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Least Biased Psychological Assessment of Non-Verbal Severle Physically Handicapped Persons

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LEAST BIASED PSYCHOLOGICAL ASSESSMENT OF NON-VERBAL SEVERELY PHYSICALLY HANDICAPPED PERSONS

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THE PROBLEM

The general social problem which this study addresses is the inaccessibility of accurate psychological assessment to some expressively communicatively handicapped members of our society.

Significance

The basic significance of the problem is that, if it is ameliorated, communicatively handicapped persons will have more accurate assessment available and can then experience equally with other members of society such benefits as: 1. More completely informed placement in developmental or remedial programs. 2. Better informed bases for individual goals and objectives as guidelines in individual program design.(1)

The growing emphasis of governmental funding sources on requiring delivery of individualized human services in response to carefully assessed and reassessed need underscores the significance of the problem. A human rights movement in good momentum in the United States during the 1970's is promoting public awareness of the rights of handicapped persons to access to responsive and accountable developmental and remedial services. (2) As such services proliferate, elaborate

monitoring procedures are evolving. For each individual seeking developmental or remedial service from a given agency which receives federal funds, data-base information collection usually begins with comprehensive historical and diagnostic findings and is continued through each step of placement, program design, program implementation, and periodic review and evaluation.

For entry into many such service programs the diagnostic procedures involved include a fairly detailed assessment of skills which are described variously as intelligence, adaptive behavior, mental, cognitive, or psychological skills. Currently, many traditional assessment measures of these attributes are being challenged as being unfairly discriminatory or biased when used to assess some populations.(3) The most evident dispute arises when representational test constituents used to present a task in a given test have not been part of the prior cultural experience of the person asked to perform the task. Culture-fairness, spoken-to by some test originators before mid-century, is under renewed professional scrutiny. Some proponents of the use of existing measures contend that unfairness arises with misuse of a test or misintrepretation of results rather than arising from factors inherent in the test items. (4)

Another form of unfair discrimination or bias has been observed by those few practitioners who have been charged with the task of assessing the cognitive skills of persons who may have an experiential and cognitive base

from which to respond to the concepts in test items, but who do not possess the capabilities to use the communicative response mode in which the item is designed. For some non-verbal individuals a repertoire of tests is available which rely on pointing to indicate answer choices. (5) Yet there are still remaining non-vocal persons who are also so motorically involved that they cannot voluntarily produce sufficiently fine gestures to indicate choices on these existing non-verbal tests. Attempts are characteristically made by examiners to overcome the aforementioned impediments. Some of the attempts include: 1. Pro-rating, scoring tests using only the items in which communication was not a prohibitive factor. 2. Guessing at the intention of the testee. In experienced hands this may be better than no assessment, but it leaves many opportunities for misinterpretation and unconscious cue-giving. 3. Time-consuming binary yes, no, selection process. All of these methods reduce the amount of control over the situation by the person attempting to take the test, and so constitutes a source of lessened autonomy.

Motivation for investigation

The motivation for this investigation stems from the writer having experienced the problem first hand, both in its wide implication of an observed social inequality, and in its narrow interpretation as the mutual frustration which results when test responses in psychological testing situations are

unclear or are examiner-dependent because of the communicative limitations of the examinee.

In the electronics market a device has emerged which would appear to lend itself to at least partially overcoming the above-cited barriers. It is a system whereby a motorically limited person may indicate messages by controlling a signal which scans message spaces. The signal is activated by any of a number of supersensitive mechanisms which are matched to the neuromuscular capabilities of the user. It is now theoretically possible to adapt items from a conventional standardized psychological test for administration via presentation and response on such an electronic device.

The Columbia Mental Maturity Scale presents itself as uniquely adaptable to presentation on the Zygo communication board in both purpose and physical dimensions.

Its ninety-two pictorial and figural classification items are arranged in three, four and five stimulus arrays from which the one which does not belong should be indicated by other-than-verbal response. The reasoning abilities which it purports to estimate include both simple perceptual discrimination and higher level abstract manipulation of symbolic concepts.

For the 1973 edition, a system of interlevel standard scores was developed to bring comparability of scores from level to level.

"Data for the common items are used to compute an estimate of the mean and variance of each full length test

had it been taken by both groups. These estimates are subsequently used to develop a linear equation relating raw scores on one full length test to raw scores on the other." (6)

Final norms were derived from the above interlevel scores essentially by converting smoothed cumulated percentages to normal deviates which, using $16_z + 100$, were transformed to Age Deviation Scores.

Supplied with a test instrument with an accepted theoretical base and a respectable standardization background, which also possesses obvious adaptability of its stimulus arrays to the communication board presentation, the writer felt sufficiently motivated to pursue the investigation.

Problem restated as hypothesis

The specific hypothesis to be confirmed by quantitative study is that: A test comprised of items modified from an existing standardized psychological test (the Columbia Mental Maturity Scale) for administration via an electronic scanning mechanism (the Zygo electronic communication board) constitutes a reliable as well as valid test.

The statistical design of this study will be to obtain a correlation coefficient and a comparison of means by subjecting the scores obtained from administering the adapted test and the standard version of the test to a Pearson product moment and a paired "t" analysis. The null hypothesis and the specific procedures are dealt with in Chapter 4.

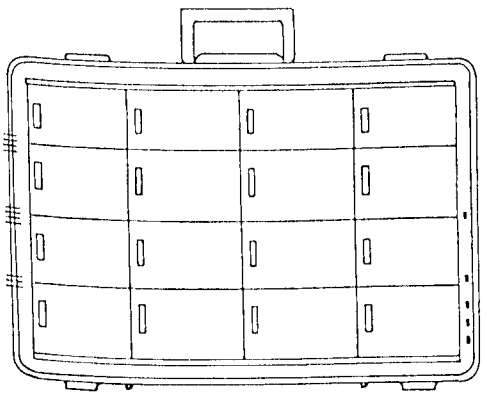
Assumptions, limitations. The assumption is made that such an adaptation will not change the established validity of the test. Theoretical limitations to the usefullness of this study will be imposed by the relatively small sample of population used to estimate the reliability of the adapted test. Statistical assumptions and limitations will be those of the chosen correlation and means comparison procedures.

Definition of terms. Two terms in the hypothesis could be open to interpretation. The first such term is psychological test. The authors of the 1973 Third Edition of the Columbia Mental Maturity Scale are more modest in their statement of what their test purports to measure in contrast with the comprehensive theorizing behind the Binet and Wechsler statements on the nature of intelligence which their tests presume to sample. The Columbia authors refute the idea that their test - or any test - can be used to estimate innate capacity or general intelligence. (6) They do not want a concept of constancy or fixity of ability level to be construed from the results of their test. They do purport to be measuring general reasoning ability, the ability to formulate a rule or principle associating various pictures or geometric forms, or, put another way, the ability to discern relationships among various types of visual symbols.

This ability is one of the three broad categories of abilities evidencing intelligence as put forth by Wechsler. However, Wechsler denies that it, or any other component can

be dealt with in isolation because of "couplings" and "resonances" which he perceives as occurring among components which account for variance in performance. (7) He felt that the word intelligence was a limiting construct much in the same way as is electricity and that we, analogously, know intelligence by what it enables us to do. Binet postulated a similar combined functional activity of thought processes involved in mental adaptation, characterizing intelligence in action as employing direction, adaptation and self-criticism. (8) The author of the non-verbal Leiter International Test of Intelligence, characteristically, does not concern himself with the nature of the intelligence to which he refers only obliquely in the manual which accompanies his test. (9) However, as correlations between the Columbia and Scores on these three tests tend to run high even across exceptionality areas (6), it is logical to assume that they all are testing some related attributes.

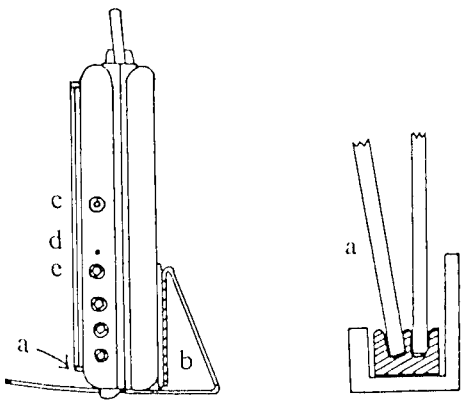
The second term needing discussion is the Zygo Communication Board. Production, use, evaluation and refinement of electronic communication systems constitute a growing field for technologists from several disciplines. Teams composed of one or more electronic experts, physical or occupational therapists, and language clinicians are pooling respective expertise to best advantage. The particular electronic communication board under study (Figure 1) consists of a black textured plastic background containing sixteen (4 X 4) horizontal and vertical message display areas, each 3" X 4",



Portable. Weighs less than 10 lbs.

Large 13" x 17" display area with 16 brilliant signal lights.

Audible alarm on each light in first column.



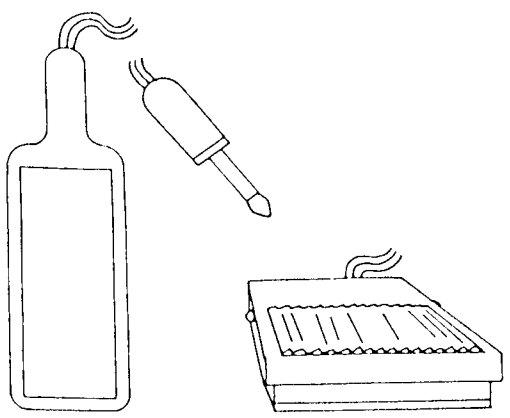
a Transparent display panel is removable, accepts grease pencil. Overlays quickly slide into place.

b Convenient folding stand.

c Alarm reset button.

d Battery indicator light flashes when recharge is needed.

e Battery charger for 8.6 AH sealed batteries. Continuous operating time: 30 hours.



Wide variety of control mechanisms.

Operating Instructions

AUTOMATIC MODE: Plug the control mechanism into the jack marked AUTOMATIC, on the side of the unit. Once the control mechanism is actuated, one light will come on and the sequence will begin. After a few seconds the light will go out and the next light will illuminate—and this continues, moving left to right, top to bottom.

The rate of change is adjustable from 3 to 10 second intervals by internal switching. When the light is in the appropriate message area, the client again activates the control mechanism. This breaks the sequence and that particular light remains on.

When the control mechanism is again activated, the sequence will continue. The Communication Board automatically switches into a battery-saving stand-by mode when the sequence has been broken for about 2 minutes.

FOR MANUAL 1 MODE: Plug the control mechanism into the MANUAL 1 jack on the side of the unit. Once the control mechanism is activated, the Communications Board turns on and a signal light will illuminate. Each time the control mechanism is activated, the light will go out and the light in the next message area will go on—sequencing from left to right, top to bottom. If a change is not made for about 2 minutes, the light will go out and the unit switches to stand-by.

FOR MANUAL 2 MODE: Plug one control mechanism into the Manual 1 jack, and another into the Manual 2 jack. The Communications Board is turned on when either mechanism is actuated. By using the MANUAL 1 mechanism, the client can select the appropriate message area in a row. To change rows, the MANUAL 2 mechanism is used. This allows for faster communication, as the client can sequence the lights horizontally to a given point, and then vertically to the appropriate message area.

Training and Limited Requirements

To make it easier for a client to learn to use the Communication Board or to accommodate clients with limited communication requirements, the ZYGO Communication Board can be adjusted to reduce the number of message areas in use. It can be programmed to establish how many lights will be used in the rows as well as how many rows may be activated.

This allows the client to begin on a very limited scale, with only two message areas. As ability increases, the number of message areas also can be increased.

This expandable programming may be utilized in all three operational modes: Automatic, Manual 1 or Manual 2.

Model 16 $295.00

Clinician Model $345.00 Display Area Programming and Auto Scan Rate controls mounted on side of unit.

ZYGO Industries, Inc. warrants its products for a period of one year.

which contain scanning signal lights which the user stops by means of unique controls, in the area which contains his desired message.

The term non-vocal severely physically handicapped persons may hereafter be referred to as NVSPH in accordance with practice initiated by Trace Center personnel. (7)

Chapter 2

AN OVERVIEW OF THE LITERATURE

Endorsing PL 94-142 and pursuant to a grant from the Bureau of Education for the Handicapped, United States Office of Education, Department of Health, Education, and Welfare, the Council for Exceptional Children has published a policy statement regarding non-discriminatory psychological and educational evaluation (2)(10).

The first of eleven Non-Discriminatory Provisions for the purpose of developing an individualized education program for each child by the local, intermediate, or state education agency reads:

> Assessment instruments shall be appropriately adapted when used with children of impaired sensory, physical, or speaking skills and must consider each child's age and socio-economic and cultural background. (Italics mine)

The literature concerning adaptation of assessment instruments when used with children who have sensory adequacy in at least one modality and, who also possess speaking skills has a respectable amount of material wich can be consulted and utilized. Psychometricians working with the deaf and the blind, although they do not possess all the options of those who test hearing and seeing children, nevertheless have diagnostic instruments at their disposal

which can afford them elective strategies such as administering pre-determined batteries, or of permitting the results of their findings on initial screening tests to suggest the nature of subsequent behavior samplings. Fewer adaptations are available for assessing persons who do not possess, or do not, or cannot utilize speaking skills.(5) The search narrows to nearly no print material describing adaptations of standardized testing materials for persons handicapped by both non-functional speech and physical limitations to gesturing and fine pointing.

Remarks from two authorities typify the frustration with which professional persons are contending when they attempt to work with severely communicatively handicapped children.

When writing of cerebral palsied children, Loring (11) states:

> It is primarily among children with sensory and speech disorders that we find the so-called non-testable children, estimated to comprise 10-15% of the patients. These children cannot be tested with standard intelligence tests because of their severely limited capacities of response.

In an unpublished Master's Thesis by Deborah Harris-Vanderheiden titled AN INITIAL STUDY OF THE LANGUAGE DEVELOPMENT AND VOCABULARY USAGE OF NON-VOCAL HANDICAPPED CHILDREN (12) she writes:

> Throughout this study one of the most frustrating challenges was to find an assessment procedure which adequately measured these subjects' educational and language skills. There just aren't any measures currently available and immediate attention needs to be

> given to this area. Educators can develop effective educational programs only if they are able to effectively assess the child's current level of performance and ability.

Mrs. Harris-Vanderheiden, among her Recommendations for Further Study, lists:

"Exploration and development of non-verbal testing methods which are specifically applicable to the non-vocal impaired child."

Close to one hundred technical communication aids have been identified and cataloged as part of the vigorous work being done at the Trace Center for the Severely Communicatively Handicapped at the University of Wisconsin-Madison (13). Since several of these implements are one-of-a-kind prototypes which have been developed for unique needs and since several of them are so expensive as to be prohibitive for being included in a circulating collection there is yet no central library or center where these aids may be comparatively inspected or loaned for use or inspection, though such a project is under serious discussion and may become a reality soon according to Center personnel.

In the literature which the development and use of the above aids has generated, there is generous reference to the establishment of augmentative and prosthetic communication systems of all degrees of sophistication and a wide selection of material dealing with choices of symbol systems and syntactical speech equivalencies, but next to no references concerning facilitation of a formal psychological assessment process via any of the communication aids.

The literature relating more specifically to communication board-type aids and their programming is mainly confined to articles in newsletters, and journals, to descriptive materials disseminated from professional conventions, and under subheadings of print materials disseminated from professional conventions dealing with the larger problem of non-vocal communication in general. It represents mainly an attack on the general expressive problem and in only one instance has this researcher found documentation of any attempts to use technology similar to that under investigation for formal psychological assessment procedures as is the intent of this study.

In the film MR. SYMBOL MAN (14) a segment of the background permits the viewer to glimpse a psychologist and a pre-reading non-vocal child interacting via the Wechsler Intelligence Scale for Children. The child is giving her responses by means of a pointing communication board containing Bliss symbols (15). This same psychologist, in telephone communication with the writer has indicated that she has recently administered the verbal WISC items via Bliss symbolics on an electronic communication board device. A formal print description of the procedure will not be available until the dissemination of a summary report of the Canadian government grant project under which the work was done.

A few references are extant pertaining to informal, educational, or language oriented tests being presented via

various aids. Vanderheiden, Raitzer, and Kelso in their exposition of the technically complex and singularly responsive electronic communication board known as the Auto-Com (16) state,

> Through using Auto-Coms many teachers discovered that their students didn't really have skills it was previously thought they had acquired. The Auto-Com was especially functional in assessing such previous skill deficiencies. Following accurate assessment of skill deficiencies, many teachers went on to teach new skills which were difficult to teach the child prior to this acquisition of the Auto-Com.

Hill, Campagna, Long, Muench and Naecker (17) describe the use of an electronic response panel which was devised for assessment purposes.

> A response panel with six keys was used to train the child to make responses to a keyboard. The keys were 23¼ inches wide and 2¼ inches long. They were set ½ inch apart. A stimulus holder placed in a central position above the response keys was also provided in order that match-for-sample problems could be presented. A light source behind each key provided immediate reinforcement when the appropriate key was activated. The pictures from the Peabody Picture Vocabulary Test were presented on the response panel to test vocabulary.
>
> In order to test her comprehension for verbal materials, she was first trained to respond by using the extreme left key for "yes" and the extreme right key for "no". The keys were first color coded and later the words "yes" and"no" were used. Stories were read to her and she used these two keys to answer simple yes-or-no questions about the story content.
>
> In order to test the child's ability to make form, size, and color discriminations, materials from a programmed reading-readiness series designed for kindergarten and early first grade were used. (Maney, 1965)

The Roto-Com, a scanning aid consisting of a 12" X 12" X 3" box which has a rotating pointer on its face, was developed by the Cerebral Palsy Communication Group, the

forerunners of the Trace Center. It is illustrated in the Annotated Bibliography of Communication Aids (13) with plates from the Miller-Yoder Test of Grammatical Comprehension: Experimental Edition. By verbal report from a speech pathologist who used the device, the Peabody Picture Vocabulary Test also had been presented via this aid.

Three print volumes encompass most of the ideas and emerging principles for non-vocal communication programming in general. They are used as texts in workshops sponsered by the Bureau for the Education of the Handicapped and conducted by Trace Center personnel from the University of Wisconsin.

Perhaps the most definitive state-of-the-art treatise in the field is Non-Vocal Communication Techniques and Aids for the Severely Physically Handicapped, edited by Gregg C. Vanderheiden, M.S., Director, Trace Research and Development Center for the Severely Communicatively Handicapped, University of Wisconsin (18). The volume is based upon transcriptions of the 1975 Trace Center National Workshop Series on Non-Vocal Communication Techniques and Aids. In it several authors explore the theoretical and practical problems inherent in implementing any number of alternate communication systems. Communication models and developmental skill acquisitions are discussed in reference to identifying the communicatively at-risk child. A main portion of the work describes the tools which have evolved as the result of efforts to overcome the problems. An equally valuable portion

describes actual programs where these tools are at work. The Appendices contain extensive technical and topical bibliographies.

In the Non-Oral Communication System Project 1964/1973 Edited by Beverly Vicker (19) the communicative process is looked at theoretically from the non-oral standpoint and summaries are provided covering nine years of development of non-oral materials and programming. Contributions from the OTR community toward adaptive positioning of users and integration of board systems into the users existing positioning and prosthetic systems provide useful guidelines as does a model case history with which the manual closes. Appendices furnish sample communication board display materials.

Communication and Assessment Strategies, Edited by Lyle Lloyd (20) is a comprehensive overview of the current status of productive work being done with the developmentally disabled child in the field of communication. A chapter within this book entitled "Communication Techniques and Aids" begins with the rationale that augmentative communication techniques are necessary for some children to be able to take advantage of the programs which new legislation is opening up to them. The variables to be dealt with in setting up individual systems for individual children are considered as they stem from a three-component model consisting of:

1. A physical mechanism or means of indicating or transmitting the elements of a message to a receiver.

2. An ideo-symbol system and vocabulary to provide the child with a set of symbols that can be used to represent things and ideas for communication to a receiver.

3. Rules and procedures for combining and presenting the ideo-symbols so that they will be most easily interpretable by a receiver. References and suggested readings following this chapter, while extensive, contain several obscure and poorly accessible listings.

The paucity of literature relating directly to the problem of enhancing testing procedures for severely communicatively handicapped persons may be partially a function of the relatively small target population involved. For example, in the Non-Oral Communication Project (19) conducted by the University of Iowa at the State Hospital Residential School from 1964 to 1973 only twenty-two persons were served. (It remains obvious to the writer that the relatively small number of persons so handicapped in no way reduces the extremity of their need so long as any persons are bound to unnecessarily restrictive expressive systems or to perpetual improvisation.)

Chapter 3

REVIEW OF FIELD EXPERIENCES

Before selecting a single hypothesis to test quantitatively, the writer in an earlier chapter expressed concern for the larger problem of psychological assessment of non-vocal severely physically handicapped persons in general. In pursuit of that concern and in the course of narrowing this investigation to a single quantifiable study which would yield statistical inferences, several field experiences were designed and undertaken. A synopsis of the investigation of alternative message-selection systems and message-element systems which appear sufficiently appropriate to merit further use and study constitutes this chapter.

Alternative Means to Indicate

In the absence of useable pointing skills and in the absence of electronic indicating equipment, eye-gaze may be used to effect message selection. A piece of equipment to utiilize eye-gaze was constructed by the writer from plexi-glass (Figure 2). On a four inch width frame with overall dimensions of 16" X 20", the full alphabet and all the num-bers from one through nine were affixed in eight evenly spaced groups. A glancing code system has been devised to select each desired letter within the groups to compose words.

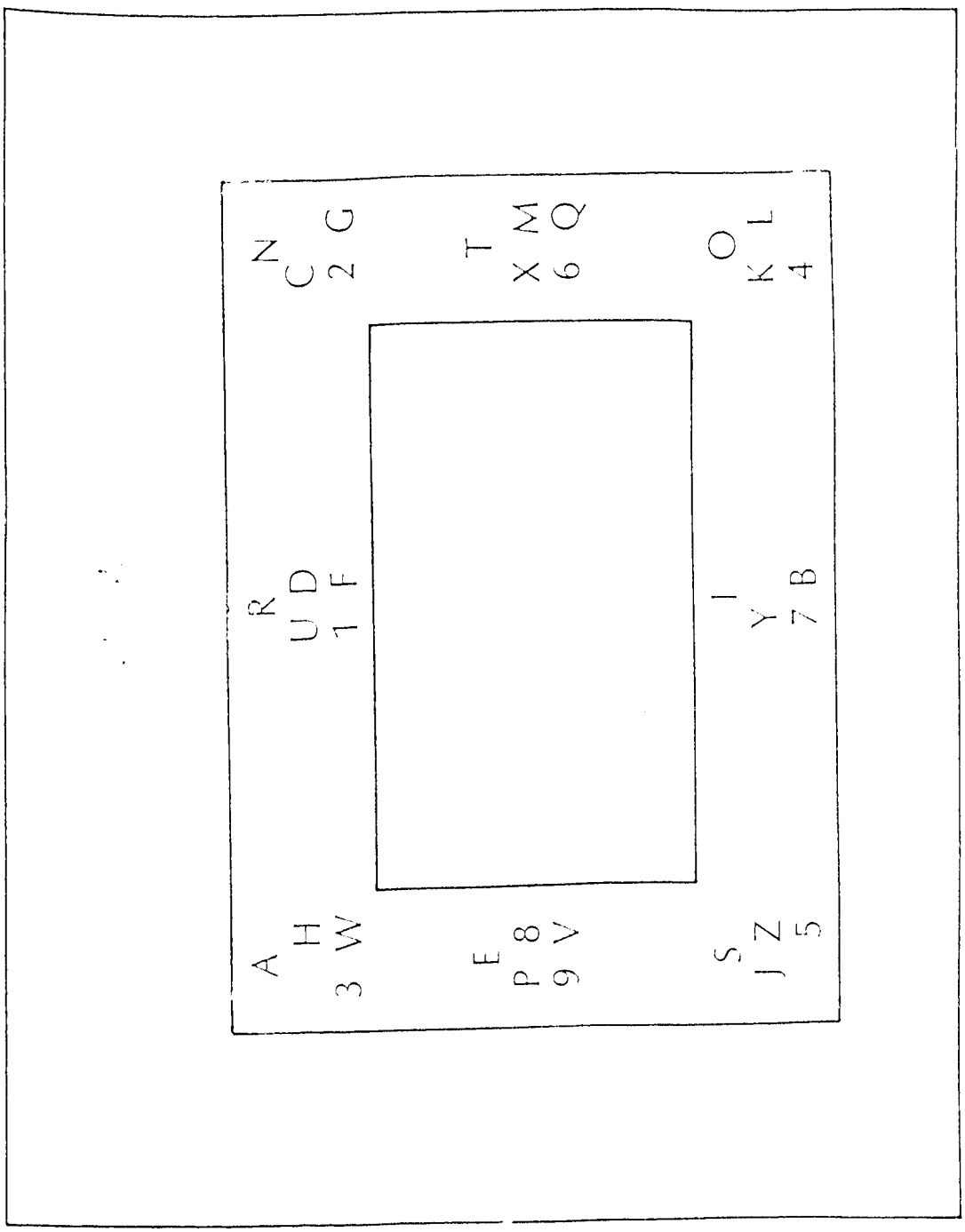


Figure 2. Eye Gaze Chart

Thus, with time and patience, messages can be sent by persons who have acquired spelling skills. (The originator of this code system became so proficient at indicating, and his family became so adept at interpreting that they could eventually communicate by eye position alone without the use of the plexiglass prop.)(18)

The application of the eye-gaze chart was tried by this writer in three ways as a vehicle for indicating choices on the Columbia Mental Maturity Scale. In one instance the easy stimulus items from lower level-of-difficulty cards were isolated and placed with double-sided tape in three, four, or five widely spaced positions on the chart. One inch numbers were affixed on the back of each isolated card so that the test administrator could record either from matching the gaze response with the number on the back of the card or from observing the gaze response from the front of the chart.

In a second application, three, four, and five positions were color coded on the plexiglass chart by means of translucent chartpak tape, and three, four or five lower-level stimulus selections were coded directly beneath each stimulus on the original cards with these same colors. The test-taker responded by looking at the position on the chart that carried the corresponding color to that beneath the selected stimulus.

In the third adaptation, higher-level, more difficult discrimination stimuli were coded with numbers so that the test-taker need only look at the numeral below his selection and then fix his gaze on the corresponding numeral on the chart.

In order to collapse the time required to spell out responses, the eye-gaze chart can be adapted to transmitting traditional and non-traditional orthography either by direct selection technique above described, or by encoding techniques where the user refers to row and column arrangement of vocabulary constituents by means of number or color code. Thus, if vocabulary lists are made sufficiently broad, "verbal" response to verbal test items can be expressed via this procedure.

Adapted pointing has been investigated as a means of indicating choices. The most obvious and apparently useful adaptation for administering the Columbia Mental Maturity Scale to persons who possess only gross pointing skills has been to isolate each stimulus from a given card and place the cards in maximumly widely spaced positions on a lap-trap or similarly defined area within the given range of motion of the person being assessed. The person then, by means of fingers, toes, foot, fist, pointing dowel, or whatever, indicates his choice by direct selection. In some instances, when NVSPH persons are lacking even these rudimentary controls over their extremities, pointing can be effected by means of a head-wand which is controlled by neck movements. The writer has found that the most obvious disadvantage to this arrangement is its socially bizarre effect. Electronic devices which can be controlled by similar neck movements do not convey this stigmatizing effect.

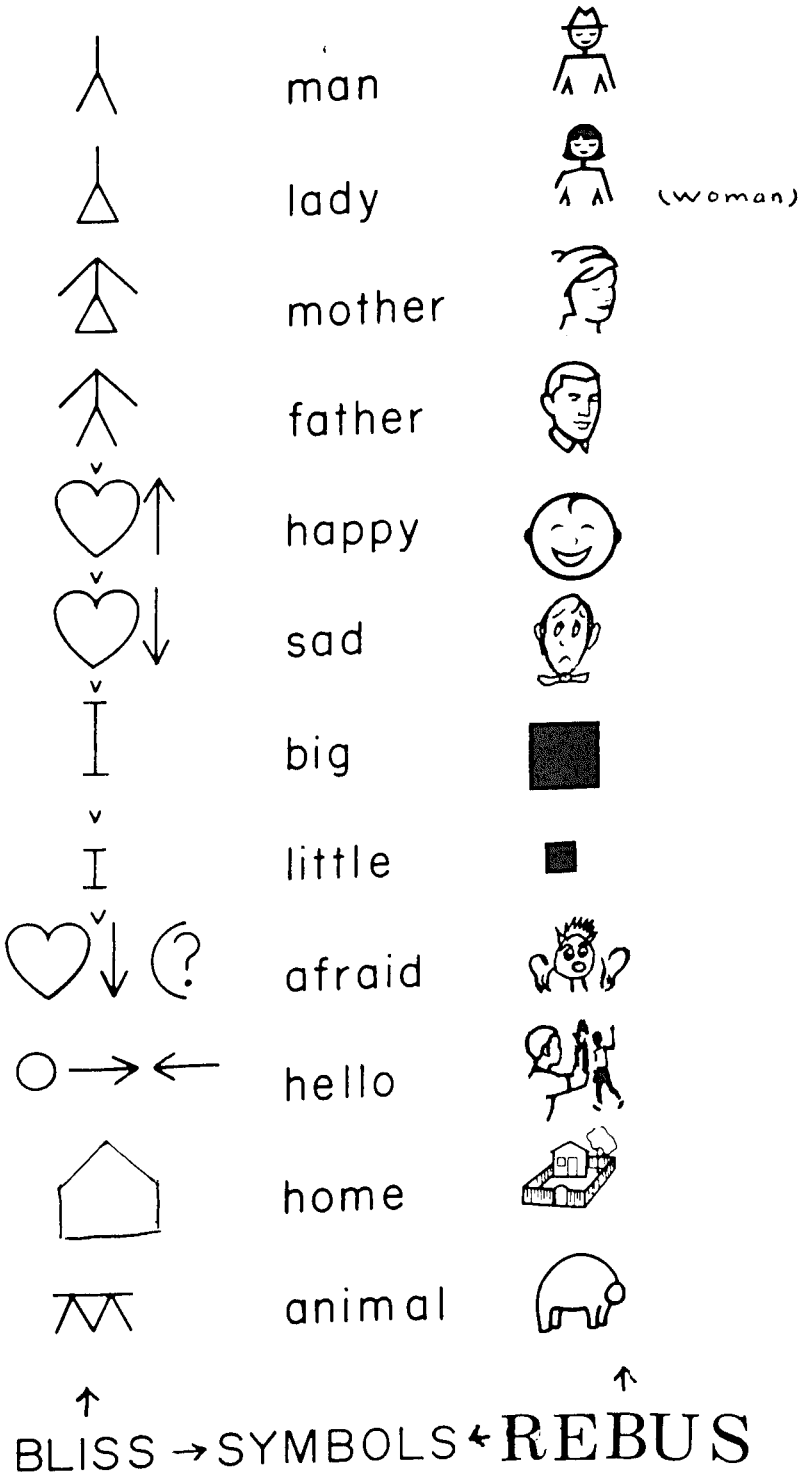
Alternative Symbol Systems

Before implementation of any psychological assessment involving verbal responses can take place using any message selection system, a symbol system of some nature must be established. In instances where a close-to-normal intellectual and linguistic level is present in the prospective user and the person is of school age, then an available graphic vocabulary in traditional orthography usually needs to be developed. In instances where prereading linguistic and lower intellectual developmental levels are to be dealt with, alternate graphic symbol systems need to be made available.

Among the many considerations in selecting an appropriate symbol system not the least of them is the ability of the message receiver to decode the message. To this end it has appeared more feasible to utilize and adapt symbol systems already developed and in some degree of common use rather than to spend interminable time in developing and disseminating a new system (not that a perfect universal system yet exists). Two of the most useful visual graphic systems in the experience of the writer have been the Blissymbols and Rebus. (Figure 3)

Blissymbolics is a primarily ideographic symbol system which was designed originally to comprise a universal graphic language which could be used by persons from any part of the world. Its current popularity lies with its use among non-verbal severely physically handicapped persons.

FIGURE 3


man
lady
(woman)
mother
father
happy
sad
big
little
afraid
hello
home
animal
BLISS → SYMBOLS ← REBUS

Through the Blissymbolics Foundation in Toronto, Canada, formal vocabulary displays have been developed and teaching guidelines have been developed to promote their use. The predominately ideographic nature of these symbols makes them less readily utilized by lower-functioning persons than more pictographic systems while it offers up to 750 vocabulary choices for higher-functioning persons with means to expand this number of modifications and combinations.

Although "homemade" pictographs or line drawings frequently are reasonably easy to interpret, there has been advantage in carefully selecting from the Rebus program many of their non-homophonic rebuses to comprise a picto-graphic symbol system which is acquired relatively readily by developmentally lower-functioning persons. (21) A major advantage of this system has been the availability of com-mercially prepared rub-on characters which make for easy uni-form reproduction although they are slightly small in scale.

As mentioned in the chapter relating to the literature, the Blissymbols have had pilot tries as a medium for WISC verbal response. This writer intends to continue to pursue the development of vocabularies by NVSPH persons in both Bliss and Rebus symbol systems to the end of making "verbal" test responses available to them.

The application of a non-verbal, visual-tactile, plastic shape symbol system was attempted (non-SLIP). (22) The format of this program proved not to be conducive to vo-cabulary expansion and the results in terms of expressive potential were obviously prohibitively inadequate.

Alternative Non-Verbal Test Adaptations

Non verbal tests, items from tests other than the Columbia Mental Maturity Scale were "piloted" by reproducing salient features in scale to fit the Zygo Communication board. A dozen sample items from the Pintner-Patterson Non-Language Intelligence Test and the Cattell Culture-Free Intelligence Test were chosen for a feasibility project.(23)

A deciding reason against using either of these instruments for a full scale study was that they were not adaptable in their original dimension as is the Columbia test, and to reproduce them to scale with sufficient technical attention to salient features would have been prohibitive in time and other current resources.

Chapter 4

DESIGN OF THE STUDY

From the main hypothesis, sub-problems and their related methodologies and procedures emerged chronologically as follows:

Sub-Problem I

Modify position and presentation of original Columbia Mental Maturity Scale task items to conform to the Zygo communication board specifications.

Method. Technically adapt items making the least possible change in spatial and sequential format.

Procedures. (Table 1)

Sub-Problem II

Carry out quantification procedures to determine if the above modifications do, in fact, make a difference.

Method. Follow sequential steps:

A. Choose statistical design.

B. Set up record and data sheets.

C. Procure population sample.

D. Administer test and record responses.

E. Subject test results to statistical analysis.

(A) Choose statistical design.

TABLE 1

TECHNICAL MODIFICATIONS OF CCMS ITEMS

Conditions necessitating change	Change made or proposed
1. Display units on the communicator are equal in size and non-moveable while the original distances between stimuli vary with the number and size of stimuli.	1. Cards were cut to three uniform lenths depending on whether they accomodate 4, 4, or 5 stimuli. (Original 6" width was retained.) Stimuli, with some original surrounding space, were mounted on Grumbacher heavy weight rough Florentine darwing paper which is the nearest and best available match to the original stock in the selection carried by the leading paper suppliers in Indianapolis.
2. Signal lights are necessary to indicate choice on the board.	2. Portals just barely accomodating the signal lights were cut.
3. There is no fifth signal light or display place available on the Zygo board in a given row.	3. In five instances, correct responses were rotated from the last display place to another display place. A mock signal light was placed before the last place.
4. Some of the original soil-protected surface will be lost in the process of adjusting cards to the board, or new, unprotected surface was introduced in the process of expanding display areas.	4. Surfaces will be covered with matte finish laminating film.

Procedure. Since the question to be resolved is the reliability of the adapted test for its ability to measure the same psychological functions that the original test measures, a Pearson Product Moment correlation was selected as an optimum vehicle to express the degree of this relationship between the two tests.

To determine how the test scores were comparable on the two tests a paired "t" test was chosen.

(B) Set up record and data sheets.

Procedure. Test item response recording had to be modified for the adapted test because of the few instances where the last choice of five is the original correct choice, but cannot be retained so because of the restrictions of the electronic board. Also, while administering the adapted test, scoring is done while facing the board, thus reversing the original scoring sequence. Therefore, completely new score sheets were designed and printed to accomodate these changes (Appendix 1). Data sheets were prepared in the manner suggested by Kolstoe (24) for the Pearson Product Moment calculations and by Guenther (25) for the paired "t" calculations.

(C) Procure population sample, attempting representation of a balance of age, sex, and socioeconomic background factors.

Procedure. Parents of seventeen boys and eighteen girls between the ages of three and on half and nine and one half, living in Old Northside, Eagledale, Butler-Tarkington,

and Meridian-Kessler neighborhoods of Indianapolis were solicited and gave their informed consent to have their children participate in the study (Appendix 2). At least one boy and one girl were selected in each half year age level.

(D) Administer tests and record data.

Procedure. The test was administered in the standard form and in the adapted form to the target population and scores were recorded in both raw and age-deviation scores. One half of the children were administered the adapted test first, the other half, the standard test first.

(E) Subject test results to statistical analysis.

Procedure. The scores on both original and adapted administrations were subjected to the Pearson Product Moment and paired "t" analysis. A scattergram was also prepared which showed on visual inspection, considerable regression toward the mean (Table 2).

Pearson Product Moment procedure:

Hypothesis:

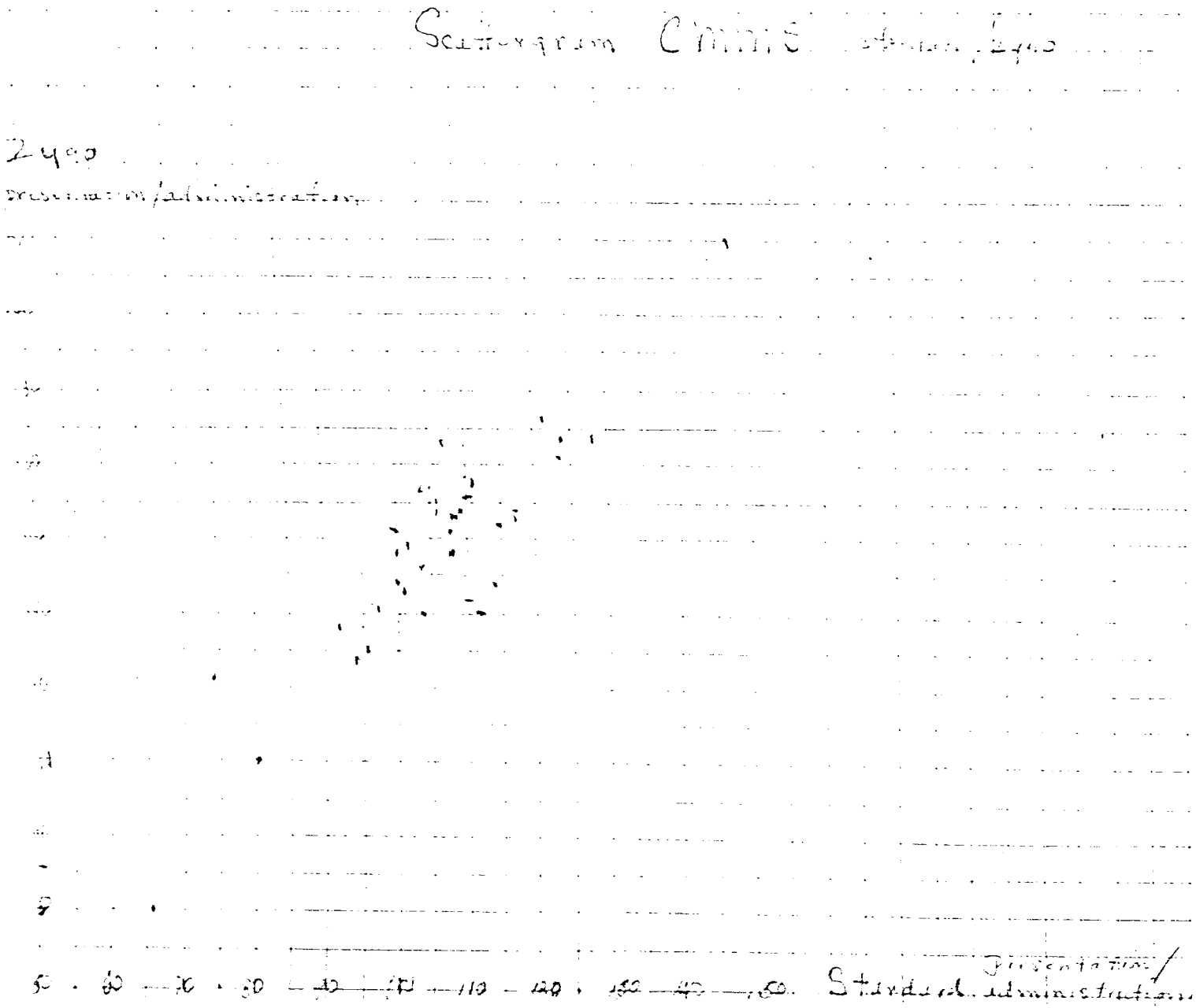
There is no relationship between the scores obtained on Columbia Mental Maturity Scale when administered in its original standard manner and the scores obtained when administered to the same population in the adapted manner.

Test: $H_0: r_1 = 0$ vs. $H_1 r \neq \pm .44$ (99% confidence interval)

Given: $N = 35$, $\alpha = .01$

Results: $r = .92$, $r = .93$ Raw and ADS scores respectively.

TABLE 2


Scattergram Crimes
2400
Presentation/administration
Standard administration

Paired "t" procedure: (19)

Hypothesis:

There will not be a difference between the means of scores obtained on the Columbia Mental Maturity Scale when administered in its original standard manner and the scores obtained when administered to the same population in the adapted manner.

1. $H_0: \mu_1 = \mu_2$ vs. $H_1: \mu_1 \neq \mu_2$

   $H_0\ \mu_0 = 0$ vs. $\mu_0 \neq 0$

2. $\alpha = .05$ $N = 35$

3. Statistic $T_{n-1} = \bar{D}/SD/\sqrt{N}$ which has a "t" distribution provided:

   a. The sample children are selected randomly from the group for which the conclusions apply

   b. The distribution of differences is normal

   c. The means are equal as hypothesized

4. The critical region is $t_{34} = \bar{d}/SD/\sqrt{35}$ $<t_{34}; .05 = -2.03$ and $t_{34}; > t_{34}; .95 = +2.03$ (using Fischer's "t" table in Kolstoe). (25)

5. Calculations yield:

RAW SCORES	ADS SCORES
"t" = 2.07	"t" = 2.15

6. Since the observed value of the statistic does fall in the critical region H_0 must be rejected.

Sub-Problem III

Interpret results.

Method. Compare results with hypothesized results.

Procedure. The statistical results showing .92 and .93 correlation coefficients between the respective raw scores and age deviation scores on the two versions of the test support the hypothesis that there is a significant relationship between the two tests and we can reasonably assume that the adapted test measures reliably those psychological function variables which the original test measures. We can therefore ultimately assume that when the adapted test is administered by itself that we are measuring these variables reliably.

The results of the means comparison indicates that for some reason children are apt to receive slightly higher scores on the adapted test. Speculation can be made in accounting for this phenomenon.

The visual vertical mode of presentation may have been in favor of children who had not yet accomodated fully to horizontal near point visual tasks.

The advancing of the indicating signal could have had a structuring effect on the search procedure.

The novelty of manipulating the controls of the communication board may have contributed to more sustained attention.

The distance and sequential spatial rearrangements made in the modification of the test could have operated in an unknown fashion to make choices more evident.

Any combination of these factors may have been at work.

Whatever the cause, the effect was that the children obtained an average of 1.2 more points on their raw scores and 1.9 more points on their age deviation scores on the adapted test. To correct for this state of affairs when the results of the adapted test must be interpreted in line with other standardized procedures, it is suggested that the test interpreter subtract a single point from a raw score and two points from an age deviation score to approximate a score comparable with the standardized version of the test.

Chapter 5

SUMMARY AND RECOMMENDATIONS

Summary

Children and other persons functioning cognitively at developmental levels between ages three and one half and nine and one half who are non-verbal and severely gesturally limited now have abailable to them a means by which they may have their reasoning ability assessed in the same terms as other persons.

The field of psychological tests for children was surveyed to determine which of the existing measures might be more usefully adapted to the alternative administration techniques dictated by the physical limitations of non-verbal, severely gesturally handicapped persons. The 1973 Columbia Mental Maturity Scale was selected because its pictorial format was adaptable within the above stated constraints and its validity and other standardization concerns were sufficiently documented.

Concommitantly, alternative technical communication aides were explored to determine which of them might facilitate test item choice selection with the least departure from normal presentation and response. The Zygo electronic communication board was selected for this function.

Subsequently the 1973 Columbia Mental Maturity Scale stimulus items were affixed to cards which accomodated to the specifications of the Zygo communication board.

The problem then remained to determine whether, when the test items were presented in this modified, adapted form, the test remained a reliable test. The validity of the test was not considered to have been at all affected by the re-arrangements which were only spatial and sequential in nature.

Upon administering both the original and the adapted forms of the test to thirty-five children representing a balance of sex, age, and socioeconomic factors, a positive correlation coefficient was found to exist at the .01 significance level. A difference was found between the means which suggested that two points be subtracted from the age deviation score or one point be subtracted from a given raw score before interpreting results of the adapted test. Therefore, it is reasonable to assume that persons taking only the modified version of the test are receiving a reliable assessment and that the scores are comparable with the above adjustment.

Recommendations for Further Study

Two relatively unrelated ideas for further pursuits have persisted. One idea refers to the development of a technlogical choice-indicating device, the other to an application of non-verbal symbol systems.

First recommendation: Instead of modifying the CCMS stimulus cards to adapt to an existing electronic device, it would be more normalizing to contrive an electronic scanning device with easily adjustable signal-scanners so that the test administrator would adjust the position of the signal lights to conform with the requirements of each original stimulus card.

Second recommendation: Further development of the use of non-vocal symbol systems is warranted so that non-vocal severely physically handicapped persons may have the advantages of being able to respond to psychological tests in which verbal items are utilized.

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DOB:

DOT:

CA:

BEGIN LEVEL A&B

1. 3 2 [1]
2. 3 [2] 1
3. 3 [2] 1
4. [3] 2 1
5. 5 4 [3] 2 1
6. 4 3 2 [1]

BEGIN LEVEL C

7. [3] 2 1
8. [4] 3 2 1
9. 4 3 2 [1]

BEGIN LEVEL D

10. 5 4 3 [2] 1
11. 4 3 2 [1]
12. [4] 3 2 1

BEGIN LEVEL E

13. 4 [3] 2 1
14. 4 3 2 [1]
15. 5 4 3 [2] 1
16. [4] 3 2 1
17. 5 4 [3] 2 1
18. [4] 3 2 1
19. 4 3 [2] 1
20. 5 4 [3] 2 1
21. 5 4 [3] 2 1
22. 5 4 3 [2] 1
23. 4 [3] 2 1
24. [4] 3 2 1
25. 4 3 2 [1]
26. 4 3 [2] 1
27. 5 4 [3] 2 1

BEGIN LEVEL F&G

28. 5 4 [3] 2 1
29. 4 3 [2] 1
30. 5 4 [3] 2 1
31. 5 [4] 3 2 1
32. [5] 4 3 2 1
33. 4 3 [2] 1

BEGIN LEVEL H

34. [4] 3 2 1
35. 4 3 2 [1]
36. 5 4 [3] 2 1
37. 4 3 2 [1]
38. 4 [3] 2 1
39. [4] 3 2 1
40. 4 [3] 2 1
41. 5 [4] 3 2 1
42. 5 4 [3] 2 1
43. 4 [3] 2 1
44. [5] 4 3 2 1
45. 5 4 3 [2] 1
46. 4 3 2 [1]
47. 5 4 3 [2] 1
48. 4 3 2 [1]
49. 5 4 [3] 2 1
50. 5 4 3 [2] 1
51. [4] 3 2 1

END OF LEVEL A

52. 5 4 3 [2] 1
53. 5 [4] 3 2 1
54. 4 3 [2] 1
55. 5 4 [3] 2 1
56. 5 [4] 3 2 1
57. 4 3 [2] 1

END OF LEVEL B

58. 4 3 2 [1]
59. 5 4 [3] 2 1
60. 5 4 3 [2] 1
61. [5] 4 3 2 1
62. 4 [3] 2 1
63. 5 4 3 [2] 1
64. 4 3 2 [1]
65. 5 [4] 3 2 1
66. 5 4 3 [2] 1

END OF LEVEL C

67. 5 4 3 [2] 1
68. [5] 4 3 2 1
69. 5 4 [3] 2 1

END OF LEVEL D

70. [5] 4 3 2 1
71. 4 [3] 2 1
72. 5 4 [3] 2 1
73. 5 4 3 [2] 1
74. 5 [4] 3 2 1
75. 5 4 3 [2] 1
76. 5 4 3 [2] 1
77. 5 4 [3] 2 1

END OF LEVEL E

78. 4 3 2 [1]
79. [4] 3 2 1
80. 5 4 3 [2] 1
81. 5 [4] 3 2 1
82. 5 4 [3] 2 1
83. [5] 4 3 2 1
84. 5 4 3 [2] 1

END OF LEVEL F

85. 4 [3] 2 1
86. 5 4 [3] 2 1
87. [4] 3 2 1

END OF LEVEL G

88. 4 [3] 2 1
89. 5 4 [3] 2 1
90. 5 [4] 3 2 1
91. 5 4 3 [2] 1
92. 5 4 3 [2] 1

END OF LEVEL H

NAME

APPENDIX 1

COUNSELING AND TESTING SERVICES

BUTLER UNIVERSITY · INDIANAPOLIS, INDIANA 46208

May 27, 1977

Dear Parent/Guardian,

I am a student at Butler University completing the advanced degree of Specialist in Education in the field of Educational Psychology. My thesis concerns the testing of non-verbal physically handicapped children. I have modified one of the well-known existing tests, the Columbia Mental Maturity Scale, so that it can be hopefully used for this purpose, but I need to verify the reliability of this modified test by administering it to some non-physically handicapped children.

I think your child would enjoy participating in the study and I would be happy to share my results with you should you give your consent. You are welcome to be present during the testing if you think your presence would not take away from your child's ability to concentrate.

I have taken courses at Butler intermittently for over thirty years. I have worked with the retarded of Marion County for more than ten years. I have attended All Saints Parish for over fifty years. You may address any inquiries regarding my intentions to:

Gloria Kemper	283-3742	4627 Boulevard Pl.	46208
Dr. Paul Coleman PhD	283-9329	Butler U. 46th&Sunset	46208
Dorothy Kestner MS	639-6271	MCARC 2400 N. Tibbs	46222
(after 3pm please)	(Marion Co. Assoc. for Retarded Citizens)		
Fr. Jack Eastwood	635-2538	All Saints, 16th&Central	46202

If you are interested, please return the following consent form to me.

Sincerely,

Gloria Kemper

Gloria Kemper, MS

I hearby give my informed consent for Gloria Kemper to administer the Columbia Mental Maturity Scale to my child_____.

(Signature of Parent or Guardian)_____Date_____
