Examining phonological awareness in deaf children who are learning to read in a transparent orthography: evidence from Greek*

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Abstract

This paper investigates the development of phonological awareness in Greek deaf children. A battery of phonological awareness tasks that assessed syllable, rhyme and phoneme awareness was administered to one group of deaf preschoolers (n = 13, CA = 5;9), one group of deaf children in primary school (n = 11, CA = 7;8) and two hearing comparison groups. The results showed that deaf preschoolers did not have phonological awareness at any linguistic level. After an average of 21 months of literacy instruction, deaf children had developed syllable awareness.

Keywords: phonological awareness, Greek, deaf, reading, orthography

1. Introduction

Phonological awareness is the ability to reflect on and manipulate the constituent segments of spoken words. It develops at three levels: at the syllabic level, at the intrasyllabic level and at the phonemic level. Syllable awareness, onset-rime awareness and phoneme awareness are different components of phonological awareness (Høien et al. 1995). The developmental sequence of phonological awareness is from syllabic to intrasyllabic and finally to phonemic awareness (Goswami & Bryant 1990). Whereas syllable awareness and onset-rime awareness typically develop by the age of four, phoneme awareness develops at a later stage, around the age of six (Goswami & Bryant 1990).

Although it is now a well-established fact that phonological awareness is closely related to reading acquisition, evidence on the relationship between the two is unresolved. Whereas some studies have shown that phonological awareness is a precursor of reading acquisition (Lundberg 1991; Lundberg & Høien 1991; Mann 1991), others provide evidence that phonological awareness is a corollary of it (Morais et al. 1979; Morais 1991; Wimmer et al. 1991; Morais & Kolinsky 1995).

It has been argued that phonological awareness develops faster in transparent orthographies, such as Greek, Spanish and Italian, than in non-transparent orthographies, such as English (for an overview, see Ziegler & Goswami 2005). According to the psycholinguistic grain size theory, different grain sizes are favored in

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different languages, because languages differ in the consistency with which phonology is represented in orthography, (Ziegler & Goswami 2005).

Greek is transparent for reading as each grapheme corresponds to one phoneme. However, it is not transparent for spelling as each phoneme corresponds to more than one grapheme. It has been claimed that the transparency of the orthography in conjunction with the phonics teaching approach lead to a faster development of phonological awareness (Porpodas 1999, 2001; Nikolopoulos & Goulandris 2000). Evidence that syllable awareness precedes phoneme awareness can be found in Aidinis & Nunes (2001), who also found that syllable awareness and phoneme awareness make significant and independent contributions to reading and spelling in Greek. Harris & Giannouli (1999) provide some developmental data on phonological awareness in Greek hearing children. They found that at the beginning of the year kindergarten children had developed syllable awareness and by the end of the year they were also able to do a vowel substitution task and a phoneme counting task. A comparison of the kindergarteners with a group of first graders who had only been in primary school for one week revealed that the latter performed significantly higher on phoneme awareness and that they were almost at ceiling on the syllable task. When the first graders were tested again at the end of the year, they were at ceiling on all three phonological awareness measures. These findings suggest that the transparency of the Greek orthography does lead to a faster development of phonological awareness than is found in children learning to read English.

Deaf individuals can develop phonological awareness via residual hearing, lipreading (Dodd 1980, 1987; Dodd et al. 1998) or gesture information such as Cued Speech (Alegria et al. 1999; Charlier & Leybaert 2000; Alegria & Lechat 2005).

Syllable awareness. Evidence that syllable awareness can develop in deaf individuals comes from James et al. (2005), Olson & Nickerson (2001), Sterne & Goswami (2000) and Transler et al. (1999). James et al. (2005), Sterne & Goswami (2000) and Transler et al. (1999) also provide evidence that deaf individuals draw on orthographic knowledge when making phonological judgements about syllables. In particular, James and her colleagues administered a matching-to-sample syllable task to a group of cochlear implant users (n = 19, mean CA = 8;4). Participants were given four pictures and they were asked to indicate the word that matched the cue word. The task consisted of two conditions. In the congruent condition the two distracters (*tissue*, *sandal*) contained an unequal number of letters and syllables compared to the cue word (*leg*). Thus, in the congruent trials orthographic knowledge alone could lead participants to the target word (*cot*). In the incongruent condition orthographic length did not agree with phonological length. For example, in the set *torch-nurse-camel-tiger* the cue word (*torch*) had the same number of letters as the three alternatives. However, only one of these alternatives (*nurse*) shared the same number of syllables as the cue word. Therefore, in this condition orthographic knowledge could not lead to a correct judgement and participants would need to draw on their phonological knowledge in order to identify the correct word. In Sterne & Goswami (2000) 15 deaf children (mean CA = 11;7) were administered a yes/no judgement task. In the congruent condition, the two words had the same number of letters and the same number of syllables (*dog-box)* or one of the two words was phonologically and orthographically longer (*telephone-bowl*). In the incongruent condition, the words had either the same orthographic length but different phonological length (*hair-baby*) or the same phonological length but different orthographic length (*tomato-kangaroo*). Finally, in Transler et al. (1999) 21 French deaf children (mean CA = 10;6) were asked to copy down words and pseudowords. It was hypothesized that if children had an awareness of syllables then

they would chunk the multi-syllabic words into syllabic units whilst they were copying them. Whereas the participants in James et al. (2005) and Sterne & Goswami (2000) performed significantly above chance, the children who took part in the study by Transler et al. (1999) produced syllabic segmentations only when orthographic cues were consistent with phonological cues.

Rhyme awareness. Rhyme awareness in deaf individuals has been investigated by James et al. (2005), Sterne & Goswami (2000) and Campbell & Wright (1988). In the short-term longitudinal study by James et al. (2005) the rhyming pairs were orthographically congruent (*sock-clock*) or incongruent (*one-run*). At Time 1 there was no difference between trials that were orthographically congruent and trials that were orthographically incongruent. Twelve months later at Time 2 performance on the orthographically incongruent trials had improved significantly. Sterne & Goswami (2000) found that deaf children were able to make rhyme judgements and that orthography affected both accuracy and reaction time. Campbell & Wright (1988) reported similar results. In the spelling congruent condition of Campbell & Wright's study, the word endings were orthographically and phonologically similar (*house-mouse*) or dissimilar (*rose-rope*). In the spelling incongruent condition, the word endings were either orthographically dissimilar but phonologically similar (*tree-key*) or orthographically similar but phonologically dissimilar (*vase-case*). Although participants could make rhyme judgements, they performed significantly less accurately in the incongruent condition. Thus, it emerges from these studies that rhyme awareness can develop in deaf children although orthography also plays an important role.

Phoneme awareness. James et al. (2005) and Sterne & Goswami (2000) examined phoneme awareness in deaf people. The phoneme task in James et al. (2005) was a picture based task that was designed so that the initial phonemes in the cue word and in the target word had either the same or different spelling (e.g. *finger-fox*, *queen-cot*). The results showed that at T1 phoneme awareness had not developed in the cochlear implant users. Only trials where spelling knowledge could aid the phoneme judgement were significantly above chance. When tested again at T2, participants scored higher on the phoneme test, but there was still a large discrepancy between trials where spelling knowledge could be used (as in *finger-fox*) and trials where it could not be used (as in *queen-cot*). In Sterne & Goswami (2000) deaf children were given a set of written non-words one of which was homophonous to a real word (*snaik-paik-snoik-snaip,* in English *snaik* is homophonous to a real word, *snake*). Participants were asked to choose the non-word that most sounded like a real word. The researchers found that the judgements were significantly above chance level on this test, which indicated that the deaf children were able to use phonological coding when reading non-words. It can therefore be concluded that phonological representations of phonemes can develop in deaf children, especially when orthographic cues are also available.

In conclusion, it emerges that phonological awareness can develop in deaf people at all three linguistic levels of syllable, rhyme and phoneme. However, in deaf people phonological awareness is also likely to be mediated heavily by orthographic knowledge. To date, no previous study has investigated the phonological awareness and reading skills of Greek deaf children, who read in a transparent orthography. If it were found that phonological awareness develops faster in Greek deaf children, then we might conclude that deaf children rely heavily on orthography to develop phonological awareness. The clinical implication of this would be that training deaf children on grapheme-phoneme correspondences and starting with those that occur most consistently in their language would help deaf children develop phonological representations. That by extension would help them develop their reading skills.

Hearing children do not need to be exposed to literacy to develop phonological awareness. By the time they go to school they have acquired a considerable number of phonologically segmented spoken words. This is not the case with deaf children. Can orthographic transparency help Greek deaf children develop their phonological awareness skills to a level comparable to that of Greek hearing children? In order to address this question, deaf and hearing children took part in this study. The research questions are:

a. What is the developmental trajectory of phonological awareness in Greek deaf children?
b. What is the effect of literacy acquisition on the development of phonological awareness in Greek deaf children?
c. What is the effect of orthographic transparency on the development of phonological awareness in Greek deaf children?

On the basis of findings from previous studies it was predicted that the developmental trajectory of phonological awareness would follow the progression syllable awareness – rhyme awareness – phoneme awareness. It was also predicted that participants who were already in primary school would perform better than preschoolers, thus showing an effect of literacy acquisition. With regard to the effect of orthographic transparency it was predicted that the Greek deaf participants would develop phonological awareness earlier and faster than children who have participated in studies in other languages.

2. Method

The study is short-term longitudinal with three data collection points each six months apart (T1-September 2004, T2-March 2005, T3-September 2005). The data presented here were collected at T1.

2.1 Participants

Two groups of deaf children participated in the study. One group was at the nursery school (n = 13, mean CA = 5;9) and one group was at the primary school (n = 11, mean CA = 7;8). The participants had a hearing loss greater than 71dB in the better ear. Seventeen children were hearing aid users and seven were cochlear implant users. All participants used oral speech and some of them also used sign language. Ten children were in a mainstream school, twelve were in a special school for the deaf and two were in a special unit for hearing impaired children. Among the participants in primary school, five attended the first grade, two attended the second grade and four attended the third grade.

Two hearing comparison groups were also recruited. One group consisted of preschoolers (n = 14, mean CA = 5;3) and one group consisted of first graders (n = 16, mean CA = 6;3).

2.2 Material

The material consisted of a new battery of phonological awareness tasks investigating phonological awareness at the levels of syllable, rhyme and phoneme. The phonological awareness tasks were yes/no judgement tasks. Participants saw two pictures on a laptop screen and they were asked to judge whether the pictured items were the same length (syllable task), whether they ended with the same sound (rhyme task) or whether they

began with the same sound (phoneme task). Each phonological awareness task consisted of 36 main items and 4 practice items. The total number of correct responses was used in the analyses.

The syllable task consisted of a congruent condition and an incongruent condition. In the congruent condition the two pictured items had labels with the same number of letters and the same number of syllables (/'ɸi.ði/ - /'vɐ.zɔ/) or one of the two words had a greater number of letters and syllables (/tɾɐ.'pɛ.zi/ - /'ɾɔ.ðɐ/). In the incongruent condition the two words had the same number of letters but different number of syllables (/mɔ.'li.vi/ - /'sku.pɐ/) or the same number of syllables but different number of letters (/ci.'θɐ.ɾɐ/ - /kɐɾ.'pu.zi/). There were 9 items in each subtask. The Greek words for the examples transcribed above and the corresponding English words are given in the footnote below[1].

The rhyme task consisted of 12 rhyming pairs (/'bɔ.tɐ/ - /'kɔ.tɐ/, /bɐ.'lɔ.ni/ - /pɛ.pɔ.'ni/), 12 semantically similar pairs (/kɐ.'ɾɔ.tɔ/ - /pɐ.'tɐ.tɐ/) and 12 pairs that were not phonologically or semantically related (/'ksi.lɔ/ - /'pɐ.pjɐ/)[2]. The rhyming words were either disyllabic or trisyllabic. In these pairs the shared segment consisted of the final syllable and the vowel preceding that syllable.

Finally, the phoneme task comprised 18 same-phoneme pairs and 18 different-phoneme pairs. In the same-phoneme pairs the shared sound was always in initial position and it occurred in a CV-CV (/'fɐ.lɛ.nɐ/ - /'fɔ.ɾɛ.mɐ/), CCV-CV (/'ðɾɔ.mɔs/ - /'ðɔ.djɐ/) or CCV-CCV (/stɐ.'fi.ʎiɐ/ - /sxɔ.'li.ɔ/) environment. In the different-phoneme pairs the initial sounds had either the same manner of articulation (/ti.'lɛ.fɔ.nɔ/ - /pɛ.tɐ.'lu.ðɐ/) or the same place of articulation (/ɾɔ.'lɔ.i/ - /lu.'lu.ði/)[3].

In order to ensure that the participants knew the words and they could match the pictures with the target labels, prior to experimental testing, the stimuli were presented as picture-pointing tasks and picture-naming tasks. In the picture-pointing task participants saw four pictures on a laptop screen and were asked to point to the one named by the experimenter (first named author). In the picture-naming task participants were presented with cards, each one depicting an object, and were asked to provide the corresponding word.

The criteria followed for the selection of the stimuli were that they should be words which can be depicted, that they should be early acquired by hearing children and that they should be some of the first entries in a deaf child's repertoire. The majority of the items were first administered to the deaf and hearing children who participated in the study which the first author carried out as part of her postgraduate studies (Kyritsi 2003). In addition, the phonological awareness battery designed for this study was piloted on Greek hearing children (Kyritsi & James 2005). It was therefore deemed that the stimuli were appropriate for the present study.

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[1] Syllable task: /'fi.ði/ *φίδι* - /'vɐ.zɔ/ *βάζο* (*snake – vase*), /tɾɐ.'pɛ.zi/ *τραπέζι* - /'ɾɔ.ðɐ/ *ρόδα* (*table – wheel*), /mɔ.'li.vi/ *μολύβι* - /'sku.pɐ/ *σκούπα* (*pencil – broom*), /ci.'θɐ.ɾɐ/ *κιθάρα* - /kɐɾ.'pu.zi *καρπούζι* (*guitar – watermelon*)

[2] Rhyme task: /'bɔ.tɐ/ *μπότα* - /'kɔ.tɐ/ *κότα* (*boot – hen*), /bɐ.'lɔ.ni/ *μπαλόνι* - /pɛ.'pɔ.ni/ *πεπόνι* (*balloon – melon*), /kɐ.'ɾɔ.tɔ/ *καρότο* - /pɐ.'tɐ.tɐ/ *πατάτα* (*carrot – potato*), /'ksi.lɔ/ *ξύλο* - /'pɐ.pjɐ/ *πάπια* (*wood – duck*)

[3] Phoneme task: /'fɐ.lɛ.nɐ/ *φάλαινα* - /'fɔ.ɾɛ.mɐ/ *φόρεμα* (*whale – dress*), /'ðɾɔ.mɔs/ *δρόμος* - /'ðɔ.djɐ/ *δόντια* (*road – teeth*), /stɐ.'fi.ʎiɐ/ *σταφύλια* - /sxɔ.'li.ɔ/ *σχολείο* (*grapes – school*), /ti.'lɛ.fɔ.nɔ/ *τηλέφωνο* - /pɛ.tɐ.'lu.ðɐ/ *πεταλούδα* (*telephone – butterfly*, /ɾɔ.'lɔ.i/ *ρολόι* - /lu.'lu.ði/ *λουλούδι* (*clock – flower*)

3. Results

The mean performance of each group on the phonological awareness tasks is shown in Table 1. Using the Binomial Test of proportion it was found that the chance level was 24 out of 36. It can be seen that as a group the deaf preschoolers were not significantly above chance level on any of the phonological awareness tasks. The deaf participants who were in primary school performed above chance on the syllable task. The mean score of the deaf primary school children on the phoneme task was higher than the score on the rhyme task. With regard to the hearing comparison groups, the preschoolers were above chance on the syllable task and on the rhyme task. The first graders were above chance on all phonological awareness tasks. Their performance on the syllable task was almost at ceiling. Both hearing groups performed less well on the phoneme task with the hearing preschoolers scoring below chance level.

Table 1. Performance of each group in mean (and standard deviations) on the phonological awareness tasks

	Deaf Children		*Hearing Children*	
Tasks	Preschoolers (n= 1 3)	Primary School (n = 11)	Preschoolers (n = 14)	Primary School (n = 16)
Syllable	19.69 (3.25)	25.64 (5.84)	29.21 (5.26)	32.63 (3.88)
Rhyme	17.15 (3.79)	20.27 (4.45)	27.36 (6.08)	28.44 (6.08)
Phoneme	17.77 (1.88)	23.18 (6.7)	19.71 (4.29)	26.13 (7.61)

Note: Maximum is 36 and chance level is 24

With respect to the developmental sequence of phonological awareness, the deaf groups scored higher on the syllable task than on the rhyme and phoneme tasks. Further, the preschoolers performed similarly on the rhyme task and on the phoneme task whereas the primary school children performed better on the phoneme task than on the rhyme task. Both hearing groups scored higher on the syllable task than on the rhyme task and they also scored higher on the rhyme task than on the phoneme task.

To further explore whether performance varied significantly across the three phonological awareness tasks within-subjects comparisons were carried out using the Friedman test. For both deaf groups performance varied significantly across the three tasks (deaf preschoolers: $\chi^2 = 7.87$, $p = .019$; deaf primary school: $\chi^2 = 13.9$, $p = .001$). Performance was also significantly different for the hearing comparison groups (hearing preschoolers: $\chi^2 = 19.74$, $p < .001$; hearing first graders: $\chi^2 = 11.23$, $p = .004$). In order to examine which between-task differences were significant, pair-wise comparisons were computed. Wilcoxon tests showed that for the deaf preschoolers performance differed significantly on the syllable – rhyme tasks ($z = -1.97$, $p = .05$) and on the syllable – phoneme tasks ($z = -2.33$, $p = .02$). For the deaf primary school children the difference was statistically significant on the syllable – rhyme tasks ($z = -2.94$, $p = .003$). In relation to the hearing preschoolers, performance differed significantly on the rhyme – phoneme tasks ($z = -3.17$, $p = .002$) and on the syllable – phoneme tasks ($z = -3.3$, $p = .001$)). With regard to the hearing first graders, significant differences were found on the syllable – rhyme tasks ($z = -2.91$, $p = .004$) and on the syllable – phoneme tasks ($z = -2.3$, $p = .003$).

A second prediction was that the participants who were already in primary school would perform better than the preschoolers, thus showing an effect of reading acquisition on phonological awareness. In order to investigate this, between-subjects analyses were carried out. It was found that the performance of the deaf groups differed significantly on all three phonological awareness measures (syllable task: $z = -2.69$, $p = .007$; rhyme task: $z = -1.99$, $p = .05$; phoneme task: $z = -2.38$, $p = .018$). In contrast, the performance of the hearing groups was differentiated only on the phoneme task ($z = -2.16$, $p = .031$).

4. Discussion

What is the developmental trajectory of phonological awareness in Greek deaf children? Cross-linguistic research has shown that the development of phonological awareness progresses from syllabic awareness to intrasyllabic awareness and finally to phonemic awareness. It was predicted that the same pattern would emerge from the performance of the participants in the present study. The data obtained from the hearing participants confirm this prediction. Both hearing groups scored higher on the syllable task. Poorest performance was on the phoneme task.

The deaf preschoolers were below chance on all three phonological awareness tasks. The deaf children who were in primary school were on average above chance only at the syllable task. It appears therefore that syllable awareness develops first in Greek deaf children. The primary school children performed better on the phoneme task than on the rhyme task. This may not seem consistent with previous findings indicating that in deaf as well as in hearing children phoneme awareness develops after rhyme awareness.

It has to be borne in mind, though, that previous findings come from studies which have been carried out mainly in English, which has a non-transparent orthography. The fact that the Greek deaf children, in contrast to English deaf children, performed better on the phoneme task than on the rhyme task could be attributed to the one-to-one mapping between graphemes and phonemes for reading in Greek. Because of this transparency, it is possibly easier for Greek deaf children to realise that the written words *φάλαινα* (/'fɐ.lɛ.nɐ/, *whale*) – *φόρεμα* (/'fɔ.ɾɛ.mɐ/, *dress*) begin with the same phoneme than it is for English deaf children to realise that the words *queen-cot* share the initial phoneme, despite the fact that this is realised by different graphemes.

Further, during administration of the phoneme task, it was noticed that some participants used fingerspelling to make a judgement. It could be argued that, because of the orthographic transparency, fingerspelling may provide a more accurate basis for making phonemic judgements in Greek than in English. In both languages each handshape corresponds to an individual grapheme. However, in Greek each grapheme corresponds to a single phoneme whereas in English a grapheme may correspond to more than one phonemes. As a result, the use of fingerspelling could help a Greek deaf child develop phonological representations at the phonemic level but it would not necessarily be the same accurate source of information for an English deaf child.

Finally, speech and language therapists typically train beginning deaf readers on individual letters and on identifying these letters within words. Training usually starts by identifying letters that occur at the beginning of a word. If a deaf child is presented with a letter and with a word beginning with that letter, the child will gradually begin to realise that that initial letter corresponds to the initial sound of that word. This process of associating individual phonemes with individual graphemes is probably easier and

quicker for a Greek deaf child, who reads in a transparent orthography, than for an English deaf child.

What is the effect of literacy acquisition on the development of phonological awareness in Greek deaf children? In order to investigate the effect of literacy acquisition on the development of phonological awareness, the performance of the deaf preschoolers was compared with the performance of the deaf children who were already in primary school. It was predicted that the primary school children would perform better than the preschoolers. This prediction was confirmed. The performance of the deaf groups was significantly different on all phonological awareness measures. Hearing first graders also performed better than hearing preschoolers. The fact that this difference was statistically significant only on the phoneme task suggests that in hearing children syllable and rhyme awareness but not phoneme awareness can develop before reading is introduced.

What is the effect of orthographic transparency on the development of phonological awareness in Greek deaf children? At the outset of this study, it was predicted that the data would provide evidence for an effect of orthographic transparency on the development of phonological awareness in Greek deaf children. However, this is a difficult issue to address for two main reasons. First, few studies conducted in other languages have investigated phonological awareness in deaf children and only one study has been carried out with deaf children whose chronological age was similar to the age of the participants in the current study. One study that investigated phonological awareness in young deaf children aged 4;02 to 6;02 (n = 24) was by Harris & Beech (1998). They found that the deaf children had significantly poorer phonological awareness than the hearing comparison group and that their scores ranged from 39% to 89% correct. However, this leads to the second point which is that, until more data are available from studies carried out with matched language samples and matched tasks, it is difficult to determine to what extent it is orthography that causes variation in the attainment of phonological awareness by different language groups. Although it is believed that the current study contributes to the under-researched area of phonological awareness and literacy acquisition in Greek deaf children, it will be important for future research to continue to address the issue of the relation between orthographic transparency, phonological awareness and reading acquisition in deaf children who read in a transparent orthography.

5. Conclusions

Overall, the results from the current study indicate that phonological awareness can develop in Greek deaf children. However, it should be noted that, as the individual data indicate, in deaf children phonological awareness does not develop 'automatically' by a particularly age, like syllable and intrasyllabic awareness do in typically developing hearing children. In addition, as the comparison of the two deaf groups showed, literacy acquisition seems to be a particularly determinant factor in the development of phonological awareness even at the syllabic level. Although it was not possible to assess the reading skills of the participants at Time 1, it appears that reading development and orthographic knowledge form a basis on which deaf children can draw conclusions about spoken words and their written representations.

If literacy acquisition is particularly important for the development of phonological awareness in deaf children, the sooner deaf children are taught literacy the sooner their phonological awareness will begin to emerge. Of course, that presupposes that the deaf child has reached a certain cognitive and language level, which in turn will depend on

age of hearing loss detection and various other factors. It might be the case that deaf children who have some literacy knowledge, or at least grapheme-phoneme knowledge, at preschool will go on to develop their phonological awareness faster and will have better reading outcomes than deaf children who do not. Intervention studies could help explore this possibility.

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