: voiced	67.2	1441		
Anteriors	49.7	2338	78.2	1563	Obstruents: unvoiced	38.4	3086	100.0	2284
Palatals	36.8	2523			Stridents	22.5	2436	15.1	1261
Velars	9.7	454	52.0	804	Sonorants: nasals	57.5	974		
Obstruents: plosives	29.3	2771	61.5	1634	Sonorants: non-nasals	41.7	3199	93.0	302
Obstruents: fricatives	49.6	2436	46.6	1760					

n – total number of the occurrences
n – ukupni broj pojavljivanja

The gaps in the table are a consequence of the fact that some articulatory types in a particular position were not represented enough in our set or they do not exist in the language all together (e.g. voiced obstruents in the coda of isolated words). The disparity of the sample warns against hasty conclusions; however the results still show certain tendencies.

According to the expectation there is a higher stability among voiced obstruents and sonorants while nasal sonorants are better identified than non-nasal sonorants. Certain differences appear in the identifying consonants in the onset and coda. Preservation of anteriors and plosives is in this respect significantly better in the coda than in the onset. It needs to be added that regarding the analyzed set we deal with mutually binding variables. Anterior plosives are robustly represented in the tested W1, in coda prevailing. Also the high recognisability of palatals is influenced by mutual interconnection: mainly palatal sonorants were represented.

Moreover Table 2 does not show where and how frequently the individual categories were used by listeners in words, which were incorrectly substituted.

A somewhat closer picture, yet still a rather tentative one, can be provided by comparison of coefficients ϕ elicited for certain oppositions relevant for the differentiation of phonemes in Czech. (The basics is the calculation of the value χ^2 (by df1) taking in consideration the amount of data.) In case of the words with diconsonantal onset the values for the consonant immediately next to the nucleus are presented, which is in accordance with the values for the coda. The satisfactory correlation is obtained mainly in the recognition of the features sonority and voicing: nasals/rest: $\phi = 0.66$ (n: 4147), sonorants/rest: $\phi = 0.46$ (n: 4147), obstruents – voiced/unvoiced: $\phi = 0.56$ (n: 2814). In the set of W1 these characteristics previously occur in onset. Comparing the results between the onset and the coda, where possible, the identification of consonants seems a little bit more successful in the onset (on the contrary to the data in Table 2). Samples: obstruents – plosives/fricatives: onset $\phi = 0.50$ (n: 2814); coda $\phi = 0.17$ (n: 2284), anteriors/rest onset $\phi = 0.44$ (n: 4510), coda $\phi = 0.36$ (n: 2616) (compare Alwan et al., 1999; Chen & Alwan, 2003; Meyer & Morse, 2003; Lecumberri & Cook, 2007).

It is worth mentioning that the result is strongly related to the position immediately next to the nucleus, i.e. to the direct influence of the transient. The contact with the nucleus is important also for consonants in coda. For example the probability of correct identification is increased by the preceding nucleus especially in fricatives. In future research the examination of the relevant acoustic parameters of individual categories of phonemes would be worthwhile, in this case for instance the duration (cf. e.g. Horga, 1995).

5. CONCLUSION

In spite of certain inconsistencies in the analyzed material, the examination of consonantal parts of monosyllabic words in their perception in noise gives some positive results. The presence of both onset and coda is recognized with a high significant probability. By comparison, the correct determination of the number of consonants in both positions is lower and the results decrease with the increasing noise level. Even lower is the completely correct identification of onset and coda and it is strongly influenced by noise level, too. In spite of this, better results on correctly

identified individual consonants regardless of the whole group recognition, and the order within the group show importance of the qualities of the consonants themselves. As expected, consonants with tone characteristics are more successfully recognized. Next to the sonorants Czech listeners seem to be sensitive to the voiced/voiceless contrast within the obstruents. Regarding the articulatory characteristics that underlie phonological oppositions of consonants in Czech, our sample implies slightly better results for consonants in the onset than in the coda. In future research it would be profitable to expand the material, especially with polysyllabic words, to analyze the relevant acoustic parameters and to take more into account the frequency of consonantal clusters in Czech.

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PERCEPCIJA ČEŠKOG U BUCI: POČETNI I ZAVRŠNI DIO SLOGA U JEDNOSLOŽNIM RIJEČIMA

Sažetak

Istraživanje se bavi percepcijom češkog u buci. Prijašnja su istraživanja pokazala da su broj slogova u riječi i kvaliteta jezgre sloga najstabilnija obilježja u bučnim uvjetima. U ovom se radu istražuje utjecaj strukturnih i artikulacijskih karakteristika konsonantskih dijelova slogova na percepciju riječi. Govorni materijal sastoji se od jednosložnih riječi koje omogućuju pouzdano određenje početnog i završnog dijela sloga. Upotrijebljeni su podaci s dvije najviše razine buke (300 slušača procjenjivalo je deset testnih uzoraka). Također se promatrao utjecaj različitih razina buke na stabilnost promatranih parametara. Rezultati su pokazali visoku razinu pouzdanosti razlikovanja otvorenih i zatvorenih slogova, posebno u završnim dijelovima slogova. Nešto je manja uspješnost razlikovanja konsonanata bez obzira na položaj. Analiza fonema pokazala je da je točnost identifikacije cijelih početnih i završnih dijelova slogova vrlo niska. Suprotno tome, identifikacija pojedinih konsonanata znatno je bolja, bez obzira na prepoznavanje cijele skupine glasnika i bez obzira na mjesto konsonanta u skupini te je povezana s nekim artikulacijskim kvalitetama bitnim za češki fonološki sustav. Konsonanti sa zvonkim karakteristikama (sonanti i zvučni pravi konsonanti) visokog su stupnja prepoznatljivosti. Nešto bolju prepoznatljivost pokazali su konsonanti u početnom dijelu sloga. Ovo bi istraživanje trebalo proširiti i na višesložne riječi, na relevantne akustičke parametre, a rezultate bi trebalo tumačiti s obzirom na učestalost konsonatskih skupina u češkom.

Ključne riječi: jednosložne riječi, percepcija riječi u buci, češki jezik