



## Distinctive Features of Phonemes and First Language Acquisition by a Normally Developing Child Without Hearing Impairment: Evidence from Slovak<sup>1</sup>

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**Abstract**

Speech audiometry uses various types of perceptual tests for the diagnostics of hearing impairment. One of them is a matrix test (Akeroyd et al., 2015), originally prepared for adults, which fully respects the phonological rules of a language, including neutralizations of phonological oppositions based on distinctive features. The shorter version of this test, a so-called reduced matrix test, can be helpful in speech audiometry focusing on children and infants. The goal of our paper is to find out if distinctive features of phonemes are important in the process of first language acquisition. If yes, reduced matrix test aimed at children and infants can be created as a mere simplification of the matrix designed for adults (Panocová & Gregová, 2019). However, if distinctive features do not affect first language acquisition, completely new matrix has to be prepared for infants. The research was based on the longitudinal observation of two infants whose mother tongue is Slovak.

### 1. INTRODUCTION

A matrix test is one of the latest types of perceptual tests used in speech audiometry to diagnose the degree and nature of hearing impairment. The first matrix test<sup>2</sup> was introduced by Hagerman (1982), and later it was improved by Wagner et al. (1999a,b,c). Detailed guidelines for constructing the matrix test and comparing it to the other type of speech test, the digit triplet test, as developed by the ICRA (International Collegium of Rehabilitative Audiology) working group on Multilingual Speech Tests, can be found in Akeroyd et al. (2015). Following Akeroyd et al. (2015, p. 3), the main linguistic characteristics of the matrix test are as follows:

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<sup>2</sup> Matrix test “consists of five-word long sentences, each of which has the same syntax but is not necessarily meaningful, i.e. the semantic content is unpredictable (e.g. ‘Thomas wins eight red shoes’; ‘Kathy bought two dark spoons’)” (Akeroyd et al., 2015, p. 3). The test is used for speech intelligibility testing.

1. the base matrix is to consist of 50 words (10 names, 10 verbs, 10 numerals, 10 adjectives, 10 objects),
2. word order is language-specific but fixed in all generated sentences,
3. sentences must be grammatically correct, but they do not have to be meaningful,
4. the pronunciation of words should be equal across all possible word combinations in the sentence,
5. the number of syllables within word groups should be balanced,
6. selected words should contain the phonemes with the highest distribution in the given language, and
7. semantically neutral words with high frequency (in corpora, dictionaries, etc.) should be preferred to be familiar to children.

In the first stage of our research (Panocová & Gregová, 2019), we provided a comprehensive description of the whole linguistic process connected with preparing such a test in Slovak, a language with rich inflectional and derivational morphology, as well as abundant neutralization processes at word edges. Both the morphological and the phonological properties of the language are crucial for selecting the individual linguistic items used in the given matrix test, as is clear from the criteria specified for the matrix.

The neutralization of the phonological opposition of voice (also known as the assimilation of voicing) is the most important feature of correct pronunciation in Standard Slovak. This is a regressive type of assimilation that occurs at the boundary between (1) two words, (2) prefix and word base, (3) word base and suffix, and (4) two-word bases. The basic rule can be simplified as follows: (1) when a voiceless obstruent follows a voiced obstruent, the voiced obstruent also becomes voiceless, and (2) when a voiceless obstruent is followed by a voiced obstruent, a sonorant or a vowel, the voiceless obstruent becomes voiced (see, e.g., Král', 2005, pp. 55–63). As a result, when selecting linguistic items for the matrix, all words in the 'adjective' position end in the voiceless obstruent *ch* /x/, as, for example, in *žltých* 'of the yellow'. This is determined by the morphological rules of Slovak and by the syntactic position of the given item in a sentence. Thus, to follow the rules of the neutralization of voice, all the items in the 'object' position had to start with either a voiced segment or a voiceless one, but it was not possible to select words starting with both types of sounds (for the whole matrix for Standard Slovak, see Panocová & Gregová, 2019).

The second stage in our research is preparing a so-called reduced matrix test that can be used in speech audiometry focused on children and infants. However, before completing this task, one important question has to be answered: Are phonological oppositions based on distinctive features of phonemes important in early first-language acquisition? If yes, the design of the reduced matrix is very simple – it is sufficient to curtail the matrix prepared for adults. However, if the answer is no, a completely new matrix has to be prepared for infants.

Consequently, our present study aims to investigate the acquisition of Slovak as a first language based on distinctive features theory. The paper is designed as follows. First, the language acquisition process will be briefly introduced; then, we will concentrate on distinctive features of phonemes in Standard Slovak. Finally, the acquisition of consonants in terms of their distinctive features will be presented as a result of the longitudinal observation of two

children aged between 0–6. The interpretation of the obtained data and ideas for further research are presented in the concluding section.

## 2. LITERATURE REVIEW

### 2.1. First-language acquisition in brief

The acquisition of a mother tongue is a fascinating process. Young human has only a few years of their early life to get familiar with the lexicon and the various linguistic and pragmatic rules governing the usage of words in communication (Schmidt, 2008). Universally speaking, the whole acquisition process can be divided into several stages, starting with vocalization, babbling, and ending with speech (for details, see, e.g., Steinberg & Sciarini, 2006, pp. 3–34). The acquisition of speech sounds follows certain, and we may even say universal rules. As is well-known, the consonants /p/, /b/ and /m/ are usually the first to be produced by a child. The sounds /t/ and /d/ follow. Consonants like /k/ and /x/ are usually the last to be articulated by children<sup>3</sup>. Various theories explain the order in which consonants are produced in the first-language acquisition process. Some researchers explain the ordering by the place of articulation. Specifically, a front-to-back order is decisive (for further details, see, e.g., Braine, 1971; Ferguson & Garnica, 1975; Steinberg & Sciarini, 2006).

Nevertheless, Jakobson (1968) and his followers claim that the order in which infants articulate consonants depends on the distinctive features of those sounds. Although, at first sight, it seems that the front-to-back order theory and order depending on distinctive features represent two completely different approaches to the issue of the ordering of sounds in the process of first-language acquisition, the opposite is true. Distinctive features are given by sounds' articulatory and acoustic properties (including the place of articulation). Thus we predict that Jakobson's idea about their importance in the acquisition of consonants may have relevance, as we will illustrate below.

### 2.2. Distinctive features of Slovak consonant phonemes

In Standard Slovak, there are 27 consonant phonemes (see Table 1 for the phonetic classification of Slovak consonant phonemes), of which 20 are obstruents, and 7 are sonorants.

manner/ acoustic imp.	voicin g	Place							
		bilab ial	labiode ntal	alveolar		palato - alveol ar	Palata l	vel ar	glott al
				pre- alveol ar	post- alveol ar				
stop/plosiv e	voicel ess	p		t		c		k	
	voic d	b, m		d, n		ʃ, ɲ, ʎ		g	
spirant/ fricative	voicel ess		f	s	ʃ			x	
	voic d		v	z	ʒ, r, l		ʝ		h

<sup>3</sup> Taking the fact that vowels do not tend to cause difficulties when acquired by infants into account, we will concentrate on consonants alone.

semi-occlusive/ affricate	voicel ess			ts	tʃ				
	voice d			dz	dʒ				

**Table 1.** Phonetic classification of Slovak consonants<sup>4</sup> (Gregová, 2022, p. 57)

Following the original conception of distinctive features as proposed by Jakobson and Halle (1956), Sabol (1989, pp. 283–285; see also Gregová, 2022) delimited the following distinctive features for Slovak consonant phonemes:

1. diffuse (D)–non-diffuse (D<sup>0</sup>): diffuse sounds are those articulated in the front part of the oral cavity, that is, bilabial, labiodental, and pre-alveolar consonants;
2. acute (A)–non-acute (A<sup>0</sup>): acute consonants are articulated in the middle of the oral cavity (alveolar and palatal sounds);
3. occlusive (O)–non-occlusive (O<sup>0</sup>): occlusive sounds are stops in terms of the manner of articulation and semi-occlusives that also have the closure phase;
4. lateral (Lt)–non-lateral (Lt<sup>0</sup>): lateral consonants are characterized by a special type of obstacle created with the tip of the tongue while air passes freely via the sides of the tongue;
5. strident (S)–non-strident (S<sup>0</sup>): strident consonants have great noisiness, acoustically speaking;
6. voice (Vc)–non-voice (Vc<sup>0</sup>): the phonemes /b, d, ʃ, g, dz, dʒ, z, ʒ, h, v/ are voiced, and the phonemes /p, t, c, k, ts, tʃ, s, ʃ, x, f/ are voiceless; and
7. nasal (N)–non-nasal (N<sup>0</sup>): in Standard Slovak, only the phonemes /m, n, ŋ/ are nasal.

The distinctive features of sonorants and obstruents are captured in Table 2 and Table 3, respectively.

	r	l	ʎ	m	n	ɲ	j	v
V	+	+	+	+	+	+	+	+
C	+	+	+	+	+	+	+	+
D	+	+	-	+	+	-	-	+
A	+	+	+	-	+	+	+	-
Lt	-	+	+	0 <sup>5</sup>	0	0	-	+
N	-	-	-	+	+	+	-	-

**Table 2.** Distinctive features of Slovak sonorants (Kráľ & Sabol, 1989, p. 286)

<sup>4</sup> IPA symbols have been used to note down Slovak consonant phonemes.

<sup>5</sup> A phonemic zero (0) indicates that the given feature is irrelevant for the delimitation of the given phoneme.

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	p	b	f	v <sup>6</sup>	t	d	s	z	ts	dz	ʃ	ʒ	ʧ	ʤ	c	ɟ	k	g	x	h
<b>V</b>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>C</b>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<b>D</b>	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
<b>A</b>	-	-	-	-	+	+	-	-	+	+	+	+	+	+	+	+	-	-	-	-
<b>O</b>	+	+	-	-	+	+	-	-	+	+	-	-	+	+	+	+	+	+	-	-
<b>S</b>	0	0	0	0	-	-	+	+	+	+	+	+	+	+	-	-	0	0	0	0
<b>Vc</b>	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+

**Table 3.** Distinctive features of Slovak obstruents (Kráľ & Sabol, 1989, p. 287)

### 2.3. The acquisition of Slovak as a first language

#### 2.3.1. A summary of the previous research in this field

Research on children's acquisition of speech has been intensive since the 1950s. Researchers (see, e.g., Kutáľková, 2002; Slančová, 2008) agree that in Slovak, the first consonants children can articulate are usually the bilabial sounds /p, b, m/ followed by the alveolars /t, d, n/ and the labiodentals /f/ and /v/. Those categories of sounds are characterized by a relatively undemanding articulatory structure that is easily observable. The child usually acquires these sounds by the age of three. The articulation of the velars /k/ and /g/ comes later due to the more complex production process of those sounds, approximately by the age of four or five. At that time, the child also articulates the sounds /j, x, h/ as well as /c, ɟ, ɲ/ and sibilants. The hissing sibilants /s, z, ts, dz/ are usually produced prior to the articulation of the hushing sibilants /ʃ, ʒ, ʧ, ʤ/. The consonants /l, ʎ, r/ are the last to be acquired, typically by the age of six or seven (see, e.g., Pačesová, 1968; Ohnesorg, 1974; Vyštejn, 1995; Dvořák, 1998; Kutáľková, 2002).

## 3. METHODOLOGY

### 3.1. A summary of the results of the current research<sup>7</sup>

In the present research, we observed the speech development of two children: a girl, Sofia (born 29/9/2015), and a boy, Janko (born 6/9/2016). Since we were in daily contact with both children, it was very easy to watch the gradual acquisition of individual speech sounds, make notes, and evaluate the data obtained on the basis of their comparison with other similar research (see above). Fortunately, both children are developing normally and without any impairment that may accompany the complicated process of first-language acquisition. Although Janko was only six at the time of the research, he was already articulating all speech sounds, as well as Sofia, did at the age of six.

<sup>6</sup> In Standard Slovak, the phoneme /v/ functions both as a sonorant and as an obstruent.

<sup>7</sup> The aim of this paper is not to analyze the phonological development of children's speech but to prove or disprove the assumption that the distinctive features of phonemes are important in the process of first-language acquisition. That is why we provide only a summary of the ordering of consonants' pronunciation. This is merely the starting point for the core of our research – the application of distinctive features of phonemes.

Our results reflect the speech development standards typical of Slovak, as presented above in section 2.3.1. The first consonants were those articulated with the lips, that is, /p, b, m/. The acquisition of /t, d, n/ was almost simultaneous with the acquisition of /f, v/. Sofia also acquired /s/ and its voiceless counterpart /z/ together with non-sibilants. This can be explained by her very frequent exposure to this sound because it is the first sound of her name. Janko started producing sibilants a bit later after the acquisition of /b, d, j, g, f, v/. By the end of the fifth year of their lives, both children clearly articulated all consonants in all word positions except for /l/ and /r/. It is very difficult to pronounce these two sounds properly due to the complicated position of their articulators, especially the tongue. Sofia had a little difficulty with the production of /l/, which was frequently replaced with /l/. But concentrating on this sound in the speech of adults who communicated with her helped her to overcome this obstacle. By the age of 5 years and 7 months, she had mastered the whole consonant inventory of Standard Slovak. As for Janko, by the age of 4–5, his speech was full of palatalized sounds /c, ě, ň, ě/ and hushing sibilants /š, ž, ť, dž/, which was probably the result of the slightly affected, cuddly communication of his mother. For example, he said *ja šom* /ja šom/ instead of *ja som* ‘I am’ and *čem to* /šfem to/ instead of *xcem to* ‘I want it’. However, this imperfection disappeared as soon as his mother started communicating with him in a standard way.

All in all, the acquisition of the consonant sounds of these two children between the ages of 0–6 corresponds with general standards and expectations, and no deviations were detected.

## 4. RESULTS AND DISCUSSION

### 4.1. The acquisition of sounds and their distinctive features

The phonological interpretation of the data from the viewpoint of the distinctive features of phonemes is as follows:

#### By the age of three:

/p/ [+diffuse, -acute, +occlusive, -voice]  
 /b/ [+diffuse, -acute, +occlusive, +voice]  
 /m/ [+diffuse, -acute, +nasal]

/t/ [+diffuse, +acute, +occlusive, -voice]  
 /d/ [+diffuse, +acute, +occlusive, +voice]  
 /n/ [+diffuse, -acute, +nasal]

/f/ [+diffuse, -acute, -occlusive, -voice]  
 /v/ [+diffuse, -acute, -occlusive, +voice]

#### By the age of four or five:

/k/ [-diffuse, -acute, +occlusive, -voice]  
 /g/ [-diffuse, -acute, +occlusive, +voice]



/j/ [-diffuse, +acute]

/x/ [-diffuse, -acute, -occlusive, -voice]

/h/ [-diffuse, -acute, -occlusive, +voice]

/c/ [-diffuse, +acute, +occlusive, -strident, -voice]

/ɟ/ [-diffuse, +acute, +occlusive, -strident, +voice]

/p/ [-diffuse, +acute, +nasal]

/s/ [+diffuse, -acute, -occlusive, +strident, -voice]

/z/ [+diffuse, -acute, -occlusive, +strident, +voice]

/ts/ [+diffuse, +acute, +occlusive, +strident, -voice]

/dz/ [+diffuse, +acute, +occlusive, +strident, +voice]

/ʃ/ [-diffuse, +acute, -occlusive, +strident, -voice]

/ʒ/ [-diffuse, +acute, -occlusive, +strident, +voice]

/tʃ/ [-diffuse, +acute, +occlusive, +strident, -voice]

/dʒ/ [-diffuse, +acute, +occlusive, +strident, +voice]

#### **By the age of six:**

/l/ [+diffuse, +acute, +lateral, -nasal]

/ʎ/ [-diffuse, +acute, +lateral, -nasal]

/r/ [+diffuse, +acute, -lateral, -nasal]

It is clear that the first distinctive feature that enters the speech of a child is Diffuse, followed by Occlusive. Acute enters the speech as the third feature almost simultaneously with Nasal. Strident follows, followed by Lateral as the last feature (similar results were reported by Bónová, 2016). In terms of the articulatory and acoustic properties of sounds, Diffuse is connected with the articulation in the front part of the oral cavity (lips, teeth, tongue, and alveoli), which is the easiest from the viewpoint of the gradual development of fine motorics of articulators. The first sounds of /p/ and /b/ are the result of a kind of “playing” with articulators. Thus, the first manner of articulation a child gains is the creation of a complete obstacle, as is the case with /p/ and /b/, for example. This explains the occurrence of the feature Occlusive. In the second stage of first-language acquisition, articulation in the central part of the oral cavity follows, as is reflected in the appearance of the features Acute and Nasal, which depends on the movement of the soft palate. Strident mirrors noisiness in the acoustic evaluation of a sound and requires a certain degree of phonological awareness. This explains its occurrence only by the age of four (or five). Lateral is the last feature to appear, reflecting its status as the most complicated type of articulation (see Table 1). The consonant /r/ is the last to enter into a child’s speech due to its complicated method of articulation. First, a child uses /j/ instead of /r/ (phonological opposition diffuse–non-diffuse), and later /l/ is used instead of /r/ (opposition lateral–non-lateral). A child realizes the difference between /r/–/j/ and /r/–/l/; however, s/he cannot apply the difference in the pronunciation. Consider, for example,

Child: ...*budeme tam jáno.*

Mother: *Jano?*

Child: *Mami, nie Jano, ja myslím jáno...*

(*ráno* vs. *Jano* = morning vs. John).

The feature Voice appears in speech from the very beginning of children's mastery of speech sounds. In Slovak, similar to many other languages, this feature is important for making a difference between two phonemes that are identical in all their other articulatory and acoustic properties (that is, all the other distinctive features) and differ in terms of voicing only, such as, for example, /p/–/b/, /t/–/d/, /s/–/z/, etc. Apparently, this feature is part of the phonological awareness of a child from the very beginning of their speech acquisition.

What follows from this is that the ordering of the distinctive features of consonant phonemes in the whole process of speech acquisition corresponds with the front-to-back theory. This finding proves the well-known fact that distinctive features, despite being theoretical constructs, reflect articulatory and acoustic properties of sounds (see, e.g., Giegerich, 1992). In addition, Jakobson's idea about the universal order of sound acquisition was partly supported also by Ferguson and Farwell (1975).

## 5. CONCLUSIONS

This research, which aimed to carry out a longitudinal study of the development of consonants by two children mastering their mother tongue, shows that the acquisition of consonants and the gradual development of speech organ motorics – as indicated by previous research – is the basis for an individual's phonology (see Ferguson & Farwell, 1975). Phonetic development (the ability to use articulators) goes hand in hand with phonological development and is reflected in the gradual application of individual distinctive features, as originally proposed by Jakobson (1968). This means that the reduced matrix test, applicable in speech audiometry focused on children and infants, can be designed – at least in the Slovak context – as a mere reduction of the matrix test prepared for adults, and no special linguistic rules need to be included in the matrix test for children.

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