Comparability of Blind and Sighted Subject Test Scores as Affected by Mode of Test Presentation

Summer 1982

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COMPARABILITY OF BLIND AND SIGHTED SUBJECT TEST SCORES AS AFFECTED BY MODE OF TEST PRESENTATION

BY

GARY A. MEISELES
B.A., Fairleigh Dickinson University, 1976

THESIS

Submitted in partial fulfillment of the requirements for the Master of Science degree in Industrial Psychology in the Graduate Studies Program of the College of Arts and Sciences University of Central Florida Orlando, Florida

Summer Term
1982
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On March 16, 1980 two hundred twenty-five blind people gathered in New Delhi, India in order to present a petition to Prime Minister Indira Gandhi. The petition was a request to be granted status as a special backward class. This would have granted them more rights, and provided better conditions than they then enjoyed. The Indian police beat back the peaceful demonstrators with bamboo canes used as clubs.

One eyewitness gave the following account:

...the blind, who had sticks in their hands with which they grope their way, put up whatever little resistance they could and in the process, without knowing who their enemy was, they hurt their own brethren. With their black goggles falling off, their chappals (sandals) missing and their sticks being snatched by the police, blood oozing from their heads and faces and their clothes getting torn in the struggle, it was a pathetic scene to look at (Sentinel Star, March 18, 1980, p. 12-A).

The blind in the United States are not treated as poorly as those in India, but they are persecuted in more subtle, yet equally destructive ways. Less than one-third of working age visually handicapped persons were in the labor force as of June, 1979. Additionally, a mere 80% of that visually handicapped labor force was actually employed. This is in contrast to the overall labor force which includes three-fourths of the U.S. population, with 92% of that labor force actually employed (Kirchner and Peterson, 1979).

Kirchner and Peterson also found that the visually disabled attained fewer high prestige occupations, but were over-represented in the "blue-collar" occupations. They speculated that the cause of this
discrepancy might be any combination of three general issues: (1) discrimination, (2) discouragement, and (3) disincentives to work.

There is presently a bill, S.446, before the Senate known as the "Equal Employment Opportunity for Handicapped Act of 1979", and if passed it will bring handicapped workers under coverage of Title VII of the 1964 Civil Rights Act. The 1973 Rehabilitation Act only extends protection to the handicapped when dealing with Federal contractors and sub-contractors, so this bill, which is expected to pass, will fill the gap into which most handicapped workers currently fall.

Once this bill is passed there will be a rush to validate all selection tools for the various types of handicapped people. The blind will fall under the protection of this bill, which indicates a need to determine the most efficient and accurate mode for presenting a test to both blind and sighted job applicants.

The question of whether or not a test validated on a sighted population is valid for use on a blind population has been considered for a number of years. In 1914 Irwin and Goddard modified the 1911 edition of the Binet scales for use by the blind. Irwin, being blind himself, used his personal judgement in eliminating items that were inappropriate for use by the blind, and added items from other sources to replace the ones that he had eliminated.

Haines (1916) reported the results of a new test, the Point Scale for the Blind, which incorporated much of Irwin's material. Haines used a point scale rather than an age scale because an age scale requires a very large population for validation purposes, and for determining at
what age level a particular item belongs. When point scales are used, similar items are grouped together in order to make the test easier to administer. The final score, the sum of the correct responses, can then be compared to age norms in order to determine where the child is in respect to other children his age. This test was used solely as a way of eliminating the "feebleminded" from the Ohio State School for the Blind. In doing so, Haines found that, in general, blind children matched sighted children very closely in mental ability.

Maxfield (1927) adapted the Stanford Achievement Test for use with blind children. The 1923 edition of the test was administered in braille versions to blind students by adapting the directions and the time limits. In 1933 Maxfield tried to present the Stanford tests orally, but found that method too demanding on both the subjects and the tester, and suggested using only a braille edition to help eliminate the effect of fatigue.

During this period Samuel Hayes started his research on testing of the blind. He began in 1923 by adapting the Stanford-Binet Scales for the blind. This adaptation is well known as the "scissors and paste" adaptation because all inappropriate items were eliminated by pasting an appropriate item over it. It was not until 1930 that an adapted version was finally printed by Hayes. Standardization problems became evident in this adaptation, until the Terman-Merrill Revision of the Binet became available in 1937.

In 1942, Hayes (1943) adapted the Terman-Merrill Revision for use with the blind, naming it the Interim Hayes-Binet Intelligence Test for
the Blind. The term "interim" was used by Hayes because he planned further revisions of the test as data were collected. Unfortunately, such adaptations never appeared. Although the content of the test is dated, psychologists who are able to compensate for its' defects are still using it.

The issue of vocational testing of the blind had been around for about twenty years before the first major step in that direction was taken. Bauman, in 1942, adapted the Minnesota Rate of Manipulation and the Pennsylvania Bi-Manual Worksamle tests. She felt that adapting existing tests was better than creating new ones because the results from the tests could then be given to potential employers in terms that they already understood, from tests with which they were familiar.

In 1943 Bauman used five different tests to compare a group of blind applicants for vocational training. The tests included: two parts of the Minnesota Rate of Manipulation test, the Pennsylvania Bi-Manual Worksamle, the O'Connor Finger Dexterity Test, and a Toolsample test. A total of 86 subjects, either totally blind or with only light perception, were used. The subjects' scores were converted to standard scores, based on norms for sighted persons, in order to provide easy comparison with sighted applicants for the program. Bauman found that the blind groups compared very favorably to the sighted persons.

In 1946 DiMichael prepared a manual for the use of the Wechsler-Bellevue Intelligence Scale, Interim Hayes-Binet Intelligence Test for the Blind, Kuhlmann-Anderson Intelligence Tests, Otis Classification Test, and the Pintner General Ability Tests as measures
of intellectual development. The manual also included the Kuder General Interest Survey as a measure of interest, and both the Minnesota Multiphasic Personality Inventory and the Neyman-Kohlstedt Diagnostic Test as measures of personality. A number of these tests were offered in braille versions with this adaptation.

This early phase of the testing of the blind peaked in 1951 with the publication, by Bauman and Hayes, of *A Manual for the Psychological Examination of the Adult Blind*. This provided detailed information on numerous tests, including the specific modifications for use with the blind, and listings of standardization information, including reliability and validity measures when available for blind populations. This manual also presented general information that was, and still is, very important for the examiner who is facing a test with a blind person for the first time. In discussing this manual in 1972 Bauman said: "Although that manual is twenty years old and cannot include the many improved tests and techniques developed during those years, it is still the only publication purporting to be a manual for the psychologist new to work with the blind, and copies of it are still requested by newcomers to the field (p. 190)."

Newland started his work on the Blind Learning Aptitude Test (BLAT) in 1952 (Newland, 1961), but it was not published until 1969. This test was developed for the use of the visually handicapped and was not adapted from a test for the sighted. The BLAT is a tactual test, similar to the adaptations of Ravens Progressive Matrices, and involves no braille reading or verbal responses. Along the same lines, Wattron
(1956) adapted the Kohs' Block Design by roughening sections of the wooden blocks. The test was totally tactual, and correlated very highly \((r=+.84)\) with the Interim Hayes-Binet test.

Starting in 1957 Gruber (1960) developed the Tactual Reconstruction Pegboard, and Jones (1960) developed the Vocational Intelligence Scale for the Adult Blind. Both tests were developed for the Office of Vocational Rehabilitation, and they provided norms for both the partially sighted as well as the totally blind.

The Haptic Intelligence Scale for the Adult Blind (HIS) was developed by Shurrager and Shurrager in 1964. This test consisted of a series of subtests, many of which were a translation of the performance scales of the Wechsler Adult Intelligence Scale (WAIS) into three dimensional form. The norms were developed to parallel the norms for the WAIS, but the authors warned against assuming that the HIS tapped the same abilities in the blind as the WAIS did in the sighted. The test never gained wide acceptance, probably due to the fact that it was normed only for persons who were totally blind, which is a very limited population, and excluded the much larger population of legally blind persons with some useful residual vision.

Rich and Anderson (1965) attempted to adapt Ravens' Coloured Progressive Matrices for the blind as a valid measure of intelligence. The 36 items in the test consisted of a raised design that was tactually perceptible, and six pieces with raised designs from which the subject was to select the one that would best complete the analogy implicit in the matrix. The subjects were administered three versions of the Raven
and the verbal scale of the Wechsler Intelligence Scale for Children (WISC). The results indicated that the blind children scored much lower on the Raven adaptations than did sighted subjects on the printed version. The correlation of the Raven adaptation with the WISC Verbal IQ was +.31, thereby showing a moderate degree of validity for the Raven adaptation as a test of intelligence. Rich and Anderson concluded with the warning that further research was needed before the Raven adaptation could be used on a clinical basis.

Gilbert and Rubin (1965) compared the performance of blind children on the Interim Hayes-Binet and the WISC. They administered both tests to 30 children between the ages of six and fourteen. The correlation between the two tests was a very high +.90. This result led the examiners to suggest using the WISC rather than the Hayes-Binet due to the time involved in administering the latter. The subjects became tired, discouraged, and restless during the administration of the Hayes-Binet, but not during the administration of the WISC. In order to test this suggestion Gilbert and Rubin retested 20 subjects (two to three years later) on the WISC. The correlation between the two administrations of the WISC was +.91, thereby confirming the usefulness of the WISC for a blind population. The authors did conclude, however, that a new intelligence test standardized on blind children would be superior to the WISC, because they felt that the WISC did not fairly measure all the skills of the blind.

Trisman (1967) adapted and translated the Sequential Tests of Educational Progress (STEP) into braille. A total of 1623 blind
subjects and 1868 sighted subjects were tested. The sighted subjects were given two separately timed parts of 35 minutes each, and the blind subjects were untimed, given the morning for part one, and the afternoon for part two. The scores were converted in order to compare the scores on the braille form to the existing norms. Trisman found that the braille and sighted versions of the test were similar in difficulty, at least under the conditions in which the test was administered. He also found that his blind sample was comparable in achievement level to the national norm sample when the blind were tested with the braille version of the test.

Tillman (1967a, 1967b) compared the performance of blind and sighted children on the WISC. A total of 110 sighted and 110 blind students from southeastern schools in the United States were used. Students who were large print readers, or large print readers who could read braille, were not employed. Results were reported by subtest on the WISC, with the blind subjects performing about the same as the sighted subjects on Arithmetic, Information and Vocabulary, but less well on Comprehension and Similarities.

Much research has been conducted on the use of intelligence tests with the blind, as is evident from the above discussion. Streitfeld and Avery (1968) compared the WAIS and HIS to determine which one better measured verbal achievement of the blind. They found that for the totally blind the tests were equally good, but for the partially blind the WAIS was better.
Avery and Streitfeld (1969) considered the time involved in administering tests to the blind. They gave 32 blind subjects the full HIS. They then rescored the test using 46% of the items on five of the six subtests. The subjects' scores obtained by the two scoring methods were correlated, resulting in an $r=+.99$. They suggested using a shortened version of the HIS in order to save time and lessen the strain on the subjects.

In 1970 Davis developed the Perkins-Binet Tests of Intelligence for Blind Children (P-B). The P-B has two forms, one for subjects with useable vision and one for subjects without any useable vision. This test was developed in an attempt to answer the criticisms that earlier tests were subjected to: lack of tests normed on blind subjects, and an over-emphasis on verbal skills.

Coveny (1972) conducted a study to determine the split-half reliability for both forms of the P-B, and to compare the P-B scores to verbal WISC scores. Coveny used 55 subjects split into two groups. The first group contained 19 males and 11 females, who were all braille readers. The second group contained 13 males and 12 females, who were all print readers. The two groups were randomly divided into two separate subgroups, and each subgroup was designated to receive either the P-B or WISC first. This split was an attempt to control for any effect of order of presentation. After administration of the P-B an odd-even split/half reliability technique was used to divide the test items. The reliability coefficients were highly positive (+.96 and +.94), and the correlation between the two forms and the WISC were also highly positive (+.86 and +.74).
Numerous other studies dealing with testing of the blind have been conducted: Tillman and Osborne (1969) gave 12 blind and sighted subjects the WISC and received varied results, with the blind performing better on the Digit Span; Eaves and Klonoff (1970) compared 40 blind and sighted children on the Tactual Performance Test and found no significant differences between the groups; Bauman (1973) developed an interest inventory for the blind that did not include activities which required vision and achieved split/half reliabilities ranging from +.84 to +.92 on the ten scales, but no validity study was attempted.

Morris (1974) adapted the 1973 edition of the Stanford Achievement Test Series for use by the visually handicapped. The norms for the test were recomputed to include only those items that were going to appear in the braille edition after all inappropriate items were eliminated. Since the tests in this series were power tests there were no time limits, and therefore no need for adjustment, but more time was allowed for completion due to the slower braille reading rates. Morris suggested administering the tests in braille or large print versions, but they could be administered orally if needed.

There are many related issues in the testing of the blind. A major debate concerns the mode of presentation to the subject. The most obvious method, which has already been referred to, is translation into braille. Auditory methods are also popular, including talking books, compressed speech, and oral presentation.

The braille system was first developed by Charles Barbier, a French Army officer, to allow his men to send and receive messages at night.
Louis Braille refined the system to meet the needs of the blind for a method of reading. The method finally gained some acceptance in 1854 when it was further modified by the French School for Blind Children. In 1869 the Missouri School for the Blind became the first American school to use the system, but it was not standardized internationally until 1932 when the United States and England accepted Grade 2 braille as the standard (Birns, 1976).

Foulke (1970) sees braille as superior to auditory methods of information processing because the reader can vary his rate at will, retrace to clarify ambiguous material, and employ format cues (i.e. indentations and page numbers) to help him find information (p. 87). Regardless of these advantages, braille is a very slow method of reading.

The silent reading speed of sighted high school students is between 250 and 500 words per minute. Sighted adult readers often average 500 to 600 words per minute, with some rates as high as 1,000 words per minute having been confirmed. Braille, however, is read at an average of 60 words per minute by junior high school students and 80 words per minute by senior high school students. Experienced adult braille readers may attain speeds of 104 words per minute, less than half the rate of sighted high school students. Subsequent to Foulkes' research, Crandell and Wallace (1974) developed a training procedure to increase braille reading rates up to 225 words per minute without a loss of comprehension.

Braille presently offers 149 whole-word signs, purportedly the most frequently used words in written English, thereby requiring braille
abbreviation (Buckley, 1977). Buckley found that whole-word signs were not allocated to many common English words, and that many whole-word signs actually occurred infrequently. He suggested that modifications be made in the whole-word aspect of braille, but changes of such magnitude are slow in coming and have yet to be realized.

Many studies have compared different procedures for presenting material to blind and sighted subjects. Holland (1936) presented the Otis Classification Test, Part II, in aural form to physically normal and blind students. The blind were given braille sheets with the question numbers and the possible answers. They were told to read the answers as the tester pronounced them, and to then record their answers. The sighted subjects were given mimeographed material with the same information as the blind subjects. Results showed that, in general, the physically normal and blind subjects performed equally well.

Holland performed item analyses on the items on which the blind performed better than the sighted. He found that, with only one exception, the sighted missed the longer and more complicated questions. He concluded that the blind have a wider auditory memory span. That conclusion seemed supported from his observation that the blind showed fewer requests to have questions repeated.

Davis and Nolan (1961) presented the Word Meaning sub-test from the Stanford Achievement Test Series in both braille and aural modes to 336 braille readers. The reported means showed that the subjects scored highest in the aural modes, although the difference was significant at only the two lowest grade levels. A more meaningful comparison for this
study would have been to compare a group of sighted subjects to a group of blind subjects, with varying methods of administration.

Nolan (1963) reported that children comprehended story-telling passages equally well in auditory and tactual modes, but textbook passages were better comprehended in braille modes. Nolan then varied the amount of practice with the material to be learned. After this manipulation it was found that there were no significant differences between the listening and reading conditions.

Nolan and Morris (1969) conducted a study to compare methods of listening. Previous research indicated that attentive postures and some sort of activity during listening aided comprehension. Results showed that comprehension of materials presented at normal listening rates were superior to comprehension of materials presented at compressed rates. Comprehension was highest for the normal listening rate—note taking mode. As the material increased in level of difficulty the effectiveness of the note taking also increased.

Tuttle (1972) conducted a study comparing the three most common modes of material presentation to the blind: braille, normal recording, and compressed speech recording. Average reading speed is 104 words per minute, and recordings at normal speeds are a little faster at 175 words per minute. Compressed speech recording is a fairly new approach to blind reading. This procedure speeds up the recording without voice or pitch distortion. This allows for a "reading" speed of 275 words per minute. This is within the average reading speed of high school seniors as discussed earlier.
Tuttle transcribed the Reading Versatility Test into three modes. Each of his 104 subjects took three equivalent forms of the test, one in each mode, with control exercised over the order of presentation.

The subjects spent 31.8 minutes on the reading task in the braille mode, 16.9 minutes in the normal recording mode, and 11.3 minutes in the compressed recording mode. The comprehension score was highest for the braille group, but not significantly so.

Tuttle then computed the Index of Learning Efficiency. This was computed by dividing the number of correct responses by the number of minutes spent reading the material. The indices were: .59 for braille, .92 for normal recording, and 1.36 for compressed speech. These results indicated that compressed speech was the most efficient mode.

Results such as Tuttles' should not be viewed as a blanket condemnation of braille. Braille is still the most precise mode for communicating verbal information to the blind and should still be employed, especially for complex and technical materials.

Numerous researchers have observed the effects of aural presentation on blind subjects: Bauman (1958) observed that subjects that had been blinded for a long time had learned to obtain information from subtle outside auditory cues, often not evident to the recently blinded; Nolan and Davis (1967) noted that aural testing should diminish that part of variance attributable to differences in reading ability; Bauman (1972) commented that a blind subjects' remaining senses can be improved by practice; and Carney (1972) observed that it was possible for the blind to tell when someone was smiling, nervous, tense, or unsure by his tone of voice.
A major conceptual problem in the testing of the blind has been raised by numerous researchers, including Gilbert and Rubin (1965):

Some psychologists have held that all those tests in which the results might be influenced in any way by the physical handicap should be avoided since the disadvantage offered to the subject makes an accurate appraisal of his abilities impossible. Others have contended that since one of the purposes of the tests is to evaluate the handicapped person's ability to compete with others not so afflicted, the handicap cannot be ignored, and the afflicted must be evaluated on the same basis as the non-afflicted (p. 238).

As of January 1, 1973, there were only 24,195 legally blind students enrolled in other than college programs throughout the United States (Morris, 1974). This dearth of available subjects has greatly hampered attempts to validate tests on a blind population.

Bateman (1965) and Swallow (1979) expressed similar concerns with the effect of modifying existing tests for the blind. Once the tests have been modified, in any way, the test is invalidated. One approach to this problem would be to readapt the test norms using a test adaptation procedure outlined by Nolan and Davis (1967).

In general, the question of norms should be dictated by the problem being considered. Bauman (1972) felt that norms for the sighted could still be used since, in most cases, the blind were being compared to the sighted. This is especially true in cases of vocational testing where the blind job applicant is competing against his sighted counterpart.

Malikin and Freedman (1970) stated the issue of norms succinctly: "In most cases, we can only say that we have compared how a visually impaired person performs on a test as compared with a sighted person whom he resembles in other aspects, not how he performs against himself,"
or against a population of other visually impaired persons (p. 147)."

In most cases, that comparison is the vital one in vocational testing. In situations such as this, the use of tests normed on a sighted population would be acceptable.

Even if the issue of norms is solved by accepting the arguments of Bauman (1972) and Malikin and Freedman (1970), then one issue remains a glaring problem for the blind job applicant: most organizations do not encounter many blind job applicants, and therefore do not have braille versions of the tests employed for selection on hand. In most cases, an employee of the organization will read the print version of the test to the blind applicant. Even if the fact that the reader is not trained for the task is ignored, the issue still remains concerning the mode of presentation.

Numerous studies have been conducted comparing an adapted version of a test (usually into braille) to the printed version of the test (Rich and Anderson, 1965; Trisman, 1967; Tillman, 1967a; Tillman, 1967b; Tillman and Osborne, 1969; Morris, 1974, for example). As yet, however, no research has compared the performance of blind applicants and sighted applicants on the same test, but in differing modes of presentation as in the case of the blind applicant having a print version of a test read to them. The present study is being conducted in order to attempt to answer that question. Specific hypotheses include:

I. Blind subjects will not score as well as sighted subjects when the blind subjects take the test aurally and the sighted subjects take the test in print.
II. Blind subjects will score better on braille versions of the test than on aurally presented versions.

III. Blind subjects will not show a significant difference from sighted subjects when both groups take the test in their respective print modes.
METHOD

Subjects

Two groups of ten subjects each were used in this study. The first group consisted of five male and five female blind, high school students from the Florida School for the Deaf and Blind in St. Augustine, Florida. The second group of subjects consisted of five male and five female sighted, high school students from various schools in the Orlando, Florida metropolitan area.

Apparatus

Parallel forms (A and B) of the Verbal and Numerical Personnel Tests for Industry (PTI) were used. Alternate form reliability for both the PTI Verbal Test and PTI Numerical Test varied from $r = +.73$ to $r = +.92$. Both the Verbal and Numerical Tests of form A were transcribed into braille. The Verbal and Numerical Tests of Form B were both recorded onto audio cassettes.

Sighted subjects were provided with paper and pencil during all testing conditions and a cassette tape player for the aural testing conditions. Blind subjects were provided with braille writers and braille paper during all testing conditions, and a cassette tape player for the aural testing condition. During administrations of the braille and aural Numerical Tests to the blind groups, subjects were provided with an abacus as a substitute for scrap paper. Subject Consent Forms, and Personal Information Sheets were completed by all subjects in both groups (Appendices A and B).
**Procedure**

This study required the administration of two tests, one verbal and one numerical, in a print mode, and then re-administration of both tests in an aural mode. In actuality it is impossible to administer the same test twice due to practice effects. To solve this problem parallel versions of both tests were used. PTI Form A, Verbal and Numerical, was designated as the form for the print mode of testing (braille for the blind subjects). PTI Form B, Verbal and Numerical, was designated as the form for the aural mode of testing.

Although the PTI did not provide norms for blind subjects the use of a test normed on a sighted population was in line with Malikin and Freedman (1970) and Bauman (1972). They agreed that such an approach was appropriate in vocational testing situations because the blind applicant would be compared to sighted counterparts when applying for jobs.

In order to procedurally conduct the study, one of the two parallel forms of the PTI needed to be transcribed into braille. Form A of the PTI, designated as the print test, was transcribed into braille at the Rehabilitation Center for the Blind in Daytona Beach, Florida.

The Form A Verbal Test was easily transcribed without any change in the content of the test. The Form A Numerical Test, however, presented a unique problem.

Forms A and B of the PTI Numerical Test consisted of mathematical questions, some of which were accompanied by, or based on, diagrams, charts or tables. Under ideal conditions the diagrams would be
transcribed into braille, thereby keeping the content of the test intact. The Rehabilitation Center, however, did not have the capability to transcribe diagrams. It was therefore decided to re-write all of the diagrammatical questions, in both the Form A and Form B Numerical Tests, into a verbal form, eliminating the need for the accompanying diagrams. In re-writing the test items it was decided to retain the interpretive nature of the items by describing the diagram, and not directly providing the information from the diagram. The re-written questions were also inserted in the print version of the test which was to be presented to the sighted subjects.

As noted earlier, the number of legally blind persons enrolled in programs, other than college, is extremely limited (Marcus, 1974). Due to the limited availability of blind persons in the population it was determined that the blind subjects should be secured and tested before the sighted subjects were selected. It would then be possible to create a matched sample of sighted subjects to form the sighted experimental group.

Queries to the Rehabilitation Center quickly revealed the difficulty to be encountered in securing a group of blind adults who were proficient braille readers. The need to control as many extraneous variables as possible (i.e. age, education, occupation) made the task more difficult. It was, therefore, decided to obtain a homogeneous group of blind subjects from the student population at the School for the Deaf and Blind (SDB) in St. Augustine, Florida.
The SDB is a residential school that prepares deaf and blind students to deal with their handicaps in the outside world. This is accomplished in conjunction with a regular school curriculum that progresses to the twelfth grade level.

The Principal for the Blind at the SDB was contacted for help in securing the group of blind subjects. Due to the lengthy administration time necessary for the tests (four hours), it was decided to offer ten dollars ($10) to the first ten student volunteers. Critical data for the subjects (age, race, sex, etc.) is summarized in Table I.

The sighted subjects were recruited from a group of summer intern students working at the University of Central Florida. This group was supplemented by individually obtained subjects, resulting in a group closely matched to the group of blind subjects (Table I). Sighted subjects also received ten dollars ($10) for their participation in the study.

At the time of testing the students were randomly assigned to one of the order conditions which would receive either the print or the aural tests first. This controlled for order effects by averaging them over all subjects. While still in a group, the purpose of the study was explained to the subjects and Personal Information Sheets and Subject Consent Forms were completed. Subjects were then divided into the two order groups.

Group A was given the aural version of the tests first. Each subject was assigned to a separate room with a cassette tape player which they controlled. The tape was set to play a recorded version of
Table I

Subject Factor Comparisons

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<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<td>8</td>
<td>9</td>
<td>10</td>
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<tr>
<td>Age</td>
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<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>16</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>Race</td>
<td>B</td>
<td>W</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>W</td>
</tr>
<tr>
<td>Sex</td>
<td>M</td>
<td>F</td>
<td>F</td>
<td>M</td>
<td>M</td>
<td>F</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
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<tr>
<td>Educational Level</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic Status</td>
<td>L</td>
<td>MI</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>MI</td>
</tr>
</tbody>
</table>

Key:  B = Black  
      W = White  
      M = Male  
      F = Female  
      L = Low Socioeconomic Status  
      MI = Middle Socioeconomic Status
the PTI Verbal Test B first. They were instructed as to the use of the machine, but told not to rewind the tape. If there were any problems they were to turn the tape off and call the experimenter. Group A finished the Verbal Test in approximately twenty minutes. The cassettes were then reversed and the subjects were given the same instructions and started to work on the PTI Numerical Test B. Subjects finished the Numerical Test in approximately forty-five minutes. After a short break the subjects in Group A were given the print/braille versions of the tests as detailed below.

Group B was given the appropriate print or braille versions of the tests first. The print/braille test administrations were accomplished in groups for ease of administration. The PTI Verbal Test A was completed by the subjects first, followed by the PTI Numerical Test A. Total testing time in this experimental condition averaged two hours. After a short break, the subjects in Group B were given the aural versions of the tests as detailed above.

The subjects were paid as they left the room. Their individual results were mailed to them at the addresses they provided on the Personal Information Sheets.
RESULTS

The mean age of the blind students was 16.7 years, and the mean educational level was 10.6 years. The mean age of the sighted subjects was 16.9 years, and the mean educational level was 11.4 years.

The group means and standard deviations for both the Verbal and Numerical Test scores are summarized in Tables II and III, respectively.

All subject data was analyzed by a 2x2x2 Analysis of Variance (ANOVA) with repeated measures on the third factor, mode of presentation. The analysis was conducted separately for both the Verbal and Numerical Test results.

Table IV presents the results of the ANOVA for the Verbal Tests. None of the main effects were found to be significant: $F(1,16) = .1244, p > .05$ for the effect of vision; $F(1,16) = .4154, p > .05$ for the effect of sex; $F(1,16) = 2.3895, p > .05$ for the effect of mode of presentation. In addition, none of the factor interactions were found to be significant.

Table V presents the results of the ANOVA for the Numerical Tests. The main effects of vision and mode of presentation were not found to be significant with $F(1,16) = 2.4553, p > .05$ and $F(1,16) = .1071, p > .05$, respectively. The main effect of sex, however, was found to be significant with $F(1,16) = 10.31, p < .01$. None of the factor interactions were found to be significant.
### Table II

**Means and Standard Deviations of Subject's Verbal Test Scores**

<table>
<thead>
<tr>
<th></th>
<th>Blind</th>
<th>Sighted</th>
<th>$\bar{x}$</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Print</strong></td>
<td>25.10</td>
<td>20.80</td>
<td>$\bar{x}$</td>
<td>22.95</td>
</tr>
<tr>
<td></td>
<td>9.25</td>
<td>6.97</td>
<td>S.D.</td>
<td></td>
</tr>
<tr>
<td><strong>Aural</strong></td>
<td>27.20</td>
<td>22.80</td>
<td>$\bar{x}$</td>
<td>25.00</td>
</tr>
<tr>
<td></td>
<td>9.64</td>
<td>3.22</td>
<td>S.D.</td>
<td></td>
</tr>
</tbody>
</table>

$\bar{x}$ 26.15  21.80
### Table III

**Means and Standard Deviations of Subject's Numerical Test Scores**

<table>
<thead>
<tr>
<th></th>
<th>Blind</th>
<th>Sighted</th>
<th>(\bar{x})</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Print</strong></td>
<td>6.90</td>
<td>10.60</td>
<td>S.D. 8.75</td>
</tr>
<tr>
<td></td>
<td>7.36</td>
<td>2.84</td>
<td></td>
</tr>
<tr>
<td><strong>Aural</strong></td>
<td>7.30</td>
<td>9.70</td>
<td>S.D. 8.50</td>
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<tr>
<td></td>
<td>7.05</td>
<td>3.69</td>
<td></td>
</tr>
</tbody>
</table>

\(\bar{x}\) 7.10 10.15
Table IV

Analysis of Variance with Repeated Measures on Mode of Presentation - Verbal Test

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2602.975</td>
<td>39</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Between Subject</td>
<td>2216.475</td>
<td>19</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Vision</td>
<td>189.225</td>
<td>1</td>
<td>189.225</td>
<td>.1244</td>
</tr>
<tr>
<td>Sex</td>
<td>632.025</td>
<td>1</td>
<td>632.025</td>
<td>.4154</td>
</tr>
<tr>
<td>Vision x Sex</td>
<td>46.225</td>
<td>1</td>
<td>46.225</td>
<td>.0304</td>
</tr>
<tr>
<td>Error</td>
<td>24341.025</td>
<td>16</td>
<td>1521.314</td>
<td>-</td>
</tr>
<tr>
<td>Within Subject</td>
<td>386.500</td>
<td>20</td>
<td>19.325</td>
<td>-</td>
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<tr>
<td>Mode</td>
<td>42.025</td>
<td>1</td>
<td>42.025</td>
<td>2.3895</td>
</tr>
<tr>
<td>Mode x Vision</td>
<td>.025</td>
<td>1</td>
<td>.025</td>
<td>.0014</td>
</tr>
<tr>
<td>Mode x Sex</td>
<td>3.025</td>
<td>1</td>
<td>3.025</td>
<td>.1720</td>
</tr>
<tr>
<td>Mode x Vision x Sex</td>
<td>60.025</td>
<td>1</td>
<td>60.025</td>
<td>3.4129</td>
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<tr>
<td>Error</td>
<td>281.400</td>
<td>16</td>
<td>17.587</td>
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### Table V

Analysis of Variance with Repeated Measures on Mode of Presentation - Numerical Test

<table>
<thead>
<tr>
<th>Source</th>
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<th>F</th>
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<td>-</td>
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<tr>
<td>Between Subject</td>
<td>1245.875</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Vision</td>
<td>93.025</td>
<td>1</td>
<td>93.025</td>
<td>2.4553</td>
</tr>
<tr>
<td>Sex</td>
<td>309.625</td>
<td>1</td>
<td>390.625</td>
<td>10.31*</td>
</tr>
<tr>
<td>Vision x Sex</td>
<td>156.025</td>
<td>1</td>
<td>156.025</td>
<td>4.118</td>
</tr>
<tr>
<td>Error</td>
<td>606.200</td>
<td>16</td>
<td>37.887</td>
<td>-</td>
</tr>
<tr>
<td>Within Subject</td>
<td>105.500</td>
<td>20</td>
<td>5.275</td>
<td>-</td>
</tr>
<tr>
<td>Mode</td>
<td>.625</td>
<td>1</td>
<td>.625</td>
<td>.1071</td>
</tr>
<tr>
<td>Mode x Vision</td>
<td>4.225</td>
<td>1</td>
<td>4.225</td>
<td>.7238</td>
</tr>
<tr>
<td>Mode x Sex</td>
<td>3.025</td>
<td>1</td>
<td>3.025</td>
<td>.5182</td>
</tr>
<tr>
<td>Mode x Vision x Sex</td>
<td>4.225</td>
<td>1</td>
<td>4.225</td>
<td>.7238</td>
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<tr>
<td>Error</td>
<td>93.400</td>
<td>16</td>
<td>5.837</td>
<td>-</td>
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</tbody>
</table>

*p < .01
In order to further analyze the data a Pearson Product-Moment Correlation was computed between each subject's print and aural test scores for both their Verbal and Numerical Test results. The correlation between the blind subjects print and aural scores on the Verbal Test was $r = +.904$. The correlation between the blind subjects print and aural scores on the Numerical Test was $r = +.906$. Conversely, the correlation between the sighted subjects print and aural scores on the Verbal Test was $r = +.007$, and the correlation between the sighted subjects print and aural scores on the Numerical Test was $r = +.524$. 
DISCUSSION

The results of this study did not support any of the three hypotheses. The first problem encountered with the study came during the test selection phase. Extreme difficulty was encountered in identifying a test (other than intelligence and achievement tests) that had been validated on a blind population.

When dealing with general ability tests or tests that have a wide usage, such as intelligence tests, it would be feasible to consider separate norms for the blind. In an applied setting, however, this would be virtually impossible. Organizations that utilize selection tests may never encounter a blind job applicant, therefore, obtaining norms for the blind would not be cost effective. Further, should an organization decide to go to the time and expense of obtaining norms for the blind, most would be unable to validate the test due to the limited number of blind employees within their organization.

The thrust of this study was to consider the blind job applicant, and it was therefore desirable to utilize a selection instrument that might be encountered in the "real world." The Personnel Tests for Industry were selected for that reason.

As noted earlier, test items containing diagrams were re-written to eliminate the diagrams and permit transcription into braille. Test items containing diagrams typically test two factors: the testee's ability to answer the question based on their knowledge of the subject
matter; and the testee's ability to interpret the diagram, by extracting and utilizing the needed information. Eliminating the diagram also eliminates the information concerning the testee's ability to interpret diagrams.

Re-writing the test items resulted in items that were very lengthy. In attempting to retain the interpretative nature of the items, they were re-written so as to describe the diagram. The re-written items were therefore complex and time consuming, and possibly more difficult than they were in their original form.

The preferred alternative to re-writing the test items would, of course, be to have the diagrams transcribed into braille along with the rest of the question. If this proved to be impossible, as in the case of the present study, an alternate approach would be to eliminate all of the diagrammatic items from the test. Scores would then be adjusted to compensate for the reduced number of items. Future studies, if unable to transcribe diagrams into braille, should take one of these alternate approaches rather than altering the test items and possibly invalidating the test (Bateman, 1965 and Swallow, 1979).

The data analysis tends to support the theory that re-writing the test items may have affected the validity of the test. The Verbal Test, unlike the Numerical Test, was virtually unaltered in the transcription to braille. The scores on the Verbal Test resulted in an $F = 2.3895$ for mode of presentation. Although this $F$ ratio is not significant, the mean differences were in the expected direction. Altering the Numerical Test may have weakened the discriminative power of the test.
An alternative interpretation to the above might dismiss the result as due to verbal skills being more sensitive to differences in mode of presentation. Logically, however, one would assume that the quantitative skills required for the Numerical Test would be more sensitive to such differences.

The only significant result in this study was unexpected and unpredicted, namely, the significant main effect of sex in the Numerical Test. Appendix C summarizes the test scores by sex of the subjects and mode of presentation. Males, both blind and sighted, performed significantly better on the Numerical Test than their female counterparts. Although the F ratio for the interaction of Vision x Sex was not significant ($F = 4.118$), the effect was strong between blind males and blind females. The pattern, although not as strong, is the same for the sighted males and sighted females. This result may ultimately be found to be significant once problems are worked out in future studies.

In addition to the analysis of variance, correlational procedures were utilized to examine the relationship between each subject's print and aural scores for both the Verbal Test and the Numerical Test. As noted earlier, the blind subjects' test scores were highly correlated when computed among the same trait, but different mode of presentation ($r = +.904$ for the Verbal Test and $r = +.906$ for the Numerical Test). The test scores for the sighted subjects, however, produced much lower correlations ($r = +.007$ for the Verbal Test and $r = +.524$ for the Numerical Test). The restriction of range as evidenced by the low standard deviations (Table II and Table III) may help to explain the
disparity between the correlations for the scores of the blind subjects and the correlations for the scores of the sighted subjects.

If we are able to assume that the test scores of blind subjects are not significantly different than the test scores of sighted subjects, the correlations reported above for the blind subjects take on a new light. The high correlations between the blind subjects' test scores in both test modes may provide the needed predictability for selection decisions, once again, assuming there are no significant mean differences.

In summary, although the results of the present study did not support the stated hypotheses, there may still be a positive result. This study did not find a significant difference between the test scores of blind and sighted subjects, regardless of the mode of presentation. This fact, coupled with the correlations reported for the blind subjects, implies that a blind subject's score on a print test may be predicted by their score on an aural version of the same test.

It would not be advisable, however, for an organization to base their defense of their testing program on this study because of the many procedural problems encountered. The problems with test selection have already been discussed, but additional problems were encountered while obtaining the subjects.

The most striking feature of Table I concerns the race of the subjects. Of all blind subjects tested, 80% were black. This observation raised some questions concerning the sample as a true representation of the SDB population. The SBD was contacted requesting
information concerning the racial makeup of the student population. The overall student population at the SDB was reported as approximately 50% white and 50% black. The sample secured for this study was, therefore, not representative of the SDB population, much less the blind population in general. This, of course, severely limits the external validity of the study.

A possible explanation for the over representation of black students in the blind sample could be related to socio-economic status. All of the black students were from the low end of the socio-economic scale. The offer of ten dollars ($10) for four hours work may have been more tempting to them than to the students at or near the middle or high end of the socio-economic scale. Therefore, the offer of ten dollars ($10) for participation, which was utilized to secure subjects, may have been the variable that biased the sample.

The overrepresentation of black subjects carried over to the sighted sample because the sighted sample was matched to the blind sample. As a result, the sighted sample was secured by preselection based on factors of race and socio-economic status.

In order for a study of this nature to be helpful, and applicable to employment situations, it is critical that the subject samples be truly representative of the population. To this end, future research must take a broader view than was possible in this limited study. It is essential that the entire student population of a specific grade level at a school such as the SDB be tested. This procedure would average out all subject variables (age, race, sex, etc.). Once this step was
completed it would be possible to test the same grade level in a public school system to obtain a matched sample. A procedure such as this would provide a larger and more representative sample on which to base comparisons. This would also increase the external validity of the study.

If it were not possible to test an entire grade level in the school systems additional controls would have to be placed upon the subject variables. When dealing with small sample sizes and a subject matching design it is important to control as many variables as possible. Future studies should therefore include a control for intellectual ability which could be obtained either from historical subject information or from a pre-test. This information would provide controls for the individual differences in intellectual ability that are not possible to obtain by the matching of other subject variables.

It is entirely possible that future research which corrects the problems encountered with the Numerical Test and the sample selection will find significant results. It is also possible that future research will duplicate the results of this study. In either case, the possible effects of mode of test presentation to blind subjects will be one step closer to being settled.
Appendix A
Subject Consent Form

I __________________________ give my permission to Gary Meiseles to use the test scores I will generate on the Personnel Tests for Industry, Verbal and Numerical parts, sections A and B, for his research.

It is understood that my scores will be provided to me, but will not be revealed to any outside party.

It is further understood that my scores may be reported in any research, provided that I am not identified in any manner.
Personal Information Sheet

NAME: 
AGE: 
SEX: 
ADDRESS TO WHICH YOU WISH YOUR RESULTS SENT: 

AGE AT ONSET OF BLINDNESS: 
NUMBER OF YEARS LEGALLY BLIND: 
CAUSE OF BLINDNESS (IF KNOWN): 

NUMBER OF YEARS READING BRAILLE: 
LENGTH OF TIME STUDYING BRAILLE IF DIFFERENT FROM ABOVE: 

HAVE YOU EVER APPLIED FOR AND TESTED FOR A JOB WITH THE STATE OF FLORIDA? 
IF SO, WHEN? 
WHAT POSITION? 
HOW WAS THE TEST ADMINISTERED? 

OTHER COMMENTS: 

DO NOT WRITE BELOW THIS LINE 

NUMERICAL SCORE A: ___________  NUMERICAL SCORE B: ___________ 
VERBAL SCORE A: ___________  VERBAL SCORE B: ___________ 
PREFERRED MODE OF TESTING:
Appendix C
Table VI

Verbal Test Score Means by Sex of Subject and Mode of Presentation

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print</td>
<td>27.2</td>
<td>18.7</td>
</tr>
<tr>
<td>Aural</td>
<td>28.7</td>
<td>21.3</td>
</tr>
</tbody>
</table>

Table VII

Numerical Test Score Means by Sex of Subject and Mode of Presentation

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print</td>
<td>11.6</td>
<td>5.9</td>
</tr>
<tr>
<td>Aural</td>
<td>11.9</td>
<td>5.1</td>
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</table>
REFERENCES


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