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Section 1. Examining written-language assessment and intervention: links to literacy. How deaf and normally hearing students convey meaning within and between written sentences.

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HOW DEAF AND NORMALLY HEARING STUDENTS CONVEY MEANING WITHIN AND BETWEEN WRITTEN SENTENCES

Forty-nine normally hearing and 49 severely and profoundly deaf or hard-ofhearing participants representing five age groups (1 O, 11, 12, 13, and 14 years) wrote compositions elicited from the Accident/Emergency picture of the Peabody Language Development Kit., This study compared the frequency and proportional distribution of the use of written-language variables that represented (1) intrasententiat syntax--T-unit analysis, (2) intrasententiat semantics--propositional analysis, (3) intersentential syntax--syntactic cohesive devices, and (4) intersentential semantics--- semantic cohesive devices. Though there were no significant differences between the writing of the normally hearing and deaf or hard-of-hearing students in the total number of propositions, cohesive devices, and T-units, there was a significant difference between the total number of words produced. Differences Were found between the strategies chosen by the deaf or hard-of-hearing writers in both syntax and semantics and those of their normally hearing peers. Additionally, age-trend analysis demonstrated significant linear and quadratic age differences for syntactic measures but only quadratic age differences for the semantic measures. This finding indicates the possibility of different developmental trends for syntax and semantics.

Introduction

Since the 1970s, language development research about deaf or hard-ofhearing students has been characterized by componential studies that strongly emphasized the syntactic module (Quigley, Steinkamp, Power, & Jones, 1978). These studies focused on the development of a single component of the language system, resulting in sophisticated in-depth knowledge of syntactic development. Not only did this focus on deaf or hard-of-hearing children's syntactic development in the 1970s leave many unanswered questions about the development of semantics, pragmatics, and phonology in this population, but it provided no information about the ways different components relate to one another. Consequently; the ways syntax and semantics and semantics and pragmatics interact at different times during language development in deaf or hard-or-hearing children and youth are unknown.

Unfortunately, the vast amount of information we have about language development and deaf or hard-of-hearing children and youth has not had the anticipated effect of remediating their language delays. While academic achievement of younger students with hearing losses has improved, these students have not shown significant improvement when they leave the educational system at ages 18 to 21 (Karchmer, 1991). Perhaps the problem lies in the perspective from which we have viewed these findings. We may, in fact, be looking at the correct aspects of language, but they may be packaged incorrectly or differently. Is the reason that deaf or hard-of-hearing children and youth use very little subordination an inability to understand subordination, a lack of vocabulary required to form subordinate clauses, or simply a delayed development of their syntactic knowledge? Is developing a specific skill in one language parameter a prerequisite to developing a skill in another language parameter? For example, the acquisition of verbs may be considered a prerequisite for grammar use (Bates, Bretherton, & Snyder, 1988).

To investigate the interaction or connection between language components, it is important to select a language mode offers an optimal sample of the language components of interest and an analysis procedure that is sufficiently sensitive to separate developmental changes. Written language may provide an optimal mode for investigating interrelationships between syntax and semantic development.

When children achieve written-language competency; the boundaries between syntax and semantics are less obscured by production constraints, i.e., intelligibility of speech production or sign language communication. The investigations of language development in the deaf or hard-of-hearing population have emphasized the development of syntax structures and disordered characteristics in syntax production and comprehension. The literature reveals that most deaf or hard-of-hearing students with severe or profound sensorineural hearing losses who have no additional disabilities fail to master elements of English morphology, grammar structures, and transformational grammar rules, even by age 21. Progress during the school-age period is barely perceptible, because many of these students make only a single year of gain over a 10-year period from age 12 to age 21 in rules of transformational grammar, reading comprehension, and vocabulary development (Quigley et al., 1978; Osberger, 1986). The diversity of the deaf or hard-ofhearing population seems to take on bimodal characteristics after age 12, with many students seemingly reaching a plateau in their language development and others going on to achieve age-level functioning (Geers & Moog, 1989; Moeller & Johnson, 1989; Yoshinaga-Itano & Pollack, 1987). The semantic characteristics of language have been found to have the strongest relationship to reading achievement in the deaf or hard-of-hearing population (Davis, Shepard, Stelmachowicz, & Gorga, 1981; Osberger, 1986; Geers & Moog, 1989; de Villiers, 1991).

So far, nothing in the literature has helped explain why the majority of deaf or hard-of-hearing students make almost no measurable gains in language after age 12, despite years of intervention. If we hypothesize that some type of cognitive reorganization takes place at approximately age 12, and that, during this period of development, deaf or hard-of-hearing students must make a transition from one style of language learning to a higher level of functioning, one might see a reflection of this cognitive reorganization in Ushaped curves. This would indicate a decrease in function that occurs during reorganization. Some skills may be less affected than others by such cognitive reorganization and may maintain linear incremental gains during this stage of development. Perhaps these skills, represented by linear increases, are not as critical to the demands of a higher level of language development as other skills are. Syntax skills have been characterized by linear development through mean length of utterance and words per T- or C-unit (Hunt, 1965; Loban, 1963). To examine the presence of U-shaped curves, it is important to use frequency counts, particularly in stages during which the proportional use of specific language characteristics does not change with age.

Several researchers have found that the proportional use of text cohesive devices does not increase after the age of 10 years. One might assume that the frequency of one aspect of development might decrease while the frequency of another might increase. Another assumption might be that the frequency of specific skills all might decrease until such time as the higher level strategy is mastered, at which point there would be a rise in function, and individual aspects might take on new characteristics that support the higher level.

Higher level language strategies require that students (1) master the skill of subordination, evidenced by the use of subordinate or dependent clauses, (2) connect ideas in texts from one sentence to another by using related vocabulary or specific parts of speech, such as pronouns, demonstratives, and conjunctions, commonly referred to as text cohesive devices, and (3) elaborate on main ideas presented, presumably by making reference to information in world knowledge and life experiences. Each of these language characteristics requires students to master reference by linking ideas syntactically and semantically. Perhaps an underlying cognitive structure is prerequisite to each of these skills.

Most research studies on deaf or hard-of-hearing students' language development examine the problem through an isolated language component, such as syntax; however, examining the interaction of semantics and syntax might help identify whether there are common difficulties across components. Examining how students use concepts of connection, cohesion, and world-based inferences within sentences (intrasententially) and between sentences (intersententially) may provide new information.

This chapter proposes a model that focuses on the semantic characteristics of written-language development inter- and intrasententially. Analyses of syntactic skills are included for investigating the relationship of these skills to the proposed semantic analyses. In 1978, when the data for this study were collected, analyses of clause development, such as the T-unit and Syntactic Density Score, were not widely used with deaf or hard-of-hearing populations. The literature in the 1990s establishes these techniques as appropriate measures of syntactic growth for language-disordered populations (Nipold, 1993; Scott, 1988).

Recent studies of normally achieving, reading-disabled, and learningdisabled students' narrative discourse processing and production suggest that semantic analyses of their output reveal interesting group differences (Liles, 1985a, 1985b, 1987; Merritt & Liles, 1987,1989; Roth & Spekman, 1986; Snyder & Downey, 1991), thereby providing data that demonstrate sensitivity to populations with language difficulties. Current analyses of normally achieving students' written language (Bereiter & Scardamalia, 1987; Kintsch, 1991) indicate that their compositions' semantic coherence is a robust developmental characteristic. Consequently, semantic analyses of students' written compositions appear to be powerful tools for detecting individual and developmental differences. Intra- and intersentential connective systems can be analyzed semantically.

Intrasentential Semantic Analysis

Key semantic characteristics may be found beyond the single word level. An investigation beyond the single word logically begins at the sentence level. Bereiter and Scardamalia (1987) suggest that semantic characteristics may be observed in compositions' idea or proposition organization. Propositional code theory posits that information is represented in units of knowledge that can stand as separate assertions (Anderson, 1980), regardless of the modality of input (Hayes-Roth, 1979; Plylyshyn, 1973), and are, additionally, free of syntactic restraints.

It was important to find a way to determine the conceptual meanings underlying the text. The propositional theory proposed by Kintsch (1974) seemed to best fit this need. Propositions are idea units, each one representing a single idea. They consist of abstract word concepts, one serving as a relation, the others as arguments of the proposition. Word concepts may be represented by one or more words. A text's meaning is assumed to be represented by a list of connecting propositions. (An example of propositional analysis of a sample story can be found in Appendix II.) Propositional analysis provides a semantic tool that allows comparison with syntactic measures intrasententially and may provide a means of investigating relationships between syntax and semantics at this level.

Propositional analysis is not the only means of investigating semantic relationships in written text. Analyzing text cohesion provides information on the way each description of character, event, or episode is bound together from one specific idea to another. Analyses of text cohesion study the relationship between sentences and the text. For sentences to truly form a story rather than a series of unrelated sentences, cohesion must exist within the body of the text. This semantic system can be achieved through grammar or vocabulary (Halliday, 1977).

Cohesive tie analysis, by Halliday and Hasan's (1976) definition, examines elements of (1) intersentential semantic language through lexical repetition and collocative cohesions and (2) intersentential syntactic language through reference and conjunction cohesions.

In summary, to investigate the relationship between semantics and syntax in the written language of students with educationally significant hearing losses, measures of clause development represent intrasentential syntax, measures of propositional analysis represent intrasentential semantics, and measures of text cohesion represent both intersentential syntax and semantics.

To date, the text cohesion of the written language of deaf or hard-ofhearing children and youth has been examined only recently (de Villiers, 1991; Klecan-Aker & Blondeau, 1990). This study proposed to investigate the productive written language of students with educationally significant hearing losses by examining text cohesion.

The goal of examining the relationship between syntax and semantics in written language is best achieved by examining relationships within the same linguistic unit, i.e., the clause or sentence. Thus, propositional and T-unit analyses are uniquely suited to accomplish this end. By contrast, it is difficult to discern relationships between syntax, which operates intrasentential1y and story-grammar categories, which span several sentential units. (For comprehensive reviews of story-grammar categories see Roth and Spekman, 1989; Merritt and Liles, 1987; and Just and Carpenter, 1987.)

Intrasentential Clause Development

It seems important to broaden the investigation of language development in deaf or hard-of-hearing students to correspond more closely to current psycholinguistic concepts of the semantic component of linguistic competence. Although analyses of clause development must be considered measures of syntactic ability, such analyses also can be thought of as measures of semantic ability within the sentence context, that is, the ability to incorporate many propositions within one sentence structure through a variety of syntactic forms. The skill requires both syntactic and semantic abilities. Therefore, an analysis of clause development can complement current analyses of structures via transformational grammar because it allows comparison between groups beyond the mastery of transformational grammar structures and addresses the flexible use of syntax to convey meaning. Clause development analysis, thus, supplies a necessary bridge between semantic and syntactic language abilities in the construction of written narrative discourse.

Research Questions

The purpose of this investigation was to examine the written compositions of students with hearing losses in three ways: (1) the development of clause structure, a measure of syntactic development within the sentence, (2) the development of propositional usage, a measure of semantic development within the sentence, and (3) the development of text cohesion devices, a measure of the relationship of syntax and semantics between sentences in a text.

The questions that formed the basis of this research project were: (1) What is the relationship between syntax and semantics in the written-language development of students with normal hearing and students with hearing losses?, (2) What is the relationship between the written-language characteristics of students with normal hearing and students with hearing losses?, and (3) Are the measures chosen to represent syntactic and semantic language characteristics sensitive to age differences?

Method

Participants

Deaf or Hard-of-Hearing Participants

The deaf or hard-of-hearing participants comprised 49 school-aged students, the total Colorado population that met the participant selection criteria in 1978, when the study was conducted. The participants were divided into five age groups: group I--age 10 (N=10), group II--age 11 (N=6), group III--age 12 (N=13), group IV--age 13 (N=12), and group V--age 14 (N=8). All students demonstrated greater than 65 dB pure tone average (PTA) hearing levels in their better ears (American National Standards Institute [ANSI], 1970). Their hearing losses were prelingual and sensorineural, and all had ages of onset prior to 18 months. The means and standard deviations of hearing thresholds for the deaf or hard-of-hearing students are shown in Table 1.

The participants were free of other sensory disabilities, including central nervous system dysfunctions and emotional physical, and intellectual disorders and excluding corrected visual impairment. Eighty percent of the deaf or hard-of-hearing students had intelligence quotients of at least 83 on the performance scale of the Wechsler Intelligence Scale for Children (WISC) or Wechsler Intelligence Scale for Children-Revised (WISC-R); the other 20% had scores from other performance tests of intelligence that indicated at least average intellectual potential.

Last, all deaf or hard-of-hearing participants attended Colorado public day schools and were educated in either oral-aural (OA) or total communication/ simultaneous communication (TC) method programs. Twenty-one of the students used TC methods, and 25 used OA methods. No method was reported for 3 of the 49 students. Comparisons of language characteristics by methodology are reported in a study contained in chapter 3 of this monograph. There were more male students than female students, as is characteristic of the deaf or hard-of-hearing population in the U.S. Fifty-five percent of the students were male and 45% percent were female. The distribution is identical to that reported for the population as a whole (Jensema & Trybus, 1978). Normally Hearing Participants

The participants comprised 49 school-aged students matched for age, urban/semi-urban residence, gender, and performance intelligence scores on the WISC-R. They were free of additional disabilities described earlier. These participants were students in Denver and its surrounding suburbs, as were the deaf or hard-of-hearing participants. Further, their school records indicated that they achieved in the normal academic range for their grade levels.

Materials

This study used the Accident/Emergency picture from the Peabody Language Development Kit (1977) to elicit written-language samples. The types of paper and pencils the students were familiar with were used in testing. The picture depicted an accident scene involving an automobile and a boy lying on the ground beside a motorbike. Emergency personnel and spectators such as pedestrians and shop owners were shown at the scene of the accident. The single-colored picture was chosen to control schemata represented. Picture stimuli like the one chosen for this study are often used in classrooms to elicit oral-aural, signed, and written-language samples in deaf or hard-of-hearing populations. Further, the method of eliciting written stories based on a single picture stimuli is the method for collecting written-language samples for both the Picture Story Language Test (Myklebust, 1965b) and The Test of Written Language (Hammill & Larsen, 1983).

Procedure

Examiners

Fifty educators of deaf or hard-of-hearing students, audiologists, and speechlanguage pathologists who had worked with deaf or hard-of-hearing students were selected as examiners by the Colorado Department of Education's state representative for special education to assess the approximately 700 deaf or hard-of-hearing students in the state. The data from 49 of the 700 students on whom complete records were obtained is reported in this study. Only 49 of the 700 students had the required characteristics for participant selection. The examiners were trained to administer the written-language test and a variety of other assessment tools through a series of five statewide workshops conducted by author Yoshinaga-Itano.

There were two examiners for the normally hearing sample: YoshinagaItano and a research assistant. The research assistant was trained in the testing procedure using the guidelines developed to train examiners for the deaf or hard-of-hearing sample. Testing

This study used the following procedure for both normally hearing and deaf or hard-of-hearing participants: The examiner appeared before a group of students holding the Accident/Emergency picture of the Peabody Language Development Kit so each student could see it. Each group had an average of 8 students. The examiner instructed them using the language system used in their classrooms (oral-aural or total communication), "Look at this picture carefully." After a pause of 20 seconds, the examiner told them, "You are to write a story about this picture. You may look at it as much and as often as you care to. Be sure to write the best story you can. Begin writing whenever you are ready." The instructions were repeated until it was clear that all students understood. The picture was then placed in a central position where it could be seen easily. Thereafter, the examiner remained present and available but in the background. Questions were answered neutrally, indicating that neither help nor further suggestions would be given. If a student asked a question on content, such as, "Should I put a title?," the reply was, "If you want to. Write a story the way you think is best." Infrequently, students said, "I can't write a story." In this event, encouragement was given through comments such as, "Try to write something--anything you can think of." The objective of the procedure was to secure the best sample of written language of which individuals were capable, even if it was only a few poorly produced words or phrases. The students were allowed as much time as they needed to complete the story. Most students completed the story in 20 to 30 minutes. These procedures are similar to those given for the Picture Story Language Test (Myklebust, 1965b).

Data Reduction

Intrasentential clause development. The analysis of clause development was coded according to the requirements described by Hunt (1965) for the T-unit analysis and Golub and Kidder (1974) for the Syntactic Density Score. No deviations from these criteria were required.

In this research study, raw data were obtained in 13 category levels: (1) number of T-units (#TU), (2) words per T-unit (WPTU), (3) words per main clause, (4) words per subordinate clause, (5) subordinate clauses per T-unit, (6) number of modals (#MODALS), (7) number of be and have forms in the auxiliary (#AUX), (8) number of prepositional phrases (#PREP), (9) number of possessive nouns and pronouns (#POSS), (10) number of adverbs of time, (11) number of gerunds, participles, and absolute phrases

($GERUNDS), (12) Syntactic Density Score (SDS), and (13) grade level. These procedures' reliability was established by Hunt (1965) and Golub and Kidder (1974) (see Appendices I and II).

Intersentential text cohesive devices. Text cohesion coding was based on criteria developed by Halliday and Hasan (1976) for analyzing written texts. All written attempts were coded, with the exception of unintelligible responses. The cohesion of the written-language samples was analyzed according to the Halliday and Hasan criteria (1976). The types of cohesions (endophoric references in the text) were categorized as follows: (1) reference (pronoun, demonstrative, and comparative), (2) lexical repetition, (3) collocations (general nouns, verbs, superordinates, synonyms, and antonyms), and (4) conjunctions (see Appendix III).

Intrasentential propositional analysis. Each written composition's narrative discourse was analyzed for the number of propositions that could be identified (Kintsch, 1974; Turner & Greene, 1978). Data were obtained in three levels: total propositions (TOTPROPS), number of major propositions (TOTMAJPROPS), and number of minor propositions (TOTMINPROPS). Major propositions were defined as propositions containing predicates; minor propositions contained either modification or connective relations (see Appendix II).

Intercoder reliability was determined in a pilot study. A criterion of 90% agreement was set to continue coding. Five hundred judgements were made on the written-language performance of 15 participants for the reliability study. Design

This study used a three-factor repeated measures design: participants nested in (age crossed by hearing status) crossed by language measures, P (A x H) x M. The first factor, age, had five levels: ages 10, 11, 12, 13, and 14. The second factor, hearing status, had two levels: normally hearing and deaf or hard of hearing. The third factor, language measures, the dependent language variables, had three levels in Phase I, five levels in Phase II, eight levels in Phase III, and nine levels in Phase IV. Phase I compares the quantity and productivity of total words, cohesions, and propositions between groups. Phase II compares the quantity and productivity of types of propositions and cohesive devices between groups. Phase III compares the proportional use of cohesive devices, propositions, and clause development between groups. Phase IV compares the quantity and productivity of clause development between groups. The Biomedical Computer Program (1982) mixed models, repeated measures, and univariate and multivariate analyses of variance were used to analyze the data (Dixon & Brown, 1979).

Studies of semantic aspects of language acquisition are characterized by quadratic trends (U-shaped curves and developmental increases and decreases); for example, learning to comprehend spatial and dimensional adjectives (Cook, 1976). Bever (1981) suggests that U-shaped curves characterize specific cognitive development aspects; therefore, instead of using only traditional linear analysis to characterize developmental trends, this study also investigated language development through quadratic curve analysis.

Results

Phase I: Quantity and Productivity Characteristics: Total Words, Total Cohesions, and Total Propositions

Design

To determine whether normally hearing and deaf or hard-of-hearing students' productivity levels were significantly different, the total words (TW), TOTPROPS, and total cohesions (TOTCOHS) in their written compositions were compared.

Normally hearing and deaf or hard-of-hearing group comparisons. There was a main effect for hearing status ($F(1,88)=4.75$, $p<.01$) and for age ($F(1,88)=2.75$, $p<.05$). There was a significant interaction of measures by hearing status ($F(2,176)=6.93$, $p<.01$). Deaf or hard-of-hearing students produced fewer words in their written stories than did their normally hearing peers but similar quantities of TOTPROPS and TOTCOHS. There was a significant three-way interaction of measures by age by hearing status ($F(8,176)=2.22$, $p<.05$). Developmental Age Trends

The age trend was a quadratic, or inverse U-shaped, curve ($F(1,88)=4.96$, $p<.05$). There was a significant interaction of hearing status and age ($F(4,88)=2.92$, $p<.05$). There was a significant quadratic age trend for TW and TOTCOHS, but not for TOTPROPS. It is interesting that, although deaf or hard-of-hearing students use fewer words than their normally hearing peers, they use similar units of meaning and connections between sentences.

There was a significant interaction of measures by age ($F(8,176)=3.01$, $p<.01$) and measures by age quadratic ($F(2,176)=5.38$, $p<.05$). Normally hearing students generally produced more TW, TOTPROPS, and TOTCOHS at each age level; however, this finding was not consistent in the age group 12 years. In this age group, deaf or hard-of-hearing students produced quantitatively more on these language measures than their normally hearing peers. When the ages were collapsed, no significant difference was found between normally hearing writers and deaf or hard-of-hearing writers on TOTPROPS or TOTCOHS.

Though it is not a new finding that students' TW production increases until about ages 12 to 13, when a decrease in production occurs (Myklebust, 1965a), it is interesting and new information that deaf or hard-of-hearing students produced similar quantities of TOTPROPS and TOTCOHS in shorter essays. Their strategies for including semantic information must, then, be characteristically different. Another way to investigate this difference is to compare proportional use of types of cohesive devices and propositions.

Phase II: Analysis of Inter- and Intrasentential Language Characteristics Through Proportions

Normally hearing writers produced a significantly larger number of TW, though their TOTPROPS and TOTCOHS did not differ significantly from their deaf or hard-of-hearing peers. To determine whether or not the differences found in the semantic and syntactic characteristics of the written compositions can be explained exclusively by increased number of words, it seemed important to examine the semantic aspect of written language for qualitative differences in the distribution of inter- and intrasentential syntactic and semantic characteristics. Thus, proportions were constructed for the variables. A measures factor was constructed consisting of five levels: (1) major propositions/total propositions (MAJPROPS/TOTPROPS), (2) minor propositions/ total propositions (MINPROPS/TOTPROPS), (3) syntactic cohesions/total cohesions (SYNCOHS/TOTCOHS), (4) semantic cohesions/total cohesions (SEMCOHS/TOTCOHS), and (5) syntactic density score/total syntactic density score possible (SDS/TOTSDS). MAJPROPS/TOTPROPS was chosen as a measure of the compositional distribution of intrasentential semantic information. This proportion represented the operationally defined semantic cohesive devices, the use of lexical repetition, and collocations. MINPROPS/ TOTPROPS was coded semantically by syntactic category, so it was included to investigate whether development differed from MAJPROPS/TOTPROPS. SYNCOHS/TOTCOHS was chosen to represent intersentential syntactic relationships and to compare these with intersentential semantic relationships represented by SEMCOHS/TOTCOHS. SDS/TOTSDS was chosen to represent intersentential syntactic development. For the purposes of this study, MAJPROPS were defined as propositions that required explicit predicates. MINPROPS included all other types of propositions. SYNCOHS were defined as all reference and conjunction cohesions. SEMCOHS were defined as lexical repetitions and lexical collocations. All proportions were transformed through an arcsine transformation to allow the use of parametric statistics. Developmental Age Trends

The effect of age-level performance on these proportions was not significant. There was no main effect for the factor age (F(4,88)=1.15; p>.05). The interaction between age and hearing status was found not to be statistically significant (F(4,88)=1.87; p<.05). Since there was no significant interaction between age and hearing status, language performance differences between normally hearing and deaf or hard-of-hearing students may not be attributed to developmental or age differences in the deaf or hard-of-heating students between ages 10 and 14. If age differences are a factor, trends with students under age 10 must be investigated. These findings are consistent with recent studies that found no developmental change in normally hearing students' use of cohesive devices in either oral or written communication. Normally Hearing and Deaf or Hard-of-Hearing Group Comparisons

A statistically significant main effect for the factor of hearing status (F(1,88)=] 7.36; p<.001) was found,, indicating that normally hearing students' performance differed significantly from deaf or hard-of-hearing students' performance on these proportions.

Performance on the language measures differed according to hearing status. A statistically significant interaction was found between measure and hearing status (F(4,85)=8.32; p<.0001). The specificity of this interaction was investigated through the Bonferroni t-test.

Normally hearing students produced proportionately more MINPROPS/ TOTPROPS (52-53%) in their written language than did deaf or hard-ofhearing students (42--48%) (mean diff.=6.79; T-value=5.72; df=72.51; p<.001). Deaf or hard-of-hearing students used a greater percentage of MAJPROPS (43-48%) in their written language than did their normally hearing peers (3639%) (mean diff.=-6.15; T-value=-5.21; df=72.9; p<.001). The proportionate number of SEMCOHS/TOTCOHS (lexical repetitions and collocations) produced was similar in deaf or hard-of-hearing and normally hearing groups (27-36%); however, normally hearing students produced proportionately more SYNCOHS (51-60%), consisting of demonstratives and pronoun references, than deaf or hard-of-hearing students (46-57%) (mean diff.=3.85; T-value=2.26; df=92.8,5; p<.05). The overall syntactic ability of deaf or hard-of-hearing students was significantly less than the normally hearing students (mean diff.=5.07; T-value=3.62; dr=96; p<.001).

Comparison of Measures

Performance on each proportion differed significantly from performance on the other proportions used to measure written-language abilities. A statistically significant main effect was found for measures (F(4,85)=279.26; p<.0001). Not only was there no difference in age-level performance overall across proportions, but no age differences were found for individual proportions. There was no statistically significant interaction between language measures and age (F(16,352)=.83; p>.05).

Last, the interaction between any two of the three factors, measure, age, and hearing status, did not change at any level of the third variable. No statistically significant interaction was found between measure, age, and hearing status (F(16,250)=.59; p>.05). The differences due to measure, age, and hearing status were consistent overall.

Discussion

Proportional analysis revealed, first, that no developmental trends were present in either the normally hearing or the deaf or hard-of-hearing students' written language, suggesting that the strategies school-aged writers use, when measured by proportions, remain similar between the ages of 10 and 14 years, regardless of hearing status. These language strategies may develop before written-language skills. Second, deaf or hard-of-hearing students' written language was characterized by proportionately more MAJPROPS and proportionately fewer MINPROPS than normally hearing students' Deaf or hard-of-hearing students also produced proportionately fewer SYNCOHS than their normally hearing peers. Although normally hearing and deaf or hard-of-hearing students did not produce significantly different[#] TOTCOHS in their written stories, normally hearing students had slightly more TOTCOHS than their deaf or hard-of-hearing peers. This nonsignificant difference in TOTCOHS, however, became significant when examining proportional use of semantic versus syntactic cohesive devices. Overall, SDSs were significantly lower in deaf or hard-of-hearing students, showing that they had poorer syntactic skills than normally hearing students.

In summary, deaf or hard-of-hearing writers tended to rely less on grammatical variety within their clauses and more on predicates as primary semantic and syntactic devices to the exclusion of other strategies. Since proportional use of syntactic and semantic devices was different, it seemed important to investigate the nature of these differences through quantitative comparisons.

Phase III: Analysis of Inter- and Intrasentential Productivity Relationships

Purpose

Since the results of Phase I demonstrated that quantities of TOTPROPS or semantic units within sentences and the TOTCOHS or semantic/syntactic units between sentences were not significantly different when comparing normally hearing and deaf or hard-of-hearing writers, the distribution and diversity of types of propositions and cohesive devices were investigated. Perhaps deaf or hard-of-hearing writers use different semantic strategies within and between sentences than their normally hearing peers. Design

The second analysis was designed to investigate the productivity (i.e., the quantity) of various elements of clause development, text cohesion, and narrative discourse with respect to the interaction among eight language measures: (1) number of T-units (#TU), (2) number of subordinate clauses, (3) number of major propositions (#MAJPROPS), (4) number of minor propositions (#MINPROPS), (5) number of reference cohesions, (6) number of conjunction cohesions, (7) number of lexical repetition cohesions, and (8) number of lexical collocation cohesions. Thus, two measures represented clause development or intersentential syntax (#TU and number of subordinate clauses), two measures represented propositional analysis or intersentential semantics (#MAJPROPS and #MINPROPS), two measu res (number of reference cohesions and number of conjunction cohesions) represented intrasentential syntax, and two represented intrasentential semantics (number of lexical repetition cohesions and number of lexical collocation cohesions). Developmental U-Shaped Age Trends

Analysis of variance revealed a number of findings. A significant main effect was found for age (F(4,88)-- 3.36; p<.05). To examine the nature of the age effect, both linear and quadratic trend analyses were performed. No linear developmental trend was found; however, an overall quadratic trend (Ushaped curve) on the age factor was found to be statistically significant (F(1,88)=8.15; p<.01). The effect of age peaked at ages 12 and 13 with lower performance at ages 10, 11, and 14. Although the measures represented (1) syntactic units within sentences, (2) semantic units within sentences, (3) syntactic units between sentences, and (4) semantic units between sentences, U-shaped, or quadratic, trends were found in each category, possibly indicating the presence of a construct with an interaction between syntax and semantics, rather than a modular dissociation between syntax and semantics modules, at least in this age range.

No significant interaction was found between hearing status and age (F(4,88)=2.07; p<.05). The significant difference between age groups that followed a quadratic trend was characteristic of both normally hearing and deaf or hard-of-hearing groups. This finding implies that the U-shaped curves indicate a construct present in both groups, regardless of hearing level. Thus, this strengthened the idea that a cognitive reorganization might occur around age 12, since the trend is present in both groups despite the differences in the quantities of all measures produced when considered individually. Normally Hearing and Deaf or Hard-of-Hearing Comparisons

A statistically significant main effect also was found for hearing status (F(1,88)=5.76; p<.05). The deaf or hard-of-hearing group was less productive than the normally hearing group. In addition, age-group differences were common to both normally hearing and deaf or hard-of-hearing students.

Students performed differently on the types of propositions, types of cohesions, and types of syntactic forms with a statistically significant difference among measures (F(7,616)=81.91; p<.0001). More importantly, there was also a significant interaction between measures and hearing status (F(7,616)=11.04; p<.001). The Bonferroni t-test for pair-wise comparison of means was used to examine these interactions. Normally hearing students produced more subordinate clauses (mean diff.=2.31; T-value=2.41; df=80.63; p<.05), more MAJPROPS (mean diff.=7.12; T-value=2.11; df=-83.4; p<.05), more MINPROPS (mean diff.=13.37; T-value=3.2; df=67.4; p<.01), and more collocation cohesions than deaf or hard-of-hearing students (mean diff.=2.9; T-value=3.2; df=75.67; p<.01). Deaf or hard-of-hearing students' production of demonstratives, pronoun reference cohesions, lexical repetitions, and conjunction cohesions was similar to normally hearing students' production. These differences are interesting, particularly because there was no significant difference in the number of T-units when comparing normally hearing and deaf or hard-of-hearing students. Therefore, length, when analyzed by number of T-units, was similar regardless of hearing status. Table 2 presents the means and standard deviation comparisons of the two groups. Considerable variance was found in both normally hearing and deaf or hard-of-hearing populations. This finding is particularly significant since most language assessments administered at this age level show minimal differences by age or hearing loss and minimal individual variation within the deaf or hard-ofhearing population (Quigley et al., 1978). Perhaps, then, these measures are sensitive to important variations in the deaf or hard-of-hearing population, and these variations may help clarify the language plateaus that have been so perplexing in the deaf or hard-of-hearing population.

Developmental Age Trends by Measure

Students performed differently on measures as functions of age (F(18,197)=1.59; p<.05). These developmental trends were similar in normally hearing and deaf or hard-of-hearing students' writing. Though not all the measures demonstrated significant linear trends, the number of subordinate clauses and MINPROPS did, as shown by the significant linear age by measure interaction (F(7,616)=2.38; p<.05). Similarly, the quadratic age trend was found in some, but not all, variables (F(7,616)=3.76; p<.001). Variables that showed quadratic age trends were #TU, MAJPROPS, MINPROPS, REFCOHS, and lexical repetition cohesions. The variable #COLLCOHS had an unusual quartic trend (F(4,40)=2.92; p<.05) (several increases and decreases).

Since normally hearing and deaf or hard-of-hearing students included similar numbers of propositions, cohesions, and T-units in their written compositions, inclusion of fewer subordinate clauses, fewer MAJPROPS and MINPROPS, and fewer collocation cohesions indicates that deaf or hard-ofhearing writers might rely on different strategies and processes.

Phase IV: Analysis Of Clause Development

Purpose

The semantic/syntactic interaction analysis used in this study is an unusual approach to investigating, deaf or hard-of-hearing writers' written language. A critical question about the comparability of this data to other research studies must be addressed: perhaps the narrative task influenced the unusual quadratic trends identified in the first two phases of this study Design

This phase of the study demonstrates the comparability of this data to other language samples previously reported in literature. Measures included in this analysis were: (1) number of WPTU, (2) number of words per main clause, (3) number of words per subordinate clause, (4) number of subordinate clauses per T-unit, (5) number of modals, (6) number of be/have forms in the auxiliary, (7) number of prepositional phrases, (8) number of possessive nouns and pronouns, (9) number of adverbs of time, (10) number of gerunds, participles, and absolute phrases.

Developmental Age Trends

An overall main effect was found for age on language performance, as demonstrated by a statistically significant main effect for the age variable ($F(4,88)=3.92$; $p<.01$). A trend analysis was conducted to determine the form of these age-level differences. A significant developmental trend was present, as evidenced by the statistically significant linear factor ($F(1,88)=7.1$; $p<.01$). Thus, differences in age level were related to increased production of specific syntactic structures as a function of age. The quadratic trend was also statistically significant ($F(1,88)=4.6$; $p<.05$), indicating that, in addition to the linear development of the syntactic structures, production peaked in the middle age groups and dropped in the oldest age group.

Age trends did not differ according to measure, as indicated by a lack of statistically significant interaction between age and measure. All syntactic measures showed both linear and U-shaped age trends. It is interesting to note that frequency productivity showed different developmental trends. Semantic measures were U-shaped in development, but some syntactic measures were U-shaped and others were linear. We hypothesize that this curvilinear phenomenon, though more pronounced in semantic than syntactic development, represents a cognitive reorganization from rote production to analyzed or metalinguistic understanding. Normally Hearing and Hard-of-Hearing Group Comparisons

A statistically significant main effect was found for membership in the normally hearing or hard-of-hearing groups. The normally hearing students performed significantly better than the deaf or hard-of-hearing students on these language measures ($F(1,88) = 13.38$; $p <. 01$). Age differences and significant linear and quadratic U-shaped trends were present in both groups with no statistically significant interaction between group and age ($F(4,88)=2.29$, $p<.05$).

A statistically significant interaction was found between language measures and hearing status ($F(8,704)=2.29$; $p<.05$). The Bonferroni t-test was chosen to investigate the nature of interaction between language measures and group membership. Normally hearing students produced more WPTU (mean diff.=2.48, T-value=4.71; df=86.2; $p<.0001$), more words per main clause (mean diff.=1.39; T-value=3.52; df=98.59; $p<.0001$), more words per subordinate clause (mean diff.=1.28; T-value=2.76; df=95.69; $p<.001$), more prepositional phrases (mean diff.=3.37; T-value=2.49; df=95.7; $p<.05$), more adverbs of time (mean diff.=l.86; T-value=5.31; df=-74.45; $p<.0001$), and more gerunds and participles (mean diff.=2.10, T-value=3.02; dr=84.1; $p<.01$) than deaf or hard-of-hearing students. The production of modals, be/have forms in the auxiliary, and possessive nouns and pronouns was similar in deaf or hardof-hearing and normally hearing samples. A comparison of the two groups' means and standard deviations is found in Table 3. Though this study represents one genre and genre has been found to affect WPTU, the data correspond to results of other studies of normally hearing students (Scott, 1988; Hedberg & Westby, 1994). Performance on each language measure was significantly different from performance on every other language measure, shown by the statistically significant main effect for measures ($F(8,81)=95.5$; $p<.0001$). Discussion

This phase demonstrated that traditionally found slow linear gains in syntactic language development also were identified in the language samples of deaf or hard-of-hearing writers, demonstrating that these language samples provide language similar to deaf or hard-of-hearing writers who participated in other studies with a variety of language tasks. The quadratic trend may provide clues on cognitive reorganization during certain developmental stages.

Conclusions

Developmental Age Trends

Analysis of clause development showed developmental sensitivity for both normally hearing and deaf or hard-of-hearing students between ages 10 and 14. Age-level differences represented both linear increases in production and quadratic age differences, characterized by peak performance in the middle age groups. Linear developmental and quadratic age trend differences characterized participants' performance on all language measures (see Table 4).

The linear age trend in Phase IV establishes the comparability of this data to existing literature. Additionally, the fact that the age trends, both linear and quadratic, occurred in the writing of both the normally hearing and deaf or hard-of-hearing students leads to the conclusion that this is a real phenomenon, that it is not an artifact of differences in productivity (deaf or hard-ofhearing students produced significantly fewer words than normally hearing students), sampling method (both normally hearing and deaf or hard-of-hearing students showed the same age trends), genre (WPTU for normally hearing students are comparable to studies of oral language and studies with other genre), or other characteristics.

Propositions and Cohesions

In Phase III, significant age differences were found, but these differences were predominantly quadratic rather than linear functions. The youngest children's performance, age 10, did not differ dramatically from the older students' performance, age 14. Students ages 11, 12, and 13 were more productive than either 10-or 14-year-old-students. Therefore, if semantic skills develop linearly as measured by propositional and cohesive analysis, it appears that such linear development must occur before age 10 or after age 14. On the other hand, the quadratic development observed in this study may reflect the U-shaped developmental curve observed in other aspects of language and cognitive development (Bever, 1981). U-shaped curves have been interpreted to denote the switch from more holistic and rote use of particular structures (characterized by high accuracy scores), to analysis of structure (characterized by high error), to fully flexible and analyzed use of structure (Bates et al., 1988). Semantic language abilities in written language also may develop in oral language before age 10. Once skills necessary for reproducing printed words, such as syntax, phonics, and visual-motor integration abilities, are mastered or these skills become automatic to a certain degree, semantic characteristics can be expressed, which allows for complete expression, unhampered by resource allocation constraints (Snyder & Downey 1983).

Analysis of inter- and intrasentential syntax and semantics through proportions was characteristically different from analysis through frequency counts. No significant differences by age were found when comparing proportions. Proportional use of MINPROPS/TOTPROPS, MAJPROPS/ TOTPROPS, SEMCOHS/TOTCOHS, and SYNCOHS/TOTCOHS did not differ by age. The difference in proportional usage, found according to hearing status, does not appear related to developmental differences between ages 10 and 14. Such differences, however, cannot be termed disorders, since the exact development of these language abilities before age 10 is not yet known. Additionally, if significant cognitive behavior occurs at the 12-to 13-year-age level, this transitional behavior is not captured by proportional information.

In general, syntactic age differences appear to be characterized by both linear and quadratic development. The semantic skills investigated in this study, while characterized by age differences, follow primarily, but not exclusively, quadratic trends. There is only slight evidence of a linear component on the MINPROPS variable. This variable appears to be highly interactive with the syntactic component of language (Turner & Greene, 1978). This finding has implications for clinical application: using frequency count measures for developmental growth may seem to indicate that a child is plateauing or losing language skills, but this trend may simply reflect the language development of normally hearing children. However, when we focus only on measures that demonstrate linear development, such as mean length of unit measures, we may overlook interesting developments in other language areas.
Consistency of Age Trends Irrespective of Hearing Status

In all three analyses (analysis through proportions, analysis through frequency or productivity, and analysis of clause development), the interaction between hearing status and age was not found to be significant. Age differences or lack of age differences found in deaf or hard-of-heating participants also were found in the normally hearing sample, demonstrating again that the linear and quadratic trend differences found are not unique to deaf or hardof-hearing writers. Although the two groups differed in performance on the language measures, these differences represented parallel performance. Deaf or hard-of-hearing students, then, show less overall productivity in total words. However, changes :in productivity at each age level were representative of changes seen in the normally hearing population.
Different Age Trends by Measure

Although no significant differences by age were found in the analyses of frequency or productivity, a significant interaction was found between measures and age. Again, these results reaffirm that syntactic structures seem to develop linearly, while semantic measures seem to develop quadratically. Normally Hearing and Deaf or Hard-of-Hearing Group Comparisons

Clause development. Deaf or hard-of-hearing students produced significantly fewer WPTU; words per main clause; words per subordinate clause; prepositional phrases; adverbs of time; and gerunds, participles, and absolute phrases in their written language than their normally hearing peers. By contrast, they produced similar numbers of modals, possessive nouns and pronouns, and be/have forms in the auxiliary compared to their normally hearing peers; however, deaf or hard-of-hearing students used structures more stereotypically and with less variety. This finding may reflect that deaf or hard-of-hearing writers' language development was arrested in the rote unanalyzed stage. For example, almost all modals used by deaf or hard-of-hearing writers in this sample were some form of the future tense will and were used stereotypically. These findings replicate what is known about the written syntax of deaf or hard-of-hearing students and establish this student sample's comparability to the literature (Heider & Heider, 1940; Myklebust, 1965a, 1965b; Simmons, 1962, 1963). This article's specific contribution to the literature is a description of the relationship between these syntax characteristics and the semantic language characteristics (see Table 5).

To accurately interpret the results of this study, remember that measures of clause development are frequency counts rather than error analyses. The primary issue demonstrated by the means and standard deviations of frequency counts is the absence of structure and structure development. Therefore, deviance of the structures produced cannot be addressed; rather, absence or limited use of these syntactic structures can be investigated. The productivity or frequency with which deaf or hard-of-hearing students used specific syntactic skills is a parallel, but delayed, reflection of the productivity of normally hearing students (Yoshinaga, 1983); however, modals; be/have auxiliaries; gerunds, participles, and absolute phrases; and adverbs of time were rarely used. Lack of these structures significantly affects subordination through dependent clauses. This almost nonexistent use of important syntactic structures was supplemented by a corresponding overuse of other categories, such as pronouns and prepositions.

In fact, although text lengths differed when comparing normally hearing and deaf or hard-of-hearing students, the frequency count of specific categories was identical. Do deaf or hard-of-hearing students conceptually understand (1) conditionals such as could, should, would, might, will, and must, (2) fine distinctions in comprehension of verb tenses dependent on be/have auxiliaries, (3) transformation of verb forms to nouns and adjectives through -ing as with gerunds and participles, and (4) adverbs indicating time concepts?

Propositions and cohesions. The significance of the measures and hearing status interaction provides perhaps the most interesting information about deaf or hard-of-hearing students' written language. Proportionately; deaf or hard-of-hearing students used more MAJPROPS than normally hearing controls. For example, they were concerned with delivering the message: car hit boy. It did not seem critical to them to describe the car, or the driver, how the car hit, or any specific details about the boy. Normally hearing students, on the other hand, used a greater proportion of MINPROPS in their narrative discourse. They used more descriptors related to temporal and qualitative characteristics and location, providing readers with specifics about the situation. MINPROPS use requires more facility with syntactic forms. In summary, written language appeared more elaborate in the normally hearing sample than in the deaf or hard-of-hearing sample. Deaf or hard-of-hearing students produced proportionately more information conveyed through predicates than normally hearing students of the same age. Deaf or hard-of-hearing students produced similar total numbers of propositions to normally hearing students; however, since the propositions were predominantly predicatebased, deaf or hard-of-hearing students did not use semantic units that were easily subordinated in syntactic structures. Additionally, propositional information was action oriented, rather than elaborately descriptive.

Significant differences were found between the two groups according to their use of cohesive devices in written text. Deaf or hard-of-hearing students' text was less redundant and the quantity of cohesive devices was much less prominent in their writing. Information in the text often did not require cohesive devices, since each idea was an independent and complete unit of information, not necessarily relying on information previously delivered. Deaf or hard-of-hearing students used a smaller variety of cohesive devices. Interestingly, although the total number of cohesions was similar to the normally hearing sample's, the number of reference cohesions, lexical repetition cohesions, and conjunctions used by deaf or hard-of-hearing students was not statistically different from their normally hearing peers'. Deaf or hard-ofhearing students used many pronouns and demonstratives in their written language. They repeated lexically. The boy was referred to repeatedly as the boy rather than as Johnny or the child or the paperboy. Deaf or hard-of-hearing writers used primarily additive and conjunctions as compared with normally hearing writers, who used a larger conjunction repertoire.

The written-language samples of the deaf or hard-of-hearing students showed that omitting structures was more characteristic than incorrectly using those structures. Only 2 of the 49 deaf or hard-of-hearing students used cohesive forms of substitution or ellipsis. Collocation cohesions were used minimally and often absent. Use of synonyms, superordinates, antonyms, and metaphors was so uncommon that often only one or two instances were recorded, even in samples over 100 words long. Thus, these data suggest significantly restricted collocation use. This lexical skill shows no developmental trend in deaf or hard-of-hearing students between ages 10 and 14.

Lastly, this investigation is the first to describe linear and reverse quadratic age trends for ages] 0 to 14, as illustrated in Table 5. The unusual quadratic trend seems to indicate that use of certain syntactic structures in written language also relates to the development of semantic structures in written language (Yoshinaga-Itano & Snyder, 1985). Interestingly, the quadratic effect in the normally hearing sample peaks at age 13, while in the deaf or hard-ofhearing sample, it appears to peak at age 12. Thus, not only is the quadratic versus linear trend an unexplained phenomenon, but the 12-year versus 13year difference is equally puzzling. Further, when reviewing results of other written-language studies, similar quadratic trends can be seen in the Myklebust Picture Story Language Test (1965b) tables. Osberger (1986) also found little growth in the language skills of deaf or hard-of-hearing students beyond age 12. The findings of Allen (1986), Karchmer (1991), and Trybus and Karchmer (1977) also appear to reflect this statistic.

Conclusion

In summary, while deaf or hard-of-hearing students produced quantities of overall units of meaning similar to their normally hearing peers, they were severely delayed in developing syntax skills that help them communicate ideas. Additionally, they lacked a variety of either semantic or syntactic tools for conveying information. Overall, their cohesion use was dependent primarily on three types of devices: demonstratives, pronouns, and lexical repetition. Deaf or hard-of-hearing students produced proportionally more MAJPROPS than normally hearing students. This finding indicates that deaf or hard-of-hearing students introduced more topics in their writing without elaborating them. Normally hearing students used strategies that introduced topics then provided elaborated, subordinated information about them.

However, this research does not provide information regarding the exact nature of the MAJPROPS used or the cohesiveness of the MAJPROPS required to write a good story. Further investigation is warranted about storygrammar structure and types of MAJPROPS employed in deaf or hard-ofhearing students' written language. These relationships were reported by Yoshinaga-Itano, Downey, and Snyder (1990). Since linear development of cohesion and propositions was not demonstrated, development of these skills in oral- or total-communication narrative discourse or in early writtenlanguage skills of deaf or hard-of-hearing students must be studied. If Ushaped curves are a developmental phenomenon, one would expect them to be preceded by linear development. Expressive language samples of deaf or hard-of-hearing students between ages 2 and 10 might reveal increased production at each level or a linear growth pattern. The peak of the U-shaped curve occurs at the age level at which deaf or hard-of-hearing students have been found to plateau in their language development and reading comprehension on standardized instruments (Allen, 1986; Karchmer, 1991; Osberger, 1986; Trybus & Karchmer, 1977). Perhaps the U-shaped curve represents a period of cognitive reorganization that requires a certain level of language development. Because of significant delays in language development, deaf or hard-of-hearing students may be unable to achieve higher level skills at later developmental stages. The primary development of the semantic language skills examined here may occur prior to the development of written language. Development of the art of story telling and the understanding of story coherence may occur at ages or stages similar to normally hearing students'. Development of these skills can be measured in students' written language after they have mastered decoding skills or phonics, spelling, punctuation, grammar, and syntax rules. The skills measured in written language may simply reflect prior development of semantic skills acquired in oral/ total-communication receptive and expressive language, just as it reflects such development in students with normal hearing. The findings of this research are just an initial step toward understanding development of meaning in deaf or hard-of-hearing students' stories. Future investigations that might include story-grammar and causal chain analyses may provide clues about schemata development and knowledge acquisition by deaf or hard-of-hearing students.

Use of collocation types should be further investigated in the deaf or hardof-hearing population's written language. Error analysis of demonstrative and pronoun use, though probably not providing new information, would reiterate what other studies have reported on the difficulties deaf or hard-ofhearing students have with these syntactic forms. Proportional use of semantic cohesive devices should not include using lexical repetitions with collocation devices, since excessive repetition tends to mask collocation effects.

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Table 1. Pure Tone Averages of the Better Ear by Age

Age	Range	Mean	Standard Deviation
10	68-110 dB	93.2 dB	14.9
11	67-100 dB	87.8 dB	15.5
12	67-100 dB	92.6 dB	13.9
13	70-105 dB	90.2 dB	12.7
14	70-100 dB	88.8 dB	9.9

Table 2. Means (Standard Deviations) of Normally Hearing (Nil) and Deaf or Hard-of-Hearing (D/HH) Students by Age for Text Cohesions and Propositional Analysis

Variable	Age:	10	11	12
#TU	NH	10.1 (3.5)	15.8 (10.7)	13.2 (6.5)
	D/HH	10.5 (10.5)	12.0 (4.4)	19.0 (9.5)
#of Subordinate	NH	1.6 (1.5)	3.2 (4.4)	6.5 (3.5)
Clauses	D/HH	2.1 (3.3)	3.3 (2.6)	4.8 (4.6)
# of Major	NH	14.6 (6.3)	26.8 (19.9)	25.6 (13.9)
Propositions	D/HH	14.5 (10.9)	19.3 (6.3)	19.9 (18.6)
# of Minor	NH	21.3 (15.2)	47.3 (40.8)	45.2 (22.1)
Propositions	D/HH	17.2 (17.8)	17.7 (6.7)	39.7 (25.2)
# of Reference	NH	15.6 (7.9)	25.8 (19.6)	25.0 (9.6)
Cohesions	D/HH	15.4 (8.7)	21.7 (6.7)	31.0 (14.0)
#of Conjunction	NH	5.9 (3.2)	9.8 (1.5)	6.6 (3.4)
Cohesions	D/HH	3.0 (1.9)	4.7 (3.6)	8.8 (8.2)
# of Lexical				
Repe-	NH	5.0 (3.6)	8.2 (4.9)	7.5 (7.1)
tition Cohesions	D/HH	7.5 (5.6)	8.4 (5.2)	17.9 (14.2)
#of LexicalCollo				
	-NH	3.2 (1.9)	8.2 (4.9)	4.5 (3.3)
cation Cohesions	D/HH	2.9 (2.9)	4.1 (2.5)	4.3 (3.3)

	Age	13	14
#TU	NH	18.1 (10.0)	13.0 (7.5)
	D/HH	13.4 (6.7)	9.4 (3.8)
#of Subordinate	NH	7.2 (8.6)	6.0 (3.5)
Clauses	D/HH	3.0 (3.4)	3.1 (2.3)
# of Major	NH	40.0 (28.4)	28.3 (14.3)
Propositions	D/HH	18.2 (8.9)	3.4 (3.4)
# of Minor	NH	75.7 (77.9)	47.0 (28.1)
Propositions	D/HH	26.5 (23.6)	16.9 (5.0)

#of Reference	NH	31.1 (11.4)	16.3 (11.4)
Cohesions	D/HH	22.4 (17.4)	25.4 (5.5)
#of Conjunction	NH	11.7 (7.7)	6.6 (2.8)
Cohesions	D/HH	6.2 (4.7)	6.0 (4.0)
#ofLexicalRepe-	NH	15.2 (16.4)	7.1 (6.7)
titionCohesions	D/HH	10.8 (8.8)	8.4 (4.0)
#ofLexicalCollo-	NH	9.5 (7.7)	8.3 (3.2)
cation Cohesions	D/HH	3.0 (3.9)	3.2 (2.4)

Table 3, Means (Standard Deviations) of Normally Hearing (NH) and Deaf or Hard-of-Hearing (D/HH) Students by Age for Clause Development

Variable	Age:	10	11	12
WPTU	NH	7.5 (1.2)	8.9 (1.7)	10.5 (2.8)
	D/HH	6.9 (2.3)	7.7 (1.3)	7.8 (1.6)
#of Words/	NH	6.0 (2.1)	8.1 (1.2)	5.2 (1.9)
Main Clause	D/HH	5.8 (1.4)	6.5 (1.3)	6.8 (1.3)
# of Words/	NH	4.4 (2.9)	3.8 (2.5)	5.6 (1.3)
Subordinate				
Clause	D/HH	2.9 (2.8)	2.5 (4.3)	3.9 (1.9)
# of Subordinate	NH	0.14(0.11)	0.16(0.13)	0.50 (0.67)
Clauses/T-Unit	D/HH	0.16(0.19)	0.26(0.23)	0.43 (0.19)
# of Modals	NH	0.4 (0.5)	1.7 (2.4)	1.5 (1.6)
	D/HH	1.1 (0.7)	1.9 (1.3)	3.3 (3.5)
#of Be/Have	NH	2.2 (1.8)	3.8 (3.5)	6.4 (3.9)
Auxiliaries	D/HH	3.1 (2.5)	2.9 (1.8)	5.9 (5.3)
# of Prepositional	NH	5.4 (2.9)	7.0 (5.7)	9.8 (5.0)
Phrases	D/HH	4.6 (5.7)	4.4 (2.6)	10.6 (6.7)
# of Possessive	NH	2.2 (1.8)	3.0 (2.1)	3.4 (2.3)
Nouns/	D/HH	2.2 (2.4)	2.1 (1.7)	5.3 (4.5)
Pronouns				
# of Adverbs of	NH	2.1 (1.7)	5.3 (5.3)	3.9 (3.4)
Time	D/HH	0.8 (1.2)	0.5 (0.5)	1.8 (1.7)
#of Gerunds,	NH	1.9 (2.0)	5.1 (5.1)	3.5 (1.9)
Participles, and	D/HH	1.7 (3.7)	1.5 (1.5)	2.9 (2.9)
Absolute Phrases	--	-- --	-- --	-- --

Variable	Age:	13	14
WPTU	NH	11.5 (3.5)	12.3 (2.3)
	D/HH	7.9 (2.7)	8.4 (1.7)
#of Words/	NH	8.8(12.1)	9.2 (1.3)
Main Clause	D/HH	5.9 (3.8)	7.4 (1.5)
#of Words/	NH	6.4 (1.4)	3.9 (2.3)
Subordinate Clause	D/HH	3.8 (2.2)	4.6 (3.1)
# of Subordinate	NH	0.47(0.34)	0.51(0.24)
Clauses/T-Unit	D/HH	0.38(0.38)	0.21(0.23)

#ofModals	NH	4.2 (6.2)	1.0 (1.1)
	D/HH	1.7 (1.52)	0.9 (.5)
#of Be/Have	NH	13.5(21.7)	5.6 (2.7)
Auxiliaries	D/HH	3.5 (2.9)	3.4 (2.6)
#of Prepositional	NH	8.9 (6.9)	11.0 (8.6)
Phrases	D/HH	7.5 (8.1)	6.1 (3.1)
# of Possessive	NH	6.4 (4.9)	4.1 (4.6)
Nouns/	D/HH	2.4 (2.9)	1.7 (1.9)
Pronouns			
#of Adverbs of	NH	5.0 (3.3)	4.4 (1.7)
Time	D/HH	0.9 (2.8)	0.9 (0.8)
#ofGerunds,	NH	7.5 (6.2)	4.4 (2.5)
Participles, and	D/HH	3.1 (2.7)	3.1 (2.5)
Absolute Phrases	--	--	--

Table 4. A Comparison of Normally Hearing (NH) and Deaf or Hard-ofHearing (D/HH) Students by Variable and Category

No Significant Differences	Significant Differences (D/HH students produced less)	Significant Differences (D/HH students produced more
INTRASENTENTIAL SYNTAX	INTRASENTENTIAL SYNTAX	INTRASENTENTIAL SYNTAX
#TU # Modals #Be/Have Auxiliaries # Possessive Nouns/ Pronouns	Syntactic Density Score # Sub ordinate Clauses # Prepositional Phrases # Adverbs of Time # Gerunds, Participles, and Absolute Phrases WPTU Words per Main Clause Words per Subordinate Clause Subordinate Clauses per T-unit	
INTERSENTENTIAL SYNTAX	INTERSENTENTIAL SYNTAX	INTERSETENTIAL SYNTAX
# Conjunction Cohesions #REFCOHS	SYNCOHS/TOTCOHS	
INTRASENTENTIAL SEMANTICS	INTRASENTENTIAL SEMANTICS	INTRASENTENTIAL SEMANTICS
TOTPROPS	#MAJPROPS #MINPROPS MIN PROPS / TOTPROPS	MAJPROPS/TOTPROPS

INTERSENTENTIAL SEMANTICS	INTERSENTENTIAL SEMANTICS	INTRASENTENTIAL SEMANTICS
TOTCOHS	#Collocation Cohesions	
# Lexical Repetitions		
SEMCOHS/TOTCOHS		

Table 5. A Comparison of Variables by Developmental Trend for Both Normally Hearing and Deaf or Hard-of-Hearing Students

No Age Development	Linear	Quadratic
MAJPROPS/ TOTPROPS	# Sub ordinate Clauses	#TW --
MINPROPS/ TOTPROPS	# Minor Propositions	#TOTCOHS --
SYNCOHS/ TOTCOHS	Subordinate Clauses/T-Unit	#TU
SEMCOHS / TOTCOHS	WPTU	# MAJPROPS
Syntactic Density/ Total Score Possible	Words/Main Clause	#MINPROPS
TOTPROPS	Words/Subordinate Clause	#REFCOHS
# Conjunction Cohesions	# Prepositional Phrases	# Lexical Repetition Cohesions

No Age Development	Linear and Quadratic
MAJPROPS/ TOTPROPS	# Modals --
MINPROPS/ TOTPROPS	# Be/Have Auxiliaries
SYNCOHS/ TOTCOHS	# Possessive Nouns and Pronouns
SEMCOHS/ TOTCOHS	# Adverbs of Time
Syntactic Density/ Total Score Possible	# Gerunds, Participles, and Absolute Phrases
TOTPROPS	--
# Conjunction	--
Cohesions	--

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Appendix I--Syntactic Density Score (SDS) of a Sample Story

	Loading	Frequency	LxF
1. Words per T-unit	.95	6.2	5.9
2. Subordinate clauses per T-unit	.90	0.33	0.3
3. Main clause word length (mean)	.20	4.0	0.8
4. Subordinate clause word length	.50	4.0	2.0
5. Number of modals (will, shall,can, may, must, would, etc.)	.65	0.0	0.0
6. Number of be/have forms in the auxiliary	.40	6.0	2.4
7. Number of prepositional phrases	.75	1.0	0.75
8.Number of possessive nouns and pronouns	.70	4.0	2.8
9. Number of adverbs of time(when, then, once, while, etc.)	.60	0.0	0.0
10. Number of gerunds, participles, and absolute phrases [*]	.85	0.0	0.0

SDS=14.91
SDS/Total # T-units=14.91 /10=1.49

Grade Level Conversion Table:

SDS	.5	1.3	2.1	2.9	3.7	4.5	5.3	6.1
Grade	1	2	3	4	5	6	7	8

SDS	6.9	7.7	8.5	9.3	10.1	10.9
Grade	9	10	11	12	13	14

[*] Absolute phrases are infinitives that take the place of nouns (e.g., To be or not to be, that is the question).

Appendix II--Propositional Analysis of a Sample Story

The boy is dead. The man's car is crash the bike. The woman m sading because he dead. The boys bike is new. The doctor is coming because he is hurt. The papper is messy. The lady's crying because his leg is broken. The boy's nam is Mike. The man is looking at the boy. Mike isn't woke the then and asleep.

[*]1) (DEAD, BOY)

*2) (CRASH, BIKE, CAR)

3) (MAN, CAR)

*4) (SAD (predicate), WOMAN)

*5) (DEAD, BOY)

6) (CAUSALITY: 4, 5)

*7) (IS, BIKE)

- 8) (BOY'S, BIKE)
- 9) (NEW, BIKE)

*10) (COME, DOCTOR)

*11) (IS, HURT, BOY)

12) (CAUSALITY: 10, 11)

*13) (IS, PAPER)

14) (MESSY, PAPER)

*15) (CRY, LADY)

*16) (BREAK, LEG, BOY)

- 17) (CAUSALITY: 15, 16)
- 18) (D/HHS, LEG)

* 19) (IS, NAME, MIKE)

20) (BOY'S NAME)

*21) (LOOK, MAN)

22) (LOCATION: AT BOY)

* 23) (WAKE, MIKE)

24) (CONDITION: NEGATE 23)

* 25) (IS, ASLEEP, MIKE)

26) (CONNECTION: 23, 24, 25)

Total # of propositions=26

Total # of major propositions=14

Total # of minor propositions=12

[*] major propositions

T-Unit Analysis

1. The boy is dead.
2. The man's car is crash the bike
3. The woman is sading because he dead.
4. The boys bike is new.
5. The doctor is coming because he is hurt. 6) The papper is messy.
6. The lady's crying because his leg is broken.
7. The boy's nam is Mike.
8. The man is looking at the boy.
9. Mike isn't woke the then and asleep.

Total # of T-units=10

Appendix III---Analysis of Text Cohesion in a Sample Story

# of Reference Cohesions=8

Pronoun	Demonstrative
he/boy	the/bike
he/boy	the lady/woman
his	she/man
the/boy	

# of Lexical Cohesions=9

Repetition	Synonyms
boy's	isn't woke/asleep
bike	Mike/boy
boy's	lady/woman
man	
Mike	

# of Conjunction Cohesions=4

Additive	Causal
and	because
	because
	because

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