Abstract. The study examines differences between experienced and inexperienced listeners in understanding the speech of the deaf. Listeners heard test words in three conditions: sentences, isolated, and segmented (the last being words produced in sentences, excised, and then presented in isolation). Factors believed influential in listener differences were examined: predicted word intelligibility, sentence context, sentence length, and position of the word in the sentence. Scores for experienced listeners were consistently higher than those for inexperienced listeners for all factors considered. Differences between listeners were greatest for test words in sentences, followed by isolated and segmented test words. However, there was no statistically significant interaction between listener experience and any of the factors considered. Thus, the data do not support several hypotheses that have been proposed to account for listener differences. For both experienced and inexperienced listeners, scores varied systematically depending on the amount of linguistic context in the sentence. In addition, a significant difference in scores for isolated and segmented test words suggests coarticulatory effects in the speech of the deaf that may significantly affect intelligibility for both groups.

INTRODUCTION

Those who work with the deaf are not suprised when a child whose speech is judged relatively intelligible in the classroom is still virtually unintelligible to the "man on the street." That there are judgment differences between experienced listeners (e.g., teachers of the deaf) and inexperienced listeners is widely accepted. In fact, intelligibility of deaf speech has been rated according to how likely the speaker is to be understood by "most trained teachers of the deaf, most people familiar with deaf speech, or almost everyone" (Thomas, 1963). In spite of this common observation, while consid-
erable effort has been directed to studying speaker characteristics for intelligibility, relatively little attention has been accorded factors related to listeners.

Investigators (Brannon, 1964; Markides, 1970; Smith, 1972) have noted that a naive listener may understand about one word in every five produced by a deaf speaker. In contrast, an experienced listener's ability to understand deaf speech seems clearly superior (Mangan, 1961; Markides, 1970; Monsen, 1978; Thomas, 1963). These studies used listeners to rate overall intelligibility or to transcribe speech production. Several differences between listening groups have been noted. First, intelligibility scores decreased from experienced to naive listeners (Mangan, 1961; Monsen, 1978; Nickerson, 1973; Thomas, 1963). Some overlap in individual data was observed, but as a whole, group scores for naive listeners never approached those of the experienced. For both groups, scores were higher for sentences than for isolated words with a wider range of intelligibility observed for sentences than for words (Hudgins, 1949; Subtelny, 1977; Thomas, 1963). Sentence scores for experienced listeners have been reported from 31% (Markides, 1970) to 83% (Monsen, 1978); sentence scores for inexperienced listeners ranged from 18.7% (Smith, 1972) to 73% (Monsen, 1978).

These data educe several hypotheses about listener differences. For example, the consistency of the reported speech production errors suggested to Hudgins and Numbers (1942) that the experienced listener may recode deaf speech to compensate for typical deaf articulatory errors. Since these error patterns are presumably unknown to the naive listener, articulatory cues cannot be used to enhance intelligibility. Hudgins and Numbers (1942) also hypothesized that experienced listeners may make better use of contextual information. They argued that the naive listener was so distracted by the quality of deaf speech that information could not be derived from available contextual cues. On the other hand, higher scores for sentences than for isolated words led Brannon (1964) to conclude that context was extremely important for the naive listener. Thomas (1963) noted that both groups profited from context, since scores for "everyday" sentences were higher than for isolated words. In these investigations, and others (Hudgins, 1949; Subtelny, 1977), context was defined as a word produced and heard in a sentence. However, the sentences varied considerably in the amount of linguistic information and different vocabulary was used in the sentence and isolated word conditions. Furthermore, for non-deaf speakers words produced in sentences differ from those produced in isolation (Lieberman, 1963; McGarr, 1981; Miller, Heise, & Lichten, 1951; O'Neill, 1957; Pollack & Pickett, 1963, 1964), although this difference has not been studied in deaf speakers.

Finally, in these studies, the criterion of listener experience was not always carefully controlled. In some instances experienced listeners were very familiar with the children, the speech training protocol, or the test material. In other studies, the listeners were not familiar with any of these factors. Many feel that it is personal knowledge of a particular deaf speaker that gives the experienced listener his or her advantage. But the extent to which each of these factors increases intelligibility of deaf speech for listeners has not been determined. This study was undertaken, therefore, to study systematically those factors believed to account for some of the differences between experienced and inexperienced listeners to deaf speech.
METHODS

Listeners

One hundred and twenty listeners participated in the study—sixty experienced and sixty inexperienced. An experienced listener was a person who had more than one year's experience in listening to the speech of the deaf. The sixty experienced listeners were teachers of the deaf, speech pathologists, and audiologists in schools for the deaf. The listeners did not know the child whose speech they heard or the school at which the child received training. The number of years of experience ranged from just over 1 year to 25 years; mean number of years' experience was 6.8 years. In addition to meeting the experience criterion, each of the listeners had normal hearing and was a native speaker of English.

An inexperienced listener was defined as having no previous experience in hearing the speech of the deaf. There were 60 inexperienced listeners recruited primarily from undergraduate classes. These listeners also met all other criteria required of the experienced group.

Subjects

Twenty severe-profoundly deaf children from the Lexington School for the Deaf served as subjects in the study. The children were equally divided into two age groups, one of 8- to 10-year-olds and another of 13- to 15-year-olds, with 5 females and 5 males in each group. All subjects were congenitally deaf and had no handicaps other than deafness. The group mean pure tone average for .5, 1, and 2 kHz was 98.6dB (ISO) in the better ear. The children were judged by their speech supervisors to have fair, average, or good speech. No child whose speech was judged totally unintelligible was included in the study.

Materials

The test materials comprised 36 monosyllabic words each of which was embedded in a sentence. The words were selected in order to examine possible interactions between listener experience and articulatory cues. Each word was empirically defined with respect to its predicted intelligibility when produced by a deaf child. This measure was obtained by ranking all words produced by deaf children in Smith's (1972) study. The 18 monosyllabic words ranked highest for intelligibility and the 18 monosyllabic words ranked lowest for intelligibility formed the test corpus. Scores for test words in the present study were subsequently compared with those of Smith and showed the same clustering of high and low intelligibility scores.

In order to examine the effect between listener experience and context, each of the 36 words was embedded in a sentence that varied with respect to the amount of overall contextual information. A definition of high or low contextual information was made for each of the sentences using a standard word prediction technique. Twenty undergraduates (not listeners) were asked to "fill-in the blank" when presented with a written version of the sentence with the test word omitted. A sentence was defined as high in contextual information if 15 or more undergraduates completed it with the same word. A
sentence was defined as low in contextual information if 15 or more undergrada-
utes selected different words to complete the sentence.

The sentences were also designed with respect to other factors that were
believed to be important to listeners: (1) the number of syllables in the
sentence, and (2) the location of the test word in the sentence. The
sentences were either 3, 5, or 7 syllables in length; the location of the test
word in the sentence occurred either (1) at or near the beginning of the
sentence, (2) in the middle of the sentence, or (3) near or at the end of the
sentence. Figure 1 is a schematic diagram summarizing key factors in the test
materials. For the 36 test words in sentences, all factors in Figure 1 are
relevant to the test material. For the test words in isolation, only
predicted intelligibility is a factor. The test materials are presented in
Appendix 1.

Listening Conditions

Since an isolated word differs from one in a sentence both in perception
and production, an additional set of stimuli was produced maintaining the same
balance of context and word intelligibility. Specifically these test words
were originally produced in sentences but were subsequently heard by the
listeners in isolation. These words are referred to as segmented test words
and were obtained by processing the audio tape recordings of the childrens'
sentences on the Haskins Laboratories spectrum and waveform editing system.
Segmentation was accomplished using both auditory and visual cues. Because
test words produced in sentences and isolation may vary in overall amplitude,
the levels for the test words were equalized in each of the 3 listening
conditions described below.

1. Test words produced in sentences and presented to the listener in
sentences. Listeners were asked to write down the whole sentence; however,
the scores for test words were of primary interest.

2. Test words produced in isolation and presented to the listener in
isolation.

3. Test words produced in sentences, excised from the sentences, and
presented to the listeners in isolation--segmented test words.

In each condition, the deaf speakers' samples were randomized in order to
avoid learning effects. That is, each listener heard only one child with no
repetition of the same test word on a tape. A single deaf child's intelligibili-
ity score was thus an average of 3 experienced and 3 inexperienced
listeners' scores.

RESULTS

Intelligibility scores were obtained for experienced and inexperienced
listeners, and analyses of variance performed to test for significant interac-
tions between listener experience and other factors. Separate analyses were
performed for test words in sentences, in isolation, and in segmented
conditions because the number of factors was different for each type of
Figure 1. A schematic diagram summarizing the key factors in the test material. See text for further details.
stimulus. The factors considered in these analyses included listener experience, predicted word intelligibility, degree of sentence context, and two additional factors pertaining to the speakers: age of the children (younger versus older), and sex (male versus female). The analyses of variance for test words in sentences and for segmented test words included all five factors. The analysis for isolated words had only four factors since context was not a factor for words produced and heard in isolation.

In performing the analyses of variance, data were transformed using the arcsine transformation (Brownlee, 1965). Because of the large number of F tests performed in each of these analyses, only those effects with a significance level of .01 or smaller were considered. Table 1 summarizes data for each of the main effects as well as any significant interactions.

Listener experience was highly significant for test words in sentences and in isolation, but about the borderline significance level for segmented test words. There was no significant interaction between experience and any factor for test words in sentences or in isolation. There was evidence of a borderline interaction (<.015) between experience, intelligibility and context for segmented test words. Additional significant main effects included: context, predicted word intelligibility, and age (the latter factor was significant only for test words in sentences and in isolation). Sex was not a significant factor. There was evidence of an interaction between predicted word intelligibility and context (IXC) for test words in sentences.

In order to analyze the differences between the types of stimuli, a fourth analysis of variance was done. In this analysis the factors were: the type of stimulus (test words in sentences, in isolation, and segmented conditions), listener experience, and predicted word intelligibility. Each of the main effects was significant at the < .01 level. There were no significant interactions.

Listeners' Scores

Table 2 summarizes the mean scores obtained by experienced and inexperienced listeners for each type of speech stimulus. Experienced listeners consistently obtained higher scores than inexperienced listeners. For both groups, scores for test words in sentences were highest followed by scores for isolated words and then scores for segmented words. Scores for test words in sentences were more than double the scores for segmented words. The greatest difference between listeners occurred on sentences—11%. In contrast, the difference between listeners was 6% and 3% for words in isolation and for segmented test words, respectively. Intelligibility scores were also obtained for all words in sentences (cf. Table 2). Scores based on all words were only slightly higher than for scores based on test words alone.

Predicted Intelligibility of Test Words

Mean scores obtained by experienced and inexperienced listeners as a function of predicted intelligibility of test words are plotted in Figure 2. Experienced listeners obtained higher scores than inexperienced listeners for either high or low intelligibility words in sentence, in isolated, or in segmented conditions. The overall pattern of the data for high and low
<table>
<thead>
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<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance</th>
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<td>Experience (E)</td>
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<td>2.44</td>
<td>20.5</td>
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<tr>
<td>Context (C)</td>
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<td>6.38</td>
<td>53.61</td>
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<td>Word Intell. (I)</td>
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<td>2.73</td>
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<td>Age (A)</td>
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<td>12.04</td>
<td>11.58</td>
<td>.003*</td>
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<td>Sex (S)</td>
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<td>1.07</td>
<td>1.03</td>
<td>.326</td>
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<tr>
<td>IxC</td>
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<td>1</td>
<td>2.20</td>
<td>18.50</td>
<td>.001*</td>
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</table>

**ANALYSIS OF VARIANCE FOR TEST WORDS PRODUCED AND HEARD IN SENTENCES**

**ANALYSIS OF VARIANCE FOR TEST WORDS PRODUCED AND HEARD IN ISOLATION**

**ANALYSIS OF VARIANCE FOR TEST WORDS PRODUCED IN SENTENCES AND HEARD IN ISOLATION (SEGMENTED)**

*Significant at < .01 level  
**Significant between .01 and .02 levels*
<table>
<thead>
<tr>
<th>Type of Stimulus</th>
<th>Listeners</th>
<th>Mean Score % Correct</th>
</tr>
</thead>
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</tr>
<tr>
<td></td>
<td>Inexperienced</td>
<td>.30</td>
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<td>Test words produced and heard in isolation</td>
<td>Experienced</td>
<td>.29</td>
</tr>
<tr>
<td></td>
<td>Inexperienced</td>
<td>.23</td>
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<tr>
<td>Test words produced in sentences and heard in isolation (i.e. segmented)</td>
<td>Experienced</td>
<td>.16</td>
</tr>
<tr>
<td></td>
<td>Inexperienced</td>
<td>.13</td>
</tr>
<tr>
<td>All words produced and heard in sentences</td>
<td>Experienced</td>
<td>.49</td>
</tr>
<tr>
<td></td>
<td>Inexperienced</td>
<td>.35</td>
</tr>
</tbody>
</table>
Figure 2. Mean scores obtained by experienced and inexperienced listeners for test words in sentences, in isolated and in segmented conditions. Data are graphed as a function of predicted word intelligibility (high or low).
intelligibility words was similar for both groups. Test words with high predicted intelligibility received higher scores than those with low predicted intelligibility for each type of stimulus. For either high or low intelligibility words, scores were highest when the test words were in sentences, followed by test words in isolation, and finally segmented test words. However, the effect of intelligibility was most pronounced for test words in sentences and in isolation. In these conditions, scores obtained by both groups of listeners were noticeably higher for test words with high predicted intelligibility than with low. High or low intelligibility had less effect on the scores for segmented words. There was no statistically significant interaction between intelligibility and stimulus type.

**Sentence Context**

Mean scores obtained by experienced and inexperienced listeners for test words as a function of sentence context are plotted in Figure 3. For all conditions, experienced listeners scored higher on average than inexperienced listeners but again, no statistically significant interaction was found. The differences between experienced and inexperienced listeners for test words in either high or low context sentences was roughly 10%. Since segmented test words were originally produced in sentences, the effect of context on intelligibility of these stimuli was also examined. The difference between listeners for segmented words produced in high or low context sentences was roughly 5%.

The magnitude of the context effect is also evident in Figure 3. Scores for both groups of listeners were greater for the high context conditions than for the low. Scores for test words in high context sentences were approximately 16% greater than those in low context sentences for listeners. For segmented test words, difference between high and low context conditions was approximately 8% for either group. Thus, the effect of context for words produced and heard in sentences is substantial. If the same test words are segmented in such a way that, although produced in context they are heard in isolation, the effect of context is much smaller, but not negligible.

**Interaction Between Experience, Context, and Intelligibility**

Of special interest was the significant interaction between intelligibility and context for sentences as well as any interaction involving experience and these factors. The interactions between context and predicted intelligibility (IC) were statistically significant for test words in sentences. A borderline interaction was obtained for listener experience, context and predicted word intelligibility (EIC) for segmented test words. These three factors are plotted in Figure 4.

For test words in sentences, the pattern for experienced and inexperienced listeners is similar, with the difference between listeners averaging about 10% across each of the four combinations of intelligibility and context. For both groups of listeners, the ranking of scores (from highest to lowest) as a function of predicted intelligibility and sentence context were: (1) high intelligibility, high context, (2) low intelligibility, high context, (3) high intelligibility, low context, and (4) low intelligibility, low context.
Figure 3. Mean scores obtained by experienced and inexperienced listeners for test words graphed as a function of high or low context.
Figure 4. Mean scores obtained by experienced and inexperienced listeners for test words plotted as a function of predicted word intelligibility and context.
For segmented test words, the overall patterns for experienced and inexperienced listeners show relatively the same ranking of intelligibility as for the sentence condition. That is, for both experienced and inexperienced listeners, high context words were most intelligible and low context words, least intelligible. Also, on average, scores for test words with high intelligibility were higher than those with low intelligibility. In only one instance did inexperienced listeners receive slightly higher scores than experienced listeners. That is, for segmented test words with low context, the experienced listeners showed a significant drop in scores from high to low intelligibility words. This gives rise to the borderline interaction.

Between Children Differences

Intelligibility scores were also analyzed for factors related to the children's age and sex. These data are shown in Figure 5. Again, there were no interactions between listener experience and these variables. As indicated by the analysis of variance, age was a significant factor for test words in sentences and in isolation, but not for segmented test words. Older children were more intelligible than younger children for all three types of stimuli. Further, there were no significant differences between male and female subjects for test words in sentences and isolation, and only a borderline significance level for segmented test words.

Position of the Test Word and Number of Syllables

An additional analysis of variance was performed to investigate the effect of the position of the test word in the sentence, the number of syllables in the sentence, and whether there were any interactions between listener experience and these two factors.

The main effect for position of the test word in the sentence was highly significant ($p < .001$). No statistically significant effect was found for the number of syllables in the sentence. However, there was a statistically significant interaction ($p < .001$) between the number of syllables in the sentence and the position of the word in the sentence. Again, there was no statistically significant interaction between listener experience and these factors.

Figure 6 shows the percent intelligibility obtained by listeners for test words as a function of position in the sentence. Again experienced listeners obtained higher scores than the inexperienced listeners regardless of word position. For test words in sentences, the pattern of relative intelligibility was similar for both groups. Scores were highest for test words near the beginning of sentences, followed by those in the middle, and those near the end of sentences. In the sentence condition, the difference between experienced and inexperienced listeners was approximately 10% for each position. In contrast, experienced listeners scored only slightly higher than inexperienced for segmented test words. The difference between groups was only 5%; scores for test words segmented from the beginning, middle, or end of the sentences were nearly the same. There was no significant interaction between listener experiences and position of the test word.
Figure 5. Mean scores obtained by experienced and inexperienced listeners for test words plotted as a function of the subjects' age and sex.
Figure 6. Mean scores obtained by listeners as a function of the position of the test word in the sentence.
Figure 7 plots the significant interaction between number of syllables and word position in the sentence for both groups of listeners. There was no interaction effect for test words in the segmented condition. For three-syllable sentences, test words at the beginning of the sentence were less intelligible than those near the beginning of five- and seven-syllable sentences. It should be noted that the test words in three-syllable sentences were always in the word initial position, while those in the five- and seven-syllable sentences occurred near (within two syllables) the beginning of the sentence but not in the word initial position. Differences between experienced and inexperienced listeners were greatest for test words near the beginning of five-syllable sentences, and for test words near the middle and end of seven-syllable sentences.

**DISCUSSION**

Intelligibility scores for the experienced listeners were consistently higher than those for inexperienced listeners. Further, the differences in the test scores between experienced and inexperienced listeners were essentially constant for all factors investigated: (1) predicted word intelligibility, (2) degree of sentence context, (3) number of syllables in the sentence, and (4) position of the test word in the sentence. For both groups of listeners, the scores for test words in sentences were consistently higher than scores for test words in isolation followed by segmented words.

Where comparisons are possible, these data are not inconsistent with the literature. For words produced and heard in isolation, the scores obtained by experienced listeners are reported from 35% (Subtelny, 1977) to 42% (Hudgins, 1949); the mean score for experienced listeners in this study was 29%. For inexperienced listeners, the reported scores range from 17% (Brannon, 1964) to 28% (Thomas, 1963); mean score obtained by the inexperienced listeners in this study was 23%. Test words with high predicted intelligibility fell essentially mid-range of the published data for either experienced or inexperienced listeners. This suggests that phonetically balanced monosyllables frequently chosen as the speech stimuli for deaf subjects are similar to test words with high predicted intelligibility used in this study. Choice of phonetically balanced monosyllables in speech evaluations would likely result in higher intelligibility scores for deaf speakers than if other word lists were chosen.

Scores reported for sentences vary over a wider range of intelligibility than those for isolated words. For experienced listeners, scores are reported from 31% (Markides, 1970) to 83% (Monsen, 1978); for inexperienced listeners, the range was 18.7% (Smith, 1972) to 73% (Monsen, 1978). Scores for test words in sentences in this study were 41% for experienced, and 30% for inexperienced listeners, with scores for all words in sentences only slightly higher (49% and 35%, respectively).

If sentence scores from this study are examined as a function of context, the scores for high context sentences were 49% for experienced and 38% for inexperienced listeners and nearly mid-range of data reported in the literature. Scores for sentences with low context were 33% for experienced, and 21% for inexperienced listeners and fell near the lower end of the reported range for the respective groups. Apart from the present study, which controlled for
Figure 7. Mean scores obtained by listeners as a function of the position of the test word in the sentence and the number of syllables in the sentence. Data are for test words in the sentence condition.
the degree of context, the speech materials resulting in high intelligibility were those that contained words of common usage or were highly redundant in linguistic information. (e.g., Thomas, 1963; Monsen, 1978). Speech materials that resulted in lower intelligibility scores were either spontaneous speech samples (John & Howarth, 1965; Markides, 1970) or sentences that varied considerably in length and grammatical complexity (Smith, 1972). This wide variation in intelligibility scores reported for deaf children with very similar hearing losses implies the necessity for a set of uniform speech materials, thus permitting more meaningful evaluation of intelligibility, and also better comparison among deaf speakers.

These data do not, however, support several hypotheses that have attempted to explain the differences between listeners. Hudgins and Numbers (1942) proposed that experienced listeners obtained higher scores than inexperienced listeners because they are familiar with typical errors in production of deaf speech, and recode the speech so as to compensate for these errors. If this were the case, one would expect an interaction between listener experience and predicted word intelligibility. By definition, words with high intelligibility were ones that deaf children were likely to produce correctly. Similarly, words with low intelligibility were ones that deaf children were likely to misarticulate. Hence, if the above hypothesis was correct, experienced listeners would show a greater relative gain for low intelligibility words, since these words should have more errors for the listener to recode. However, no significant interaction was obtained. The measured difference in scores between experienced and inexperienced listeners for test words with high intelligibility was about the same as those for test words with low intelligibility, as shown in Figure 2. The lack of a statistically significant interaction between listener experience and predicted word intelligibility does not mean that experienced listeners recode deaf speech in the same way as inexperienced listeners, but rather that recoding strategies are more subtle and less easily defined than previously proposed.

A second hypothesis (Hudgins & Numbers, 1942; Thomas, 1963), proposes that experienced listeners simply make better use of contextual cues. Scores for both classes of listeners were higher for sentences with high context than for those with low context (cf. Figure 3) and there was no evidence of a statistically significant interaction between listener experience and context. The improvement due to experience was essentially constant for both high context and low context stimuli. Again, the lack of a statistically significant interaction does not repudiate the importance of context, but rather indicates that should an interaction exist, it is likely to be of a smaller magnitude than suggested.

While the effect of context on speech intelligibility has long been realized, it had been argued by Hudgins and Numbers (1942) that context may be even more important for listeners of deaf speech. Specifically, they hypothesized that the effect of articulatory errors on the intelligibility of deaf speech could be reduced by the contextual constraints of the sentences, and by implication, the greater the articulatory errors, the greater the effect of context. This third hypothesis concerning an interaction between intelligibility and context was supported by the data. The effect of word intelligibility, from high to low, accounted for a greater change in scores for high context sentences than for low context sentences (cf. Figure 4, top). While
there was a significant interaction between intelligibility and context for test words in sentences, the interaction between these factors and listener experience was not statistically significant, suggesting that both experienced and inexperienced listeners are benefiting to the same extent from this information. This effect was observed even for individual children whose intelligibility scores were low (<30%) (cf. McGarr, 1978). These results contravene Sitler, Schiavetti, and Metz (in press) who found no effect of context for subjects with poor intelligibility. It should be noted that Sitler et al. did not control for the degree of context in their test materials and also used different vocabulary for their isolated words and sentences.

A fourth view is that personal knowledge of the deaf speaker which enables the experienced listener to obtain higher intelligibility scores. Since the inexperienced listener does not know the speaker, his or her scores would be lower. In the literature, a definition of experienced listener included persons who knew the subjects, such as teachers or parents (Mangan, 1961), listeners who were trained on either the test materials or the deaf speakers (Hudgins, 1949), as well as listeners who were generally familiar with the speech of the deaf, but did not personally know the speakers. In contrast, all inexperienced listeners were specified as having no previous experience with the deaf. In this investigation, none of the listeners, experienced or inexperienced, knew the child whose speech they heard. Hence, the hypothesis of personal knowledge of the speaker alone enabling the experienced listener to obtain higher intelligibility scores was not supported in the study (see also Gulian & Hinds, 1981). While it is likely that children who are known to parents or teachers may be more intelligible than to other listeners, further research is warranted to quantify the effect of personal knowledge.

A final notion is that knowledge of a particular speech teaching strategy results in a distinctive speech pattern, characteristic of the child's school, which enables the experienced listener who is cognizant of these strategies to obtain higher intelligibility scores. Similarly, if other experienced listeners, or inexperienced listeners, are unfamiliar with this educational approach, the intelligibility scores will be lower. This view is also not supported by the data. Although the error patterns of the subjects are not discussed in detail here (cf. however, McGarr, 1978), the error patterns were similar to other deaf children (Smith, 1972; Levitt et al., Note 1). Also, the experienced listeners in this study did not know at which school the child was trained. Teachers serving as experienced listeners who were from the same school as the children scored no better or worse than the experienced listeners from other schools. It would seem that once familiar with deaf speech, the experienced listeners were able to generate higher scores for deaf speakers in general.

One can infer from the results of this study that the effect of context is important in perception as well as in production. For the former, the effect of linguistic context was seen in the differences in test scores for speech stimuli with high or low context, and also in the differences between test words produced and heard in sentences, and test words produced in sentences but heard in isolation (i.e., segmented). It should be remembered that the recordings of test words in sentences and in segmented conditions

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were identical. These results are described in greater detail elsewhere (McGarr, 1981).

The effect of phonetic context on production is noted in the differences in test scores between isolated words and segmented test words, the scores for the former being considerably higher. The difference in test scores indicates that deaf children produce words in context differently than words in isolation. This finding has been observed for hearing speakers (Lieberman, 1963; McGarr, 1981; Miller, Heise, & Lichten, 1951; O'Neill, 1957; Pollack & Pickett, 1963, 1964) but heretofore has not been quantified for deaf speakers. The data in this study suggest that deaf speakers do not produce speech "like-beads-on-a string" (Haycock, 1933). Rather, coarticulation occurs in the speech of the deaf and significantly affects intelligibility. It would be wrong, however, to assume that, since this effect seems to be a negative one (manifested by relatively low scores for segmented test words), the deaf child should be taught to produce speech one-word-at-a-time in order to improve intelligibility. While this study did not consider test words produced in isolation but heard in context, it is well known that speech produced by the concatenation of isolated words, without additional processing (Flanigan, 1972), is both difficult to understand and unpleasant to hear.

Another production effect observed was that the total energy for a word produced in isolation was different from that for the same word produced in sentences. Specifically, isolated test words tended to be more intense than those produced in sentences, and longer in duration. However, the perceptual differences observed in the study between test words in sentences and in isolation cannot be ascribed to differences in intensity, since the levels for test words in each condition (sentences, isolation, and segmented) were equalized.

Of the variables considered in this study, only the stimulus type (test words in sentences, in isolation, or in segmented conditions) showed any evidence of a possible interaction with listener experience. That is, the difference between experienced and inexperienced listeners was greater in sentences than in isolation. The finding of no significant interaction between listener experience and any factor investigated implies that the effect of experience is not due to any superficial recoding of deaf speech on the part of the listener. If the factors considered in this study (i.e., context, predicted word intelligibility, sentence length, or word position) were the keys to the differences between listeners, then marked improvement in the intelligibility of deaf speech for the "man on the street" could be accomplished by a training program that concentrated on those factors most responsible for the differences between listeners.

In addition to the main effects tested, it is also known that the difference between experienced and inexperienced listeners was not due to any secondary effects such as idiosyncracies in particular children or in specific test words. Overall scores for younger children were slightly poorer than those for older children, as was also observed by Smith (1972), and there was little difference between male and female speakers. Similarly, examining the scores obtained by experienced and inexperienced listeners for individual test words did not reveal any unusual variation from the patterns obtained for any other variables in the study.
In sum, the difference between experienced and inexperienced listeners cannot be accounted for in any obvious way. For each factor, analysis of the data indicates a remarkably constant difference between groups. The result of this finding suggests that the advantage of experience cannot be attributed simply to one or two variables, at least for the factors considered within this study. Consequently, the differences between experienced and inexperienced listeners must be due to fairly complex aspects of deaf speech that are not immediately apparent to the listener, but that must be learned. The fact that the difference between listeners was constant suggests that the effect occurs fairly consistently over a wide range of variables and there is a need for additional research. Such research might include studies of the effect of the personal knowledge of the speaker; the importance of visual cues; how spectral information in the speech of the deaf is coded differently from that of normals; and how coarticulatory phenomena are manifested in the speech of the deaf.

REFERENCE NOTE


REFERENCES


Appendix 1

Test Sentences recorded by the deaf subjects. The test word is underlined in each sentence.

**High Context**

3 Syllables

Keep quiet.
Read the book.
Come with me.
The dog barks.
Comb your hair.
That's no good.

5 Syllables

The cat chased the mouse.
My name is Nancy.
Get your coat and hat.
Get your ball and bat.
Did you brush your teeth?
Is there no more milk?

7 Syllables

That man is not my father.
I wish I had a pony.
We have food for the picnic.
The flag is red, white and blue.
May I have a piece of cake?
Can you dive in deep water?

**Low Context**

3 Syllables

Feed the dog.
Have a lot.
You did it.
I need it.
Get the cake.
This is his.

5 Syllables

They will come again.
Is that the tall one?
Mother has the car.
Who wants this ice cream?
It's easy to hear her.+
He said he could go.

7 Syllables

The book is on the table.
What was the name of that boy?
If it's cool I cannot go.
Is the fat baby crying?
It is nice on a fall day.
We will go to the beach today.+

+These sentences contain an additional syllable.