Deaf Readers' Comprehension of Complex Syntactic Structure

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What differentiates adult deaf readers who are proficient at reading English from those who are less proficient? Are there aspects of English grammar that the good reader understands but the poor reader does not? Is there some cognitive factor in the process of reading that good readers are better at? In this paper we address these questions by examining good and poor deaf readers' understanding of some aspects of English grammar. In particular, we examine comprehension of one complex syntactic structure—relative clauses—using tests of the comprehension of relative clauses in written English, signed English, and American Sign Language (ASL). We also investigate how good and poor deaf readers' use of phonological coding in short-term working memory contributes to reading differences (Conrad 1979; Hanson 1982; Lichtenstein 1985).

Studies with good and poor hearing readers have indicated that poor readers exhibit a variety of language-related impairments, including phonological segmentation difficulties, naming difficulties, working-memory deficits, and impaired performance on tests of the comprehension of complex syntax (for review see Liberman & Shankweiler 1987). However, despite these seemingly disparate impairments, a unified account of poor readers' difficulties can be given by locating the source of reading impairment in the phonologically based working-memory system (Shankweiler & Crain 1986). Under this account, poor hearing readers have trouble using phonologically based coding in working memory, and this difficulty underlies their apparent lexical and syntactic problems.

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What makes phonological coding in working memory so important? In reading and listening, individual words of a sentence must be retained while the grammatical relations among words are determined. Evidence suggests that working memory is most efficient for verbal material (including written material) when the processing involves phonological coding. For readers suffering from impaired phonological coding in working memory, processing individual words and putting these words together into phrases and sentences can be computationally overloading, impairing overall reading performance.

Is it even possible for deaf readers to use phonological coding in the absence of auditory input? We note that, despite common assumptions that a phonological code must be auditory, this assumption is not supportable. Phonological units relate not specifically to sounds, but rather to articulatory gestures and, as such, could also have motor and visual components (see Hanson 1989 for a discussion). Studies of good and poor deaf readers have indicated that use of a phonologically based working-memory code is characteristic of good deaf readers (Conrad 1979; Hanson, Liberman & Shankweiler 1984; Lichtenstein 1985). Thus it is possible that poor deaf readers, like their hearing counterparts, suffer from difficulties in using a phonologically based code. It is interesting to note, however, that tests of short-term memory for American Sign Language stimuli show evidence that deaf readers use a sign-based code (Bellugi, Klima & Siple 1975; Krakow & Hanson 1985; Poizner, Bellugi & Tweeney 1981).

Since hearing children are exposed to spoken language in sufficient quantity for normal language acquisition to occur, it is perhaps not surprising that most hearing children with reading difficulties do not have a specifically syntactic deficit. However, for deaf readers, since much of the input for English syntax comes from written material, it is reasonable to ask whether syntactic deficits might remain, possibly in addition to deficits in phonologically based working-memory processes.

Evidence for a processing deficit over a syntactic deficit in deaf readers takes the following form: In tests of syntactic processing, subjects (adults and children, good and poor readers) will always make some errors, and certain sentence types might be more taxing than others. If good readers have syntactic competence, which poor readers lack, then poor readers should have an overall depressed level of performance on syntactic tasks, and we do not predict a particular pattern of errors across sentence types. However, if poor readers have the same syntactic competence as good readers but are suffering from a processing impairment of the type suggested by the unified-processing-deficit hypothesis, then we would expect to find a similar pattern of errors across sentence types for the two groups. That is, sentence types that are especially taxing for good readers will be similarly taxing for poor readers, while the sentence types producing the highest performance for good readers will also produce the highest performance for poor readers.

Given this background, this study was designed to follow up on reports of deaf students' syntactic difficulties (e.g., Quigley, Smith & Wilbur 1974), with a test battery designed to differentiate the hypothesis that deaf adult students have a specific syntactic deficit in written English from the hypothesis that a processing deficit might underlie syntactic difficulties. We began with a study examining comprehension of relative clauses in order to be able to examine a variety of sentence types and to be able to make comparisons with studies of hearing readers (e.g., Smith 1987).

We tested the two hypotheses using a battery of tests for the comprehension of relative clauses in English and ASL, and a serial-memory test that should indicate whether phonologically based coding was being used (for details, see Lillo-Martin, Hanson & Smith n.d.). The subjects who participated in this study included twenty-six students at Gallaudet University, all of whom were in their preparatory or freshman year, were severely or profoundly deaf, and came from deaf families who used ASL as the primary means of communication. On the basis of a paragraph-reading comprehension test administered in this study, subjects were divided into two groups of thirteen each: good readers and poor readers. These two groups form the basis for the comparisons in the syntactic tests.

TEST BATTERY

The test battery included the following tests:

1. The Raven's Progressive Matrices (1965) ten-item screening test, a nonverbal measure used to ensure that the two groups were equivalent in intelligence scores;
2. The Gates-MacGinitie Reading Test (1978)-Comprehension Subtest, a multiple-choice test using questions based on short paragraphs, providing grade-equivalent scores used to divide the subjects into good and poor reader groups;
3. The Test of Syntactic Abilities (Quigley, Steinkamp, Power & Jones 1978)—Relativization 1: Comprehension subtest (selected items), an assessment test used to provide a measure of the subjects' comprehension of relative clause structures based on a standardized reading test normed on deaf children and adults;
4. American Sign Language relative clause comprehension tests—picture choice and figure manipulation, used to assess subjects' comprehension of relative clause structures in ASL, following Smith (1987) in design, with some modifications for the signed presentation;
5. Signed English relative clause comprehension test—picture choice and figure manipulation, used to assess subjects' comprehension of relative clause structures in Pidgin Sign English, similarly following Smith (1987); and
6. A serial recall test, following Hanson (1982), used to measure phonological coding in working memory by comparing memory for rhyming versus nonrhyming lists of words.

RESULTS

The groups were different in reading ability by four grade levels (good readers grade level, 9.34; poor readers grade level, 5.08), although their intelligence scores did not differ significantly. Thus, the groups were appropriate for comparison. On the written English relative clause test and all the signed tests, the groups were not significantly different in their percentage of correct responses, although the poor-reader group was consistently lower overall than the good-reader group. Furthermore, in all five of these tests, the groups performed exactly parallel across sentence types, as evidenced by a significant effect of sentence type, but no group-by-sentence-type interaction was found. This result is entirely predicted by the unified-processing deficit hypothesis. Unexpectedly, there was no evidence for phonological coding in the serial recall test for either the good-reader group or the poor-reader group.

DISCUSSION

Although these groups were significantly different in their reading scores, with a difference of four grade levels, we found no significant difference in the syntactic comprehension ability for complex sentences with relative clauses. Whether given in written English, Pidgin Sign English, or ASL, relative clause structures were comprehended by the subjects in both of these groups. In fact, an analysis of the (few) errors that were made shows that the pattern was exactly parallel. The distribution of correct responses across sentence types, and the type of erroneous responses given, were parallel across the two groups (as evidenced by an effect of sentence type without a group effect or interaction). Furthermore, the errors on the tests were parallel to the error patterns found in a similar study by Smith (1987) with hearing subjects. Thus, across the signed tests, and comparing signed tests with spoken tests administered to hearing subjects, a parallel pattern of results was found.

The results of the tests discussed here support the hypothesis that syntactic knowledge (in particular, knowledge of relative clause structures) is not deficient in poor deaf readers. However, there were some important differences between subjects' performance on the signed tests and on the written English test. First, the average score on the written test was below the average on all the signed tests. Second, the error pattern was not parallel across the signed and written tests. This result was unexpected, given the results found in many relative clause studies with hearing children and adults, both good and poor readers. However, we suggest that this finding can be accounted for by considering the differences in test and stimuli design between the two test types. In particular, the signed tests took into account pragmatic factors that have been found to make an important difference in studies of relative clause comprehension by hearing children (Hamburger & Crain 1982; Goodluck & Tavakolian 1982). The standardized written test did not take these factors into account.

There was one unexpected result in this test battery. Given the results of previous studies of working memory in deaf college students (e.g., Hanson 1982; Lichtenstein 1985), we fully expected to find that the good readers, at least, would show evidence of phonological coding. However, such phonological effects were not apparent in the present study, and we do not know whether this was due to inadequate testing procedures or to the failure of these subjects to use phonological coding. Given the evidence from previous studies, the possibility of phonological processing differences distinguishing between good and poor deaf readers must still be considered.

Even without the expected phonological coding difference, the results from the syntactic tests suggest that grammatical knowledge is equivalent in both reader groups, at least with respect to relative clauses. Given this result and the previous literature cited above, we suggest that the differences in reading ability between the groups of deaf readers that we tested are likely to be based on processing differences rather than on differences in grammatical knowledge. An underlying processing difference would account for the slightly lower performance by the poor reader group, along with parallel error-type performance by the two groups. Any hypothesis claiming that these poor readers have deficient structural knowledge compared to the good readers is not supported by these findings. Thus, the cognitive basis for reading in relation to the processing function merits continued investigation by researchers in deafness. Our further work is investigating additional sentence types, as well as various techniques for examining memory coding.

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