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Abilities of phonological awareness in the context of cognitive development in preschool age

Soňa Grofčíková & Monika Máčajová
Constantine the Philosopher University in Nitra, Slovakia
sgrofcikova@ukf.sk & mmacajova@ukf.sk

Abstract
Phonological awareness is considered a key phenomenon having crucial position among abilities and processes which are important and responsible for the development of reading and writing (initial literacy). The paper deals with the significance and level of development of selected cognitive functions of a child in relation to the abilities of phonological awareness. The child´s current cognitive development is a predictor for certain level of phonological awareness. The paper is focused on a description of speech perception, language, oral vocabulary and phonological memory of children in preschool age. It is an output of the research project VEGA no. 1/0637/16 Development of a Diagnostic Tool to Assess the Level of Phonemic Awareness of Children in Preschool Age.

Keywords: Phonological and phonemic awareness, cognitive development, phonological/speech perception, language acquisition, working memory

Introduction

Level of cognitive development is crucial for initial literacy of a child. Fluent reading with understanding and writing are expected outputs in the primary school instruction. Development of these skills also depends on the level of a child´s readiness prior to entry into the primary education. Language acquisition is a very complex issue which could be examined on different levels, e.g. neurological (biological), cognitive, phonological, linguistic as well as social-affective. Therefore, the main goal of the paper is to focus on selected cognitive functions and their role in the process of phonological and phonemic awareness in preschool age. Level of phonological and phonemic awareness of a pre-schooler can be a strong predictor of successful initial reading and writing. It is important that a child is able to decode any information which is essential for comprehension and can be defined as an ability to assign sounds in spoken language to written symbols (Stanovich, In Reading, Deuren, 2007). Phonological awareness is one of the processing abilities responsible for successful decoding.

According to Anthony and Francis (2005), research has identified three phonological processing abilities: phonological memory, phonological access and phonological awareness. Jošt (2011) describes phonological processing in the relationship to those cognitive processes which take to consideration auditory features (attributes) of language, then phonological processing includes phonological awareness, short term phonological memory, access to phonological information in long term memory and modulation factor (ability to recognize melody, intonation, and rhythm of spoken speech).

First, **phonological awareness** is defined as a single, unified phonological processing ability related to literacy during preschool and early elementary school years. Bentin (1992) described it as a heterogenic metalinguistic competence involving abilities that differ in developmental trends and origins. Phonological awareness refers to the phonological structure of spoken words, it is the ability to detect, isolate, and manipulate with sub-word phonological segments. Anthony and Francis (2005) emphasize that it refers to one's degree of sensitivity to the sound structure of oral language, independent of meaning. It is one's conscious ability to recognize, discriminate, and manipulate the sounds in language, speech sounds within larger units like words, syllables (Torgesen, 2002; Vaessen, 2010; Goswami, 2015). Difficulties with detecting or manipulating sounds in words are responsible for problems in learning to read, therefore child´s experiences with oral language are significant in developing phonological awareness, which is strongest during the period when a child learns the alphabetic code (knowledge of letters in the alphabet) and it can usually take one to three years depending on the orthographic transparency of the written language (Vaessen, 2010). However, the child does not have to know to name letters or their corresponding sounds to be able to demonstrate phonological awareness.

According to Anthony and Francis (2005), this ability manifests itself in a variety of **phonological skills** that appear in a predictable time sequence and recognition must always precede production. Among these skills which are performed in different types of tasks are hierarchically included rhyming (judging whether two words rhyme), matching rhyme and alliteration, syllable blending and splitting, full phoneme segmentation and manipulation (e.g. deleting, substituting). Distinctions among phonological awareness skills are based on the unit of word structure, whether a task is focused on syllables or on smaller intrasyllabic units (onsets, rimes, phonemes) (Anthony, Francis, 2005). These phonological skills are demonstrated step by step in three ways by detection (matching similar sounds), synthesis (combining smaller segments into syllables and words), and analysis (segmenting words or syllables into smaller units, phonemes) (Abbott et al., 2008; Jošt, 2011). Assumptions of correct auditory analysis and synthesis in a child include the following: maturity of a child,

achievement of appropriate level of cognitive processes and systematic perception, quality of attention, language mastery, good vocabulary (Máčajová, 2011). It has been suggested (Bentin, 1992) that the testing of phonological awareness may differ at least in three dimensions: 1) operation requirements (detection, isolation, or manipulation of the phonological segments); 2) manner of testing awareness of phonological codes (indirect or explicit); and 3) size of the relevant phonological segment (syllabic, sub-syllabic, phonemic). Anthony and Francis (2005) maintain that in the development of phonological awareness, firstly children become increasingly sensitive to smaller and smaller parts of words as they grow older. They can detect syllables before onsets and rimes, and manipulate with onsets and rimes before phonemes within intrasyllabic word units. Secondly, they can detect similar and dissimilar sounding words, manipulate with sounds within words, and generally blend phonological information before they can segment phonological information of the same linguistic complexity. Thirdly, children improve phonological awareness skills they have already acquired while they are learning new ones (Anthony et al., 2003). Bentin (1992) also pointed to many researches and measurements according to which preschool children are relatively successful in rhyme detection tasks, can accurately count the number of syllables in words, but they cannot isolate single phonemes. He described phonological skills of pre-schoolers as follows: they should be able to recognize how many words are in a sentence (word level), to segment and blend words of at least three syllables (syllable level), to understand the concept of rhyming, to recognize and generate rhyming words (rhyme level), to isolate the beginning or ending sounds in words, to segment and blend sounds in a word with three sounds, and to change a sound in a word to make a new word in familiar games and songs (sound level). Five and six-year-old pre-schoolers should be able to orally blend and delete words and syllables without the support of pictures or objects, orally blend the onsets, rimes, and phonemes of words, and to orally delete the onsets of words, with the support of pictures or objects (Abbott, et al., 2008).

Another construct related to phonological awareness is **phonemic awareness**. There is often confusion between these two terms, both focus on the sound elements of spoken language. However, phonological awareness is a broader term including phonemic awareness. Jošt (2011) considers phonemic awareness as one of the phonological skills included in the ability to analyse words into smaller units. Then, phonemic awareness is a subtype of phonological awareness, the most advanced level of phonological awareness that the child can achieve, and it refers to the ability to recognize and consciously manipulate with speech at the level of phonemes, to detect the smallest units in the spoken words. Saussure (2007) defines phoneme as the smallest unit of a complex sound system of language, functioning as a part of distinctive linguistic forms (critical to the identity of these

forms and bonded to their linguistic meanings). A change of sound in a word changes meaning of the whole word as well. Phoneme is a summary of acoustic perception and articulation movements; it is a composed unit of the heard and pronounced. Then phonemic awareness is defined as knowledge that words consists of separate sound segments which are smaller than syllable or as knowledge about features of separate sounds (Torgesen, Al Otaiba, Grek, 2005). It is sensitivity, an understanding that words can be divided into a sequence of phonemes. It refers to specific auditory abilities which enable to identify individual sounds in the words. These auditory abilities, like perceiving phonemes, identifying word boundary and parts of words, detecting similarities among words, are the abilities required for a successful decoding of orthographic symbols, the alphabet (Torgesen, 2002). Mikulajová and Dujčíková (2001) see phonemic awareness as a top phase in the development of phonemic hearing. It is an ability to consciously manipulate with word segments, to recognize word auditory structure, to identify sequence of sounds in speech, to realize sound analysis, synthesis and complex manipulation with speech sounds, in contrast to Jošt (2011) who claims that phonemic awareness is only a part of analysis (ability to analyse first sound/phoneme of a word, last sound/phoneme of a word, or middle sound/phoneme of a word). Reading and van Deuren (2007) distinguish phonemic skills like letter naming fluency, nonsense word fluency and phoneme segmentation fluency. Liberman (In Vaessen, 2010) stated that the perception of phonemes does not seem to be an integral part of the human language system; therefore children´s preliterate levels of phonemic awareness are very low. Goswami (In Vaessen, 2010) also maintains that the awareness of phonemes, in contrast to the awareness of larger sound units, arises only when reading skills start to emerge. Bentin (1992) emphasized that the alphabetic principle requires the ability to isolate and manipulate single phonemes in coarticulated speech. The major factor that initiates this ability is the exposure to the alphabet. Phonemic awareness cannot be initiated by the alphabet unless the early form of phonological awareness is well developed. Children whose phonological awareness level is not adequate must be explicitly trained for phonemic segmentation. Phonemic segmentation training in kindergarten, for a relatively short period, is effective in raising the metaphonological skills required for the easy acquisition of reading.

Phonological processing abilities can be displayed through variety of tasks. Many published researches and investigations on phonological awareness used independent tasks for the construct assessment. McBride-Chang (1995) describes four operations which are required from a child in these tasks. First, a speech segment must be perceived. Second, the speech segment must be held in memory long enough for an operation to be performed. Short-term memory is important

for this task. Third, the operation (e.g. manipulation, deletion, identification of a speech segment) must be performed. This represents general cognitive ability. Fourth, the results of this operation must be communicated to the teacher, in preschool age usually orally.

Speech perception is associated with various phonological processing skills in children. Auditory perception (phonological perception) is a basic process to be pointed out in context of phonological skills and is closely related to child´s own speech development. Humans can detect a wide range of sounds, some of them are non-speech sounds analysed by different areas of right brain hemisphere, and the speech sounds that are usually processed by left hemisphere. Stimuli for auditory perception are acoustic waves originated in vibrations of things, and perceived by ears as receptors. Development of speech perception is a matter of global perception of speech, later segmentation. Speech perception is an ability to perceive, recognize, and pronounce sounds in language (Zelinková, 2001). It begins with detection at the level of acoustic signs, then phonemes and finally words. Goswami (2015) states that children who are less sensitive to the auditory stimuli of the prosodic and rhythmic patterning in language may be at risk for developmental dyslexia and specific language impairments. Active production and communicative interactions are also important for the early acquisition of a language. If a child´s sound pronunciation is incorrect, it must be taken into consideration that s/he cannot hear properly (e.g. cannot capture the sound by outer ear; in inner ear, cochlea cannot analyse the sound). It is also a reason for developing sound perception through various activities. Foy and Mann (2001) indicate that speech perception is closely associated with rhyme awareness measures. Children with a less developed sense of rhyme had a less mature pattern of articulation. Phonemic awareness is associated with phonological perception and production. Children with low phonemic awareness skills showed a different pattern of speech perception and articulation errors than children with strong abilities. However, these differences appeared to be largely a function of age, letter and vocabulary knowledge. Antony and Francis (2005) specify that learning the names of letters and the sounds they represent provides a concrete way how to attend to phonemes. Phonemes do not have physical reality independent of each other. That is, phonemes produced in speech are acoustically inseparable because adjacent phonemes are coarticulated. Children develop sensitivity to differences in placement, location of articulation, before they develop sensitivity to differences in phoneme voicing (Treiman, Broderick, Tincoff, Rodriguez, In Anthony, Francis 2005). Manner of articulation refers to the direction of air or voice emission from the vocal tract or the degree of narrowing of the vocal tract. As mentioned previously, hemispheric lateralization is also very important in language acquisition and exists for various language functions. According to neurological

research, a sound from each ear projects bilaterally, the left hemisphere processes sound from the right ear, speech sounds processed through the right ear will be understood faster and more accurately than speech sounds processed through the left ear. The left hemisphere has a tendency for speech and music rhythm; it specializes in processing word sounds, morphemes, semantics, and grammatical rules. The right one is specific for tonality (e.g. melody of music, intonation of speech), non-speech sounds, emotional intention of vocalization and understanding (Zillmer, Spiers, Culbertson, 2008). An issue of the time of lateralisation is also significant, we can distinguish several theories, most of them concluding that lateralization is completed around puberty. Plasticity of the brain enables children to acquire not only their mother tongue, but also a second language (Lenneberg, Scovel, In Brown, 2000). Speech perception starts to develop in the fifth month of prenatal stage, but matures between the child´s fifth and seventh year. During preschool age, auditory analysis, synthesis and differentiation develop significantly. The child perceives speech of the others (also its meaning), can split words into syllables by clapping. At the end of preschool age, the child can recognize first/last phoneme in a word, is able to differentiate whether words are similar or not. In six years, most children can differentiate all phonemes of a word, vowel length, soft and hard consonants (Lechta et al., 1990). Research findings (Bentin, 1992) showed that initial phoneme isolation and initial phoneme deletion performed by pre-schoolers were better with vowels than with consonants. In case of the last phoneme isolation, final consonants were easier to isolate than final vowels. The author further explained that a phone can be coarticulated with different phonetic contexts, there can be no direct correspondence in segmentation between the acoustic signal and the phonetic message it provides. Therefore, speech perception cannot be based on a simple translation from a set of auditory representations to a set of perceptual phonetic categories. Phonetic distinctions in speech are easy and natural, awareness of phonetic categories appears much later in ontogenetic development and probably requires more than simple cognitive maturation (Bentin, 1992).

Another part of cognitive development related to this topic is **language acquisition and oral vocabulary**. Language is a complex, specialized skill, which develops in child spontaneously without conscious effort, is qualitatively the same in every child, and distinct from such more general abilities as intelligence or information processing (Brown, 2000). Research evidence points to the general superiority of comprehension over production in child´s language. Children seem to understand more than they can produce. The researchers suggest that the ease of children´s language acquisition is due to brain´s sensitivity to rhythmic language patterns, a sensitivity that does not depend on the form of the language (Garrett, 2009). Phonological development is a part of language acquisition. Children learn

the sounds and combinations of sounds that are permissible in their language; they form phonological representations for real words. Individual differences in the quality of these representations, measured by phonological awareness tasks, predict reading acquisition across languages (Ziegler, Goswami 2005). Syllable and rhyme awareness develops prior to literacy across languages, but awareness of phonemes symbolised by letters varies according to orthographic transparency. Children learning languages with a 1:1 mapping from letter to sound (e.g. Finnish, German, Slovak) rapidly acquire phonemic awareness. Children learning languages that lack a 1:1 mapping from letters to sounds (e.g. English, French) acquire phoneme awareness more slowly. Goswami (2015) further underlines that also fluency is acquired faster in languages where the mapping from letter to sound is 1:1, where syllable structure is simple (consonant-vowel syllables), and where there are relatively few phonemes. Fluency is acquired more slowly in languages with inconsistent spelling systems, many phonemes (English has around 44), and where syllable structure is complex (English has relatively few consonant-vowel syllables). Language aids conceptual development, development of a theory of mind, and memory development (basis of working memory). Its primary function is to communicate, words being part of meaning experiences from early age. Conceptual representations precede language development and come out of perceptual experiences of objects and events. Words are symbols, they refer to the objects or events, but they are not objects or events themselves. Therefore, word learning is important for cognitive development. According to the study of Hart and Risley (In Goswami, 2015), 4-year-old children from high socio-economic status families heard around 487 utterances per hour in comparison to children with lower socio-economic status who heard 178 utterances per hour. Kuhl (In Goswami, 2015) explained that babies will not learn language from watching television, even if the 'input' is equalised to that offered by live caretakers, because social interaction plays a critical role in perceptual learning and motivation to learn. Learning depends on neural networks distributed across multiple brain regions, visual, auditory and kinaesthetic; and the emotional system can modulate sensory processing through attentional processes. Perceptual learning mechanisms, e.g. linguistic sounds learning requires direct social interaction to be effective. Similar research outcomes were described by Maclean et al. (In Bentin, 1992), young children's performance on different tests of rhyme and alliteration detection and knowledge of nursery rhymes were related to their socio-economical background and their parents' education. It could be supposed that children of middle-class highly educated parents had more opportunities to be exposed to nursery poems and other forms of rhymes than children coming from lower-class poorly educated parents. A significant difference between the two groups can indicate that experience with rhymes is a critical initiation of the

early phonological awareness. There are great individual differences in language skills among children in the early years. However, it could be generalized (Abbott et al., 2008) that a 5-year-old child is able to use language for communication with others in familiar as well as unfamiliar social situations for various purposes, including reasoning, predicting, problem solving seeking new information, constructing real or fictional narrations. S/he can speak clearly to be understood by not only familiar, but all adults and other children, his/her pronunciation is correct, some speech errors are age appropriate. His/her vocabulary contains accepted words for categories of everyday life objects, simple and complex words describing relations among objects (Abbott et al., 2008). Children at the age of six understand about 13000 words (Garrett, 2009) in both expressive and receptive oral language.

Speech and oral vocabulary rise from sensory perceptual system, but they are considered to be higher functional systems, because their progression and expression depends on memory, attention and executive functioning. For that reason, **memory** is discussed next. In general, three main divisions of memory can be distinguished. We can talk about sensory memory, short-term memory and long-term memory in the relationship to phonological processing abilities. Short-term memory is a limited capacity, rapid access, input and retrieval system, and uses phonologic coding which relies on acoustic code. Long-term memory has unlimited capacity but with restricted rate of input and retrieval, and uses semantic coding, or associative meaning value of information to be remembered. There is a unitary view of memory functioning, i.e. that long-term memory depends on short-term one (Zillmer, Spiers, Culbertson, 2008). This notion gave the idea of multi-component working memory (short term memory) as a distinct system. Baddeley (2003) conceptualized working memory into four components, subsystems. The central executive is an attention controlling system, responsible for focusing, shifting, dividing attention and connecting to long-term memory. It coordinates, and controls other modality systems. The phonological loop is concerned with verbal and acoustic information (involves auditory verbal processes, stores speech based information). It is necessary for the acquisition of vocabulary, and is specialized for the retention of verbal information over a short time period. The visual-spatial sketch pad manipulates with images (visual inputs); and the episodic buffer as a temporary, limited capacity storage system, integrates visual, auditory information through linking with long-term memory. It differs from the central executive in concentration on the storage of information rather than attentional control. The information from different sources is linked into episodes, and buffer combines information from different modalities into a single code as a base for conscious awareness. Phonological loop model presented by Vallar and Papagno (In Baddeley, 2003) described its structure as follows:

auditory input is phonologically analysed and sent to short-term storage. Information from this system can be passed into the phonological output buffer (articulatory control system), which can result in spoken speech (direct recall) or in rehearsal. Visual inputs are analysed and transferred from orthographic to phonological recoding and finally registered in phonological buffer. Baddeley (2003) pointed to the fact that if an individual is shown a sequence of letters for immediate recall, despite of visual representation, an individual will subvocalize these letters, and retention will depend on their acoustic, phonological characteristics. Based on the Baddeley´s research, it can be assumed that good phonological (working) memory facilitates vocabulary acquisition, children with rich vocabulary can use phonological memory in vocabulary learning, acquisition of new words, and this relationship becomes more reciprocal with age. Goswami (2015) also emphasizes that during development, working memory capacity increases as a child gets older, till the teenage years. There are both visual and phonological (sound-based) working memory systems. Visually-presented material is often translated into speech-based codes for short-term retention. The capacity of the phonological working memory system is affected by factors like word length (short words are retained more), phonological confusability (more difficult to retain words that sound similar), and speech rate (child with slow articulation retains less information). Working memory has limited capacity and stores information temporarily while it is processed. Having a poor working memory can cause poor academic progress (Goswami, 2015). The ability to remember tones, sounds, patterns of voices for short period, and the ability to retrieve acoustic, auditory information stored in verbal structure are important for phonemic awareness as well as the development of working memory is important for the development of metacognition and reading. All discussed cognitive processes are interconnected and have implication for language processing and acquisition.

Conclusion

Phonological awareness is important in literacy acquisition. An individual´s development of phonological awareness and the level s/he attains are influenced by predispositions, intelligence, memory, vocabulary, experiences with oral and written language. This developmental conceptualization of phonological awareness has significant implications for the assessment of phonological awareness in school environment, diagnosing educationally relevant cognitive achievement. Finally, the early phonological awareness, which does not require awareness of single phonemes, can be started without explicit instruction and may develop independently of reading acquisition. On the other hand, sensitivity to syllabic and intra-syllabic phonological segments, the ability to isolate and

manipulate with single phonemes, does not develop spontaneously. Therefore, learning to read an alphabetic orthography provides most children with the opportunity to develop full phonemic awareness (Bentin, 1992). The level and effects of selected cognitive processes were discussed in terms of phonological and phonemic awareness, allowing one to conclude that the age appropriate cognitive development plays a crucial role in initial literacy.

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Contacts

PaedDr. Soňa Grofčíková, PhD.
doc. PaedDr. Monika Máčajová, PhD.
Katedra pedagogiky, PF UKF
Dražovská cesta 4
949 74 Nitra, Slovakia
sgrofcikova@ukf.sk
mmacajova@ukf.sk