MARTA WYSOCKA
UMCS Department of Logopedics and Applied Linguistics

Assessment of Perception of Speech Prosody

SUMMARY

Speech prosody, on account of its many functions, is a very important constituent of the linguistic communication process. It fulfills a special role in speech ontogeny, being the child's source of information on the structure and meaning of language elements. Already at the earliest stage of speech development the child shows sensitivity to prosodic features. Some scholars maintain that prosodic perception is associated with the fact that within phonematic hearing there are some specific processes called prosodic hearing.

The paper briefly discusses selected, mainly Polish, studies on the perception of speech prosody with special attention paid to its development in speech ontogeny. It also presents proposals for a diagnostic tool for the assessment of development of prosodic hearing.

Key words: Speech prosody, prosodic hearing, development of prosody perception

The assessment of prosody perception in speech ontogeny appears significant because of the role that prosody plays in the process of linguistic communication. Prosodic structures are the first to be acquired in speech ontogeny and at its early stages they are the child's most important source of information about the structure and meaning of language elements. Prosody is attributed with linguistic functions (delimitation, segmentation, signaling by means of specific intonation contours of particular types of utterance, emphasizing of significant meaningful units), paralinguistic ones, chiefly associated with expressing emotions and the sender's attitude to the message content, and extralinguistic functions relating the sender's characteristics: gender, age, and socioeconomic status.

Prosodic phenomena are regarded as an element common to speech and music. Students of the problem point out numerous analogies pertaining to the construction of language and music structures and the cerebral organization of perception processes of speech and music, as well as connections of prosodic disorders with disorders of music perception and expression. The subject of research is also the effect of musical hearing on the development of phonological awareness. We should add that underlying prosodic and musical phenomena are changes in the same psychoacoustic parameters: pitch, volume, sound duration, and tone; prosodic units have their equivalents in musical units. Research also confirms the effect of musical stimulation on speech development, particularly prosody. These facts permit a conclusion that the development of prosodic hearing is connected with the development of music perception (cf. Wysocka 2010).

PROSODIC HEARING

Within phonematic hearing some researchers distinguish specific processes responsible for the perception of prosodic phenomena, calling them prosodic hearing or musical hearing to stress the features shared by speech and music, and interrelations of mechanisms of their perception..

According to M. Klimkowski, phonematic hearing is the ability to differentiate phonemes (phonematic hearing) and suprasegmental elements: tone of voice, utterance melody, its rhythm and rate. Klimkowski emphasizes the common determinants of phonematic and musical hearing, asserting that speech development is conducive to the development of musical hearing (Klimkowski 1976: 76-77).

L. Kaczmarek (1977: 280-281) distinguishes musical hearing associated with differentiation and reproduction of pitch, tone and volume. He also points to the musicality of prosodic units realized in speech melody, rhythm and stress.

In B. Rocławski's approach, phonematic hearing is divided into phonemic and phonetic hearing. Phonetic hearing, associated with musical hearing, is responsible for the perception of the same class of sounds and for the perception of prosodic phenomena of speech. (Rocławski 1993: 20-21). The author reports that five-year-old children, especially girls, have already well-developed phonetic hearing. They respond to changes in intonation, stress position, sound duration and in articulation (Ibid: 26-27).

Z. M. Kurkowski, on the basis of the conception of hearing functions, distinguishes within phonematic hearing the following: phonemic hearing consisting in distinguishing between phonologically different utterances and in identification of phonologically the same utterances; phonetic hearing – distinguishing between sounds of the same class (phoneme); prosodic hearing

responsible for differentiation of the utterance's prosodic elements: stress, melody, rhythm, as well as for the analysis and synthesis of sounds and syllables (Kurkowski 1998: 289).

A. Domagała and U. Mirecka make an even more in-depth division of phonematic hearing. They emphasize that it serves the child in order to acquire phonological competence at the segmental and suprasegmental level, and to receive non-systemic features of speech, essential in the communication process. They distinguish phonemic hearing, associated with the segmental dimension of the phonological subsystem; phonological prosodic hearing associated with the perception of phonological suprasegmental features; segmental phonetic hearing - sound hearing - covering sound profiles i.e. their features not fulfilling phonological functions; and prosodic phonetic hearing responsible for the perception of non-systemic prosodic information determined by individual differences (Domagała, Mirecka 2001: 66).

DEVELOPMENT OF PERCEPTION OF PROSODY

The perception and expression of prosodic elements performs a significant function in language acquisition (Doherty et al. 1999; Pinker 1987). The results of studies (inter alia Juszczyk et al. 1993) show that sensitivity to prosodic factors is already characteristic of babies who respond to modifications of prosodic features and to the emotional coloring of utterances. Child-directed speech is rich in many changes in intonation, rate, dynamics, and duration. Prosodic features, which the child learns by imitation, function as a matrix, which will be filled with morphemes and lexemes in the process of the child's development. An example of such matrices, according to J. S. Bruner, is the intonation of interrogatory, exclamatory-imperative, and declarative sentences (Bruner 1980: 499).

The results of experiments show that alread1y two-month-old babies are able to perceive elements of prosody (Mandel et al., 1994), and six-month-olds can distinguish prosodically correct utterances from incorrect ones (Nazzi et al. 2000). The ability to use prosodic elements in communication develops at the later age (Cohen et al.1990; Doherty et al. 1999).

The dominant belief among students of speech prosody is that linguistic prosody develops later than emotional (after: Rymarczyk 2003, Wysocka 2010). In children, who have successfully acquired syntax and communicate with language fairly effectively, the ability to understand and express crucial elements of linguistic prosody is unexpectedly low (Beach et al. 1996). A different standpoint is taken by C. P. Doherty et al. (1999), who maintain that the development of the perception of linguistic prosody precedes the development of emotional prosody. This appears to corroborate the results of studies by P. Juszczyk et al. (1993), which point out that even small children derive considerable information from linguistic prosody.

The complete maturity of perception of emotional prosody may be acquired even later than linguistic prosody. Similar conclusions are presented by I. Cohen et al. (1990). They maintain that the complete understanding of emotional prosody occurs only at the age of eleven.

Following J. Piaget's conception, researchers stress the important role of the pre-operational period in the development of linguistic, including prosodic, awareness in the area of the perception and use of prosodic elements. This process ends at school age (Rymarczyk, 2003).

In Poland, the themes connected with prosody perception in ontogeny were explored by B. Kwarciak. He believes that speech prosody performs a fundamental role in the early stages of language acquisition. The author emphasizes that already since his/her birth, every child has biologically determined mechanisms permitting analysis of speech prosody, from which s/he derives information of utterances that s/he hears (Kwarciak 1995: 57). Studies cited by B. Kwarciak clearly show that the child, since the first weeks of his/her life, is sensitive to prosodic features, mainly to intonation contours and the temporal organization of utterances. Prosody performs a vital role in speech perception. Reactions to intonation (mainly its rising contours) can be observed already in two-months-old infants. It is a universal feature that child-directed speech is characterized by intensified prosodic features. The perceived prosodic features are also reproduced by the child and productively used, preserving their attributed function. Owing to the analysis of prosodic features the child obtains information about the conformance of an utterance to the patterns known from his/her environment. Analysis of prosodic features is an ability that appears every early both in language perception and expression, therefore it is probably a process based on innate mechanisms (after: Kwarciak 1995: 70-79). B. Kwarciak reports that by the time the first word appears, prosodic abilities have already been well learned.

Studies on the perception of emotional and linguistic prosody in children were also conducted by K. Rymarczyk (2003). Their aim was to answer the questions about the development of prosodic functions in the age groups investigated, relationships between the perception of emotional and linguistic prosody, and the effect of the subjects' gender on perception abilities in prosody. A group of children aged from four years and six months to thirteen years and eight months was tested. The results show an increase in the level of prosodic perception abilities with age. Girls performed the tasks better. In the studied age groups, linguistic prosody is characterized by great dynamics of development while the perceptual awareness in emotional prosody develops earlier and is already largely formed at the age of five. Four- or five-year-olds do emotional prosody tests with a great degree of correctness (88.3 %) In older age groups no significant improved results was reported. The subjects gained the best results in tests, in which prosodic features coincided with sentence semantics, the weakest being in nonsensical sentences.

Sadness was the best recognized emotion, while correct scores in anger recognition rose with age (Rymarczyk 2002: 54-89). In light of the research presented in the study in question there is a distinct rise in competence in linguistic prosody from six years of age, while twelve-year-old children show the level of ability comparable with that of adults. According to K. Rymarczyk an increase in the awareness of phenomena associated with linguistic prosody is connected with the development of the child's lexicon, and with school training developing the perception and expression of these phenomena. The author stresses that girls read emotions contained in prosody better than boys. It is difficult to find out if these abilities are innate or result from environmental factors due to differences in educational methods used towards each gender. Unfortunately, Rymarczyk does not provide a phonetic description of the tool she used, nor does she characterize its acoustic parameters, which is why it is difficult to interpret the study results obtained by that author from the psychoacoustic perspective which is necessary, it seems, for description of the development of prosodic hearing.

The purpose of my study (Wysocka 2010) was to establish the degree of development of prosodic hearing in five- to seven-year-old children and to trace relationships between perception processes of speech and music prosody. In my investigations I used the diagnostic tool which I constructed myself: while making it I tried to take into account the most up-to-date findings concerning the structure of prosodic units, perception of speech and music prosody, and relationships between these processes.

Studies were conducted in groups of children (ten in each) aged five (the mean age in the girls' and boys' groups being 5.3), aged six (the mean age in the girls' and in boys' group being 6.2) and aged seven (the mean age in the girls' group and in boys' group being 7.2). The selection of the age group participating in the experiments was dictated by facts concerning the language and musical development in ontogeny. Many researchers, referring to the Piagetian conception (1993), point to the important role of the preoperational process in the development of prosodic competence. The five-year-old child's phonetic hearing is so developed that s/he perceives sound features and prosodic features of speech – changes in intonation, stress position, and duration of sounds (Rocławski 1993: 20-27). The sixth year of age is crucial to the development of language awareness because at this age the child enters the next phase of cognitive development – the period of concrete operation enabling him/her to control his/her own cognitive processes. The upper age limit of the control group was selected because, as studies on language development in ontogeny show, seven-year-old children already have developed phonological competence enabling them to learn all the phonemes of their native language. To date little is known, however, about the degree to which they master prosodic competence. Worth noting is also the fact that at the age of six to seven the stage of language acquisition exclusively by way of hearing

perception ends. In school education a great role in assisting linguistic development is played by writing, which does not render the whole complexity of prosodic processes. We should suppose therefore that the most intensive development of prosodic awareness occurs during the stages preceding school age. .

The results obtained confirm the influence, suggested in literature, of preoperational thinking on the development of prosodic and musical competence, which is shown by the five-year-olds' well developed ability to differentiate intonation sequences, differentiate and define emotions contained in prosody, differentiate rhythm structures and the position of stress in rhythm and in a sentence. A high degree of prosodic competence in children of this age is obviously associated with the general direction of the development of phonetic-phonological competence. At the beginnings of this development there is perception and expression of prosodic structures which, already at the earliest stages of speech ontogeny, are the child's source of information on the structure and meaning of their linguistic constituents..

The results of the studies presented here also indicate the existence of the turning point occurring in the prosodic and musical awareness when the child passes from the preoperational thinking stage to the stage of operational thinking. It was demonstrated that five-year-old children do not yet have the ability to consciously use the knowledge about the construction of prosodic structures. This ability appears at the age of six and develops dynamically with age, which is demonstrated by the weakening predominance in successive age groups of the results of differentiation tasks (requiring automatic and unreflective reference to linguistic or musical knowledge) over definition tasks (associated with conscious and intentional use of this knowledge).

During the preoperational period, competence which enables perception of emotional prosody exceeds perceptual competence in linguistic prosody, which shows that it is acquired faster in speech ontogeny. Worth noting is the fact that the ability to distinguish emotions of joy, sadness and anger, encoded in prosody, fully develops already at the age of seven. The analysis of acoustic parameters of the materials used in the emotional prosody perception test confirms the adopted assumption, according to which emotions are encoded in prosody not only by means of changes in the voice pitch but also by using other features of speech signals, which is why we should speak of emotional prosody rather than intonation.

Confirmation of the similar development level of auditory perception in intonation, instrumental melodies and in singing melodies in individual age groups suggests that there are similar mechanisms responsible for these processes. This is of significant importance for therapeutic measures because it strengthens the advisability of using music to stimulate speech development and to treat speech disorders, in which there are problems with perception of prosodic, especially intonation, structures.

Statistical analysis did not show the influence of gender, suggested in literature, on the results of prosodic and musical tests. Slight differences in percentages observable in some types of tasks were not statistically significant.

A SUGGESTED TOOL FOR THE ASSESSMENT OF SPEECH PROSODY PERCEPTION

In view of the existing instruments in Polish logopedics for the investigation of phonetic-phonological competence in the segmental aspect, worth noting is the lack of tools for the assessment of prosodic competence. I made an effort to construct one for the needs of the abovementioned study. Because space limitations in the present article prevent a detailed presentation of the whole tool, I focused on a brief description of it, placing emphasis on its underlying methodological assumptions.

The presented instrument focuses on investigating the perception of intonation and intonation/accent structures, which stems from the well-documented conviction in literature (cf. inter alia Botinis et al. 2001, Ropa 1981) about the special importance of communicational changes in voice pitch manifested in intonation patterns and being the most regular accent-forming factor. While constructing it I took into account problems of differentiation of intonation structures, and definition of the direction of intonation pattern, the effect of desemanticization of linguistic material on intonation perception, the perception of stress in a sentence, and perception of prosody in the emotional function.

As there are many views in literature on defining prosodic phenomena, I found it necessary to precisely determine definitional ascertainments, which motivated the measures aimed at devising an accurate diagnostic tool and directed its description and the interpretation of the research results obtained. I recognized as relevant characteristics of prosodic units the following acoustic voice parameters: basic frequency (received as pitch), intensity (which produced the impression of volume with frequency), and the duration of syllabic (after: Doherty et al. 1999; Gussenhoven 2001; Hesling et al. 2005; Ostaszewska, Tambor 2000; Raithel, Hielscher-Fastabend 2004; Sawicka 1995; Wierzchowska 1980).

I adopted a one-parameter definition of intonation, according to which it is a prosodic phenomenon arisen as a result of changes of the basic frequency of speech signal received in perception as changes in the voice pitch (after: Botinis et al. 2001; Demenko 1999; Jassem 1962; Szczepankowski 1985; Szpyra-Kozłowska 2002; Wierzchowska 1967). I also assumed that intonation units are inseparably connected with the rhythm and accent structure of an utterance, and they are formed on the basis of consonances. I adopted the intoneme (also defined as fundamental melody) as the basic functional unit of intonation. This term also applies to the class of functionally equivalent tonal units (after: Jassem 1962;

Steffen-Batogowa 1996; Wierzchowska 1967a; 1980). The tone pattern within the intoneme (fundamental melody, nuclear melody, core intonation) equals the melody contour occurring in the communicatively significant section of the phrase comprising the accented (nuclear) syllable and post-accented one (after: Demenko 1999; Dukiewicz 1995; Francuzik et al. 2005; Jassem 1962; Wierzchowska 1967a; 1980).

I assumed that the main determinant of the phrase accent termed in literature as logical, rhematic, real, main or ictic accent (Demenko 1999; Sawicka 1995), which is the object of investigation and description in this study, are changes in basic frequency (Demenko 1999; Jassem 1962).

The presented tool is composed of the following tests:

• The intonation perception test consisting of intonation structure discrimination tasks in speech and tasks of determining the direction of intonation pattern (in two- and three-syllable words and in seven-syllable utterances and in their vocalic forms). The intonation structures used in the test are characterized by the falling, rising, falling-rising and rising-falling directions.

• The sentence stress perception test consisting of tasks of stress position determination and discrimination. Each task consists of four accent groups. In successive realization variants a different group is stressed.

• The emotional prosody perception test, composed of tasks of emotion determination and discrimination in speech. Particular realization variants contain realized utterances that are emotionally unmarked, or marked with joy, anger and sadness.

Durations of individual structures do not exceed three seconds, owing to which they do not go beyond the perceptual integration mechanism. The structures that made up the material for the study of prosody in the emotional function were not uniformized with regard to their duration times because in this case duration differences, along with the basic frequency patterns and intensity changes, were also analyzed.

The tests were recorded using the *Praat* program (Boersma P., Weenink D. 2006), (the sampling frequency being 22050 Hz) and a high-quality broad-band microphone, and they were saved on computer in the *.wav. format. The same program was used to construct particular test tasks from the recorded material. The musical and language material was presented by a woman with linguistic and musical training.

The discrimination tasks compiled and used in the investigations can be regarded as related to the widely used AFC (alternative forced-choice) tests in psychoacoustics. In the discrimination tasks, individual tests have the form of ‘same-different tasks’, in which the subjects are required to answer the question whether two sequences presented to the subject are the same or different. The first is the point of reference for the second which contains information that has to be

compared with information contained in the first sequence. As in the AFC tests, the subjects can have the stimuli repeated should the need arise, and the duration of the answer was not limited.

It is highly desirable that a tool for the assessment of prosodic competence should be compiled. This would permit the expansion and standardization of logopedic diagnostic management and the orientation of the therapeutic process aiming at improvement of prosodic competence. It is also necessary to develop practical aids for the enhancement of prosodic skills and competence.

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