CHANGES IN NUMBER AND TYPE OF ERRORS ON REPETITION OF ACOUSTICALLY DISTORTED SENTENCES AS A FUNCTION OF AGE IN NORMAL CHILDREN

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ABSTRACT

The intelligibility of recorded sentences, distorted by binaural switching, interruption, and low-pass filtering, was investigated in 53 children ranging in age from five to eleven and in adults. All had normal hearing. The sentence vocabulary was pretested for comprehension, articulation errors were evaluated in a way so as not to influence test results, and length and structure of the sentences were controlled. The results indicated that although the performance of children increased with age, the 11-year-old group had not attained adult performance. Error analyses showed that most errors for all age groups were acoustically unrelated to the distorted message, although adults made more acoustically related errors than did children. When children made errors in sentences, other errors (e.g., substitutions) were made to preserve the syntax or semantic integrity of the message.

When testing speech discrimination in children, single words presented out of their usual speech context impose difficulties in discrimination that are due to the task rather than to discrimination ability (Schwartz and Goldman, 1974). This may be because of the numerous linguistic and acoustic cues which are available in actual listening conditions but are absent in testing discrimination of words in isolation or in paired-comparison tasks.

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Because the effect of reducing the available cues becomes even more important under difficult listening conditions, such as near the threshold of intelligibility in quiet or with competing noise (Miller et al., 1971; Schwartz and Goldman, 1974), the use of carrier phrases or sentences may provide a more realistic assessment of children's discrimination abilities than using words out of context.

Distorted speech has been used to investigate central auditory function in adults, and distorted speech intelligibility for single words has often been measured in children (Sieganthaler, 1969; Beasley and Beasley, 1973; Palva and Jokinen, 1975; Nagafuchi, 1976; Beasley et al., 1976). Sentences, however, have been used infrequently with children (Teatini, 1970; Beasley and Flaherty-Rintellmann, 1976). Results have been reported in number correct with no type of error analysis, and several variables have been uncontrolled.

Teatini (1970) investigated distorted speech intelligibility for sentences using both children and adults as subjects. The children ranged in age from 7 to 10 years and the task was to repeat sentences. The distorted (500 Hz low-pass filtered, and time-compressed) sentences were "plain declarative," and the length ranged from a minimum of 8 to a maximum of 16 syllables. Children demonstrated an increase in speech intelligibility of 500-Hz, low-pass filtered sentences as a function of age, and
10-year-old children were “practically the same as a group of 20 to 30 year old subjects.” Results for time-compressed speech were similar to those for filtered speech. Uncontrolled variables in the Tea-tini study included a sentence vocabulary which was not tested for comprehension, unspecified syntax, and no measurement of the children’s articulation errors. All these variables could have an effect on test performance.

Beasley and Flaherty-Rintelmann (1976) used sentences appropriate in vocabulary and structure for their second and fourth grade subjects. However, their test was the assumed maximum performance type of test. On this type of test, the child is presumed to give the best possible performance, thereby reflecting the child’s true abilities. Attention and motivation are assumed to be maximal or at least to have no major effect on performance. Smith and Hodgson (1970), however, demonstrated that this assumption is erroneous for a distorted speech task and emphasized the importance of reinforcement procedures as contributors to maximum performance.

Hence, an objective of the present study was to attempt to diminish the effects of linguistic, articulatory, and behavioral variables upon repetition of distorted sentences; in addition, the lower age group was extended from 7 years down to 5 years in an attempt to obtain more developmental information about younger children. Two specific questions were addressed in this study. First, do the number of errors on repetition of sentences distorted by low-pass filtering, interruption, and binaural switching decrease as the age of children increases? Second, what are the types of errors that children make repeating distorted sentences?

Materials and Methods

Subjects. The subjects were 53 normal children, ages 5 to 11, and 12 adults. The adults were University of Kansas undergraduate and graduate students with normal articulation and normal hearing bilaterally (15 dB or better re: ISO 1964 norms for octave interval frequencies from 250 to 8000 Hz). The children were divided into groups by age in years with four 5-year-olds and from 7 to 9 children in each of the remaining 7 groups. These children met the following criteria: (1) hearing sensitivity thresholds within normal limits as defined above; (2) articulation within normal limits (Sander, 1972), as measured by the Goldman-Fristoe Test of Articulation (Goldman and Fristoe, 1972); (3) single word receptive vocabulary age not more than one year less than chronological age, as measured by the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1965); (4) comprehension of all vocabulary used in the sentences, as measured by procedures similar to those on the PPVT; and (5) correct repetition of 5 nondistorted sentences of the same structure and length as those used in the experimental test.

Speech Stimuli. Four sentence lists with 10 sentences in each list were developed for use in testing. Each of the 10 sentences was a different sentence construction (see Appendix 1), each was 9 syllables in length, and the structures were essentially those used in Section D of the Assessment of Children’s Language Comprehension (ACLC) (Foster et al., 1969). The vocabulary was from the ACLC, and the first 26 test items on the PPVT (Forms A and B), although some additional nouns and verbs (arbitrarily selected by the principal investigator) were added to avoid excessive repetition of vocabulary within each sentence list and across identical sentence types among the lists.

The sentence lists were independently evaluated by 2 judges, both of whom were graduate students in deaf education with academic backgrounds in linguistics. The following judgments were made: number of syllables, type of sentences, acceptable or unacceptable sentences (sentences which would or would not be used in the English language), and degree of semantic integration on a one to 5 scale, with one being well integrated. For example, “The doctor and nurse are in the room” was given a one rating (semantically well integrated), and “The happy rat is behind the can” was given a five rating (not semantically well integrated). To remain on the list, a sentence was required to have 9 syllables, to be correctly identified as to sentence type, and to be judged by both judges as acceptable. Also, sentences with a semantic integration rating of 4 by both judges or 5 by one judge were rejected. Seven of the original 40 sentences were revised or discarded due to judgments of unacceptability or to poor semantic integration ratings. The judges continued to rate new sentences until all met the criteria. The final lists are given in “Appendix 2.”

Additional sentence categories were practice and check sentences. Ten practice sentences contained the same construction as did the test sentences, and 6 check sentences were designed to be easy enough in construction and distortion level to ensure that no errors would occur if a child was attentive.

The sentences were arranged such that 5 practice sentences preceded each distortion condition, and each sentence list was preceded and followed by a check sentence. For example, in the low-pass filtered condition the sentences were ordered in the following manner: 5 practice sentences; check sentence; check sentence, List A; check sentence; check sentence, List B; check sentence; check sentence, List C; check sentence; and check sentence, List A, check sentence.

All sentences were recorded by an adult male speaker using a normal speaking rate and intensity through a Brul & Kjaer Model 2606 microphone into 2 channels of a Teac, A-1200 U tape recorder using high-quality Scotch 211 magnetic tape. To reorder the sentences into different lists, we rerecorded the original sentences with appropriate identification numbers preceding each sen-
tence. These served as master recordings which were distorted in the desired way.

The test sentences were distorted by binaural switching, low-pass filtering, and interruption. The sentences (List D) for binaural switching were run through a Grason-Stadler 829-E electronic switch with a period of 270 msec, a 50% duty cycle, and a 2.5-msec rise-fall time; that is, the switching rate was 3.7 times/sec. This rate was subjectively chosen by the investigator and a colleague as being the achievable rate which produced the maximum distortion. The remaining sentence lists A, B, and C were low-pass filtered at 400, 500, and 600 Hz, respectively, by Krohn-Hite 3100 and Krohn-Hite 3550 low-pass filters. Sentence Lists A, B, and C were also distorted by interruption at 40, 50, and 60% duty cycle, respectively, with a 270-msec period and a 2.5-msec rise-fall time. The check sentences were recorded at lower distortion levels, switched with a period of 100 msec, interrupted with a 70% duty cycle, and low-pass filtered at 700 Hz. The 5 practice sentences that preceded the test sentences for each distortion condition were recorded at levels increasing in amount of distortion; in other words, they progressed from easy to difficult.

Procedures. Each child was seen for one session, which lasted from 50 to 90 min, except for 2 five-year-olds who chose to do the task in 2 sessions (an option for all of the children). Following the screening procedures for hearing, articulation, vocabulary, and sentence repetition, the children were administered Section D of the ACLC for purposes of later analysis of receptive syntax errors. Then the children were given the check sentences for practice. If mistakes were made, the sentences were repeated until correct. The distorted speech samples were presented in the following order for all ages of subjects: binaurally switched, low-pass filtered, and interrupted for one-half of the subjects; and binaurally switched, interrupted, and low-pass filtered for the remaining subjects. Within the low-pass filtered and interrupted conditions, the order of the levels of distortion was presented from most difficult to least difficult, with the most difficult level being repeated to determine whether learning had taken place.

The subjects, listening under earphones at a comfortable listening level in a quiet room, first listened to and repeated the number of each sentence and then listened to and repeated the sentence. If a child gave no response, the sentence was repeated until a response was given. To discourage the children from listening to the sentences more than once, each child was instructed to guess. Also, it was explained that the task would be lengthy if the sentences had to be repeated and that the choice of a reinforcer was contingent upon responding after the first listening, as explained below. Adults were instructed to guess but were not allowed to listen to a sentence more than once.

The following procedures were used in an attempt to control behavioral variables with the children: (1) missing a check sentence resulted in taking a break; (2) toys or money were chosen following each distortion condition, with more expensive toys or more money being given if the child had responded after hearing each sentence the first time; (3) the children were corrected if they did not repeat the sentence number or responded with anything in place of the number; and (4) verbal reinforcement was given following every response from the younger children and after every 2 or 3 responses from the older children.

The subjects' verbal responses were recorded on a Panasonic RQ 309-5 cassette tape recorder, and the errors were later phonetically transcribed by the principal experimenter. Two experienced speech clinicians also phonetically transcribed the children's error responses from randomly selected tapes. In each case, the entire tape was judged, and the percentage of point-to-point correspondence between a judge and the experimenter was computed. A disagreement was either a disagreement as to whether a word was repeated correctly or incorrectly or a different transcription of the error. There was 90% or better agreement between each judge and the experimenter.

Results

Number of Errors

Two types of error counts were made. The first was whether the whole sentence was correct or incorrect. The second was a count of the number of critical elements correct. Critical elements can be defined as the principal words which give meaning to the sentence. Each sentence had 4 critical elements; for example, in the sentence “The bird is flying over the yard,” “bird,” “flying,” “over,” and “yard” are the critical elements. The 2 types of error counts showed similar results for both children and adults.

Effects of Distortion. Distortion by binaural switching produced relatively few errors. This result is in agreement with Speaks and Trooien (1974), who found that the intelligibility of speech produced at a normal conversational rate is not appreciably reduced by binaural alternation.

The effects of low-pass filtering on number of correct critical elements and number of correct sentences for all age groups combined are shown in Table 1. Effects followed the same general pattern as for each individual age group. The number correct was greatest for LP 600, followed by LP 500, LP 400, LP 400, LP 400, LP 400, and LP 400. In other words, the easier distortion levels resulted in fewer errors, and there were fewer errors on LP 400 on the second listening than on the first listening. The improvement from LP 400 to LP 400 demonstrated that some learning did take place during the distortion condition. However, because there were no order effects between the groups which received low-pass filtered sentences prior to or following the inter-
TABLE I

<table>
<thead>
<tr>
<th></th>
<th>Low-pass filtered</th>
<th>Interrupted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LP 400&lt;sub&gt;o&lt;/sub&gt;</td>
<td>LP 500</td>
</tr>
<tr>
<td>Sentences&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.75</td>
<td>5.49</td>
</tr>
<tr>
<td>Critical elements&lt;sup&gt;b&lt;/sup&gt;</td>
<td>25.77</td>
<td>34.37</td>
</tr>
</tbody>
</table>

<sup>a</sup> Maximum score is 10.
<sup>b</sup> Maximum score is 40.

ruptured speech condition at each age level, the learning effect was a result of practice with low-pass filtering rather than familiarity with the sentences.

The effect of distortion level for interrupted speech for all subjects combined also is shown in Table 1. Here again, all age groups showed similar functions. The number correct was greatest for 60% DC, followed by 50% DC, 40% DC<sub>2</sub> (second listening), and 40% DC<sub>1</sub> (first listening). Thus, the effect of severity of distortion paralleled that of low-pass filtering.

**Effect of Age.** Binaurally switched sentences were fairly easy for both children and adults, although there was a tendency for the range of errors to be larger in children than in adults (Tables 2 and 3). In every age group, there were children who had perfect scores. Children's performance generally increased with age on both low-pass and interrupted speech (Tables 2 and 3). In no condition did any of the individual groups of children ever equal the adults' mean performance. However, by age 8 the range overlapped that of adults for every distortion condition.

**Types of Errors**

In an attempt to determine error patterns which remained the same or changed with age, various types of analyses were made. In each type of error analysis only the error sentences were examined; correct sentences were not included. Two of the analyses, sentence type and number of syllables, included all subjects and all error sentences in the low-pass filtered and interrupted conditions. For the remaining analyses, selected groups and selected conditions were used. The selected age groups consisted of 5-, 7-, and 11-year-olds as well as adults. The selected conditions were LP 400<sub>o</sub>, LP 400<sub>o</sub>, 40% DC<sub>1</sub>, and 40% DC<sub>2</sub> because they resulted in the most errors. The types of error analyses and results are given below.

**Sentence Type.** The sentence types which were missed most often were rank ordered for all age groups, and comparisons were made between each age group and the adults. The correlation between the sentence types missed most often by children as compared to adults generally increased with increasing age of the children, and children and adults tended to make errors on the same sentences with one notable exception. The sentence type with 2 adjacent adjectives (for example, "The happy little girl is jumping") was comparatively easy for the adults and quite difficult for the children.

Likewise, this sentence type on the ACLC receptive syntax pretest was missed by approximately one-half of the children ages 5 through 7, and the error made was to utilize only one of the adjectives in their choice of pictures. The receptive syntax error paralleled the error on sentence repetition of omitting one adjective. The younger children consistently made this omission error on their error sentences and, although this error decreased with the increasing age, one-half of the 11-year-olds omitted one of the adjectives on their error sentences. No adult ever made this type of error.

**Number of Syllables.** In the 500- and 600-Hz, low-pass conditions, the distortion was inadequate to disrupt the perception of the correct number of syllables because all ages usually gave the correct number of syllables (9) with any errors usually being within one syllable. Both 400-Hz, low-pass conditions resulted in numerous syllable errors, which decreased with increasing age. For all ages, there was an increase in the proportion of sentences with the correct number of syllables from LP 400<sub>o</sub> to LP 400<sub>o</sub>. On LP 400<sub>o</sub>, ages 10, 11, and adults usually gave the correct number of syllables. Although the majority of the error sentences of younger children contained the correct number (9) of syllables, errors of 7, 8, or 10 syllables were frequent. LP 400<sub>o</sub> differed in that the youngest age group giving the correct number of syllables extended down to age 9, and the error sentences of younger children commonly were 8 to 10 syllables in length.

Interrupted speech had a much more drastic
## TABLE 2

**Number of sentences correct**  
*The maximum score is 10.*  

<table>
<thead>
<tr>
<th>Binaurally switched</th>
<th>Low-pass filtered</th>
<th>Interrupted</th>
<th>40% DC</th>
<th>50% DC</th>
<th>60% DC</th>
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<tbody>
<tr>
<td>Age</td>
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<td>Mean</td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>5</td>
<td>8.25</td>
<td>7-10</td>
<td>1.75</td>
<td>1-2</td>
<td>2.75</td>
<td>1-4</td>
</tr>
<tr>
<td>6</td>
<td>8.33</td>
<td>3-10</td>
<td>2.11</td>
<td>0-6</td>
<td>3.44</td>
<td>1-6</td>
</tr>
<tr>
<td>7</td>
<td>9.38</td>
<td>8-10</td>
<td>1.29</td>
<td>0-4</td>
<td>4.29</td>
<td>1-7</td>
</tr>
<tr>
<td>8</td>
<td>9.50</td>
<td>9-10</td>
<td>3.50</td>
<td>0-6</td>
<td>6.12</td>
<td>4-9</td>
</tr>
<tr>
<td>9</td>
<td>9.62</td>
<td>7-10</td>
<td>2.00</td>
<td>0-7</td>
<td>5.38</td>
<td>4-7</td>
</tr>
<tr>
<td>10</td>
<td>9.56</td>
<td>9-10</td>
<td>1.78</td>
<td>0-4</td>
<td>5.33</td>
<td>2-9</td>
</tr>
<tr>
<td>11</td>
<td>9.12</td>
<td>6-10</td>
<td>2.75</td>
<td>0-5</td>
<td>6.75</td>
<td>2-10</td>
</tr>
<tr>
<td>Adult</td>
<td>9.92</td>
<td>9-10</td>
<td>5.17</td>
<td>2-8</td>
<td>7.58</td>
<td>4-10</td>
</tr>
</tbody>
</table>

## TABLE 3

**Number of critical elements correct**  
*The maximum score is 40.*  

<table>
<thead>
<tr>
<th>Binaurally switched</th>
<th>Low-pass filtered</th>
<th>Interrupted</th>
<th>40% DC</th>
<th>50% DC</th>
<th>60% DC</th>
<th>40% DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>5</td>
<td>38.00</td>
<td>36-40</td>
<td>23.25</td>
<td>20-29</td>
<td>29.25</td>
<td>26-33</td>
</tr>
<tr>
<td>6</td>
<td>38.78</td>
<td>32-40</td>
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<tr>
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<td>27.38</td>
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<tr>
<td>Adult</td>
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<td>25-38</td>
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</tr>
</tbody>
</table>
functors have a limited lexical choice and are thus more predictable. This was not surprising because the form “mark grammatical structures and carry subtle modulatory meanings. The word classes or parts of speech involved all have few members and readily admit new members.” Functors include articles, conjunctions, auxiliary verbs, and prepositions. In the present investigation, there were always more errors on contentives than on functors. On the error sentences for each sentence type and age group, 30 to 50% of the lexical items were missed, whereas 2 to 29% of the functors were in error. This was not surprising because the functors have a limited lexical choice and are thus more predictable.

No specific contentive type consistently had more errors associated with it. However, the percentage of adjective errors consistently decreased as a function of age. The 11-year-olds did not equal the adults’ performance on adjectives for some of the sentence types.

Most functor errors were with conjunctions and prepositions. Very few errors occurred for articles (except in interrupted conditions where the article was actually missing) and auxiliaries. Younger children consistently missed a greater percentage of prepositions and conjunctions than did older children and adults, and for some sentence types the performance of 11-year-old children did not equal adults on these items.

Substitutions and Omissions. Almost all of the errors could be categorized as substitutions or omissions. Two judges listened to the tapes and determined whether the individual substitutions or omissions given by the subjects bore any resemblance to the acoustic properties of the distorted speech. The judges were instructed to be extremely lenient in their judgments, and the error was counted as acoustically determined if either judge decided that there might be some relationship between the error and the acoustic signal.

Most of the omissions were not acoustically related. Approximately 10% of the children’s omissions were acoustically related across all age groups, whereas 33% of the adults’ omissions were related to the acoustic signal. On the other hand, for several of the sentences in the interrupted conditions, the initial “the” in the sentence was completely absent in the signal. In this case, most of the adults responded with a sentence which began with the. For those subjects who omitted the initial “the” in accordance with the acoustic signal, the nouns (animate and inanimate) would usually be substituted by proper names; for example, an adult substituted “Tim and Jill are on the table” for the test sentence “The key and bell are on the table.” Children often did this also.

The words substituted in the sentences also were usually acoustically unrelated to the original word. Only about 20% of the children’s substitutions across all ages and 33% of the adults’ substitutions bore any resemblance to the original signal. These nonacoustic substitutions were of several types. Words were sometimes substituted to preserve the syntax of the sentence, as was shown in the previous paragraph. Other substitutions were made to preserve the semantic integration of the sentence; for example, on the sentence “The man is walking behind the chair” (distorted by interruption), one child answered, “The man is walking... no... The man is washing the car.” Substituted nonsense words were sometimes acoustically related but often were not. Another type of substitution was

Semantic Integration. Two judges independently rated each error sentence as to whether or not it was semantically well integrated. From 60 to 70% of the responses given by children and adults, while in error, were semantically well integrated.

Syntactic Pattern Errors. The proportion of errors on contentives and functors was determined for each sentence type and age. Brown (1973) has defined contentives as “nouns, verbs and adjectives... the word classes, or ‘parts of speech’ involved, have very many members and readily admit new members.” Functors are defined as words that “mark grammatical structures and carry subtle modulatory meanings. The word classes or parts of speech involved all have few members and do not readily admit new members.” Functors include articles, conjunctions, auxiliary verbs, and prepositions. In the present investigation, there were always more errors on contentives than on functors. On the error sentences for each sentence type and age group, 30 to 50% of the lexical items were missed, whereas 2 to 29% of the functors were in error. This was not surprising because the functors have a limited lexical choice and are thus more predictable.

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perception errors; that is, words which had been previously heard or words which came from the individual's own previous incorrect substitutions. The 5 and 6 year olds sometimes substituted entire sentences which had been previously heard.

Apparently, the listening set of the subject also influenced substitution errors. For example, 2 children substituted their last name, which was also the name of a common animal, for some of the nouns. Another error, which was more common among subjects than was the previous example, was the substitution of the word "boy" for "girl," a substitution which was in no way acoustically related for any of the conditions. This substitution increased as a function of age. In the adult group, of 30 error sentences on one sentence type, 11 contained the boy/girl substitution. On another sentence type, 5 of 14 error sentences contained this error. It was rare for girl to be substituted for boy, and no adult or 11-year-old ever made this substitution.

Thus, as shown in the previous examples, substitutions that were acoustically unrelated to the original message were determined by many complex underlying factors. Also, one substitution or omission often determined other changes in the sentence.

Discussion

The results of this study indicated that children’s performance, even by age 11, does not completely equal that of adults. Although 11-year-old children’s group performance based on number of correct sentences or critical elements was often very similar to adults’ performance, there were always differences in the absolute values of the means of the 2 groups. If the only error analysis done had been number correct, the importance of the mean differences might have been underplayed. After all, the mean differences were small in sever al distortion conditions, and the ranges of scores were overlapping for all distortion conditions. However, by analyzing the types of errors, some different patterns of errors between adults and even the oldest children became evident.

The error analysis showed that 11-year-olds made a greater percentage of errors on prepositions and conjunctions than did the adults. The 11-year-olds also made the syntactic error of omission of one of a pair of adjectives, an error which no adult ever made. As explained earlier, the measure used was to determine the proportion of these errors on the error sentences for the most difficult distortion conditions (LP1, LP2, DC1, and DC2). With this error analysis, there was a possibility that a limited number of the 11-year-olds contributed to these more immature patterns. Hence, a count was made of the nonacoustically related preposition, conjunction, and omission of one of 2 adjective errors for each 11-year-old and adult. Approximately one-half of the 11-year-olds were responding on these measures commensurate with adults, while the other half made more errors. Thus, there may be developmental differences among children of this age.

Additionally, the adult group had a greater percentage of acoustically related omissions and substitutions than did the group of 11-year-olds. On this measure, the 11-year-old children resembled the younger children rather than the adults.

A comparison with Teatini’s results (500 low-pass filtered sentences) showed similar improvements in intelligibility as a function of age. However, the mean scores in the present study were considerably higher than were Teatini’s, probably as a result of our better controlled test materials and behavioral control. Whereas Teatini concluded that 10-year-old children’s performance was essentially the same as adults’, the use in this study of more difficult speech distortion conditions and a more detailed error analysis leads to a different conclusion.

A comparison with Beasley and Flaherty-Rintelmann (1976) is difficult because they summed their data across various conditions and did not present separate data for 3- and 5-word normal sentences at each age level (second and fourth grade) for each distortion condition (unaltered, 200-msec, and 400-msec interstimulus interval). Extrapolating from their tables, it seems that the only difficulty for normal sentences was on the 5-word sentences in the 400-msec interstimulus interval with the younger children. However, without an error analysis we do not know the nature of the difficulty. Procedural influences could be that any error in the sequence resulted in the entire sequence being counted as incorrect (producing a bias against longer sentences), children were allowed to not respond to an item, and no controls were administered for attention and motivation.

Audiological studies using sentences as test stimuli with children apparently have maturational, nonauditory, contaminating factors. Our study was no exception, as shown by the error analysis. Clearly, pretesting using a receptive language test and repetition of nondistorted sentences is not an indicator of linguistic performance once the signal is degraded. We concur with the conclusion of
Mills (1975) that speech signals having high redundancy for adults have minimal redundancy for children because children have less knowledge of language and less practice with listening strategies. More explicitly, data of Entwisle and Frazure (1974) using 6- through 9-year-old children demonstrated maturation on both semantic and syntactic processing. Additionally, Elliott (1976) found increased performance on the high-predictability SPIN sentences with competing babble noise across an age range of 11 to 17, and not until age 17 was performance equal to adults.

In summary, our study showed apparent maturation on a distorted speech task, especially for the more difficult levels of distortion. However, the maturation was at least partially linguistic in nature. Acoustic distortion limited the redundancy of the speech signal, but subjects do not “fill in the blanks” acoustically. Their answers demonstrated that linguistic considerations usually overrode acoustic considerations. Children’s answers (productions) in this study indicated that they attempted to preserve semantic integrity and syntax, and, in fact, did so as well as the adults. However, their perception appeared to be affected by their relative unfamiliarity with linguistic probabilities, resulting in different types of errors and probably affecting the number of errors as well.

Thus, sentences with certain types of construction and relatively open message sets must be viewed with caution as they reflect linguistic, conceptual, and developmental variables that may not be directly related to central auditory functioning. If we are to test the effect of signal degradation alone, we must find a task that is lexically, semantically, and syntactically invariant across age groups and across children within age groups. We feel that audiologists should look more closely at types of errors as well as number of errors to achieve this goal.

References


### APPENDIX 1

#### Sentence Constructions

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<th>adj.</th>
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<th>aux.</th>
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* det., determiner; adj., adjective; n., noun; aux., auxiliary verb.; v., verb; prep., preposition; conj., conjunction.

### APPENDIX 2

#### Test Sentences

**List A**

1. The happy little girl is jumping.
2. The cat is standing under the bed.
3. The teacher and girl are in the bus.
4. The big basket is under the chair.
5. The monkey is sitting on the horse.
6. The man is walking behind the chair.
7. The clown is eating the big apple.
8. The dirty dog is behind the fence.
9. The happy boy is in the wagon.
10. The key and bell are on the table.

**List B**

1. The dirty little boy is standing.
2. The horse is walking behind the fence.
3. The baby and boy are in the bed.
4. The big balloon is behind the boat.
5. The bee is flying over the dog.
6. The clown is jumping over the shoe.
7. The girl is pulling the big wagon.
8. The little cat is under the chair.
9. The happy farmer is in the barn.
10. The table and chair are in the house.

**List C**

1. The happy dirty man is digging.
2. The cow is sleeping under the tree.
3. The man and children are in the house.
4. The big wagon is behind the bush.
5. The duck is sleeping next to the goose.
6. The girl is standing behind the fan.
7. The boy is climbing the big ladder.
8. The little snake is under the tire.
9. The dirty monster is on the roof.
10. The rope and ladder are on the truck.

**List D**

1. The happy dirty clown is sitting.
2. The bird is flying over the yard.
3. The doctor and nurse are in the room.
4. The pretty box is under the lamp.
5. The cat is playing next to the dog.
6. The boy is climbing over the fence.
7. The man is washing the dirty car.
8. The dirty pig is behind the barn.
9. The little girl is on the ladder.
10. The ball and bat are in the wagon.