INSTITUTE FOR RESEARCH IN LEARNING DISABILITIES
The University of Kansas
Lawrence, Kansas, 66045
Emphasis on Adolescents and Young Adults

RELIABILITY AND VALIDITY OF THE BAYESIAN IDENTIFICATION PROCEDURE FOR LEARNING DISABLED ADOLESCENTS

Gordon R. Alley, Donald D. Deshler,
Daryl F. Mellard, and Michael M. Warner

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The University of Kansas Institute for Research in Learning Disabilities is supported by a contract (#300-77-0494) with the Bureau of Education for the Handicapped, Department of Health, Education, and Welfare, U. S. Office of Education, through Title VI-G of Public Law 91-230. The University of Kansas Institute, a joint research effort involving the Department of Special Education and the Bureau of Child Research, has specified the learning disabled adolescent and young adult as the target population. The major responsibility of the Institute is to develop effective means of identifying learning disabled populations at the secondary level and to construct interventions that will have an effect upon school performance and life adjustment. Many areas of research have been designed to study the problems of LD adolescents and young adults in both school and non-school settings (e.g., employment, juvenile justice, military, etc.)

Co-Directors: Edward L. Meyen
Richard L. Schiefelbusch

Research Coordinator: Donald D. Deshler

Associate Coordinator: Jean B. Schumaker

Institute for Research in Learning Disabilities
The University of Kansas
313 Carruth-O'Leary Hall
Lawrence, Kansas 66045

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Cooperating Agencies

Were it not for the cooperation of many agencies in the public and private sector, the research efforts of The University of Kansas Institute for Research in Learning Disabilities could not be conducted. The Institute has maintained an on-going dialogue with participating school districts and agencies to give focus to the research questions and issues that we address as an Institute. We see this dialogue as a means of reducing the gap between research and practice. This communication also allows us to design procedures that: (a) protect the LD adolescent or young adult, (b) disrupt the on-going program as little as possible, and (c) provide appropriate research data.

The majority of our research to this time has been conducted in public school settings in both Kansas and Missouri. School districts in Kansas which are participating in various studies include: United School District (USD) 384, Blue Valley; USD 500, Kansas City; USD 469, Lansing; USD 497, Lawrence; USD 453, Leavenworth; USD 233, Olathe; USD 305, Salina; USD 450, Shawnee Heights; USD 512, Shawnee Mission, USD 464, Tonganoxie; USD 202, Turner; and USD 501, Topeka. Studies are also being conducted in Center School District and the New School for Human Education, Kansas City, Missouri; the School District of St. Joseph, St. Joseph, Missouri; Delta County, Colorado School District; Montrose County, Colorado School District; Elkhart Community Schools, Elkhart, Indiana; and Beaverton School District, Beaverton, Oregon. Many Child Service Demonstration Centers throughout the country have also contributed to our efforts.

Agencies currently participating in research in the juvenile justice system are the Overland Park, Kansas Youth Diversion Project and the Douglas, Johnson, and Leavenworth County, Kansas Juvenile Courts. Other agencies have participated in out-of-school studies--Achievement Place and Penn House of Lawrence, Kansas, Kansas State Industrial Reformatory, Hutchinson, Kansas; the U.S. Military; and the Job Corps. Numerous employers in the public and private sector have also aided us with studies in employment.

While the agencies mentioned above allowed us to contact individuals and supported our efforts, the cooperation of those individuals--LD adolescents and young adults; parents; professionals in education, the criminal justice system, the business community, and the military--have provided the valuable data for our research. This information will assist us in our research endeavors that have the potential of yielding greatest payoff for interventions with the LD adolescent and young adult.

Abstract

Three related studies were designed to address some key issues confronting the learning disability field concerning the identification of learning disabled adolescents. The first study (Research Report No. 9) addressed the question of which group(s) of professionals or parents make the most homogeneous identification decisions on learning disabilities' criteria. In the second study, (Research Report No. 10) the temporal and interscorer reliability as well as the construct and content validity of the Modified Component Disability Instrument was investigated. The reliability and validity of the Modified Component Disability Checklist and Secondary Test battery were investigated in the third study (Research Report No. 11).

The first study included a statewide random sampling of seven groups of professional educators and a group of parents of LD students. These eight groups were compared for their degree of agreement on the component disability survey instrument. The results indicated that no one group had greater consensus than any other. The conclusion was that LD teachers were an appropriate group from which to obtain likelihood ratios to be used in obtaining posterior probabilities for the LD population.

In the second study the professionals who had responded in study 1 re-estimated the probabilities they had provided 14 days earlier. This provided a measure of temporal reliability of the items. In addition, a new sample was drawn from two (Speech clinicians and LD teachers) of the seven professional groups to cross-validate the initial results. The temporal reliability coefficient obtained for individual items was sufficiently high to suggest the reliability of the judgments. Secondly, no differences were found among 41 component disability estimates between the two independent samples of professionals. As a part of this second study the survey was subjected to a factor analysis. The logical clusters of component disabilities were found to be substantiated as statistical factors.

As a part of Study 3, (Research Report No. 11) a group of seven professionals in LD found the behaviors associated with the component disabilities of the survey generally to be: (a) important, (b) grade appropriate, and (c) accessible to the teachers' observations in the classroom. The conclusion was that the Modified Component Disability Checklist is a reasonably reliable screening measure, especially at grades 8-12. In the third study a group of learning disabled adolescents and a group of low achieving peers were administered both the classroom screening measure and the battery of pre-selected tests. A multi-trait, multi-method analysis was completed. The results show a trend toward the reliable and valid nature of these two screening methods.

RELIABILITY AND VALIDITY OF THE BAYESIAN IDENTIFICATION PROCEDURE FOR LEARNING DISABLED ADOLESCENTS

Perhaps the most pressing need in the learning disability field is that of defining the population. The confusion that has existed in education as a result of poor definitional direction for the LD population is well documented (Chalfant & King, 1975; Larsen, 1978; Wissink, Kass, & Ferrell, 1975). Progress in educational programming, research and intervention development is contingent upon resolution of the definitional issue. A major focus of this Institute is to address those concerns that relate to the identification of the LD adolescent population.

The research outlined here is a series of studies that have been designed to address some of the major questions that are related to identifying characteristics of the population and secondly, reliable, valid identification procedures. While several of the hypotheses and questions in these studies related to previous work done at The University of Kansas using Bayesian aggregate procedures (Alley, Deshler, & Warner 1979); these three studies addressed issues beyond that specific procedure. Included in the research questions of these studies are the following:

1. Do members of a professional group agree on the identifying characteristics of the LD adolescent?
2. Is any one professional group more homogeneous than others and consequently more consistent in their identification?
3. Are the subjective judgment decisions of child care agents reliable and valid?
4. Can regular classroom teachers reliably observe content valid behaviors in students that are indicative of LD?

5. Is a test battery additionally useful in making an identification of LD?

The study reported here addressed Research questions three and four.

Methodology

Subjects

A selected subgroup of the Study 1 subjects (see Research Report No. 9) were used in this investigation (see Table 1). Two professional

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Insert Table 1 about here

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groups, 49 LD teachers and 13 speech clinicians, were used as a sample pool in order to establish a three-month temporal reliability of the Modified Component Disability Instrument. Of the 62 professionals, 42 persons volunteered and completed the task the second time.

Concurrently, a second random sample of 60 LD teachers and 60 speech clinicians were drawn from the Kansas Department of Education listing. The sample of these two groups was classified as the cross validation sample. Sixty-two persons volunteered by completing and returning the Modified Component Disability Instrument.

A third sample included all subjects from Study 1 and the cross validation group described above. Responses of these subjects were used to study the factor structure of the Modified Components Disability Instrument. One hundred sixty-six persons were included in this sample.

Measurement

The measure used in this study was The Modified Component Disability Instrument. A modified component disability instrument was constructed based on previous research by Alley et al. The modified com-

ponent disability measure contained 20 of the 71 original component disability items. These 20 component disabilities were grouped into four logical clusters. Two clusters had been identified by Alley et al. They were:

Best Differentiating Academic Components (Likelihood Ratios ≥ 4.0)--6 components

High Frequency Components (Probability of LD $\geq .90$)--4 components

The two additional clusters included: Best Differentiating Component Disabilities among Social Components and Worst Differentiating Component Disabilities. The five Social Component Disabilities included no likelihood ratios less than 3.0. Those social component disabilities that obtained a likelihood ratio greater than 4.00 had not been included in the initial Best Differentiating Component Disabilities because they were not deemed accessible to regular classroom observation and/or were not measurable on a formal standarized test.

The Worst Differentiating Component Disabilities were those five components with the lowest likelihoods among the 71 component disabilities. These components were included to account for attention and mental set factors of the judges.

The measure also contained an estimated percentage, which in the subject's judgment, was to indicate the prevalence of LD among secondary students. This estimated percentage was used as a part of the prior probability statement in applying the Bayesian theorem.

The 20 components and estimated percentage were then randomly ordered into the Modified Component Disability Instrument (Table 2).

Procedures

A second bulk mailing to 182 members of the subject pool was completed by the end of March, 1979. The mailing included a cover letter requesting the professional member to volunteer as a subject, the Modified Component Disability Instrument, instructions to complete the Instrument, and a stamped envelope to return the Instrument to the IRLD. This packet was identical to the packet sent to the subject pool of Study 1. A total of 118 subjects returned the Instrument to the IRLD. One procedural change was required as it related to the temporal reliability group. This part of the study was orginally designed to compare the LD group and the speech clinician group using two separate analyses. However, only 9 speech clinicians volunteered as subjects in the temporal reliability group. The sample of nine subjects was judged too small to yield reliable results, therefore only the LD teacher group (N = 32) was used in the analysis.

Research Design

Temporal reliability was calculated on each of the four clusters of items on the Instrument. This consisted of the 20 components and the estimated prevalence percentage. These reliabilities were calculated for the LD group (N=32). A .05 level of significance was used to test the null hypothesis that each Pearson r equaled zero.

The cross validation data was analyzed by each professional group across the 41 variables described above using a Hotelling T^2 test. A .05 level of significance was used.

The construct validity data of this investigation was analyzed using a principal components analysis with orthogonal rotation. Using this factor analysis method, the maximum number of factors to be con-

sidered was 10. Factors were selected with the criterion that the respective eigenvalue be equal to or greater than 1.0. All the above analyses were carried out using BMDP computer programs (Dixon, 1975).

Temporal Reliability Results

The three-month temporal reliability portion of this study investigated the stability of the probabilities assigned by the LD teachers who had completed the Modified Component Disability Instrument to compile data for Study 1. Thirty-two of these teachers then completed the Modified Component Disability Instrument three months later as a part of this investigation. The variable under study was the probability statement for each component disability.

It was found that after arbitrarily setting three categories for values of reliability coefficients: (a) less than .30, (b) from .30 to .70, and (c) greater than .70, that six variables fell within the lowest category, 29 variables were identified within the second category, and six had coefficients greater than .70. Because of the number of subjects and number of variables in the study, no statistical analysis was completed because of experiment error rate. However, the observational trend of this data has much to suggest its utility for future investigators and consumers using the Modified Component Disability Instrument with Bayesian procedures.

The six variables identified with the lowest correlation coefficients are:

CD 11 non-LD Difficulty in independent functioning

CD 16 non-LD Temper tantrums

CD 17 non-LD Resistant to receiving assistance from authority

CD 18 non-LD Difficulty in producing themes of adequate length

CD 13 non-LD Test taking skills

CD 10 LD Study skills

The six variables in the highest correlation coefficient category are:

CD 4 LD Low self-esteem, low self-concept

CD 5 LD Disability in recognizing sight words

CD 12 LD Complains constantly of physical illness

CD 15 LD Disability in organization and arrangement of written material

CD 20 LD Complains of being bored much of the time

CD 20 non-LD Complains of being bored much of the time

These 12 variables provide some interest because the category with the lowest correlations contain items related to social discrimination, worst discriminators, and high frequency component disabilities. Four of the six variables contained in the category with the highest correlation coefficients are related to social discriminators, best discriminators, high frequency disabilities, and worst discriminators. Five of the six variables are associated with the LD student. These results suggest that the Instrument appears to be a reliable measure especially as it assesses components related to LD students. (See Table 3).

Insert Table 3 about here

Cross Validation Results

The cross validation portion of the study investigated the stability of the probabilities assigned by the first group of 47 LD teachers

and the 13 speech clinicians. A second sample of 34 LD teachers and 28 speech clinicians volunteered and completed the Instrument three months after the initial subjects had completed it. Again the variables studied were the probability statements of the teachers and clinicians for the 20 component disabilities and the estimated prevalence percentage.

The data were analyzed separately for each professional group. Because of the small group size, the speech clinician group data was analyzed using a Mahalanobis D^2. The results yielded a Mahalanobis D^2 of 33.2068.between the initial speech clinician group and the cross-validation speech clinician group across the 41 variables. This finding was non-significant and one can conclude that the two groups are providing probabilities that are not divergent.

The LD teacher group data were analyzed using a Hotelling T^2. The Hotelling T^2 was used to compare the probabilities across the 41 variables between the initial group of LD teachers and the cross-validation group of LD teachers. When the data were analyzed using this statistic, a Hotelling T^2 of 56.6124 was obtained. This obtained result was non-significant at the .05 level of confidence. This finding can be used to conclude that the probabilities provided by the two LD teacher groups are not significantly different.

Factor Analysis Results

A principal components analysis was used to determine the interrelationships of the four logical clusters of component disabilities which were assumed to be orthogonal. A limited number of factors were used in the analysis. Ten factors were used because there were four logical item clusters and two classification groups which accounted for eight possible clusters. In addition, the estimated percent was considered as a possible single cluster and one factor was provided for an

"unaccounted" cluster. An eigenvalue criterion ($\lambda \geq 1.0$) was applied to the analysis to select statistical factors. A final condition was placed on the items used to describe factors (descriptors). It was an arbitrary decision to use only those descriptors which had a factor loading of .50 or higher.

The results showed that the ten factors accounted for 67 percent of the variance of the original data. The amount of variance accounted for by the ten factors ranged from 24 percent to 2.5 percent of the variance. Factor eleven did not reach the eigenvalue criterion (See Table 4).

Insert Table 4 about here

In factor one, all of the descriptors were associated with the non-LD population. Six of the eight descriptors were from the High Frequency cluster. The remaining two descriptors were related to decoding words and monitoring spelling errors. Based on these findings, the cluster was described as a non-LD High Frequency factor. This factor accounted for 24 percent of the variance of the Modified Component Disability Instrument. This finding gives principal support to one of the logical clusters identified by the investigators from data provided in their original study (Alley, Deshler, & Warner, 1979) (See Table 4).

Twelve of the items clustered on the second factor. Four of the items had loadings greater than .50. These four descriptors were all from the High Frequency cluster. All of the descriptors were representative of the LD population. Based on these findings, the cluster was described as an LD High Frequency factor. This factor accounted for

13 percent of the Modified Component Disability Instrument variance. This finding of a pure factor gives support to a second logical cluster (Alley et al., 1979).

The third factor contained 10 descriptors; five of which met the descriptor criterion. These five descriptors included all Worst Discriminator cluster variables. Four of the five descriptors were related to the LD population. The non-LD descriptor ranked fifth of the five factors. Based on these findings, this cluster was described as an LD Worst Discriminator factor. It accounted for six percent of the variance. This finding provided strong support for a third logical cluster identified by Alley et al.

The fourth factor contained 10 descriptors with loadings greater than 0.25. Three met the descriptor criterion. These three descriptors were all from the Best Discriminators cluster, and all are related to the LD population. Based on these findings, the cluster was described as an LD Best Discriminators factor. This factor accounted for four percent of the variance in the Instrument.

The fifth factor contained 10 descriptors of loading greater than 0.25. Three descriptors included two Best Discriminators and one High Frequency component. They were all associated with the non-LD population. One might describe this cluster as a non-LD Best Discriminator cluster. The fifth factor accounted for four percent of the variance.

There were nine items which loaded on the sixth factor at or above .25. Three of these met the descriptor criterion. They included two Worst Discriminators and one High Frequency component disability. The common content was attention, i.e., exhibits poor concentration, disability in recognizing correct spelling in multiple choice

format, and is overly demanding of teacher time and attention. All descriptors were related to the LD population. Based on these findings, this factor could be described as a second cluster of Worst Discriminators concerning attentive behavior within the LD population. This factor accounted for four percent of the variance.

The seventh factor contained eight items which loaded at .25 or higher. Three of these met the descriptor criterion. They included two Worst Discriminators and one Social Component Disability. All three were associated with the non-LD population. They also appeared to be describing an attention factor, i.e., is impulsive, exhibits poor concentration, and complains of being bored much of the time. This factor accounted for three percent of the variance of the Instrument.

Factor eight included 10 items which loaded above .25. Two of these met the descriptor criterion. They included only social descriptor component disabilities. Specifically, only social discriminators which were related to self-concept, i.e., is very concerned that he/she might be mentally retarded and exhibits low self-esteem, low self-concept. Both descriptors were associated with the non-LD population. These findings suggested that this factor could be described as an LD social discrimination cluster. This factor accounted for three percent of the variance.

Seven items loaded above .25 on Factor nine. Four of the seven met the descriptor criterion. They included the estimated percent item. All four descriptors were associated with the LD population. It was of particular note that the estimated percent item was a descriptor of the social cluster rather than either the High Frequency or Best

Discriminators cluster. Based on these findings, this factor was described as the LD social cluster. It accounted for three percent of the variance.

The tenth and final factor was composed of five items which also included factors four, five, and nine. Three items met the descriptor criterion. They included both the LD and non-LD populations on the Modified Component Disability Measure. Item No. 9 (disability in the use of algorithms), a Best Discriminator cluster item, identified with both LD and non-LD populations, and one Social Component Disability item, associated only with the LD population, met the criterion. These findings would suggest that this factor is specific to the mathematics component of the Best Discriminator cluster with social cluster contamination. It is, perhaps, a second order cluster of the Best Discriminators as the mathematics component disability was accounted for in factors four and five. This final factor accounted for three percent of the total variance population.

Five component disabilities did not meet the descriptor criterion on any of the ten factors. Two of these components (related to sequencing and error detection) were associated with the LD population. The remaining three components were identified with the non-LD population. These component disabilities related to: (a) sequencing, (b) physical illness, and (c) social awareness. Component Disability No. 1, related to sequencing, (e.g., becomes confused when structure changes, i.e., schedule changes, etc.) does not significantly account for the variance of the respondents when assigning probabilities on the Modified Component Disability Instrument.

Discussion

The three phases of this investigation included questions and data related to the reliability and validity of the Modified Component Disability Instrument and judgment decisions of child care agents. The first phase was to test the temporal reliability of the Instrument. It was found that the component disabilities are stable measures when considered by the LD teachers. Those component disabilities which are most unstable are measures of the High Frequency and Worst Discriminator clusters.

The second phase of this investigation was a cross validation of Study 1 using two selected groups from the first study, i.e., LD teachers and speech clinicians. These two groups of professionals did not differ in their mean probability estimates among the 41 variables. The probability means provided by Study 1 are stable across subgroups of these two certified groups.

The third phase of this study addressed the question of the validity of the logical clusters, i.e., High Frequency, Best Discriminators, Best Social, and Worst Discriminators of the Modified Component Disability Instrument. The findings suggest, with limited exceptions, that the Instrument is valid for its logical constructs both between and within the LD and non-LD groups.

These findings are in agreement with Alley et al. who found that LD teachers can make reliable probability judgments. It also supports their findings related to the component disability clusters identified in their initial study.

Phase 1 of this study is partially supported by Bronoski (1977). She obtained a high stability coefficient for the Elementary Checklist.

However, the present investigation was conceptualized to study the Modified Component Disability Instrument and the results were related to the stability of component disabilities rather than the entire instrument which Bronoski studied.

The cumulative result of the findings obtained across the three phases yields a final but important conclusion. The cumulative effect suggests that the Bayesian procedure to obtain probabilities of component disabilities, of which odds ratios and likelihood ratios are generalized, is a viable option for setting criteria to identify LD adolescents. Based on these conclusions, Question 2, "Are the subjective judgment decisions of child care agents reliable and valid?", can be answered affirmatively.

The major limitation to the Study 2 data is that it focused only on specific groups, i.e., LD teachers and/or speech clinicians. The sample is not large enough to provide definitive results. This is especially true for Phase 1 results. Perhaps, it might be said the findings of Study 2 are limited to the use of the Modified Instrument by secondary LD teachers.

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TABLE 1

Professional Groups and Parents included in the Subject Pool with number and percentage of pool used a subject for Study #1.

GROUPS	SUBJECT POOL	SUBJECT SAMPLE
Professionals		
LD Teachers	90	49
Regular Class Teachers	90	22
Remedial Reading Teachers	90	25
School Psychologists	90	33
Speech Clinicians	90	13
School Principals	90	27
School Counselors	90	36
Parents	30	11

TABLE 2

Modified Component Disability Measure

by Gordon R. Alley, Donald D. Deshler, and Michael M. Warner

1.	Disability in sequencing, e.g., becomes confused when structure changes, i.e., schedule changes, etc.	LD___%	NON-LD___%
2.	Is very concerned that he/she might be mentally retarded, or "dumb".	LD___%	NON-LD___%
3.	Is impulsive.	LD___%	NON-LD___%
4.	Exhibits low self-esteem, low self-concept.	LD___%	NON-LD___%
5.	Disability in recognizing sight words.	LD___%	NON-LD___%
6.	Exhibits poor concentration, is easily distracted by noises and other people.	LD___%	NON-LD___%
7.	Disability in detecting errors, e.g., spelling errors.	LD___%	NON-LD___%
8.	Has poor perception of social impact on others, i.e., is less able to interpret non-verbal social cues.	LD___%	NON-LD___%
9.	Disability in use of algorithms, e.g., subtracts from left to right.	LD___%	NON-LD___%
10.	Disability in using study skills, e.g., surveying, outlining, notetaking, skimming, question asking, reviewing, etc.	LD___%	NON-LD___%
11.	Disability in recognizing correct spelling in multiple choice format or content.	LD___%	NON-LD___%
12.	Complains constantly of physical illness.	LD___%	NON-LD___%
13.	Disability in test taking skills, e.g., throroughly reading instructions, review entire test before responding.	LD___%	NON-LD___%
14.	Has difficulty functioning independently, is overly demanding of teacher time and attention.	LD___%	NON-LD___%

15. Disability in the organization and arrangement of written material, i.e., exposition of a topic and differentiating one paragraph from another. LD____% NON-LD____%

16. Has temper tantrums. LD____% NON-LD____%

17. Is resistant to receiving assistance from authority figures. LD____% NON-LD____%

18. Disability in the production of themes of adequate length. LD____% NON-LD____%

19. Disability in decoding words. LD____% NON-LD____%

20. Complains of being bored much of the time. LD____% NON-LD____%

What percentage of the total secondary population do you estimate as being learning disabled?_____%

Table 3

Temporal Reliabilities (Item Stabilities) of
Each Component Disability (CD) by Classification Group (LD-Non-LD)

CD	1	LD	.47	CD	8	LD	.66	CD	15	LD	.72
CD	1	NLD	.36	CD	8	NLD	.41	CD	15	NLD	.36
CD	2	LD	.70	CD	9	LD	.47	CD	16	LD	.64
CD	2	NLD	.31	CD	9	NLD	.69	CD	16	NLD	.20
CD	3	LD	.56	CD	10	LD	.11	CD	17	LD	.54
CD	3	NLD	.31	CD	10	NLD	.42	CD	17	NLD	.03
CD	4	LD	.75	CD	11	LD	.58	CD	18	LD	.47
CD	4	NLD	.14	CD	12	LD	.89	CD	18	NLD	.06
CD	5	LD	.75	CD	12	NLD	.62	CD	19	LD	.65
CD	5	NLD	.69	CD	13	LD	.41	CD	19	NLD	.36
CD	6	LD	.66	CD	13	NLD	.10	CD	20	LD	.83
CD	6	NLD	.64	CD	14	LD	.59	CD	20	NLD	.71
CD	7	LD	.49	CD	14	NLD	.34	CD	Est.	Prct.	.66
CD	7	NLD	.46								

Table 4

Factors Identified and Named by Descriptors
using Principal Components Analysis

Factor No.	Name	Eigenvalue
1	High Frequency - Non-LD	9.91
2	High Frequency - LD	5.43
3	Worst Differenting - Non-LD/LD	2.42
4	Best Differentiating - LD	1.74
5	Best Differentiating - NLD	1.66
6	Attention - LD	1.48
7	Attention - NLD	1.38
8	Self Concept - NLD	1.23
9	Self Concept - LD	1.14
10	Cognitive & Social Awareness Rules - NLD/LD	1.02