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Author	Surname	First name	Staff/Student/ Visiting scholar/ External	School or external affiliation
1	Bow	Catherine	External	The University of Melbourne
2	Blamey	Peter	External	The University of Melbourne
3	Paatsch	Louise	Staff	Education
4	Sarant	Julia	External	The University of Melbourne
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The Effects of Phonological and Morphological Training on Speech Perception Scores and Grammatical Judgments in Deaf and Hard-of-hearing Children

Catherine P. Bow
Peter J. Blamey
Louise E. Paatsch
The University of Melbourne

Julia Z. Sarant
The Bionic Ear Institute

Seventeen primary school deaf and hard-of-hearing children were given two types of training for 9 weeks each. Phonological training involved practice of /s, z, t, d/ in word final position in monomorphemic words. Morphological training involved learning and practicing the rules for forming third-person singular, present tense, past tense, and plurals. The words used in the two training types were different (monomorphemic or polymorphemic) but both involved word final /s, z, t, d/. Grammatical judgments were tested before and after training using short sentences that were read aloud by the child (or by the presenter if the child was unable to read them). Perception was tested with 150 key words in sentences using the trained morphemes and phonemes in word final position. Grammatical judgments for sentences involving the trained morphemes improved significantly after each type of training. Both types of training needed to be completed before a significant improvement was found for speech perception scores. The results suggest that both phonological and morphological training are beneficial in improving speech perception and grammatical performance of deaf and hard-of-hearing children and that both types of training were required to obtain the maximum benefit.

Research into the language development of deaf and hard-of-hearing children indicates that although they can develop the skills required for spoken language communication, they often do so at a delayed rate compared with their age-related peers with normal hearing (Blamey et al., 2001b; Geers & Moog, 1994). Separating the skills involved in spoken language communication is not a straightforward task because the relationships among hearing, speech, and language are highly complex. Conducting controlled training studies to determine whether one skill can be improved independently of other skills is one way to investigate the potential relationships. Morphophonemics is one area in which some of these issues are evident; for example, when children delete final consonants, such as /s/ in *cats* or /d/ in *played*, they may be making production errors or morphological errors or both. In this experiment, an attempt was made to distinguish between these possibilities and determine whether explicit training in either morphology or phonology is necessary to overcome the problem(s).

Much of the research into the relationship between phonological and morphological impairment has been focused on hearing children with delayed language or specific language impairment (SLI; Paul & Shriberg, 1982; Tyler & McOmber, 1999). Although many believe that phonological and morphological disorders stem from the same underlying causes rather than constituting separate clinical entities (see Panagos, 1982 for a summary), some believe they constitute two different types of disorders (e.g., Aram & Kamhi, 1982). Paul and Shriberg (1982) identify four different patterns of association between phonological and syntactic systems, distinguishing between subjects

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with an overall syntactic delay and those whose use of phonetically complex morphophonemes is below the level of their syntactic production. Tyler and McOmber (1999) found that the use of converging sources of evidence to examine interactions between phonology and morphosyntax provides an appropriate method from which to hypothesize the source of breakdown in the production of phonetically complex morphophonemic forms.

It should not be assumed that language delay in deaf and hard-of-hearing children is identical to that in children with SLI. Gilbertson and Kamhi (1995) propose a distinction between normally developing children with hearing loss and children with language impairments who have hearing loss. One study that compared children with SLI to hard-of-hearing children (Norbury, Bishop, & Briscoe, 2001) found that on average the hard-of-hearing children outperformed the SLI group on several language measures, although the acquisition of finite verb morphology may be delayed in hard-of-hearing children. They state that although mild to moderate hearing loss appears to be a risk factor for delayed language development, it has a much less marked effect on morphosyntax than on phonological discrimination. The children in this study had severe to profound hearing loss; therefore, they may perform lower on language measures than children with mild to moderate hearing loss.

In their investigation of the language skills of cochlear implant users, Spencer, Tye-Murray, and Tomblin (1998) suggested that the use of English inflectional morphology may be less affected by maturation and aging and more affected by auditory inputs available via the cochlear implant. Svirsky, Stallings, Lento, Ying, and Leonard (2002) argue that cochlear implant users do not follow the regular patterns of language development of hearing children but rather that their development is affected by the perceptual prominence of the grammatical morpheme marker. In their study, they found that cochlear implant users produced the incontractible copula (*is/are*) correctly more often than noun plurals (s/z) and regular past tense (t/d), which they hypothesize to be due to perceptual prominence rather than grammatical factors.

Investigations of habilitation methods for hard-of-hearing and deaf children have not focused on the area of morphophonology. The focus of this study is to ask what the effects of phonological and morphological training are on speech production, morphological knowledge, and speech perception. The hypotheses investigated were:

1. Phonological training would improve phoneme production but not grammatical judgments.
2. Morphological training would improve grammatical judgments but not phoneme production.
3. Both phonological training and morphological training would improve speech perception scores.

Method

Participants

Seventeen deaf and hard-of-hearing children (8 girls and 9 boys) from an integrated primary school using oral/aural education were selected for inclusion in this study. The children were selected from a total of 29 deaf and hard-of-hearing children at the school. The selection process was based on the analyses of conversations recorded and transcribed within the 6 months prior to the commencement of the study. The scores were based on Computer-Aided Speech and Language Assessment (CASALA; Serry, Blamey, Spain, & James, 1997) analysis of the percentage of consonants correct in narrow transcription. Children who scored less than 100% in production of /s/, /z/, /t/, or /d/ in word final position were considered. For those who scored close to 100% or where there were a limited number of occurrences of these phonemes in the conversational sample, an overall view of the child's processes was considered. Children who exhibited only "natural" processes (such as glottal replacement of /t/ and final devoicing of /z/) were excluded. Each child's morphology was also considered through results on the Word Structure subtests of the Clinical Evaluation of Language Fundamentals (CELF) assessment (Semel, Wiig, & Secord, 1992, 1995) and his or her most recent annual conversational assessment. Children were included if it was apparent that they struggled with some of the most basic morphological structures.

Details of the 17 children are included in Table 1. Their ages at the first assessment ranged from 5 years,

Table 1 Detailed information on participants

Child	Group	Age	Gender	Hearing loss	Device	Implant experience	PPVT age
1	1sd	9y 8m	F	110	CI	6y 9m	7y 4m
2	1sd	5y 11m	M	60	HA		4y 3m
3	1sd	10y 3m	M	45	HA		6y 3m
4	1sd	5y 11m	F	110	CI	4y 2m	1y 10m
5	1zt	11y 9m	F	110	CI	8y 9m	6y 0m
6	1zt	11y 3m	F	88	HA		7y 0m
7	1zt	9y 11m	M	110	CI	2y 9m	6y 3m
8	1zt	9y 1m	M	55	HA		4y 7m
9	2sd	7y 11m	F	107	CI	3y 7m	5y 4m
10	2sd	8y 5m	F	105	CI	3y 9m	5y 10m
11	2sd	8y 2m	M	100	CI	3y 7m	6y 10m
12	2sd	6y 10m	M	53	HA		6y 1m
13	2sd	6y 5m	M	110	CI	3y 7m	4y 1m
14	2zt	11y 10m	M	70	CI	9y 8m	7y 5m
15	2zt	11y 3m	M	68	HA		7y 9m
16	2zt	5y 3m	F	50	HA		6y 6m
17	2zt	12y 5m	F	110	CI	9y 2m	5y 9m

M = male; F = female; HA = hearing aid; CI = cochlear implant; PPVT = Peabody Picture Vocabulary Test.

3 months to 11 years, 10 months. The column headed "Hearing loss" indicates the pure tone average unaided thresholds at 500, 1,000, and 2,000 Hz in dB HL for the better ear. The language ages were calculated from the results of their most recent Peabody Picture Vocabulary Test result (Dunn & Dunn, 1997) within the previous 12 months. Ten of the children used cochlear implants, and seven used hearing aids; however, no distinction was made between hearing aid and cochlear implant users because previous studies (Blamey et al., 2001b) suggested that individual rates of language development were not strongly correlated with device use or hearing thresholds.

Training

The 17 subjects were divided into two groups. Group 1 consisted of eight children (four girls and four boys, mean age 9 years, 2 months) trained in phonology in the first training period and morphology in the second. Group 2 consisted of nine children (four girls and five boys, mean age 8 years, 9 months) trained in morphology for the first training period and phonology in the second. Each training period was 9 weeks, followed by a 1-week evaluation period, carried out during the regular school term.

Teachers of the deaf at the participating school conducted the training. Training sessions lasted 15–20 minutes daily for one to three students at the same grade level. Teachers were asked to complete a weekly program diary for each child to indicate the content, the amount of time spent, and the teaching activities completed in each session.

Phonological training was focused on the production of /s, z, t, and d/ in final position in monomorphemic words only. Half of the children in each group were trained on /s, d/ and the other half on /z, t/. This aspect of the design was incorporated so that untrained phonemes could be included in the evaluations as a control condition. Additional phonemes outside the group /s, z, t, d/ were trained to make the training less repetitive and more interesting for the children. These additional phonemes were chosen individually on the basis of the conversational transcriptions used to select the participants. Results from a previous study (Paatsch, Blamey, & Sarant, 2001) showed that teaching phoneme production in words, sentences, and discourse leads to a greater improvement than teaching using nonsense syllables; therefore, the teachers were asked to focus on teaching the children correct production of final consonants in meaningful language. Examples included activities involving minimal pairs, where the child would have the opportunity to listen to and produce words containing final consonants and words that do not, such as *bee*, *bead*, and *beat*, and making up stories, sentences, and rhymes using the sounds in word final position.

For the morphological training, teachers were asked to explicitly teach children how to conjugate the grammatical structures of basic inflectional morphology, specifically the use of simple present tense (*he walks, they walk*), simple past tense (*I liked, you liked*), and plurality (*cat, cats, pig, pigs*). Irregular verb conjugations were excluded, with the exception of *to have* and *to be*. These morphological components were selected because of the focus on word final /s, z, t, d/. Both halves of each group were trained in the same way, so each of the four phonemes was trained with respect to morphology, whereas each child was trained in only two of the four phonemes in the phonological component. Training provided practice in reading, writing, speaking, and understanding sentences and words containing inflectional morphemes. A variety of teaching methods was used, including games, stories, worksheets, and puzzles to encourage the children to identify and produce the grammatical features correctly.

Evaluations

The assessments were administered to each subject three times: prior to the commencement of training and at the end of each 9-week training period. The balanced experimental design allowed for consideration of order effects of training: At the second assessment, Group 1 had completed phonological training but had not started morphological training, whereas Group 2 had completed morphological training but had not started phonological training. At the third assessment, both groups had completed both types of training.

For the assessment of morphology, each subject was given a list of 60 sentences displayed in large print on a computer screen. In addition to the visual presentation, younger children had the sentences read to them; older ones generally read them aloud. The combination of written and spoken modalities was chosen to give each child the greatest chance of correctly perceiving all morphemes in the sentences. All sentences used simple clause and phrase structures and were semantically plausible. These sentences contained equal numbers of constructions demonstrating past tense, plural, and third-person singular present tense morphology, and the subjects were asked to state whether each sentence was "correct" (e.g., *It rained last night. I have four cats.*) or "incorrect" (e.g., *It rains last night. I have four cat.*). The sentences were scored online by the assessor, with a score given if the subject identified a grammatically correct sentence as correct or an incorrect one as incorrect.

The authors created a speech perception test made up of 45 simple sentences containing 150 key words ending in /s/, /z/, /t/, and /d/. The sentences were constructed with almost equal numbers of words in three categories:

1. Monomorphemic, monosyllabic words (e.g., *face, meat*)
2. Bimorphemic, monosyllabic words (e.g., *eats, cried*)
3. Bimorphemic, bisyllabic words (e.g., *dresses, wanted*)

Short, common words that are routinely cut off in informal speech (e.g., *its, and, his, went, at*) were not counted as key words. The vocabulary and grammar of the sentences were aimed at the level of a five-year-old child with normal hearing, and consonant clustering and gemination across word boundaries were avoided (e.g., *first started, had done*), as were irregular forms of verbs and plurals. Sentence lists were randomized so that each child was given the same 45 sentences in a different order at each assessment. The sentences were presented live by voice to the subjects using audition alone, and the subjects responded by repeating the sentences vocally. Responses were videotaped and scored offline. The reader should note that although this is a standard method of testing speech perception in children and adults, the procedure requires a spoken response and is therefore also a test of speech production.

The speech perception sentences were scored on two levels:

1. A word-level assessment that counted a key word correct if it was produced intelligibly, including marking of morphological endings;
2. A phoneme-level assessment where the final

consonant phoneme in the key word had to be produced correctly at a phonological level.

There was occasional mismatch between these two scores; for example, when a subject produced the word *hurt* with a glottal stop for the final /t/, he or she was given a correct mark for the word but an incorrect mark for the phoneme. Conversely, if the child said a different word but produced the final consonant correctly for the target word (e.g., *spotted* instead of *swatted*), he or she was given a correct score for the phoneme but marked incorrect for the word.

The production of /s, z, d, and t/ phonemes in the word final position was assessed from videotape recordings of the Single Word Articulation Test (SWAT; Paatsch, 1997) and a conversational language sample. Broad phonetic transcriptions of the recordings were made by a phonetician experienced in the transcription of speech of deaf and hard-of-hearing children. The transcriptions were analyzed using the CASALA software (Serry et al., 1997). The numbers of /s, z, t, and d/ phonemes in final position in the SWAT test are 5, 8, 9, and 3, respectively. The average numbers of these phonemes in each conversational sample were 4.8 (3.6), 13.8 (6.9), 21.9 (8.3), and 8.0 (4.8), respectively (the numbers in parentheses are the standard deviations). Because there were relatively small numbers of items, the SWAT and conversational scores were combined, and the scores for the trained phonemes (/s, d/ or /z, t/) were combined for each child. Similarly, combined scores for untrained phonemes (/z, t/ or /s, d/) were calculated for each child. The average number of phoneme productions assessed was thus 20.8 (/s, d/) or 51.7 (/z, t/) per child per evaluation.

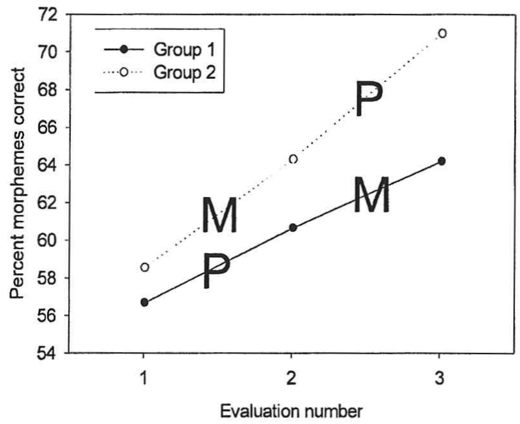

Figure 1 Results of the grammatical judgment evaluations. *M* indicates a period of morphological training. *P* indicates a period of phonological training.

Statistical Analyses

Repeated measures analyses of variance (ANOVAs) were used to analyze the data. The dependent variables were morphology (the number of correct responses given to the grammar test), speech production (the percentage of final /s, z, t, and d/ phonemes correctly produced), and speech perception (scores for both words and phonemes). The independent variables were child, and the two types of training were phonological and morphological. Results for individual children were not considered because group effects of training were considered more relevant. Planned Bonferroni *t*-tests were used with a one-tailed criterion to test the hypotheses stated in the introductory text.

Results

Morphology

Analysis of the morphological data indicated that there was significant improvement in morphology after both phonological ($t = 2.45$, $p = 0.01$) and morphological ($t = 2.13$, $p = 0.02$) training. These results are represented in Figure 1. There was no significant interaction between the two types of training, $F(1,31) = 0.00$, $p = 0.95$, indicating that both types of training independently improved morphological knowledge. Although it was expected that morphological training would result in improved morphological knowledge (hypothesis 2), the improvement after phonological training was an unexpected result (hypothesis 1).

Phoneme Production

Analysis of the speech production data indicated that there was no significant improvement in either trained or untrained /s, z, t, d/ phonemes in word final position after either phonological ($t = 0.15$, $p = 0.44$ for trained, and $t = 0.35$, $p = 0.36$ for untrained phonemes) or morphological training ($t = -0.23$, $p =$

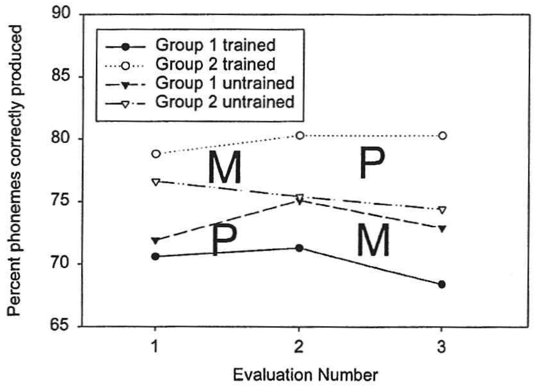

Figure 2 Combined percentage correct production scores for the final /s, z, t, and d/ phonemes from the Single Word Articulation Test and the conversations. The trained and untrained phonemes are shown as separate lines on the graph for each training group. *M* indicates a period of morphological training. *P* indicates a period of phonological training.

0.58 for trained, and $t = -0.61, p = 0.77$ for untrained phonemes). These results are represented in Figure 2. There was no significant interaction between the two types of training: $F(1,31) = 0.26, p = 0.61$ for trained phonemes, and coincidentally, $F(1,31) = 0.26, p = 0.61$ for untrained phonemes. Although it was expected that morphological training would not result in improved speech production (hypothesis 2), the lack of improvement after phonological training was unexpected (hypothesis 1).

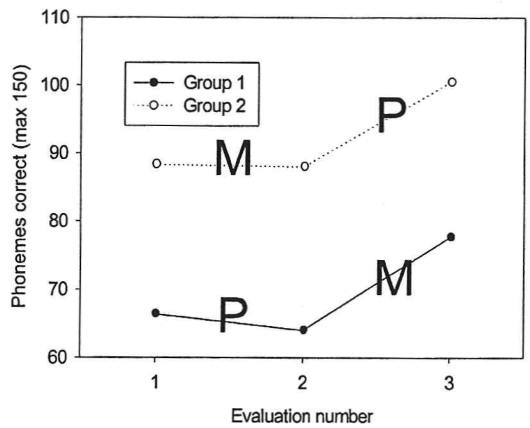

Figure 3 Phoneme scores for the speech perception evaluations. *M* indicates a period of morphological training. *P* indicates a period of phonological training.

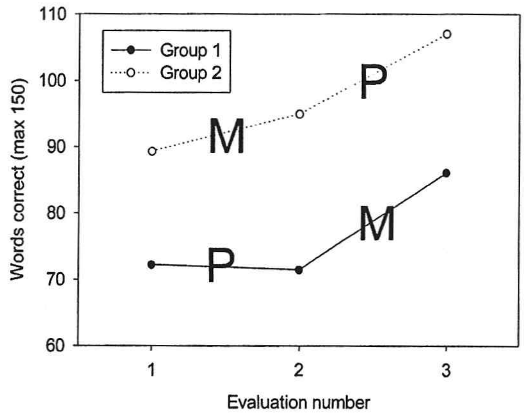

Figure 4 Word scores for the speech perception evaluations. *M* indicates a period of morphological training. *P* indicates a period of phonological training.

Speech Perception

Analysis of the speech perception data shown in Figures 3 and 4 found a significant interaction between training types in perception of phonemes, $F(1,31) = 6.06$, $p = 0.02$, and a near-significant interaction for words, $F(1,31) = 3.90$, $p = 0.057$). Inspection of the data shows that the improvements observed occurred in the second training period. This observation was confirmed by the Bonferroni *t*-tests that showed no significant differences between the mean scores at the first and second evaluations ($t \leq 1.16$, $p \geq 0.5$) and a significant difference between the final scores and all previous scores for both words and phonemes ($t \geq 2.72$, $p \leq 0.032$). The results imply that both morphological and phonological training were required to produce a significant improvement in the scores on this speech perception test. This outcome is in accord with hypothesis 3.

Discussion

A small group of children were given two types of training (phonological and morphological). The results indicate that both types of training were beneficial in improving the children's performance in the areas of morphological competence and speech perception but not in speech production. The research aimed to address three hypotheses, two of which were supported by the results and one that was not.

Hypothesis 1

Hypothesis 1 was that phonological training would improve phoneme production but not grammatical judgments. Neither part of the hypothesis was supported by the results of this study. The phonological training was not ineffective because it produced improvements in both grammatical judgments and speech perception scores. On the other hand, an earlier study of phoneme production training (Paatsch et al., 2001) was successful in producing significant improvements in phoneme production across a range of assessments, including phonetic transcriptions of the SWAT and conversational samples. The two studies were very similar in the training methods, duration of training sessions, duration of training program, staff, and participants. Thus, it is likely that the different results are a consequence of differences in the evaluations of speech production or in the specific phonemes trained and evaluated.

The first important difference to note is that the earlier study used narrow phonetic transcription, and this study uses broad transcription. Broad transcription was chosen for this study because it is consistent with the usual practice for scoring speech perception tests. On the other hand, narrow transcription is potentially more sensitive to changes in phoneme production at a subphonemic level. Bow, Blamey, Paatsch and Sarant (2002) considered the consequences of using broad and narrow transcripts in longitudinal studies of speech production in detail. They found that changes over time are likely to appear larger for narrow transcription. The second important difference is that the children in this study were older (mean age about 9 years) than those in the earlier study (mean age about 8 years). It is well known that speech production changes tend to slow as children get older, leading to a plateau in performance in deaf and hard-of-hearing children (e.g., Blamey et al., 2001a) and that fricatives and /t/ are among the latest phonemes to be acquired (e.g. Blamey, Barry, & Jacq, 2001). In this study, the evaluation was focused on /s, z, t, and d/ in word final position. When they are used as inflectional morphemes at the ends of words, these phonemes are often part of a consonant cluster (e.g., /ts/ in *cats* or /gz/ in *pigs*). The earlier study of Paatsch et al. (2001) noted that final consonant deletion and cluster reduction were the most pervasive phonological processes evident in the speech patterns of deaf and hard-of-hearing children and that neither of these processes improved a great deal after speech production training. In particular, the phoneme /t/ is frequently reduced, substituted, or deleted in normal running speech. The average percentage scores for /s, z, t, and d/ were 92% (19%), 84% (37%), 92% (21%), and 88% (13%) for the SWAT and 89% (18%), 86% (16%), 31% (19%), and 77% (23%) for the conversational samples (standard deviations in parentheses). It may be that the high proportion of final consonant deletion and cluster reduction processes in the conversational samples obscured the potentially positive effect of phonological training on speech production patterns in this study.

Finally, the CASALA analysis of phonemes correct may underestimate the number of production errors for morphological endings because of a choice that must be made at the time of orthographic transcription. The transcriber often has to decide whether to gloss what the child actually said or what the child should have said to be grammatically correct. For example, if the child says, "I have two cat," the gloss could be either "I have two cat," or "I have two cats." In the first case, there is no /s/ deletion error because there is no /s/ target phoneme in *cat*. In the second case, an /s/ deletion would be counted by CASALA. By convention, the first choice was used in this study because it requires fewer assumptions about the morphological knowledge of the child or about the intended target word(s) of the child. One consequence of this convention is that CASALA analyses of conversations are insensitive to morphophonemic errors of the kind investigated in this study.

The fact that phonological training improved morphological judgment was an unexpected bonus in this study. This is especially interesting because there was no significant improvement in phoneme production, and the grammatical judgment task responses (correct/incorrect) did not require production of the /s, z, t, and d/ phonemes in final position to be counted as correct. Presumably, the phonological training increased phonological awareness of the morphological structures although it had no statistically significant effect on the production of /s, z, t, and d/ in word final position. With the benefit of hindsight, it would have been interesting to record and analyze the sentences as read by the older children in the grammatical judgment task to see whether their productions of the trained phonemes improved after phonological training, but this was not done, and this was not the original objective of the grammatical judgment evaluation.

Hypothesis 2

Hypothesis 2 was that morphological training would improve grammatical judgment but not phoneme production. Both parts of the hypothesis were supported by the results of this study.

Grammatical judgment improved from an overall mean of 58% in the first evaluation to 68% in the third evaluation. For a two-alternative forced-choice test of 60 items, the chance score is 50%, and the individual score required to be significantly greater than chance with 95% confidence is 38/60 items correct, or 61.3%. Although significant improvements were observed and the mean score in the third evaluation is significantly greater than chance, it is clear that either a longer period of training is required to reach 100% performance on this task or additional skills and/or knowledge are required. Examples of useful additional skills or knowledge include the ability to comprehend complex grammatical structures and semantic world knowledge. The task may have been conceptually too difficult for some of the younger children, and a few of the sentences may have been outside their linguistic ability, such as the use of passive constructions (e.g., *The man was watched by a policeman*). Some children were misled by semantic content of the sentences rather than focusing on the syntactic components. For example, the sentence "The sun rise in the east" involves some world knowledge and may have distracted some children into thinking about semantic rather than syntactic correctness.

Although the data support the second part of the hypothesis, this support must be qualified by the same considerations that were discussed with regard to the null result for hypothesis 1. In other words, there could possibly have been a positive effect of morphological training on phoneme production that was obscured by other effects or was not detected by the assessment methods used.

Hypothesis 3

Hypothesis 3 was that both phonological and morphological training would improve speech perception scores. Both parts of the hypothesis were supported by the phoneme and word perception results. The first training period produced no significant improvement in the speech perception scores for either group for either type of training. The improvement after the second training period implies that it was neither the phonological nor the morphological training taken separately that caused the improvement, but the combination of the two. The fact that both groups showed similar improvement suggests that there are no order effects of training. It is possible that maturation effects and familiarity with or greater understanding of the testing process accounted for some of the improvement. It should be noted that the speech perception task involved both the child's listening and speech production skills because scores were based on accuracy of repetition of the stimulus sentences. It is not surprising that both types of training help with speech perception—i.e., morphology training assisted the children in identifying that a morpheme is required to be marked, and phonological training helped them to mark it accurately.

The children's productive use of morphological endings in conversations was not assessed in this study, and further investigation would prove useful in determining whether the improvements in receptive knowledge are reflected in their expressive performance.

Open-set speech perception tests like the one used in this study have been used to measure hearing abilities by "speech audiometry" (Bench & Bamford, 1979; Boothroyd, 1967). This practice requires the assumption that the listener's performance is limited by hearing and not by his or her linguistic knowledge or abilities. In a recent study (Blamey et al., 2001b), it was suggested that open-set speech perception test scores in deaf and hard-of-hearing children depend strongly on language abilities, in fact, more strongly than they do on the degree of hearing loss. The study used regression analysis to demonstrate the strong correlation between equivalent language age and speech perception scores on word and sentence perception tests. There are two alternative interpretations of this result: that improved language abilities lead to better perception scores or that better hearing abilities lead to both better speech perception scores and higher equivalent language age measures. In this study, the training focused on improving the spoken language skills of phonology and morphology, not on improving hearing. As a consequence, the present data support the first interpretation by demonstrating a causal relationship between an increase in language knowledge produced by phonological and morphological training, and a consequent improvement in speech perception scores. It is hoped that demonstrations of this nature will lead to increased attention to spoken language learning in addition to device fitting as a means of improving speech perception in deaf and hard-of-hearing children.

Do the Children Have Morphology Difficulties, Phonology Difficulties, or Both?

It should be noted that word endings and morphology are closely linked in English but not necessarily in other languages (Aram & Kamhi, 1982). This suggests that interactions between phonological and morphological disorders in English should not be taken to be representative of an underlying disorder independent of language. Cross-language comparisons may be required to separate these factors.

This study is a graphic example of the fact that assessments rarely measure just one sensory, cognitive, or motor skill and that training methods rarely affect the performance level of just one skill (e.g., Blamey & Alcantara, 1994). Although the results give useful information for the establishment of effective habilitation programs, they do not clearly indicate whether the subjects' difficulties were phonological or morphological in origin. The fact that both types of habilitation resulted in improved speech perception and morphological knowledge appears to support the theory that phonological and linguistic skills are closely interrelated (Panagos, 1982). This implies that deletion of morphological word endings may not be strictly a phonological or a morphological issue but a combination. The clinical implication is that children benefit most when they receive training in both morphology and phonology.

Conclusion

The study showed that both phonological and morphological training are useful inclusions in a language-based habilitation program for deaf and hard-of-hearing children of primary school age. The expected benefits of training include improved morphological knowledge and improved speech perception scores.

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