5-1-1998

Predicting academic achievement in deaf poulations using measures of learning and memory

Kelly Gleason

Running Head: PREDICTING ACADEMIC ACHIEVEMENT IN DEAF POPULATIONS

Predicting Academic Achievement in Deaf Populations

Using Measures of Learning and Memory

Master's Thesis

Submitted to the Faculty

Of the School Psychology Program

College of Liberal Arts
ROCHESTER INSTITUTE OF TECHNOLOGY

By

Kelly M. Gleason

In Partial Fulfillment of the Requirements
For the Degree of
Master of Science

Rochester, New York May 1, 1998

Approved: Jennifer Lukomski
(committee chair)

____
(committee member)

Dean: ____________________

RIT
School Psychology Program
Permission to Reproduce Thesis

PERMISSION GRANTED

Title of thesis Predicting Academic Achievement in Deaf Populations Using Measures of Learning and Memory

I, Kelly M. Gleason hereby **grant permission** to the Wallace Memorial Library of the Rochester Institute of Technology to reproduce my thesis in whole or in part. Any reproduction will not be for commercial use or profit.

Date: 4/27/98 **Signature of Author:** ____________________

PERMISSION FROM AUTHOR REQUIRED

Title of thesis ____________________

I ____________________ **prefer to be contacted** each time a request for reproduction is made. I can be reached at the following address:

____
____
____

PHONE: ____________

Date: ____________ **Signature of Author:** ____________________

PERMISSION DENIED

TITLE OF THESIS ____________________

I ____________________ hereby **deny** permission to theWallace Memorial Library of the Rochester Institute of Technology to reproduce my thesis in whole or in part.

Date: ____________ **Signature of Author:** ____________________

Abstract

The purpose of this study was to (1) examine the correlation between a test of academic achievement (SAT-9) and a test of cognitive ability (WISC-III PIQ), and between a test of academic achievement (SAT-9) and tests of memory and learning (TOMAL VSR and WSR subtests), and (2) to examine the degree to which each type of test (either WISC-III PIQ, TOMAL WSR, or TOMAL VSR) is predictive of achievement in several achievement areas for deaf and hard of hearing children. The TOMAL WSR and VSR subtests were administered to 30 children enrolled at a school for the deaf in Buffalo, NY. Data on WISC-III PIQ and SAT-9 scores were obtained from school records. Test instructions were given through Total Communication, using a combination of American Sign Language and spoken English. Significant correlations were found between the WISC-III PIQ and each SAT-9 subtest as well as between both subtests of the TOMAL and each SAT-9 subtest. Only the VSR subtest of the TOMAL was found to significantly predict achievement on the Reading Comprehension, Total Language, and Problem Solving subtests of the SAT-9. The study provides support for the use of tests of visual memory in the psychological assessment of deaf children.

Predicting Academic Achievement in Deaf Populations Using Measures of Learning and Memory

The question of how best to assess ability and achievement in children who are deaf and hard of hearing has been debated for several years and remains an important question for many school psychologists who work with this population of students. Psychologists are often faced with using assessment tools that are not appropriate for use with deaf and hard of hearing children, believing that something is better than nothing. These tools frequently have not been standardized to be used with deaf and hard of hearing populations or have outdated norms, however, are used to make critical academic decisions.

Closer examination of research and practice in the assessment field of deaf children reveals much variation in the types of assessment instruments used to measure both cognitive ability and academic achievement in deaf children. Choosing an appropriate instrument to assess deaf children's intelligence is a challenging decision (Paal & Skinner, 1988). The number of cognitive tests standardized on a deaf and hard of hearing population with deaf norms is limited, and many of these tests fail to meet minimum standards for technical adequacy (Bradley-Johnson & Evans, 1991). In addition to this, controversy exists as to whether verbal, nonverbal, or both kinds of tests should be used. Typically, tests of cognitive ability that require verbal skills are not considered appropriate for use with deaf individuals (Bradley-Johnson & Evans, 1991). Some researchers believe that because deaf and hard-of-hearing people do not have access to verbal content, verbally loaded tests should not be used to estimate intelligence (Braden, 1992). Sattler (1992) states firmly that, "The performance tests selected for hard-of-hearing children should not depend on verbal directions," since, "...they are more likely to measure the extent of the child's language deficiency" (p. 101). Furthermore, individuals who are deaf and hard of hearing who have been administered both verbal and nonverbal tests have been found to yield substantially lower scores on the verbal tests (Braden, 1992). For these reasons, the cognitive assessment of deaf children has been restricted to performance scales, even in the face of reduced reliability (Moores & Sweet, 1990). In contrast, other researchers have advocated for the use of verbal scales when testing deaf and hard of hearing students. For example, Moores & Sweet (1990) find higher correlations between verbal tests and reading achievement in deaf children than with nonverbal tests, and state that, "...their [verbal tests] potential benefit is substantial" (p. 182) and therefore question the "...utility of performance measures in making academic decisions for deaf children" (p. 183). Nonetheless, use of nonverbal intelligence tests in assessing children with hearing-impairments tends to be the most popular practice for many school psychologists (Braden, 1992).

The Hiskey-Nebraska Test of Learning Ability is the only individually administered intelligence test designed for use with school-aged deaf subjects that has been standardized separately on deaf and hearing samples (Bolton, 1978; Bradley-Johnson & Evans, 1991). However, the 1966 norms of the Hiskey-Nebraska are now severely outdated, and other measures have been found to correlate better with measures of achievement (Paal & Skinner, 1988; Phelps & Ensor, 1986). The Wechsler Intelligence Scale for Children-Revised Performance Scale has also been a popular choice, since Anderson and Sisco standardized it on deaf children in 1977 (Phelps & Ensor, 1986), and Ray adapted it by providing special verbal instructions for deaf test takers in 1979 (Blennerhassett, 1990; Bradley-Johnson & Evans, 1991). However, the WISC-R is now outdated and has been replaced by the updated WISC-III. In a three year study of deaf students, a strong relationship between the WISC-III and WISC-R

Performance IQ ($r = .93$, $p < .01$) was found which supports the validity of the WISC-III PIQ for use with deaf students (Slate & Fawcett, 1995). Other less common cognitive assessment tests used today in practice and in research include the Kaufman Assessment Battery for Children Nonverbal Scale (K-ABC NV), the Leiter International Performance Scale - Revised, Raven's Progressive Matrices, the Test of Nonverbal Intelligence (First and Second Editions), the Columbia Mental Maturity Scale, Nonverbal Test of Cognitive Skills, and Naglieri's Matrix Analogies Test-Expanded Form (Braden, 1992; Kishor, 1995; Bradley-Johnson & Evans, 1991; Phelps & Brynan, 1988; Padmapriya & Mythili, 1988, Porter & Kirby, 1986; Watson etal, 1986; Naglieri & Welch, 1991; Kamhi etal, 1990). With the exception of one study supporting the use of the K-ABC Nonverbal Scale (Porter & Kirby, 1986), far less information is available regarding the validity of using these tests with deaf children. As a result, an examiner desiring a performance assessment instrument that provides standardized testing procedures, as well as deaf norms, has limited options (Phelps & Ensor, 1986).

The lack of availability of such tests has concerned many researchers and practitioners who have turned to other means of assessing the ability of deaf children. Furthermore, mixed research findings have made it difficult to make consistent generalizations about and estimates of the intelligence of deaf individuals. In a research synthesis, Braden (1992), found that although estimates of IQ's suggest that deaf people have an IQ distribution similar to the distribution of IQ in hearing people, the center of the distribution of intelligence in deaf people is somewhat lower than that of hearing people (Braden, 1992). Blennerhassett (1990) addresses this issue citing conflicting studies in which the IQ's of deaf individuals were found to be lower, equal to, and greater than their hearing counterparts (p. 258). Braden (1989) questions the criterion-related validity of nonverbal IQ tests overall, despite their popularity among practitioners. Motor-free nonverbal tests, and verbal tests with modified instructions, are used as alternatives, though not as widely as nonverbal intelligence tests (Bradley-Johnson & Evans, 1991; Braden, 1992).

As with tests of cognitive ability, it is also important that professionals can accurately assess and predict achievement levels for deaf and hard of hearing students. However, it is not surprising to find that as with cognitive assessment, the evaluation of academic achievement of hearing impaired students presents unique problems (Phelps & Branyan, 1990). Both individually and group administered tests for deaf individuals are sparse. At the time of Phelps & Branyan's (1990) study, there were no individually administered achievement tests normed on the deaf population, and only one group test, the Stanford Achievement Test-Hearing Impaired. Currently, the Test of Early Reading Ability-Deaf or Hard of Hearing (TERA-D/HH) is the only individually administered achievement test designed for children ages 3-13 with moderate to profound hearing loss (Traxler, 1997). The Stanford Achievement Test-9th Edition provides the latest group administered achievement test, which was normed on deaf students in the spring of 1996 (Spragins, 1996), and used in the present study. Due to the lack of availability of achievement measures, and the limited age range of the TERA-D/HH, examiners often use other tests of achievement despite their lack of standardized procedures and norms for deaf children. The primary reason for this being that individually administered achievement tests are needed for making eligibility decisions for special education (Bradley-Johnson & Evans, 1991). Other group and individual achievement measures used by practitioners and researchers include the Stanford Achievement Test-8th Edition, Metropolitan Achievement Test (MAT), Kaufman Test of Educational Achievement (K-TEA), Keymath Diagnostic Arithmetic Test, Woodcock-Johnson Psychoeducational Battery, Woodcock Reading Mastery Test (WRMT), Peabody Individual Achievement Test (PIAT), Peabody Picture Vocabulary Test (PPVT), Carolina

Picture Vocabulary Test (CPVT), and the Wide Range Achievement Test (WRAT) (Bradley-Johnson & Evans, 1991; Kline & Sapp, 1989, Moores & Sweet, 1990; Phelps & Branyan, 1990; Porter & Kirby, 1986; Slate & Fawcett, 1995; Traxler, 1997; Watson et al, 1986). Overall, Phelps & Branyan (1990) assert that regardless of the measure chosen, the test administration should require little verbal interaction and be given in the communication mode with which the child is most familiar. Compared to research on the use of cognitive tests with deaf and hard of hearing individuals, less research has critically evaluated the use of achievement tests used with this population. Instead the focus of research has been on the correlation between achievement and ability tests for deaf and hard of hearing populations.

Traditionally, scores on tests of cognitive ability have been used in education as a reference point to determine if a child is making adequate academic progress, or to determine eligibility for special services based on ability-achievement discrepancies (Watson etal, 1986). In fact, the use of nonverbal tests of cognitive ability in assessing deaf children for instructional decisions, and to predict academic achievement is quite common (Phelps & Branyan, 1990). Therefore, the predictive validity of tests of cognitive ability becomes an important issue (Kishor, 1995). Several studies have examined the predictive relationship between traditional forms of cognitive assessment and various tests of academic achievement. These studies are of particular relevance to the field of school psychology, since special education eligibility decisions are often based on the relationship between a child's ability and achievement levels. Overall, correlations between nonverbal intellectual and achievement tests have ranged from .09 to .88 using several tests, different sample sizes, and different levels of significance (Kishor, 1995; Moores & Sweet, 1990); Paal etal, 1988; Phelps & Branyan, 1988; Phelps & Branyan, 1990; Padmapriya & Mythili, 1988, Porter & Kirby, 1986; Slate & Fawcett, 1995; Watson etal, 1986). This large range of correlation coefficients suggests limited or questionable predictive validity (Kishor, 1995; Paal, Skinner, & Reddig, 1988; Phelps & Brynan, 1990; Watson etal, 1986). Watson etal, (1986) point out that doubt exists as to whether nonverbal IQ scores can be used as a reference in educational planning for the hearing impaired (pg. 452). It is also the opinion of some researchers that nonverbal test scores have less value in predicting achievement, since tests requiring verbal facility correlate more closely with those abilities required for learning academic materials (Bradley-Johnson & Evans, 1991; Moores & Sweet, 1990). Therefore nonverbal intelligence tests may not necessarily be the most accurate or reliable tool in predicting achievement in this population.

In light of these findings one may ask then what other options are available to help one understand how deaf and hard of hearing children learn, and more specifically, how better to predict achievement for these children? It is understood that it is important to provide deaf and hard of hearing children the academic support necessary to help them achieve at levels commensurate with their potential. Therefore, school psychologists need to choose accurate predictors of academic achievement in selecting test batteries for identification and placement purposes with this population of students. However, it is essential that conclusions regarding educational programming and special education placement need to be based on data from several sources of information (Bradley-Johnson & Evans, 1991). Therefore more research is needed to examine the predictive validity of assessment tools other than tests of cognitive ability. One such study conducted by Watson etal (1982) examined the relationship between nonverbal intelligence and language ability in deaf children. In this study, average correlations of .45 ($p<.01$) were obtained between the measures. It was found that subtests that measured visual memory (Bead Patterns, Paper Folding, and Visual Attention Span from the H-NTLA) consistently entered the multiple regression equations as the best predictors of language performance on the Test of Language Development (TOLD) and the Reynell Developmental Language Scales (p. 199, 202, & 203). A study by Spencer & Delk (1989) examined the relationship between hearing-impaired students' performance on tests of visual processing and reading achievement. They found that significant portions of the variance (61%) in reading comprehension scores on the SAT-7 were explained by IQ (WISC-R and Leiter) and tests of memory for visual stimuli (Visual-Aural Digit Span test and the Jordan Left-Right Reversal Test) (p. 336). Researchers who examine other forms of assessment will provide knowledge of variables that influence academic achievement and subsequently will help choose appropriate academic services for deaf children (Padmapriya & Mythili, 1988).

It is important to explore the contribution other forms of tests may have in predicting academic achievement in deaf and hard of hearing children, since tests of cognitive ability may not measure all of the skills related to achievement for deaf children. For example, a disadvantage of the WISC-III Performance Scale pointed out by Spragins & Mullen (1996) is that it does not measure memory. Data on the predictive validity of other forms of assessment would assist school psychologists in making more informed data-based decisions, and in understanding achievement differences and learning styles in deaf children.

Therefore, the purpose of the present study is twofold: (1) to examine the relationship between academic achievement and measures of learning and memory and cognitive ability, and (2) to examine the degree to which each independent variable (measure of learning and memory, and measure of cognitive ability) is predictive of achievement in several achievement areas. It is hypothesized that the relationship described in (1) will exist, and that measures of learning and memory will be more predictive of achievement than the measure of cognitive ability.

Padmapriya & Mythili (1988) performed a similar study to the present study and found a significant relationship between academic achievement and certain tests of learning and memory ($r=.28$, $p<.05$), but no relationship between academic achievement and cognitive ability. In their study, learning and memory were assessed using a non-standardized, paired associate method developed by the researchers, achievement was assessed by using annual examination marks, and Raven's Standard Progressive Matrices was used to assess cognitive ability. In comparison, the present study uses the following standardized measures: Word Selective Reminding and Visual Selective Reminding subtests of the Test of Memory and Learning (TOMAL), and the WISC-III Performance IQ serve as the independent variables, and several subtests of the Stanford Achievement Test-9th Edition (SAT-9) (the only test standardized on a deaf population), to serve as the dependent variables (see Methods for further details).

Method

Participants

Subjects for the study included 30 hearing impaired children, 18 boys and 12 girls, attending St. Mary's School for the Deaf in Buffalo, New York. All subjects were between the ages of 9 and 13, with a mean age of 11 (SD=1.46 years). All of the students had profound hearing losses of 80 decibels or greater.

The parents of all children in the school between the ages of 9 and 13 inclusive (56 total), were mailed a letter explaining the research project (Appendix A) and an informed consent form (Appendix B). Those subjects for whom the consent forms were returned, and had recent (within the past three years) cognitive ability and academic achievement scores in their school records were included in the study. Due to the limited number of students in the final sample, variables such as hearing status of the parents, etiology of hearing loss, socioeconomic status, or race were considered, but not examined for their effects.

Materials

The Stanford Achievement Test (9^{th} Edition) and the Wechsler Intelligence Scale for Children–Third Edition (WISC-III) Performance IQ scores for each child were obtained from school records, and served as the academic achievement and cognitive ability scores, or independent variables in the study. The SAT-9 was published by Harcourt Brace Educational Measurement in 1996 and was normed on deaf and hard of hearing students in the Spring of 1996 (Spragins & Mullen, 1996). All of the students in the present study were tested subsequent to the 1996 norming of the test. The WISC-III Performance Scale has not been normed on deaf individuals, but research has demonstrated its validity for use with deaf populations (Kishor, 1995; Slate & Fawcett, 1995).

The Word Selective Reminding and Visual Selective Reminding subtests of the Test of Memory and Learning (TOMAL; Reynolds & Bigler, 1994) were individually administered to each child (following the procedures described below) and served as the learning and memory scores, or dependent variables in the study. These subtests are described in the TOMAL manual (Reynolds & Bigler, 1994) as follows:

> "Word Selective Reminding (WSR) is a verbal free-recall task on which the examinee learns a word list and repeats it only to be reminded of words left out in each case. It tests learning and immediate recall functions in verbal memory. Trials continue until mastery is achieved or until 8 trials have been attempted. Sequence of recall is unimportant. Visual Selective Reminding (VSR) is a nonverbal analogue to WSR whereby examinees point to specified dots on a card, following a demonstration of the examiner, and are reminded only of items recalled incorrectly. As with the WSR, trials continue until mastery is achieved or until 8 trials have been attempted" (p. 10).

These two particular subtests were chosen due to their analogue nature, brief administration time, and minimal manipulation of standardized procedures required to administer the subtests to the participants. For the TOMAL WSR and VSR subtests, the average reliability coefficients for the age range used in this study are .88 and .92 (Reynolds & Bigler, 1994). Although norms are not provided for deaf children on the TOMAL, the means and standard deviations of the sample in this study (WSR Mean=10.50, SD=2.39; VSR Mean=10.0, SD=2.09) more closely approximated those of the norming sample than of a learning disabled sample reported in the TOMAL manual (Reynolds & Bigler, 1994).

Procedure

Public Law 94-142 mandates that test instructions be provided and administered in the student's native language or other method of communication unless it is not feasible (Bradley-Johnson & Evans, 1991). However, administration procedures for deaf children have been frequently debated and differ between the practices of researchers and practitioners. Braden (1992) states, "Psychologists should not rely on oral, written, or gestural directions for deaf and hard of hearing children... the best method for insuring task comprehension is for psychologists to use the subject's native language when administering tests" (p. 92). In research examining the use of different forms of communication, Porter & Kirby (1986) found no significant differences in nonverbal K-ABC scores using American Sign Language and pantomime/gesture. Similarly, Phelps & Branyan (1988) state that, "...the administration differences of pantomime vs. total communication do not appear to make substantial differences in obtained IQ's (p. 357)." However, Sullivan (1982) found that communicating subtest instructions using total communication resulted in higher Performance IQ's than use of verbal statements, gestures, visual aides, or pantomime (cited in Bradley-Johnson & Evans, 1991; Sullivan & Schulte, 1992).

For most instruments, instructions are frequently modified to adapt instruments for use with hearing-impaired students (Bradley-Johnson & Evans, 1991). This has been cited in literature as a typical practice for researchers and practitioners (Sullivan & Schulte, 1992). Therefore, standardized directions on the TOMAL were translated into sign language by the examiner and the School Psychologist at St. Mary's School for the Deaf. The resulting directions closely approximated the standardized (spoken English) directions (See Appendix C). Care was taken to ensure that signs selected and used were familiar to the children included in the study and reflective of the dialect of the children at this school. The primary mode of communication used in the study was total communication. Bradley-Johnson & Evans describe total communication as involving "simultaneous expression using voice and sign" (p. 40).

Scores for the WISC-III PIQ, and SAT-9 were obtained from school records for each child in the study. On the SAT-9, subtest scores for Reading Comprehension, Problem Solving, Math Procedures, Total Language, and Spelling were recorded, as they were the only scores reported in the students' files.

A schedule for testing was distributed to the teachers of the children in the study one week prior to the beginning of testing. Each child was scheduled for a 15 minute time period. The examiner met each child at his or her classroom and walked him or her to the testing room. After briefly establishing rapport (about 3 minutes), first the Word Selective Reminding, and then the Visual Selective Reminding subtests were administered.

Upon completion, the examiner accompanied each child back to his or her classroom and proceeded to the next child on the schedule. After all of the children scheduled for the day had been tested, the protocols were scored. Each child was assigned a number based on the order in which the informed consent forms were received. This number, and the child's age and gender were recorded on the protocol. Standard scores (Mean=10, SD=3) were derived for each subtest. The standard scores for the TOMAL, WISC-III, and SAT-9 were then transferred to a data sheet at which point all names were removed from the protocols. The data sheet was filed in a locked cabinet in the office of the School Psychologist.

Results

Results of the study were analyzed using Pearson correlation coefficients and five univariate multiple regression equations, one for each subtest of the SAT-9. Means, standard deviations, and Pearson correlations for the Reading Comprehension, Problem Solving, Math Procedures, Total Language, and Spelling subtests of the SAT-9 appear in Table 1. All correlations between the SAT-9 subtests and the WISC-III PIQ, WSR subtest, and VSR subtest of the TOMAL were found to be positive and significant at $p < .01$.

The multiple regression analyses reveal the Visual Selective Reminding subtest of the TOMAL as the only significant predictor of achievement on three of the five achievement subtests. In the first regression analysis, the independent variables accounted for approximately 56% of the variance on the Reading Comprehension subtest. The Visual Selective Reminding subtest proved to be a significant predictor of Reading Comprehension ($p<.0058$). Neither the WISC-III PIQ nor the WSR was predictive of Reading Comprehension. See Table 2 for complete results. In the second regression analysis, the independent variables accounted for approximately 63% of the variance on Total Language subtest. The Visual Selective Reminding subtest significantly predicted Total Language ($p<.0173$). Neither the WISC-III PIQ nor the WSR was predictive of Total Language. See Table 3 for complete results. In the third regression analysis, the independent variables accounted for approximately 71% of the variance on the Problem Solving subtest. Again, the Visual Selective Reminding subtest was a significant predictor of performance on the Problem Solving subtest ($p<.0041$). Neither the WISC-III PIQ nor the WSR was predictive of Problem Solving. See Table 4 for complete results. In the fourth and fifth regression analyses, the independent variables accounted for approximately 48 and 41% of the variances on the Math Procedures and Spelling subtests respectively. None of the independent variables significantly predicted achievement in these two analyses. See Table 5 and Table 6 for complete results.

Discussion

All measures of achievement were found to significantly correlate with both cognitive and learning and memory assessment measures. Correlation coefficients across measures ranged from .49 to .81 ($p<.01$) which are generally higher than correlations found in past research. This could be due to the smaller sample size of this study, or due to the fact that all of the tests used in this study were the most recent revisions of the tests and included updated norming samples in their standardization. This suggests that both the WISC-III and TOMAL may have clinical utility for use with deaf and hard of hearing children.

Only the VSR subtest of the TOMAL significantly predicted achievement in Reading, Problem Solving, and Language achievement areas, while the WISC-III PIQ and WSR subtest of the TOMAL did not. These results suggest that the use of a visual sequential memory task may be a better predictor of achievement in deaf and hard of hearing children than an intelligence test alone. These findings are similar to Spencer & Delk's (1989) findings which showed that visual processing tests with strong visual sequential memory components (VADS and Slingerland) contribute to explanation of subjects' reading scores (pg. 337). The similar findings may be due to the similar nature of each of the tasks in the Spencer & Delk (1989) study and the present study. However, unlike the Spencer & Delk (1989) study, the present findings extend the potential application of visual processing tests to predict language and problem solving in addition to reading.

Using a variety of tests provides a more comprehensive assessment of potential in deaf and hard of hearing children, and allows school psychologists to better predict a particular child's expected academic achievement, resulting in more educated identification and placement decisions, and overall better service provision. This study provides practitioners with information relevant to the assessment of children who are deaf and hard of hearing regarding the predictive validity of both tests of cognitive ability and tests of memory and learning. The findings of the present study support the use of other forms of assessment to supplement the traditional forms of cognitive assessment used with children who are deaf and hard of hearing. It begins by validating the use of learning and memory tasks, specifically the Test of Learning and Memory. In the present study the lack of standardization on deaf children did not appear to affect the results since over half of the variability was accounted for by the measures used. However, in practice, professionals should always choose assessment batteries and interpret test results with caution when assessing children who are deaf and hard of hearing. It may be helpful to use criterion-based assessment techniques in addition to norm-referenced tools to provide a more accurate assessment of a deaf child. In advocating for the use of criterion-based assessments, Bradley-Johnson & Evans (1991) suggest that, "flexibility (in assessment) can help to determine the most appropriate procedures for teaching a skill to a particular student" (pg. 18).

Future research in the area of assessment of deaf and hard of hearing children should continue to focus on other ways to assess the learning potential of this population of students. Other assessment measures and larger sample sizes should be used. Furthermore, it would be interesting to examine the influence of other variables on academic achievement that were not examined in this study due to the limited sample size. These may include gender, race, hearing status of parents, and socioeconomic status.

References

Blennerhassett, L. (1990). Intellectual assessment. In D. F. Moores & K. P. Meadow-Orlans (Eds.), Educational and developmental aspects of deafness (p. 258, 267).

Bolton, B. (1978). Differential ability structure in deaf and hearing children. Applied Psychological Measurement, 2, 147-148.

Braden, J. P. (1992). Intellectual assessment of deaf and hard-of-hearing people: a quantitative and qualitative research synthesis. School Psychology Review, 21, 82-94.

Braden, J. P. (1989). The criterion-related validity of the WISC-R performance scale and other nonverbal IQ tests for deaf children. American Annals of the Deaf, 134 (5), 329-332.

Bradley-Johnson, S. & Evans, L. D. (1991). Psychoeducational Assessment of Hearing-Impaired Students. Austin, TX: PRO-ED.

Kamhi, A. G., Minor, J. S., & Mauer, D. (1990). Content analysis and intratest performance profiles on the Columbia and the TONI. Journal of Speech and Hearing Research, 33, 375-379.

Kline, M., & Sapp, G. L. (1989). Carolina Picture Vocabulary Test: Validation with hearing-impaired students. Perceptual and Motor Skills, 69, 64-66.

Kishor, N. (1995). Evaluating predictive validity by using different scales of the Stanford Achievement Test for the Hearing-Impaired. Journal of Psychoeducational Assessment, 13, 241-249.

Moores, D. F., Cerney, B., & Garcia, M. (1990). School placement and least restrictive environment. In D. F. Moores & K. P. Meadow-Orlans (Eds.), Educational and developmental aspects of deafness (p.125).

Moores, D. F., & Sweet, C. (1990). Factors predictive of school achievement. In D. F. Moores & K. P. Meadow-Orlans (Eds.), Educational and developmental aspects of deafness (p. 157, 182-183).

Naglieri, J. A., & Welch, J. A. (1991). Use of Raven's and Naglieri's nonverbal matrix texts. Journal of the American Deafness and Rehabilitation Association, 24 (3-4), 98-103.

Paal, N., Skinner, S., & Reddig, C. (1988). The relationship of non-verbal intelligence measures to academic achievement among deaf adolescents. Journal of Rehabilitation of the Deaf, 21, 8-11.

Padmapriya, V. & Mythili, S. P. (1988). A comparative study of deaf and normal children: cognitive factors and academic achievement. Journal of Indian Psychology, 7, 27-35.

Phelps, L. & Brynan, B. J. (1988). Correlations among the Hiskey, K-ABC nonverbal scale, Leiter, and WISC-R performance scale with public-school deaf children. Journal of Psychoeducational Assessment, 6, 354-358.

Phelps, L. & Brynan, B. J. (1990). Academic achievement and nonverbal intelligence in public school hearing-impaired children. Psychology in the Schools, 27, 210-217.

Phelps, L. & Ensor, A. (1986). Concurrent validity of the WISC-R using deaf norms and the Hiskey-Nebraska. Psychology in the Schools, 23 (2), 138-141.

Porter, L. & Kirby, E. (1986). Effects of two instructional sets on the validity of the Kaufman Assessment Battery for Children-Nonverbal Scale with a group of severely hearing impaired children. Psychology in the Schools, 23, 37-43.

Reynolds, C. R., & Bigler, E. D. (1994) Test of Memory and Learning Examiner's Manual. Austin, TX: Pro-Ed.

Salvia, J. & Ysseldyke, J. E. (1995). Assessment (6th Ed.). Boston, MA: Houghton Mifflin.

Sattler, J. M. (1992). Assessment of children: Revised and updated third edition. San Diego, CA: Jerome M. Sattler.

Slate, J. & Fawcett, J. (1995). Validity of the WISC-III for deaf and hard of hearing persons. American Annals of the Deaf, 140 (3), 250-254.

Spencer, P., & Delk, L. (1989). Hearing-impaired students' performance on tests of visual processing: Relationships with reading performance. American Annals of the Deaf, 134 (5), 333-337.

Spragins, A., & Mullen, Y. (1996). Research on using the Stanford Achievement Test with deaf and hard of hearing students [On-line]. Available: http://www.gallaudet.edu/~catraxle/sat-citations.html

Sullivan, P. M. & Schulte, L. E. (1992). Factor analysis of WISC-R with deaf and hard-of-hearing children. Psychological Assessment, 4 (4), 537-540.

Traxler, C. (1997). Reviews of four types of assessment instruments used with deaf and hard of hearing students: Academic assessment [On-line]. Available: http://www.galluadet.edu/~catraxle/ACADEMIC.HTM#tests

Vess, S. M., & Douglass, L. S. (1995). Best practices in program planning for children who are deaf or severely hard of hearing. In A. Thomas & J. Grimes (Eds.). Best Practices in School Psychology-III (p. 1123-1133). Washington, DC: National Association of School Psychologists.

Watson, B., Goldgar, D., Kroese, J., & Lotz, W. (1986). Nonverbal intelligence and academic achievement in the hearing impaired. The Volta Review, 88 (3), 151-158.

Watson, B., Sullivan, P. M., Moeller, M. P., & Jensen, J. K. (1982). Nonverbal intelligence and English language ability in deaf children. Journal of Speech and Hearing Disorders, 47, 199-204.

Appendix A

May 22, 1997

Dear Parent,

I am a graduate student in School Psychology at Rochester Institute of Technology (RIT). I am conducting a research study entitled Predicting Academic Achievement in Deaf Children Using Measures of Learning. The goal of the study is to determine if measures of learning more accurately predict academic achievement in deaf populations than measures of traditional cognitive assessment. During this study, I will be working with Dr. John Adams, School Psychologist at St. Mary's School for the Deaf, and Dr. James B. Hale, Assistant Professor of Psychology at RIT, Adjunct Assistant Professor of Neurology at the University of Rochester.

In the study, children will be removed from class or free time activities to perform two tasks with me, pending the approval of his/her classroom teacher. It will take approximately 10-20 minutes to complete the tasks. These tasks include learning a list of words, and learning where dots are located on a page. Most children find these tasks enjoyable. The information collected will be confidential, which means only Dr. Hale and I will know the results of a child's performance on the tasks. Results will be used only for purposes of the study and will be destroyed once the study is completed.

I would greatly appreciate you and your child's participation in the research study. Please read the enclosed consent form and return it to St. Mary's. If you have any questions, please feel free to call me at (716) 759-4216, Dr. Adams at (716) 834-7200 (Ext. 159), or Dr. Hale at (716) 475-2416 (NYS Relay Service 1-800-662-1220). Thank you in advance for your time and consideration.

Sincerely,

Kelly M. Gleason
Graduate Student in School Psychology

Appendix B

Informed Consent Form

This Informed Consent Form is for a research study entitled Predicting Academic Achievement in Deaf Children Using Measures of Learning by Kelly M. Gleason, Master's Degree candidate in School Psychology at Rochester Institute of Technology (RIT). Mrs. Gleason is working under the advisement of Dr. John Adams, School Psychologist at St. Mary's School for the Deaf, and Dr. James Hale, Assistant Professor of Psychology at RIT, Adjunct Assistant Professor of Neurology at the University of Rochester. The goal of the research is to determine if measures of learning more accurately predict academic achievement in deaf populations than measures of traditional cognitive assessment.

My child, ______________________________, pending approval by his/her teacher, will be removed from class or free time activities and taken to a quiet room for approximately 10-20 minutes. He/she will be given two tasks by Mrs. Gleason, a trained graduate student in the administration of these tasks. On these tasks, he/she will be asked to learn a list of words and where dots are located on a page.

The information collected will be confidential. The results will be used only for the purposes of the study and seen only by Mrs. Gleason or Dr. Hale. The results will not be used for identification or placement purposes for my child.

I have the right to withdraw my child from this study at any time during the study. My child also has the right to withdraw participation during the session if he/she wishes to do so. I can call Kelly Gleason at (716) 759-4216, Dr. Adams at (716) 834-7200 (Ext. 159), or Dr. Hale at (716) 475-2416 to withdraw my child form the study or to ask any questions that I may have (NYS Relay Service 1-800-662-1220).

Please use your initials to indicate your agreement or disagreement toward participation in the study, and return this form as soon as possible to St. Mary's School for the Deaf.

__________ Yes, I agree to let my child participate in the study.

__________ No, I would not like my child to participate in the study.

The following information is voluntary, but will aid in the selection of participants.

My child's degree of total hearing loss is: ________________
My child is MALE FEMALE (please circle one)

Please indicate your final approval by signing below. This Informed Consent Form is valid only if signed by a parent or legal guardian.

____ ______________________

Parent or Guardian Date

Appendix C

Simultaneously using a combination of signed English and spoken English, the administration directions were as follows:

Word Selective Reminding:

Spoken: "I AM GOING TO SAY SOME WORDS, AND WHEN I AM DONE, I WANT YOU TO SAY ALL OF THE WORDS AGAIN."

Signed: I SAY SOME WORDS, AND WHEN I DONE, I WANT YOU SAY ALL WORDS AGAIN.

The examiner then administered the word list as is described in the TOMAL manual (Reynolds & Bigler, 1994, p. 23). After the first trial of the word list, the child was given the next prompt, again following procedures described in the manual.

Spoken: "YOU FORGOT SOME WORDS (list words)."

Signed: YOU FORGOT SOME WORDS (sign words).

This prompt is given successively, over eight trials, or until the word list is mastered.

Visual Selective Reminding:

Spoken: "WATCH ME VERY CAREFULLY."

Signed: WATCH ME VERY CAREFULLY.

The examiner then touched a series of dots according to a pattern described in the Record Form, and according to the procedures described in the TOMAL manual (Reynolds & Bigler, 1994, p. 23), then said/signed,

Spoken: "NOW YOU DO EXACTLY THE SAME AS ME. SHOW ME WHERE I TOUCHED."

Appendix C (con't.)

Signed: NOW YOU DO EXACTLY SAME ME. SHOW ME WHERE I (motion as if touching dots in air).

After the first trial, the child is given the next prompt, again following procedures described in the manual.

Spoken: "YOU FORGOT SOME. NOW DO THEM ALL AGAIN."

Signed: YOU FORGOT SOME. NOW DO ALL AGAIN.

This prompt is also given successively, over eight trials, or until the pattern is mastered.

Table 1

Means, Standard Deviations, and Intercorrelations

SAT-9 subtest	Mean	SD	Intercorrelations		
			WISC-III PIQ	WSR	VSR
Reading Comprehension	570.53	46.46	.514*	.556*	.714*
Total Language	574.87	40.97	.655*	.584*	.755*
Problem Solving	585.13	56.39	.744*	.513*	.814*
Math Procedures	610.87	79.65	.625*	.486*	.621*
Spelling	612.10	74.65	.513*	.496*	.594*

Note. N=30; SAT-9=Stanford Achievement Test-9th Edition; SD=standard deviation; WISC-III PIQ=Wechsler Intelligence Scale for Children-3rd Edition Performance IQ; WSR=Word Selective Reminding; VSR=Visual Selective Reminding

*$p < .01$

Table 2

SAT-9 Reading Comprehension Subtest Statistical Data

Summary of Fit

R-Square	=	0.558383
R-Square Adj.	=	0.507427
Root Mean Square Error	=	32.604150
Mean of Response	=	570.533300
Observations (N)	=	30.000000

Parameter Estimates

Term	Estimate	Standard error	t Ratio	Prob>|t|
Intercept	394.6737700	36.455580	10.83	<.0001
WISC-III (PIQ)	-0.1625810	0.484176	- 0.34	0.7397
WSR	4.9818787	2.973257	1.68	0.1058
VSR	13.9910630	4.654091	3.01	0.0058*

Effect Test

Source	Nparm	DF	Sum of squares	F Ratio	Prob>|F|
WISC-III (PIQ)	1	1	119.8617	0.1128	0.7397
WSR	1	1	2984.4684	2.8075	0.1058
VSR	1	1	9606.7701	9.0372	0.0058*

*$p < .01$

Table 3

SAT-9 Total Language Subtest Statistical Data

Summary of Fit

R-Square	=	0.634982
R-Square Adj.	=	0.592865
Root Mean Square Error	=	26.139580
Mean of Response	=	574.866700
Observations (N)	=	30.000000

Parameter Estimates

Term	Estimate	Standard Error	t Ratio	Prob>|t|
Intercept	392.6687000	29.227370	13.43	<.0001
WISC-III (PIQ)	0.3979494	0.388176	1.03	0.3147
WSR	4.3594636	2.383737	1.83	0.0789
VSR	9.4919435	3.731304	2.54	0.0173*

Effect Test

Source	Nparm	DF	Sum of Squares	F Ratio	Prob>|F|
WISC-III (PIQ)	1	1	718.1165	1.0510	0.3147
WSR	1	1	2285.3188	3.3446	0.0789
VSR	1	1	4421.6695	6.4713	0.0173*

*$p < .05$

Table 4

SAT-9 Problem Solving Subtest Statistical Data

Summary of Fit

R-Square	=	0.712305
R-Square Adj.	=	0.679109
Root Mean Square Error	=	31.941010
Mean of Response	=	585.133300
Observations (N)	=	30.000000

Parameter Estimates

Term	Estimate	Standard Error	t Ratio	Prob>|t|
Intercept	321.8161600	35.714110	9.01	<.0001
WISC-III (PIQ)	0.8895955	0.474328	1.88	0.0720
WSR	2.5888024	2.912784	0.89	0.3823
VSR	14.3583010	4.559431	3.15	0.0041*

Effect Test

Source	Nparm	DF	Sum of Squares	F Ratio	Prob>|F|
WISC-III (PIQ)	1	1	3588.594	3.5174	0.0720
WSR	1	1	805.895	0.7899	0.3823
VSR	1	1	10117.707	9.9171	0.0041*

*$p < .01$

Table 5

SAT-9 Math Procedures Subtest Statistical Data

Summary of Fit

R-Square	=	0.475105
R-Square Adj.	=	0.414540
Root Mean Square Error	=	60.942150
Mean of Response	=	610.866700
Observations (N)	=	30.000000

Parameter Estimates

Term	Estimate	Standard Error	t Ratio	Prob>|t|
Intercept	290.2367600	68.141060	4.26	0.0002
WISC-III (PIQ)	1.4655844	0.904999	1.62	0.1174
WSR	6.9256786	5.557474	1.25	0.2238
VSR	9.5902621	8.699209	1.10	0.2804

Effect Test

Source	Nparm	DF	Sum of Squares	F Ratio	Prob>|F|
WISC-III (PIQ)	1	1	9740.0431	2.6226	0.1174
WSR	1	1	5767.7358	1.5530	0.2238
VSR	1	1	4513.7442	1.2154	0.2804

Table 6

SAT-9 Spelling Subtest Statistical Data

Summary of Fit

R-Square	=	0.409244
R-Square Adj.	=	0.341080
Root Mean Square Error	=	60.599790
Mean of Response	=	612.100000
Observations (N)	=	30.000000

Parameter Estimates

Term	Estimate	Standard Error	t Ratio	Prob>|t|
Intercept	344.9005300	67.758270	5.09	<.0001
WISC-III (PIQ)	0.5330901	0.899915	0.59	0.5587
WSR	7.8334217	5.526253	1.42	0.1682
VSR	12.9342580	8.650339	1.50	0.1469

Effect Test

Source	Nparm	DF	Sum of Squares	F Ratio	Prob>|F|
WISC-III (PIQ)	1	1	1288.6660	0.3509	0.5587
WSR	1	1	7378.7654	2.0093	0.1682
VSR	1	1	8210.2995	2.2357	0.1469