Phonological awareness, letter-sound knowledge and word recognition in Greek deaf children

Evi Kyritsi¹, Deborah James² & Susan Edwards¹

¹University of Reading and ²University of Newcastle

Abstract
The aim of the study presented in this paper was to investigate the relation between phonological awareness and orthographic knowledge in deaf children who read in the transparent Greek orthography. Preschool and school-aged deaf children (N = 24) and two comparison groups of hearing children (N = 30) were administered measures of phonological awareness, letter-sound knowledge and word recognition at the beginning and at the end of the school year.

The results showed different patterns of performance between the deaf and hearing groups. Three main findings emerge from the deaf participants’ performance. First, their performance did not follow the hypothesized developmental sequence (syllable → rhyme → phoneme); second, the participants who were above chance on phonological awareness had good letter-sound knowledge; third, some deaf children were above chance on word recognition but not on phonological awareness.

These findings confirm previous evidence from studies with English-speaking and French-speaking deaf individuals and they indicate that the origins of phonological awareness in deaf individuals are orthographic rather than phonological. Letter-sound knowledge appears to play a particularly important role in the development of phonological awareness in deaf children. The various factors that influence phonological awareness and reading acquisition in deaf children will be summarized.

1 Introduction

Phonological awareness is the ability to reflect on and manipulate the constituent segments of spoken words. It is a multi-dimensional construct which consists in the ability to identify, delete, isolate, blend or count syllables, onsets, rimes or phonemes (Høien, Lundberg, Stanovich & Bjaalid 1995; Stackhouse & Wells 1997; Yopp 1988). Evidence suggests that phonological awareness develops from the large units of syllables, onsets and rimes to the small units of phonemes (Carroll, Snowling, Hulme, & Stevenson 2003; Goswami & Bryant 1990; Liberman, Shankweiler, Fischer, & Carter 1974; Treiman & Zukowski 1996).

1.1 Phonological awareness and literacy in hearing children

Research with hearing children provides ample evidence that there is a very close connection between phonological awareness and literacy. In fact, as it has been said, phonological awareness forms a ‘bridge’ from speech and language to literacy (Morais 1990; Stackhouse & Wells 1997). In what follows, the focus is on the link
between phonological awareness and two specific aspects of literacy: reading and letter-sound knowledge.

To a certain extent, the relation between phonological awareness and reading is a reciprocal one. Broadly speaking, syllable awareness and onset-rime awareness develop in preschoolers whereas phoneme awareness develops as a consequence of learning to read. At the same time, however, findings from children with speech and language difficulties indicate that, if phonological awareness has not developed by a specific age, the child will have severe difficulties in reading acquisition (Carroll & Snowling 2004; Gillon & Dodd 2005; Pascoe, Stackhouse & Wells 2006). Moreover, it has been shown that rhyme awareness and, more importantly, phoneme awareness are significant predictors of reading concurrently and longitudinally (Bradley & Bryant 1978; Bryant, Bradley, Maclean & Crossland 1989; Caravolas, Volin & Hulme 2005; Hatcher & Hulme 1999; Hulme, Hatcher, Nation, Brown, Adams & Stuart 2002).

As regards letter-sound knowledge, there is evidence that this is a significant concurrent predictor of phoneme awareness in preschool children (Johnston, Anderson & Holligan 1996). Similar results are reported in Bowey (1994), who found that nonreaders with high letter knowledge outperformed nonreaders with low letter knowledge on measures of onset-rime and phoneme awareness. Extending these findings, the work of Burgess & Lonigan (1998) and Muter, Snowling & Stevenson (2004) indicates that the predictive relationship between phonological awareness and letter-sound knowledge is reciprocal and holds true not only at a single time but across time as well, with one being a significant longitudinal predictor of the other. Further, in addition to phonological awareness, letter-sound knowledge has also been found to predict reading concurrently and longitudinally (Hogan, Catts & Little 2005; Johnston et al. 1996; Muter et al. 1998, 2004).

Coming back to the relation between phonological awareness and letter-sound knowledge, one interesting question which researchers have sought to address and which has important implications for deaf children is whether the first can develop in the absence of the second. In other words, the question posed is the following: Is letter-sound knowledge a prerequisite for the development of phonological awareness in hearing children?

The findings of Stahl & Murray (1994) indicate that letter-sound knowledge appears to be necessary for the child’s ability to analyse spoken words into onsets and rimes. The researchers found that, out of 52 kindergartners and 61 first graders, the majority of the participants who were above chance on an onset-rime task also had good letter-sound knowledge; only one child who knew fewer than 45 letters managed to pass chance level. Similarly, Johnston et al. (1996) report that, out of 49 preschoolers, 42 had good letter knowledge and 25 of them also had good phoneme awareness. Seven children did not know any letters of the alphabet, and six of these children were also unable to delete or segment phonemes.

However, data reported by Hulme, Caravolas, Malkova & Brigstocke (2005) stand in contrast to the above findings. Hulme et al. investigated letter knowledge and phoneme isolation ability in young Czech and English children. The results showed that participants could isolate some phonemes for which they did not know the corresponding letters. In addition, four (Czech) children did not know any of the letter sounds tested. Out of these four children, one child scored zero on phoneme isolation, one child scored 10 and two children were 100% correct scoring 15. The authors concluded that it is possible for children to have some awareness of phonemes even if they do not know the corresponding letters.

In view of the above, it can be concluded that in typically developing hearing children letter-sound knowledge may not necessarily be a prerequisite for the development of phonological awareness. However, the same does not hold true for hearing children with speech and language difficulties. It has been demonstrated that
these children make significant progress in the development of their phonological and reading skills when intervention focuses on making explicit links between phonological skills (particularly phonemic skills) and letter-sound correspondences than when it focuses on phonological skills only (Hatcher, Hulme & Ellis 1994; Hatcher, Hulme & Snowling 2004).

1.2 The effect of orthographic transparency

One factor that influences phonological awareness is orthographic transparency, i.e. the degree to which there are consistent correspondences between letters and sounds in an orthographic system. Although the developmental trajectory of phonological awareness is the same across different alphabetic systems, the rate of the development varies. Children who read in a transparent orthography (e.g. Greek, Italian, or Finnish) develop phonological awareness, and as a consequence reading, faster than children who read in a non-transparent orthography (e.g. English). Evidence for this comes from monolingual studies carried out with different language groups as well as from cross-linguistic studies (e.g. Aidinis and Nunes 2001; Goswami, Porpodas & Wheelright 1997; Nikolopoulos & Goulandris 2000; Patel, Snowling & de Jong 2004; Porpodas 1999; Seymour, Aro & Erskine 2003).

1.3 Phonological awareness and literacy in deaf children

In deaf individuals phonological awareness is heavily mediated by orthographic knowledge. This conclusion emerges from the consistently replicated finding that deaf children, adolescents and adults perform significantly better on phonological awareness tasks when orthographic information is consistent with phonological information, e.g. dog – frog vs. hair – bear1 (Campbell & Wright 1988; Dyer, MacSweeney, Szczerbinski, Green, & Campbell 2003; Hanson & Fowler 1987; Hanson & McGarr 1989; James, Rajput, Brown, Sirimanna, Brinton & Goswami 2005; Kyle & Harris 2006; Sterne & Goswami 2000). Yet, research with deaf school-aged children and adults has also shown that, although performance is typically better in the congruent condition, some deaf individuals are still able to make accurate phonological judgments when they cannot rely on orthography (e.g. Hanson & Fowler 1987; Hanson & McGarr 1989; Sterne & Goswami 2000).

With respect to reading acquisition in deaf children, a correlation has been found between reading and phonological awareness (Campbell & Wright 1988; Dyer et al. 2003; Harris & Beech 1998). However, empirical evidence indicates that this correlation is no longer significant when differences in hearing loss, vocabulary and speechreading are controlled for (James 2002; Kyle & Harris 2002). To the best of our knowledge, there has been no previous study on letter-sound knowledge and its relation to phonological awareness in deaf children.

2 The present study

2.1 Research questions

The findings discussed above from typically developing and language disordered hearing children in conjunction with evidence from deaf individuals led to the motivation for the current study, which was carried out with Greek preschool and

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1 For example, in the pair dog – frog the words have the same spelling at the end and they also rhyme. Therefore, orthographic cues are consistent with phonological cues. By contrast, in the pair hair – bear the words have the same rime but different spelling.
school-aged deaf and hearing children. This paper focuses on data from the deaf children.

The research questions addressed in the study were the following:

- How does phonological awareness develop in Greek deaf children?
- What is the level of letter-sound knowledge in Greek deaf children and how does it relate to phonological awareness?
- What are the word recognition skills of Greek deaf children and how do they relate to phonological awareness?

The design of the study was cross-sectional and short-term longitudinal. Data were collected at two time points six months apart.

2.2 Participants

Two groups of deaf children participated in the study. One group consisted of children who were in nursery school (N=13, CA: 6;2, range: 5;2-9;1) and the other group consisted of children who were in the first, second or third grade of primary school (N=11, CA: 8;4; range: 6;4-10;9). Participants were severely or profoundly deaf, they had sensorineural congenital or prelingual hearing loss, normal non-verbal reasoning, and no confirmed or suspected learning or motor difficulties. All participants had some degree of spoken language. Seven preschoolers had been fitted with a cochlear implant and six preschoolers wore hearing aids. All school-aged children had hearing aids.

2.3 Material

The experimental measures consisted of a) a battery of phonological awareness tasks, b) three tasks assessing knowledge of letter-sound correspondences, and c) a word recognition task. Phonological awareness and letter-sound knowledge were assessed both at T1 and at T2; word recognition was only tested at T2.

In the phonological awareness battery participants were asked to judge whether pairs of pictorially presented words were the same length (syllable awareness), whether they ended with the same sound (rhyme awareness) or whether they began with the same sound (phoneme awareness). Each task consisted of 36 main items and 4 practice items.

Knowledge of letter-sound correspondences was assessed via three tasks, each of which consisted of 22 items. These tasks were the following:

- A sound knowledge task: Participants were presented with a card showing a letter and they were asked to produce the corresponding sound.
- A sound discrimination task: Each item contained two pictorially presented words. These were named by the experimenter and participants were asked to point to the word that started with the target sound.
- A letter knowledge task: The experimenter produced a sound and participants were asked to write down the corresponding letter.

Finally, as no published reading measure was available that could be used with Greek deaf children, a word recognition task was developed. This had a matching-to-sample design. Participants saw a picture and beneath it four written words. By pressing the correct colour coded key on a response box, they were asked to indicate the word that matched the picture. In total, there were 40 main items and 6 practice items in this task.
3 Results

3.1 Phonological awareness

Based on previous evidence on the developmental sequence of phonological awareness (i.e. syllable → rhyme → phoneme), it was predicted that the two groups would score higher on the syllable task and lower on the phoneme task. According to the Binomial Test of Distribution, scores above 63.89% (raw score: 23 out of 36) differed significantly from chance level (p < .05). As the means in Table 1 suggest, at T1 the Nursery Group was on average below chance on all three phonological awareness tasks. The Primary Group performed above chance on syllable and phoneme awareness but they were below chance on rhyme awareness. Highest performance for this group was on the syllable task and lowest performance was on the rhyme task. At T2 the Nursery Group passed chance level on the syllable task and on the phoneme task but not on the rhyme task. On average, they scored higher on the phoneme task than on the syllable task. The Primary Group was now above chance on all three tasks. Similarly to T1, their performance was highest on the syllable task and lowest on the rhyme task.

Table 1. Performance on the phonological awareness tasks (% correct)

<table>
<thead>
<tr>
<th></th>
<th>SYLLABLE</th>
<th>RHYME</th>
<th>PHONEME</th>
<th>SYLLABLE</th>
<th>RHYME</th>
<th>PHONEME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NURSERY GROUP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>Mean</td>
<td>61.29</td>
<td>52.96</td>
<td>51.47</td>
<td>76.25</td>
<td>53.9</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>18.89</td>
<td>15.9</td>
<td>19.21</td>
<td>14.71</td>
<td>16.29</td>
</tr>
<tr>
<td><strong>PRIMARY GROUP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>Mean</td>
<td>67.37</td>
<td>61.71</td>
<td>73.49</td>
<td>78.48</td>
<td>73.91</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>23.76</td>
<td>25.16</td>
<td>18.29</td>
<td>14.25</td>
<td>18.48</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>31.82 – 100</td>
<td>25 – 92.86</td>
<td>46.67 – 96.30</td>
<td>52.38 – 100</td>
<td>42.86 – 100</td>
</tr>
</tbody>
</table>

The above analyses were carried out with grouped data. Individual data were also analysed. The criterion of passing/failing chance level was followed in this analysis. The prediction was that participants who were above chance on rhyme awareness should also be above chance on syllable awareness and participants who were above chance on phoneme awareness should also be above chance on rhyme awareness. Indeed, at T1 participants in the Nursery Group performed according to this sequence. However, in the Primary Group two participants were below chance on rhyme awareness but above chance on phoneme awareness. At T2, one participant in the Nursery Group was below chance on syllable awareness but above chance on rhyme and phoneme awareness; in the Primary Group two participants were below chance on rhyme awareness but above chance on phoneme awareness, one participant passed chance level on the rhyme task but not on the syllable task, and one participant passed chance level on rhyme and phoneme awareness but not on syllable awareness. Therefore, at both time points some children did not perform according to the hypothesized developmental pattern.

Finally, in order to examine the development of phonological awareness over time, we carried out Wilcoxon tests. These showed that the Nursery Group performed significantly better on the phoneme task at T2 compared to T1 (z = 2.201, p < .05). Although they also performed better on syllable and rhyme awareness, these differences were not statistically significant (z = 1.540, p > .05; z = .676, p > .05). The Primary Group performed significantly better on the rhyme task (z = 2.490, p < .05) but not on the syllable (z = .255, p > .05) or the phoneme task (z = 1.245, p > .05).
### 3.2 Letter-sound knowledge and phonological awareness

Table 2 indicates that at T1 the Nursery Group had on average good knowledge of letter-sound correspondences. Importantly, as the ranges suggest, whilst some participants in this group scored low, some participants were already near or at ceiling. With regard to participants in the Primary Group, it can be seen that they all had good letter-sound knowledge. Some participants were at ceiling whereas there were no scores at floor. At T2 the Nursery Group scored high on the letter-sound tasks and the Primary Group was on average near ceiling. At this time point, there was no participant who had no knowledge of letter-sound correspondences. Individual scores ranged from 41% and 50% to 100%.

**Table 2. Performance on the letter-sound tasks (% correct)**

<table>
<thead>
<tr>
<th></th>
<th>NURSERY GROUP</th>
<th>PRIMARY GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. 2. 3.</td>
<td>1. 2. 3.</td>
</tr>
<tr>
<td><strong>T1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>67.73 62.99 60.39</td>
<td>84.95 84.3 87.19</td>
</tr>
<tr>
<td>SD</td>
<td>21.53 29.97 32.54</td>
<td>8.73 16.43 17.70</td>
</tr>
<tr>
<td>Range</td>
<td>41.38-91.38 13.64-100 9.09-100</td>
<td>70.69-94.83 63.64-100 40.91-100</td>
</tr>
<tr>
<td><strong>T2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>82.54 78.4 85.79</td>
<td>92.48 91.73 97.93</td>
</tr>
<tr>
<td>SD</td>
<td>9.33 24.14 13.18</td>
<td>6.23 16.11 6.85</td>
</tr>
<tr>
<td>Range</td>
<td>67.24-93.10 40.91-100 59.09-100</td>
<td>79.31-100 50-100 77.27-100</td>
</tr>
</tbody>
</table>

Key: 1. Sound knowledge; 2. Sound discrimination; 3. Letter knowledge

In order to investigate how letter-sound knowledge relates to phonological awareness in Greek deaf children, we examined performance on each phonological awareness task plotted against a composite score on the letter-sound tasks. For each participant the composite score represented the average of the scores obtained on the letter-sound tasks. This analysis showed that in both groups the participants who were above chance on the phonological awareness measures had average to good letter-sound knowledge. Lowest composite score for these participants was 40%. Therefore, contrary to the hearing children who were also tested in this study (Kyritsi 2007), there were no deaf children with good phonological awareness (i.e. above chance level) but poor letter-sound knowledge. On the other hand, it has to be pointed out that the participants who scored below chance on phonological awareness also had good letter-sound knowledge. Lowest composite score for these participants was 35%.

Wilcoxon tests showed an overall significant improvement in letter-sound knowledge over time. In particular, at T2 the Nursery Group performed significantly better on sound knowledge ($z = 2.197, p < .05$), sound discrimination ($z = 2.207, p < .05$) and letter knowledge ($z = 2.197, p < .05$). The Primary Group scored significantly higher on sound knowledge ($z = 2.599, p < .01$) and letter knowledge ($z = 2.032, p < .05$), whereas the difference in sound discrimination did not reach significance ($z = 1.696, p > .05$).

### 3.3 Word recognition and phonological awareness

Chance level on the word recognition task was 15 out of 40, i.e. 37.5%. As the results showed, mean performances on this task were 12.75 for the Nursery Group (SD: 5.12, range: 7-22) and 26.55 for the Primary Group (SD: 9.34, range: 15-39). It is interesting to note that three preschoolers were above chance on word recognition.
As the ranges indicate, all school-aged children performed significantly differently from chance level.

The relation between word recognition and phonological awareness was also explored. It was found that the preschoolers who were above chance on word recognition were also above chance on syllable, rhyme and phoneme awareness. By contrast, in the Primary Group not all participants were above chance both on word recognition and on phonological awareness. Some children with good word recognition ability (i.e. above chance level) were below chance on at least one of the phonological awareness measures.

4 Discussion

4.1 How does phonological awareness develop in Greek deaf children?

One aim of this study was to investigate the developmental sequence of phonological awareness in Greek preschool and school-aged deaf children. Based on evidence from English-speaking deaf children (James et al. 2005; Sterne & Goswami 2000), it was predicted that in deaf children, as in hearing children, phonological awareness develops first at the syllabic and at the rhyme level and then at the phonemic level.

Our findings cannot support this prediction. Both grouped and individual data indicate that the rhyme task might have been more difficult than the phoneme task. Moreover, it cannot be determined from our data whether syllable awareness precedes phoneme awareness. It is likely that factors relating to task demands and intervention strategies influenced participants’ performance contrary to the hypothesized direction. For example, the position of the shared segment in the rhyme task (word-finally) and in the phoneme task (word-initially) might have balanced out differences in the degree of difficulty between the two tasks. Further, during testing it was observed that speech therapists often emphasized the initial segments of words.

One argument we wish to put forward with respect to phoneme awareness, in particular, is that it is possible that the Greek orthography facilitates the development of phoneme awareness in deaf children via two main ways: first, via the consistent correspondences between letters and sounds, which allow for lexical representations to become specified at the phonemic level more quickly in Greek deaf children than, for example, in English-speaking deaf children (this would parallel the effect that has already been found for Greek and English-speaking hearing children); second, via its impact on fingerspelling which, given the one-to-one correspondence between letters and handshapes, is probably a more reliable source of information for deaf children using a transparent orthography, i.e. an orthography in which letters also map consistently onto sounds. Therefore, in addition to intervention strategies, orthography and fingerspelling are also likely to influence phonological awareness in deaf children.

4.2 What is the level of letter-sound knowledge in Greek deaf children and how does it relate to phonological awareness?

An interesting finding that emerges from our study is that, although Greek deaf preschoolers receive no formal literacy instruction, they have good knowledge of letter-sound correspondences by the time they go to primary school. This finding suggests that, similarly to hearing children with speech and language difficulties, some knowledge of letter-sound correspondences may be a prerequisite for the development of phonological awareness in deaf children. At the same time, however, the performance of the children who were below chance on phonological awareness
indicates that good letter-sound knowledge does not necessarily provide good phonological awareness in deaf children. As Figure 1 illustrates, in addition to orthography, a number of other factors appear to be equally important for the development of phonological awareness in deaf children.

Figure 1. Model of factors contributing to the development of phonological awareness and reading in deaf children.

4.3 What are the word recognition skills of Greek deaf children and how do they relate to phonological awareness?

We were also interested to see that three preschoolers had not only good letter-sound knowledge but also good word recognition ability. The same three preschoolers also had good phonological awareness. They scored above chance on all three measures at T2 and on at least one measure at T1. These findings could lead one to conclude that in deaf children, as in hearing children, phonological awareness precedes word recognition. However, the data from the Primary Group do not support this conclusion. Five participants were above chance on word recognition but below chance on at least one of the phonological awareness tasks. The profile of these participants suggests that amount of training in phonological awareness and spoken language as well as age of diagnosis are factors that can partly account for the development of phonological awareness in some but not all deaf children and for the different strategies that deaf readers use (Figure 1).
5 Conclusion

In sum, our findings indicate that some letter-sound knowledge may be a prerequisite for the development of phonological awareness in deaf children. They also suggest that orthographic transparency influences phonological awareness in deaf children in various ways. These two possibilities need to be followed up in future studies as there are important implications both theoretical (concerning the development of phonological awareness and reading in deaf children) and pedagogical (regarding the education of deaf children).

Acknowledgements

The study presented in this paper was financially supported by the Economic & Social Research Council and by the University of Reading. We are very grateful to the children who participated in the study and, of course, to their parents. We would also like to thank the Pedagogical Institute in Greece and participating schools. Finally, many thanks to Spyridoula Varlokosta for her valuable comments.

References


