PHONEME AWARENESS TASK – MEASURE OF QUALITY OF PHONOLOGICAL REPRESENTATIONS

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ABSTRACT

The quality of phonological representation (QPR) influences performance on tasks of phonological awareness (PA) and can be used as its measure. Recent studies agree that QPR may be assessed by production accuracy, speech-sound perception and phonological processing. This paper describes the development of a phoneme awareness task (PhA) for /r/ in Croatian. The PhA task (type: Odd-one-out) was administered as part of a larger battery to 600 children aged 3-7. The stimuli were sets of three nonsense words differing in the initial consonant or the syllabic /r/. The task is developmentally sensitive, with the oldest participants obtaining the highest scores. The best mastered contrast is /r-j/, followed by /r-l/ and /r-ʋ/. A higher correct score was found for strings in which /r/ is not the odd one. The differences between the organization of existing and new phonological knowledge is discussed.

Keywords: Phonological representations, phonological awareness, phoneme awareness task.

1. INTRODUCTION

Phonological development includes the development of phonological representations but also of phonological processing. Phonological representations (PRs) are cognitive constructs containing information about language units stored in the long-term memory. Munson et al. [9,10] use the term phonological knowledge for information stored in the phonological representations. The knowledge includes perceptual and articulation representations, phonological knowledge and socio-indexical information. A similar model based on the theoretical framework of dynamic systems is proposed by Rvachew and Bernhard [14], in which the emergence of new phonological knowledge is based on the acquisition of the new acoustic phonetic knowledge, i.e. the perceptual category of a particular phoneme (articulatory phonetic knowledge, differentiation from the pre-existing phonological factors, lexical factors such as vocabulary size, neighbourhood density, phonotactic probability and phoneme frequency as well as environmental and biological underpinnings). PRs develop gradually and contain different types of information. Phonological processing on the other hand includes three dimensions: PA, phonological recoding in lexical access and phonetic recoding in working memory [24]. It is widely accepted that QPR is measured by phonological processing tasks and that underdeveloped PRs or, lower quality PRs negatively influence phonological processing. Recent studies either examine general quality of PRs [1, 2, 7], or tackle the relations among articulation accuracy, phonological awareness and perceptual development [4, 5, 8, 15, 16, 18, 19, 20]. It can be concluded from those studies that the QPR is usually measured by articulation accuracy, speech sound perception and phonological processing. These three dimensions should be part of the QPR assessment battery. It seems that the PA measures in the QPR batteries should not assess general PA abilities as in standardized tests, but the quality of phonological representation of a target phoneme. PA tasks should be developed with controlled linguistic material for each target phoneme, number of items in the task and the type of PA task. Theoretical models of QPR often do not explore the ability to develop new phonological knowledge. This ability is usually measured by vocabulary learning tasks [3] but it seems that there is no study that would explore the development of new PRs from the existing ones and this research question should be further explored. The PhA task described in this study is a part of a larger battery targeting development of phoneme /r/ in Croatian. The battery included measures of articulation accuracy, phonological working memory, perceptual information in PR, phoneme awareness (PhA) and the relation between perception and articulation of the target phoneme [22]. Phoneme /r/ was chosen because it is acquired last in Croatian children's phonological development [21, 23].

2. MATERIAL AND METHOD

2.1. Participants

600 typically developing children aged 3 to 7 participated in the study (300 F and 300 M). They comprised four one-year age groups (3;0–3;11, 4;0–

4;11, 5;0–5;11, 6;0–6;11), each represented by 75 M and 75 F participants. The parents reported no disabilities or developmental delays and provided signed consent.

2.2. Task

2.2.1. Task development

QPR was assessed by the Odd-one-out task in which participants were asked to listen and recognize the word in a set of words that started with a different phoneme. Children were presented with a set of three nonsense words, two sharing the initial phoneme. Similar tasks are reported in literature [16, 19]. This task was designed to assess phoneme awareness excluding the possibility of item categorization based on another criterion, i.e. meaning among younger participants. The patterns for stimuli development were the following:

(1) (one of the typical developmental substitutions of /r/: /r-j/ or /r-ʋ/ or /r-l/) + vowel + stop

(2) /p/ + (/r̩/ or its typical vowel substitutions) + stop

Table 1: Nonsense words used in the phoneme awareness task (PhA).

No.	Item 1	Item 2	Item 3	Odd item	Contrast
0a	tub	kug	tut	2	place of art.
0b	kik	kib	pit	3	place of art.
0c	tuk	dup	dut	1	voiceness
1	rap	rag	lat	3	/r-l/
2	pid	prk	prb	1	/r̩/ (syllabic)
3	jup	jud	rug	3	/r-j/
4	rid	vig	rip	2	/r-ʋ/
5	rag	lap	lab	1	/r-l/
6	pid	prp	puk	2	/r̩/ (syllabic)
7	rub	rut	juk	3	/r-j/
8	rip	vig	vit	1	/r-ʋ/

The task included three practice items (marked 0a, 0b and 0c in Table 1) which did not include the target phoneme. The vowels used in the stimuli were /i, a, u/ because of their perceptual prominence [11, 12, 13] while the stops were used because they are considered less marked in the final position. In the stimuli with /r̩/ (syllabic), phoneme /p/ was used for similar reasons. Each pair of /r/ and typical developmental substitutions occurred twice. In one example, the word beginning with /r/ was the odd item and in the other it was the word beginning with a typical substitution. The same was applied for strings with syllabic /r̩/. The word containing /r̩/ was the odd item in one example and in the other it was the word a vowel. Except for the linguistic criteria, item placement on the screen was also controlled, since younger participants often point to the same place regardless of the stimuli [18, 19, 20].

The audio stimuli were recorded in studio conditions with professional equipment. The speaker was 31-year-old male speaking Standard Croatian.

2.2.2. Task administration

The children were tested individually in a familiar preschool setting by a trained researcher or two research assistants. The task was administered in the form of a simple computer game. Three monsters appeared on the screen saying their unusual names. Their names are the stimuli presented in Table 1.

Figure 1: Screen layout for the PhA task.

The children were told that the monsters had strange names which they would hear in a moment and that the two monsters whose names started with the same sounds were friends and the third one was not. For the syllabic /r̩/ task the instruction was that the names sounded differently. An example of the screen is shown in Figure 1. After pointing to the monster whose name began with a different phoneme the monster representing the odd stimuli became red.

The maximum score was 8. Cronbach alpha is not high (α=0.417), which is not unusual for such tasks. Similar studies [19] report Cronbach α=0.4 for phoneme /r/ and 0.2 for phoneme /l/.

3. RESULTS AND DISCUSSION

The percentage of correct responses for each age group is shown in Table 2. 440 participants scored above baseline, meaning above average (four correct answers on the eight-item task), indicating development of phonological awareness.

The results confirm that the task is developmentally sensitive. The comparison of group results reveals a developmental continuum (based on repeated measures ANOVA and Sidak's post hoc tests; $F(7, 432) = 10{,}74$ $p < 0.001$). The difference between 3-year-olds and 5 and 6-year olds is statistically significant ($p < 0.001$) as well as the differences between 4-year olds and 6-year-olds. The results also show that the task is not inappropriate for participants aged three, since simpler tasks do not reveal developmental patterns.

Table 2: Percentage of correct responses in the PhA task (N=440).

Age group	N of participants	% correct	s. d.
3;0–3;11	82	46%	0.10
4;0–4;11	107	51%	0.17
5;0–5;11	119	56%	0.16
6;0–6;11	132	63%	0.18

Similar studies revealed similar results and difficulties. All studies show relatively low scores when administered to younger children. Smaller samples studies show that the average scores are 36% for 3-year old children and 43% for four year olds [16]. Phoneme recognition in initial position in words used in Chaney's study [4] included a two-item task with lexical words. Only 14% percent of 3-year olds met the 80% criterion. Neither do Foy and Mann [7] report higher scores on similar tasks. The tasks used in their study, although slightly different and administered to a rather heterogeneous sample of 40 children aged between four and six show low average results (15%) as well. Thomas and Sènèchal [20] assessed phonological awareness using three phoneme discrimination tasks; one was two-item nonsense words, the second was a phoneme judgement task detecting misarticulations of the phoneme /r/ and the third was a phoneme recognition task with three lexical items, two being either /r-l/ or /r-w/ minimal pairs (i.e. ring-wing) and the third item serving as a foil. The average result for 3-year-olds on all three tasks was 5.7 or 47% (maximum score in 3 tasks was 12) and 5.9 or 49% for 4-year-olds. Unfortunately, the authors give cumulative score for the tasks, which limits the comparison with the results of this study as well as the administration of another task with older children in later stages of their study. Somewhat higher scores for 3-year olds compared with our results can be explained by the number of items in the task they applied – two nonsense items or three lexical words, one item differing completely (bed). Nevertheless, it can be concluded that the developmental results follow the patters reported in similar studies but also share methodological issues. It is frequently reported that adequate PA tasks for different age groups with controlled linguistic criteria need to be developed.

The results also show that higher scores in the PhA task were obtained for the odd items beginning with one of the phonemes found in the developmental substitutions and not for those beginning with /r/ and the difference is statistically significant. The results for all strings of stimuli are shown in Table 3.

Table 3: Percentage of correct responses depending on the odd item (N= 440).

Odd items beginning with /r/ or having /r̩/		Odd items NOT beginning with /r/ or having /r̩/	
Stimuli	**% correct**	**Stimuli**	**% correct**
rag, lap, lab	33%	rap, rag, lat	63%
jup, jud, rug	61%	rub, rut, jug	59%
rip, vig, vit	33%	rid, vig, rip	50%
pid, prp, puk	32%	pid, prk, prb	40%
Average	**39%**	**Average**	**53%**

In order to recognize the target item in the strings in which it begins with /r/ the item must be perceived, kept in working memory while the new phonological knowledge is being applied. If the PR of the phoneme /r/ is immature, it will influence the results of phoneme categorization. The highest result was 63% of correct responses for /r-l/ opposition in which the odd item began with /l/, while the string with the same opposition but the opposite odd item beginning with /r/ was among the lowest. This can imply that lower quality PR of the phoneme /r/ does not provide enough phonological knowledge to complete the categorization task of the examined phoneme. The results for phoneme oppositions show the highest percentage of correct responses for /r-j/ opposition regardless of the initial phoneme. This would suggest that the phonological representation of the phoneme /j/ is mature and developed, which is supported by the results from articulation accuracy task in the battery – articulation of phoneme /j/ is fully developed in the entire sample. Therefore, phoneme /j/ could be considered a control phoneme in this task. Although Thomas and Sènèchal [19] show cumulative results for all tasks, the results for their control phoneme /m/ showed higher percentage of correct responses in both perceptual and PA tasks. On the other hand, phonological representations of /r/ and /l/ are in the process of development and therefore show lower scores on both perception and categorization tasks at the age of four. The results in this study follow similar patterns.

The results for the phoneme oppositions in different age groups are shown in Table 4. Age group comparison for /r-j/, /r-l/ and /r-ʋ/ oppositions revealed significant differences between the oldest age group and other three groups.

Table 4: Percentage of correct responses depending on the phoneme opposition in all age groups (N= 440).

Contrast	Age group	% correct	s.d.
/r-j/	**3;0–3;11**	56%	0.34
	4;0–4;11	63%	0.35
	5;0–5;11	72%	0.33
	6;0–6;11	84%	0.29
/r-l/	**3;0–3;11**	52%	0.29
	4;0–4;11	53%	0.34
	5;0–5;11	56%	0.31
	6;0–6;11	67%	0.30
/r-ʋ/	**3;0–3;11**	38%	0.33
	4;0–4;11	44%	0.33
	5;0–5;11	50%	0.35
	6;0–6;11	60%	0.32
/r̩-vowel/	**3;0–3;11**	38%	0.34
	4;0–4;11	43%	0.36
	5;0–5;11	47%	0.36
	6;0–6;11	42%	0.34

The children scored lower on the /r-l/ opposition than on the /r-j/ pair, since PR of /l/ develops later and PA of the /r-l/ contrast also exhibits significant between-group differences: 5-year-olds scored higher than 3-year-olds, but lower than 6-year-olds. The other two oppositions: /r-ʋ/ and /r̩-vowel/ show different patterns. The results for the /r-ʋ/ string also showed significant differences between the 5-year-olds and 3-year-olds. The lower percentage of correct responses for the /r-ʋ/ string could be explained by the development of perceptual category and its acoustic properties being the reason why in English various synthesized stimuli are perceptually categorized as /w/. However, this may not be the case in this task because the percentage of correct responses for the /r-ʋ/ opposition in perception tasks used in the battery was higher than 80%. The reason can be the characteristics of the stimuli, duration and phonological structure. Moreover, children need more acoustic cues for the categorization of phonemes with developing PRs [6, 25, 26].

The string with syllabic /r̩/ seems to be difficult for all age groups showing significant differences only between 3-year-olds and 5-year-olds. There are several possible explanations: first it is the position of the target phoneme in the word influencing task comprehension and lowering the result. The syllable [stop+syllabic /r̩/+stop] is a less frequent pattern in Croatian, making the phonological knowledge stored in the phonological representation insufficient for the categorization task. The third reason could be that the children do not perceive syllabic /r̩/-vowel as a contrast because children often produce words with syllabic /r̩/ with other developmental substitutions. For example, the word prst (engl. finger) can yield developmental renditions as /pəlst/ and not only /pust/, /pist/ or /pəst/. However, based on the two strings in this task it can only be concluded that the PR of /r/ and syllabic /r̩/ differ developmentally and that further research with more stimuli and /l/ substitutions of the syllabic /r̩/ is needed.

4. CONCLUSION

The results show that phoneme awareness task targeting a particular phoneme is a developmentally sensitive measure of QPR. Linguistic analysis shows the quality of the existing phonological knowledge within PR and the emergence of the new knowledge related to the formation of perceptual category. QPR explains the higher percentage of correct responses for /r-j/ since PR for phoneme /j/ can be considered developed, but also the development of the new phonological knowledge is evident from the results of /r-l/ oppositions.

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6. REFERENCES

[1] Anthony, J. L., Aghara, R. G., Solari, E. J., Dunkelberger, M. J., Williams, J. M., Liang, L. 2010. Quantifying phonological representation abilities in Spanish-speaking preschool children. *Applied Psycholinguistics*, *32*(01), 19–49.

[2] Anthony, J. L., Williams, J. M., Aghara, R. G., Dunkelberger, M., Novak, B., Mukherjee, A. D. (2010). Assessment of individual differences in phonological representation. *Reading and Writing*, *23*(8), 969–994.

[3] Carroll, J. M., Snowling, M. J. 2004. Language and phonological skills in children at high risk of reading

difficulties. *Journal of Child Psychology and Psychiatry*, *45*(3), 631–640.
[4] Chaney, C. 1992. Language development, metalinguistic skills, and print awareness in 3-year-old children. *Applied Psycholinguistics*, *13*, 485–514.
[5] Chaney, C. 1994. Language development, metalinguistic awareness, and emergent literacy skills of 3-year-old children in relation to social class. *Applied Psycholinguistics*, *15*, 371–394.
[6] Elliott, L. L., Hammer, M. A., Evan, K. E. 1987. Perception of gated, highly familiar spoken monosyllabic nouns by children, teenagers, and older adults. *Perception & Psychophysics*, *42*(2), 150–157.
[7] Foy, J. G., Mann, V. A. 2001. Does strength of phonological representations predict phonological awareness in preschool children? *Applied Psycholinguistics*, *22*(03), 301–325.
[8] Mann, V. A., Foy, J. G. 2007. Speech development patterns and phonological awareness in preschool children. *Annals of Dyslexia*, *57*(1), 51–74.
[9] Munson, B., Edwards, J., Beckman, M. E. 2005. Phonological Knowledge in Typical and Atypical Speech Sound Development. *Topics in Language Disorders*, *25*(3), 190–206.
[10] Munson, B., Edwards, J., Beckman, M. E. 2012. Phonological representations in language acquisition: Climbing the ladder of abstraction. In: Cohn, A, Fougeron, C., Huffman, M. K. (eds), *The Oxford Handbook of Laboratory Phonology*. Oxford New York: Oxford University Press, 288–309.
[11] Polka, L., Bohn, O. S. 1996. A cross-language comparison of vowel perception in English-learning and German-learning infants. *J. Acoust. Soc. Am.*, *100*, 577–592.
[12] Polka, L., Bohn, O. S. 2003. Asymmetries in vowel perception. *Speech Communication*, *41*(1), 221–231.
[13] Polka, L., Bohn, O. S. 2011. Natural Referent Vowel (NRV) framework: An emerging view of early phonetic development. *Journal of Phonetics*, *39*(4), 467–478.
[14] Rvachew, S., Bernhardt, B. M. 2010. Clinical implications of dynamic systems theory for phonological development. *American Journal of Speech-Language Pathology*, *19*(1), 34–50.
[15] Scarborough, H. S. 1990. Very early language deficits in dyslexic children. *Child Development*, *61*(6), 1728–1743.
[16] Sénéchal, M., Ouellette, G., Young, L. 2004. Testing the concurrent and predictive relations among articulation accuracy, speech perception, and phoneme awareness. *Journal of Experimental Child Psychology*, *89*(3), 242–269.
[18] Thomas, E. M. (1997). *The role of articulation in phonological development and phonological awareness*. Carleton University, Ottawa, Ontario.
[19] Thomas, E. M., Sénéchal, M. 1998. Articulation and phoneme awareness of three-year-old-children. *Applied Psycholinguistics*, *19*, 363–391.
[20] Thomas, E. M., Sénéchal, M. 2004. Long-term association between articulation quality and phoneme sensitivity: A study from age 3 to age 8. *Applied Psycholinguistics*, *25*(04).
[21] Tomić, D. 2013. Acquisition of approximants in Croatian. *Proceedings Speech and Language 2013*, Beograd: Life Activities Advancement Center The Institute for Experimental Phonetics and Speech Pathology, 248–257.
[22] Tomić, D. 2013. *Odnos fonetskoga i fonološkoga razvoja glasa /r/ kod djece u dobi od 3 do 7 godina* (Doctoral Thesis). University of Zagreb, Faculty of Humanities and Social Sciences, Zagreb.
[23] Tomić, D., & Mildner, V. 2015. Development of /r/ in Croatian. In: The Scottish Consortium for ICPhS 2015 (Ed.), *Proceedings of the 18th International Congress of Phonetic Sciences*. Glasgow, UK: the University of Glasgow. ISBN 978-0-85261-941-4. Paper number 0716.1-5 https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2015/Papers/ICPHS0716.pdf
[24] Wagner, R. K., Torgesen, J. K. 1987. The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin*, *101*(2), 192–212.
[25] Walley, A. C. 1988. Spoken word recognition by young children and adults. *Cognitive Development*, *3*(2), 137–165.
[26] Walley, A. C., Michela, V. L., Wood, D. R. 1995. The gating paradigm: Effects of presentation format on spoken word recognition by children and adults. *Perception & Psychophysics*, *57*(3), 343–351.