CHAPTER IV

RELIABILITY, VALIDITY AND DISCRIMINANT ANALYSIS

4.0 Introduction

This chapter deals with presentation of the analysis of the data that has been used during the construction of the scale. An Intelligence quotient screening test using Stanford Binet test (Indian adaptation) was administered on 400 children out of whom 42 children were screened out as they could not clear the screening test or did not meet the inclusion criteria. 358 children were retained for the final study. The tool developed by the researcher was administered on 358 students and there details were noted down. All the results obtained from the tests were coded according to the coding manual prepared earlier. At the same time teachers were given a teacher's questionnaire which they had to fill up for the pupils in the class. A semi structured 4 point rating scale based on certain selected parameters to identify learning difficulty is given to the school teachers (adapted from NIMHANS- teacher's rating scale). To assess details regarding the difficulties the child was having in the regular school curricula and difficulties faced by the child in visual, auditory or phonetic areas. The teacher's questionnaire was then compared with the present developed tool and content validity of the developed tool was found out by correlating both the tests. After 6 months, children who completed 5 years of age were administered the NIMHANS specific learning difficulty index including those children who were identified as learning disabled by our newly developed tool.

The testing was an attempt to identify children's learning difficulty early. As they do not develop reading and writing skills at an early age, an attempt was made to identify the difficulties experienced by children in the precursors of learning abilities in reading and writing.

4.1 Reliability

This refers to the attribute of consistency in measurement (Gregory, 2007). There are four *general classes of reliability estimates*, each of which estimates reliability in a different way.

They are:

Inter-Rater or Inter-Observer Reliability Used to assess the degree to which different raters/observers give consistent estimate of the same phenomenon.

Test-Retest Reliability Used to assess the consistency of a measure from one time to another.

Parallel-Forms Reliability Used to assess the consistency of the results of two tests constructed in the same way from the same content domain.

Internal Consistency Reliability Used to assess the consistency of results across items within a test.

Due to the nature of testing, the test retest reliability is not considered to be suitable as these developmental skills are age dependent. Therefore, only internal consistency reliability measures were used. One of the most popular reliability statistics in use today is Cronbach's alpha (Cronbach, 1951). Cronbach's alpha determines the internal consistency or average correlation of items in a survey instrument to gauge its reliability.Cronbach's α is defined as

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N} \sigma_{Y_i}^2}{\sigma_X^2}\right)$$

Fig no 4.1

where N is the number of components (items or testlets), σ_X^2 is the variance of the observed total test scores, and $\sigma_{Y_i}^2$ is the variance of component i. Alpha is most appropriately used when the items measure different substantive areas within a single construct (wikipedia).

Use and significance:

Using Cronbach's alpha was best for our test as the test was not administered twice. Cronbach alpha is used to estimate the proportion of variance that is systematic or consistent in a set of test scores. It can range from 00.0 (if no variance is consistent) to 1.00 (if all variance is consistent) with all values between 00.0 and 1.00 also being possible. (Shikhen,

2002) Cronbach alpha will be higher for longer tests than for shorter tests (as shown and explained in Brown 1998 & 2001), and so alpha must be interpreted in light of the particular test length involved. In some of the scales we have very few items which may lead to low Chronbach alpha.

4.1.1 Reliability Analysis –Scale (Alpha)

Table 4.1

Sub Test	Items		No of items	Mean	S.D	Alpha
Phonemic decoding skills	1) phon awar	a) pat	3	0.76	0.82	0.77
		b) lbst		0.92	0.98	
		c) lpmt		0.76	0.83	
	2) rhy & blndgWrds	a) rhy	3	0.92	0.98	0.73
		b) b1t		1.18	0.94	
		c) b2t		0.93	0.80	
	3) rpd nam obj		1	0.44	0.79	
Auditory processing skills	1) aud disc		2	2.16	1.74	0.74
	2) aud mem			0.96	1.16	
Visual spatial motor skills	1) vis processing skills	a) vdt1t	3	0.71	0.76	0.72
		b) vdt2t		0.82	0.78	
		c)vis mem		1.40	1.66	
	2)spat ort	a) sot1t	3	0.81	0.72	0.73
		b) sot2t		0.83	1.05	
		c) sot3t		0.87	0.74	
	3)directionality	a) lar	2	0.82	1.37	0.76
		b) tbt		0.85	0.99	
	3) vis org	a) prot	4	0.92	1.00	0.77
		b) simt		0.46	0.63	
		c) clot		0.68	0.77	
		d) sat		1.37	1.47	
	4) vismotskil	a) vmst1t	3	0.75	1.13	0.79
		b) vmst2t		1.10	1.17	
		c) vmst3t		1.05	1.53	
	5) pic & sto seq	a) pst	2	0.90	0.96	0.73
		b) sst		0.68	0.76	
	6)lit red			0.39	0.59	
Attention	1)obj cancl test		1	0.99	1.56	
Speech and language	1) recept langu		2	0.39	0.68	0.65
	2) express lang			1.51	1.61	

Attention test comprised of cancelling or striking of black and white picture of spoons and forks given to the children. They were asked to cancel only the spoons. The mean was 0.99 and SD is 1.56.

The visual processing skill comprised of three indicators visual discrimination test 1 (total) and visual discrimination test 2 (total) and visual memory. Visual memory has 5 subtests. Visual discrimination test 1 consists of three items and visual discrimination test 2 consisted of three items. Cronbach alpha was found out to see the internal consistency of these items in measuring the visual Discrimination ability. The table no.1 shows that alpha was 0.72 which implies that the items in the subtests are highly internally consistent. Thus the test was found to be consistent and reliable.

The spatial orientation test had three subtests. The spatial orientation test 1 has three subsets spatial orientation test 2 consisted of two subtests while spatial orientation test 3 has three tests. Cronbach alpha measured for spatial orientation was found out to see the internal consistency of these items and was found to be 0.73 seen in the table no 1 which was consistent and reliable.

Directionality was tested using 2 tests-The left and right test and top and bottom test. There were eight questions in the left and right test while top and bottom had five questions. Cronbach alpha is calculated to look for internal consistency of the two items and was found to be 0.76 which suggests that these subtests were reliable and consistent.

Visual organization comprised of four indicators which were proximity test (four subtests), similarity test (four subtests), closure tests (three subtests) and synthesis and analysis (three subtests). To test internal consistency of visual organization, Cronbach alpha was calculated. The table no 1 shows that alpha was 0.77 which shows that the items in the subtest were consistent and reliable.

Visual motor skills was tested using three tests- visual motor skill test 1, visual motor skill test 2 and visual motor skill test 3 (2 subtests). Cronbach alpha was calculated to see the internal consistency of these items in measuring visual motor skills. Cronbach alpha as shown in the above table was found out to be 0.79 and thus found to be highly consistent and reliable.

Auditory memory (6 subtests) and auditory discrimination (10 subtests) comprised of auditory processing skill. Internal consistency using Cronbach alpha was found to be 0.74 which is consistent and reliable.

Language skills were tested with receptive language test and expressive language test. For testing internal consistency Cronbach alpha was used and was found to be 0.65 which was consistent and reliable.

The picture and story sequencing skill was used to test visual spatial motor skills and comprised of three subtests in picture sequencing test and 3 subtests in story sequencing test. Cronbach alpha is found out to see the internal consistency of these items. The table no.4.1 shows that alpha is 0.73 which implies that the items in the subtests are highly internally consistent. Thus the test was found to be consistent and reliable.

Phonemic awareness skill was tested using phonemic awareness test(3 subtests) and letter and beginning test(3 tests) and letter and phonemic match(4 subtest).The Cronbach alpha for measuring internal consistency is found to be 0.77 which was highly consistent and reliable.

To test phonemic decoding skills rhyming and blending words were tested. Rhyming consisted of three tests and blending had two parts with the blending test one having 4 subtests and blending 2 having 3 parts, the internal consistency was found to be 0.73 using Cronbach alpha which is consistent and reliable.

Rapid naming test was tested where children had to name 23 pictures placed in a sequence as fast as possible. Children with difficulty in learning took longer to finish the sequence and also made errors in naming them as we can see from the table 1. It highly correlated with other variables and thus was found to be consistent.

4.2 Validity

Validity – Validity in simple terms means whether the test measures what it intends to measure.Cook and Campbell (1979) defined it as the "best available approximation to the truth or falsity of a given inference, proposition or conclusion."

Types of validity - There are several types of validity

- Construct validity
- Internal validity
- Conclusion validity
- External validity
- Criterion validity

For the present study we decided to use

1) Authenticity of validity with teacher's rating- content validity
2) Most of the practitioners use NIMHANS-SLD as a diagnostic tool, it was decided to take predictive validity of our test by retesting NIMHANS –SLD for those children identified as having learning difficulty by our test- predictive validity
   The researcher independently rated the children on the developed scale (total number of children- 358) and got them scored and identified the children with learning disabilities.

4.2.1 Content Validity

It was not possible to get children rated by the teacher on all the subtests developed by us. In a classroom situation the variables possible to be rated by the teacher have been taken into consideration.

Definition - Here one essentially check the operationalization against the relevant content domain for the construct. Content validity evidence involves the degree to which the content of the test matches a content domain associated with the construct. Content validity is a non-statistical type of validity that involves "the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured" (Anastasi & Urbina, 1997).

4.2.2 Correlation of researcher's test and teacher's rating scale

Table no 4.2

Sr.No.	Teacher's Rating Test	Reserchers Test	Pearson Coeffecient α
1	te vms	vmst1t	0.69(**)
2	te vms	vms2t	0.56(**)
3	te vms	vms3t	0.44(**)
4	te audbe	adt	0.56(**)
5	te auddis	adt	0.61(**)
6	te audmem	amt	0.52(**)
7	te verexp	vet	0.63(**)
8	te atten	Object cancel test	0.98(**)

** Correlation is significant at the 0.01 level (2-tailed).

Correlation of visual motor skills test 1

An evaluation was made of the linear relationship between visual motor skill test 1 of our test and visual motor skill test of the teacher. An analysis using Pearson's correlation coefficient indicated a statistically significant linear relationship between visual motor skill test 1 of our test and visual motor skill of the teacher's rating test. This implied that the developed test on visual motor skill was content valid (table 4.2).

Correlation of visual motor skills test 2

An evaluation was made of the linear relationship between visual motor skill test 2 of our test and visual motor skill test of the teacher. An analysis using Pearson's correlation coefficient indicated a statistically significant linear relationship between visual motor skill test 2 of our test and visual motor skill of the teacher's rating test. This implied that the developed test on visual motor skill was content valid (table 4.2).

Correlation of visual motor skills test 3

An evaluation was made of the linear relationship between visual motor skill test 3 of our test and visual motor skill test of the teacher. An analysis using Pearson's correlation coefficient indicated a statistically significant linear relationship between visual motor skill test 3 of our test and visual motor skill of the teacher's rating test. This implied that the developed test on visual motor skill was content valid (table 4.2).

Correlation for auditory discrimination of researcher's test and auditory behavior of the teacher's questionnaire

An evaluation was made of the linear relationship between auditory discrimination of our test and auditory behavior test of the teacher. An analysis using Pearson's correlation coefficient between auditory discrimination of our test and auditory behavior of the teacher's test was found out and was statistically significant which showed that our developed scale on auditory discrimination was content valid (table 4.2).

Correlation for auditory discrimination of researcher's test and auditory discrimination of the teacher's questionnaire

An evaluation was made of the linear relationship between auditory discrimination of our test and auditory discrimination test of the teacher. An analysis using Pearson's correlation coefficient between auditory discrimination of our test and auditory discrimination of the teacher's test was found out and is statistically significant which showed that our developed scale on auditory discrimination was content valid (table 4.2).

Correlation of auditory memory

An evaluation was made of the linear relationship between auditory memory of our test and auditory memory test of the teacher. An analysis using Pearson's correlation coefficient indicated a statistically significant linear relationship between auditory memory of our test and between auditory memory of the teacher's test. This implied that the developed test on visual motor skill was content valid (table 4.2).

Correlation of verbal expressive language

An evaluation was made of the linear relationship between verbal expression of our test and between verbal expression test of the teacher. An analysis using Pearson's correlation coefficient indicated a statistically significant linear relationship between verbal expression test of the researcher and between verbal expression test of the teacher's rating scale. This implied that the developed test on verbal expressive language was content valid (table 4.2).

Correlation of attention

An evaluation was made of the linear relationship between colour cancellation (attention test) of our test and attention test of the teacher. An analysis using Pearson's correlation coefficient indicated a statistically significant linear relationship between object cancellation test for testing attention of the researcher and attention test of the teacher's rating scale. This implied that the developed test on verbal expressive language was content valid (table 4.2).

4.2.3 Predictive Validity

Definition - In predictive validity, we assess the operationalization's *ability to predict something it should theoretically be able to predict.* It refers to the degree to which the operationalization can predict (or correlate with) with other measures of the same construct that are measured at some time in the future.

Predictive validity validates the test by correlating the test score with the future performance on the criterion. NIMHANS SLD test is applicable to children above five years of age. Thus, the researcher decided to use NIMHANS Index for specific learning disabilities (Kapur, John, Rozario & Ommen, 1991), an existing scale, which was available for children older than five years of age. For the very same reason those children who were turning five years or older (number of children-149) after six months of age were taken into consideration and NIMHANS Index for specific learning disabilities (Kapur, John, Rozario & Ommen, 1991) is tested on these children.

It predicts the performance after sometime and therefore needs to be done after a time interval. NIMHANS Index for specific learning disabilities (Kapur, John, Rozario & Ommen, 1991) is available for children older than five years. These 149 children who were

completing five years of age after 6 months were subjected to this test after a period of six months.

4.2.4 Correlation of researcher's test and NIMHANS- SLD scale

Table No 4.3

Researcher's Test	Nimhans - SLD Test	Pearson's Coefficient - Our Test
Attention-	Attention-	0.76**
Object cancellationtest	color cancellation test	
Visual discrimination	Visual discrimination	
Vdt1t		0.39**
Vdt2t		0.42**
Spatial orientation*		
Sot1t		
Sot2t		
Sot3t		
Left & Right recognition*		
Top & Bottom recognition*		
Visual organization*		
Prot		
Simt		
Clot		
Sat		
Visual motor skills	Visual motor skills	
Vmst1t	VIS MOT SKI	0.49**
Vmst1t	WRIT SKILS	0.24**
Vmst2t	VIS MOT SKI	0.37**
Vmst2t	WRIT SKILS	0.43**
Vmst3t	NUMBERS	0.31**
Visual memory	VIS MEM	0.45**
Auditory discrimination	AUD DIS	0.47**
Auditory memory	AUD MEM	0.44**
Receptive language*		
Verbal language expression	VER EXP	0.48**
Picture sequence*		
Story Sequence*		
Literacy readinesss*	WRITING SKILLS +	
Phonemic awareness*		
Rhyming*		
Blending*		
B1t		
B2t		
Rapid naming object*		

** Correlation is significant at the 0.01 level (2-tailed).
The tests with * in the researcher's test are the parameters which are extra number of tests tested in various parameters.
+ Tests were the tests which could not be tested by researcher in her test due to age constraint

The parameters present in the researcher's test were more in number than NIMHANS (specific learning difficulty index). As the age of the children is less, they needed to be tested on a larger number of criteria to identify them as having learning difficulty. Also, maturation process is the process within the participants as a function of the passage of time (not specific to particular events) e.g. growing older etc. Some of the parameters will improve with time in all children whether or not they have learning difficulty due to developmental constraints (Lerner, 1998)

There are four developmental constraints in reading

1. *Unequal learning* because some letters, concepts and phonemes are learnt more quickly and more thoroughly than others. They are fixed effects with heterogeneous variance that results in non linear learning among elements. X and q are learnt later than m and s and phoneme rhyming is easier with consonant, vowel and consonant pattern than more complex pattern. Unequal learning of rules become important when alphabet knowledge and phonemic awareness are treated as equal uniform skills.

2. *Duration of learning* alphabets is mastered over a few years but vocabulary is not. Degree of learning is more rapid and complete for some skills irrespective of the age that it is learnt. Reading skills approach an individual growth asymptote as acquisition slows or ceiling is attained. Reading skills become nearly stable as one approaches middle school years but there is wide variation between individuals.

3. *Universal mastery*- some reading skills and concepts reveal mastery of identical information among people. All competent readers know the Identical concepts about print and understand phonemic rhyming, segmentation and blending in the same manner. On assessment of these reading skills they would have the same y- intercepts. This results in zero variance among individuals when the constraint skill is at asymptotic level. This does not happen in universally mastered skills that attain identical intercepts and have no enduring individual differences. The differences in acquisition of universal mastered skills are minor (e.g. onset, rate and duration) compared to similarity over most of the time span. Unconstrained skills continue to develop over time and may reveal enduring individual differences. This difference is important for different statistical analysis and interpretation that are important for each type of skills.

4. *Co dependency*- some precursors may be necessary for a skill to be acquired, so it is constrained by it relation to other skills. Some skills like language reception, discrimination, production etc are required for reading skills to emerge. Many constrained reading skills are dependent on cognitive and linguistic development and are acquired during childhood at the same time. The parallel and simultaneous development of language and literacy skills lead to multicolinearity and it becomes difficulty to separate the relations among skills during periods of rapid development. The codependency may also invalidate the co relational studies.

Correlation of Researcher's test and NIMHANS- SLD scale

Narrative -An evaluation was done of the linear relationship between object cancellation, Visual discrimination,Visual motor skills,Auditory discrimination and Verbal language expression of our test and that of the NIMHANS test using Pearson's correlation.

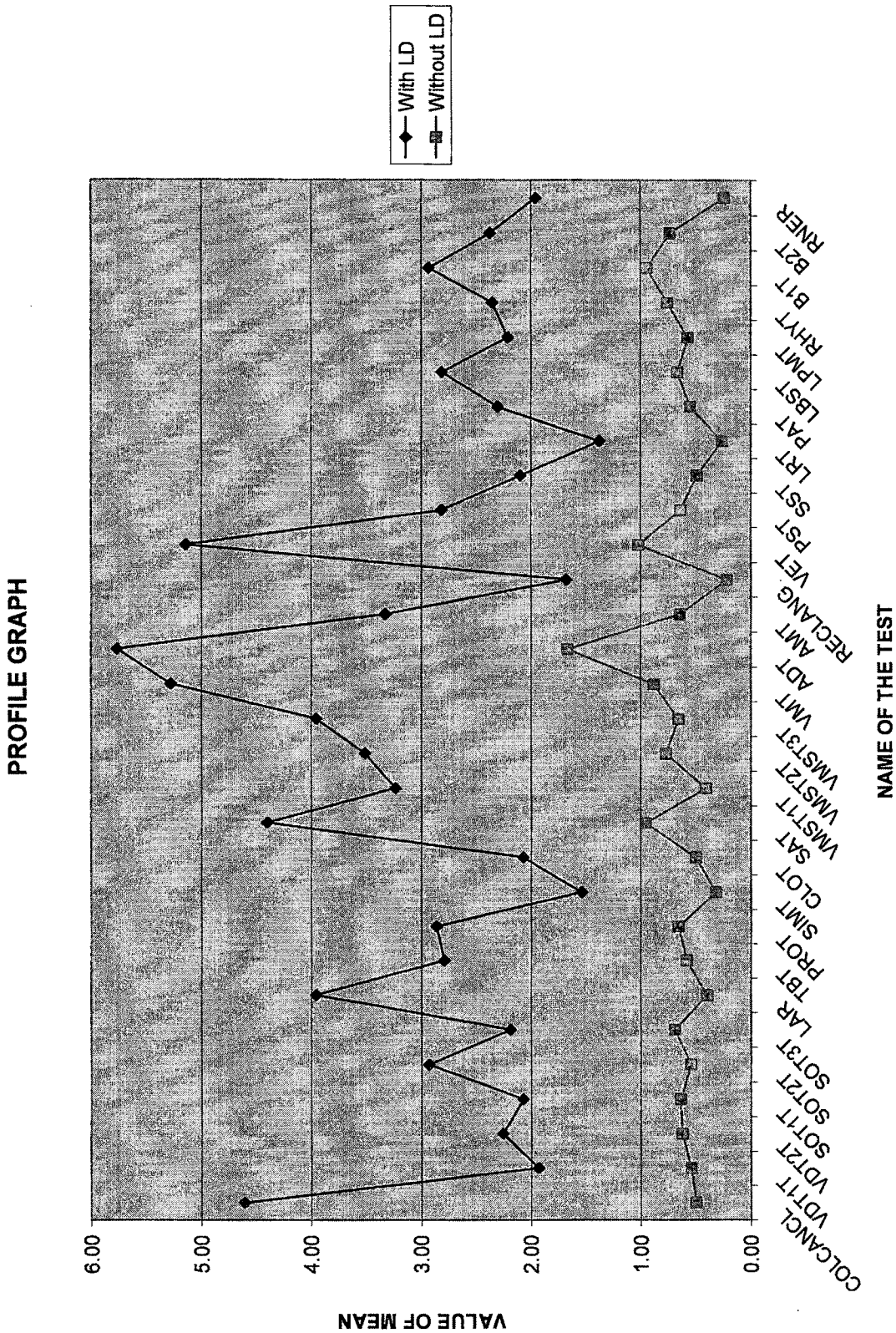
Results- An analysis using Pearson's correlation coefficient indicates (Table 4.3), a statistically significant linear relationship between object cancellation, Visual discrimination, Visual motor skills,Auditory discrimination and Verbal language expression of our test and that of the NIMHANS test

4.3 Profile of children with and without learning difficulty by the researcher's test

As we can see from the profile graph (4.4) children without learning difficulty have a limited range of mean. All the tests show a small range in the whole range of scores. Only one test shows a score value of more than 1 (auditory discrimination test).Minimum mean score values are 0.22(receptive language) and maximum mean score values are 1.66(auditory discrimination test).Children with learning difficulty show a greater degree of fluctuation with most of the mean scores greater than 1. Minimum mean scores are 1.31 (literacy readiness test) and the maximum mean is 5.58(auditory discrimination test).

4.4 Profile Graph

Graph No 4.1



4.5 Analysis of scores of children with and without learning difficulty by the researcher's test

Children identified as having difficulty in learning on the basis of the new measure were compared with children without learning difficulty

Independent samples't' test between children with and without learning difficulty by the researcher's test

Table No 4.4

Name of Test	Equal variances	Levene's Test for Equality of Variances	t-test for Equality of Means		Learning Diff - Mean	
		Sig.	t	df	Without	With
COLCANL	assumed	0	-29.59	356	0.50	4.40
VDT1T	assumed	0.25	-13.8	356	0.54	1.87
VDT2T	assumed	0	-17.53	356	0.62	2.20
SOT1T	assumed	0	-15.52	356	0.64	2.00
SOT2T	assumed	0.92	-19.88	356	0.54	2.84
SOT3T	assumed	0	-16.21	356	0.68	2.13
LAR	assumed	0	-28.14	356	0.40	3.78
TBT	assumed	0.71	-19.82	356	0.58	2.69
PROT	assumed	0.81	-18.8	356	0.65	2.78
SIMT	assumed	0.02	-14.74	356	0.32	1.47
CLOT	assumed	0	-16.72	356	0.50	2.00
SAT	assumed	0	-21.22	356	0.95	4.27
VMST1T	assumed	0.06	-27.33	355	0.40	3.16
VMST3T	assumed	0	-18.19	356	0.77	3.36
VMT	assumed	0	-28.9	356	0.65	3.82
ADT	assumed	0.32	-22.12	356	0.88	5.07
AMT	assumed	0	-21.34	356	1.66	5.58
RECLANG	assumed	0	-17.7	356	0.64	3.22
VET	assumed	0	-26.56	356	0.22	1.60
PST	assumed	0	-19.78	356	1.02	4.98
SST	assumed	0.84	-17.57	356	0.64	2.69
LRT	assumed	0	-14.11	356	0.49	2.04
PAT	assumed	0.06	-17.5	356	0.26	1.31
LBST	assumed	0.35	-18.51	356	0.55	2.22
LPMT	assumed	0.14	-15.69	356	0.66	2.71
RHYT	assumed	0.72	-13.76	356	0.57	2.13
B1T	assumed	0.05	-17.7	356	0.75	2.27
B2T	assumed	0.16	-16.57	356	0.94	2.84
RNER	assumed	0	-18.44	356	0.73	2.29
RNT	assumed	0	-24.48	356	0.24	1.87
					37.85	50.83

significant at.001level

In order to check whether the test is able to differentiate between children with risk of learning disability and children without the risk, a mean comparison test, i.e., an independent sample t test was administered on both groups across all the dimensions of the constructed test. As the table 4.5 shows, significant difference was found out between the children without learning difficulty and children identified as having learning difficulties across most of the dimensions, the t-value being significant at 0.01 level. A comparison of means show that children with learning difficulty committed higher number of mistakes in all the tests as compared to their counterparts. This significant difference between children with and without the risk of learning disability in the tests of phonemic decoding skills, auditory processing skill and visual-spatial motor skill suggests that the constructed measure is an effective instrument to identify the learning difficulty among young children.

4.6 Analysis of scores of children with learning difficulty by the researcher's test and children with learning difficulty by the NIMHANS test

Paired 't' test comparison of children with learning difficulty by the researcher's test and children with learning difficulty by the NIMHANS test

Table No 4.5

Paired Samples Test							
		Paired Diff		Std. Error			Sig.
Pair	Name of Test	Mean	Std. Dev	Mean	t	df	(2-tailed)
1	COLCANC - ATTENT	1.61	1.75	0.37	4.41	22	0
2	VDT1T - VISDIS	-0.26	1.98	0.41	-0.63	22	0.53
3	VDT2T - VISDIS	0.26	2.12	0.44	0.59	22	0.56
4	VMST1T - VISMOSK	1.96	1.49	0.31	6.29	22	0.00
5	VMST1T - WRISK	-7.57	15.9	3.32	-2.28	22	0.03
6	VMST2T - VISMOSK	2.43	1.93	0.4	6.06	22	0.00
7	VMST2T - WRISK	-7.09	15.24	3.18	-2.23	22	0.04
8	VMST3T - NUMBER	1.13	3.11	0.65	1.74	22	0.10
9	VMT – VISMEM	2.26	3.14	0.65	3.46	22	0.00
10	ADT – AUDDIS	0.65	3.13	0.65	1.00	22	0.33
11	AMT - AUDMEM	-1.26	3.22	0.67	-1.88	22	0.07
12	VET – VEREXP	3.17	1.7	0.35	8.97	22	0

Table 4.5 shows the results of a paired sample t-test conducted to compare the test scores of children who were identified as having learning difficulty by the researcher's test

and the Nimhans- SLD (tested after a time interval of six months) scores. No significant difference was found in most of the tests except in Attention test, Visual motor skills and verbal expression tests. Theis shows that children identified as having learning difficulty continued to have the difficulty even after a period of six months. Some areas like Attention , Visual motor skills and Verbal expression showed improvement as the child continues to mature in all areas of development including learning sklls. Above table shows that scores did not differ significantly at .001 level.

4.7 Discriminant Analysis

Discriminant analysis **is** a statistical method used to classify the dependent variable between two or more categories. Discriminant function analysis is used to determine which continuous variables discriminate between two or more naturally occurring groups Discriminant function analysis is multivariate analysis of ariance (MANOVA) reversed. In MANOVA, the independent variables are the groups and the dependent variables are the predictors. In DA, the independent variables are the predictors and the dependent variables are the groups. As previously mentioned, DA is usually used to predict membership in naturally occurring groups. It answers the question: can a combination of variables be used to predict group membership? Usually, several variables are included in a study tosee which ones contribute to the discrimination between groups Discriminant analysis also has a regression technique, which is used to predict the value of the dependent categorical variable. When the category of a dependent variable is more than two, it will simply be an extension of the simple discriminant analysis called the multiple discriminant analysis. Discriminant function analysis is broken into a 2-step process: (1) testing significance of a set of discriminant functions, and; (2) classification. Computation wise, the first step leads to a matrix of pooled within-group variances and covariances. The two matrices are compared via multivariate F tests in order to determine whether or not there are any significant differences (with regard to all variables) between groups. One first performs the multivariate test, and, if statistically significant, proceeds to see which of the variables have significantly different means across the groups (Poulsen & French, 2004). Psychologists have made extensive use of discriminant analysis especially in the areas of personnel and education setting (Klecka,1980).

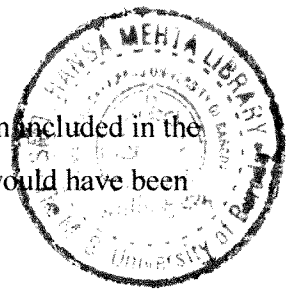
Table No 4.6

GROUP STATISTICS						
	GROUP I (N = 126)		GROUP II (N = 23)		TOTAL (N = 149)	
	LD-0		LD-1			
VARIABLE NAME	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
COLCANCL	0.84	1.32	2.65	2.66	1.12	1.72
VDT1T	0.68	0.7	1.13	0.92	0.75	0.75
VDT2T	0.83	0.7	1.39	0.94	0.92	0.77
SOT1T	0.78	0.67	1.39	0.94	0.87	0.75
SOT2T	0.8	0.96	2.04	1.52	0.99	1.15
SOT3T	0.75	0.7	1.52	0.9	0.87	0.78
LAR	0.68	1.34	2.26	1.96	0.93	1.55
TBT	0.8	0.9	1.78	1.28	0.95	1.03
PROT	0.84	0.96	1.61	1.23	0.96	1.04
SIMT	0.36	0.59	0.78	0.67	0.42	0.62
CLOT	0.66	0.69	1.17	0.98	0.74	0.77
SAT	1.21	1.27	3.13	1.79	1.5	1.53
VMST1T	0.51	0.9	1.87	1.58	0.72	1.14
VMST2T	0.99	1.06	2.48	1.73	1.22	1.3
VMST3T	0.85	1.26	1.78	1.93	0.99	1.42
VMT	1.13	1.36	3.43	2.71	1.49	1.83
ADT	2.07	1.52	3.91	2.63	2.36	1.85
AMT	0.79	0.94	2	1.83	0.98	1.2
RECLANG	0.28	0.55	0.7	0.88	0.34	0.62
VET	1.28	1.42	3.04	1.99	1.55	1.65
PST	0.79	0.75	2	1.41	0.97	0.99
SST	0.56	0.59	1.35	1.11	0.68	0.75
LRT	0.36	0.54	0.65	0.65	0.4	0.57
PAT	0.66	0.66	1.43	1.08	0.78	0.79
LBST	0.76	0.86	1.7	1.18	0.91	0.97
LPMT	0.64	0.73	1.35	1.11	0.75	0.84
RHYT	0.88	0.79	1.52	1.31	0.98	0.91
B1T	1.02	0.85	1.65	1.23	1.11	0.94
B2T	0.77	0.72	1.43	1.16	0.87	0.83
RNER	0.37	0.79	0.91	1.28	0.46	0.9

This is the table of means which tells us the mean and standard deviation for each of our variables broken down by category membership

Table No 4.7

Analyasis Case Processing Summary			
Unweighted Cases		N	Percent
Valid		149	100.0
Excluded	Missing or out-of-range group codes	0	0.0
	At least one missinf discriminating Variable	0	0.0
	Both missing or out-of-range gorup codes and at least one missing discriminating variable	0	0.0
	Total	0	0.0
Total		149	100.0



This table tells us that 100% of the 149 cases in the data file have been included in the analysis. If any case had a missing value for one the variables then the case would have been dropped from the analysis and this would have been reported in the table.

Table No 4.8

Tests of Equality of Group Means					
	Wilks' Lambda	F	df 1	df 2	Sig.
AGE (MO)	0.99	0.85	1	147	0.36
COLCANCL	0.85	25.20	1	147	0.00
VDT1T	0.95	7.18	1	147	0.01
VDT2T	0.93	10.99	1	147	0.00
SOT1T	0.91	14.30	1	147	0.00
SOT2T	0.85	26.73	1	147	0.00
SOT3T	0.87	21.30	1	147	0.00
LAR	0.86	23.14	1	147	0.00
TBT	0.88	19.95	1	147	0.00
PROT	0.93	11.35	1	147	0.00
SIMT	0.94	9.80	1	147	0.00
CLOT	0.94	9.30	1	147	0.00
SAT	0.79	38.74	1	147	0.00
VMST1T	0.81	33.96	1	147	0.00
VMST2T	0.83	30.55	1	147	0.00
VMST3T	0.94	8.90	1	147	0.00
VMT	0.79	38.35	1	147	0.00
ADT	0.87	22.03	1	147	0.00
AMT	0.87	22.54	1	147	0.00
RECLANG	0.94	9.22	1	147	0.00
VET	0.85	26.20	1	147	0.00
PST	0.80	36.59	1	147	0.00
SST	0.85	25.52	1	147	0.00
LRT	0.97	5.39	1	147	0.02
PAT	0.87	21.53	1	147	0.00
LBST	0.88	20.15	1	147	0.00
LPMT	0.91	15.09	1	147	0.00
RHYT	0.94	10.21	1	147	0.00
B1T	0.94	9.40	1	147	0.00
B2T	0.92	13.45	1	147	0.00
RNER	0.95	7.36	1	147	0.01

This table tells us whether there is a significant effect of category for each of the predictor variables. For example here we can see that there is significant difference.

The Wilks' lambda (F test) is used to test whether or not the discriminant model is significant as a whole. If the F test shows the overall significance of the model, then the individual variables are accessed to see which variable will move the significance from the group mean (Burr, & Doak, 2007).

4.7.1 Box's Test of Equality of Covariance Matrices

Table No 4.9

Log Determinants

LD	Rank	Log Determinant
0	31	-27.769
1	[a]	[b]
Pooled within-groups	31	-24.153

The ranks and natural logarithms of determinants printed are those of the group covariance matrices.

a. Rank < 23

b. Too few cases to be non-singular

Test Results[a]

Tests null hypothesis of equal population covariance matrices.

a. No test can be performed with fewer than two nonsingular group covariance matrices.

4.7.2 Summary of Canonical Discriminant Functions

Table No 4.10

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.672[a]	100.0	100.0	.634

a. First 1 canonical discriminant functions were used in the analysis.

This Eigenvalue is a measure of how well the discriminant function discriminates between the categories (the larger the value the better the discrimination). The % of variance column helps in comparing the relative success of the functions. The Eigenvalues : This is also called characteristic root, which tells us the variance explained by each discriminant function.(Burr, & Doak, 2007).

Table 4.11

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.598	67.829	30	.000

This table provides a test of null hypothesis that the value of the discriminant function is the same for our test and for the teacher's rating scale. Wilki's lambda tells us whether the

independent variables have been categorized significantly, successfully by the group membership decided in the predictive variable. All the independent variables used in the newly developed test have been significantly discriminated by the grouping variable decided on the basis of the teacher's rating given to the children. Chi square is significant which explains that the grouping variable significantly discriminates the independent variables.

Table 4.12

Standardized Canonical Discriminant Function Coefficients	
Name of Test	Function
	1
AGE_MO	-0.02
COLCANCL	-0.16
VDT1T	0.01
VDT2T	-0.28
SOT1T	-0.23
SOT2T	0.04
SOT3T	0.18
LAR	-0.28
TBT	0.10
PROT	-0.10
SIMT	-0.19
LPMT	0.33
RHYT	-0.16
B1T	-0.27
B2T	0.17
RNER	-0.60
CLOT	-0.06
SAT	0.39
VMST1T	0.47
VMST2T	0.14
VMST3T	-0.13
VMT	0.69
ADT	-0.06
AMT	0.01
RECLANG	-0.47
VET	0.07
PST	0.55
SST	0.08
LRT	-0.20
PAT	0.28
LBST	0.33

This table tells us the extent to which each of predictor variable is contributing to the ability to discriminate between the categories. The discriminant function coefficients denote the unique contribution of each variable to the discriminant function, while the structure coefficients denote the simple correlations between the variables and the functions. The coefficients have been standardized so that one can compare the contribution of each

regardless of the units in which it is measured. Rather like correlation coefficients, the values range from -1 to+1.

Table 4.13

Structure Matrix	
Name of Test	Function
	1
SAT	0.63
VMT	0.62
PST	0.61
VMST1T	0.59
VMST2T	0.56
SOT2T	0.52
VET	0.52
SST	0.51
COLCANCL	0.51
LAR	0.48
AMT	0.48
ADT	0.47
PAT	0.47
SOT3T	0.46
LBST	0.45
TBT	0.45
LPMT	0.39
SOT1T	0.38
B2T	0.37
PROT	0.34
VDT2T	0.33
RHYT	0.32
SIMT	0.32
B1T	0.31
CLOT	0.31
RECLANG	0.31
VMST3T	0.30
RNER	0.27
VDT1T	0.27
LRT	0.23

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions Variables ordered by absolute size of correlation within function.

This table tells us about the contribution that each variable is making to the discriminant function. In this table the variables are ordered by the magnitude of their contribution.

Table 4.14

Functions at Group Centroids

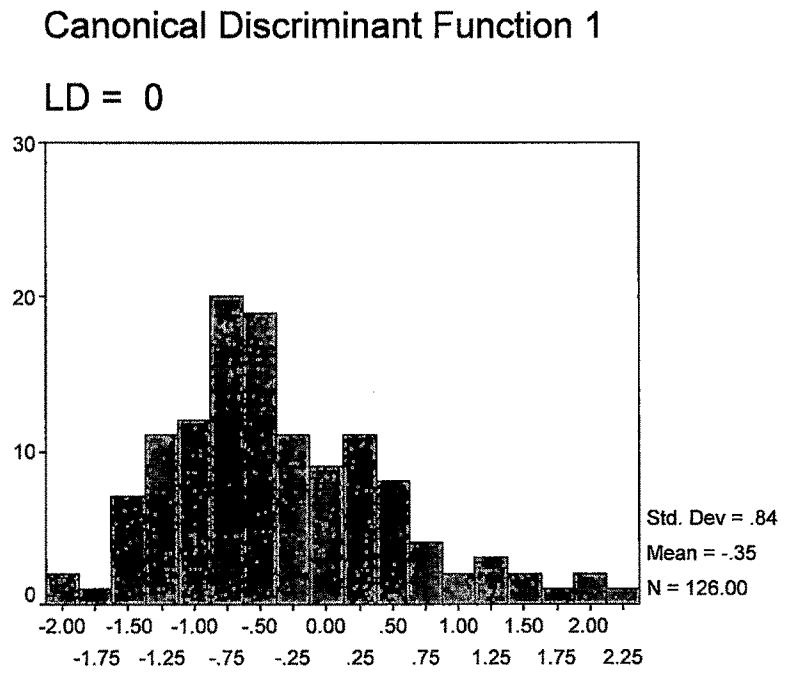
LD	Function 1
0	-.348
1	1.905

Unstandardized canonical discriminant functions evaluated at group means

This table gives the mean value of the discriminant function for each of the categories. Note that in this table the mean value of the function is positive for learning disabled children but negative for non learning disabled (normal) children. In this way the function is discriminating between the two categories of children.

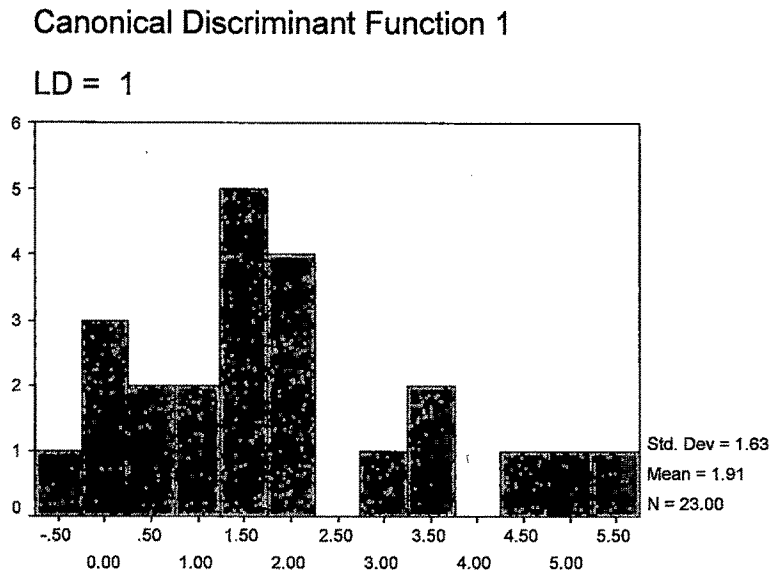
4.7.3 Separate-Groups Graphs

Graph No 4.2



Group graph of children without learning difficulty

Graph No 4.3



Group graph of children with learning difficulty

These are the separate groups' plots we requested in the discriminant analysis: classification dialogue box. We can see that the distribution of the discriminant function values differs for those with or without learning difficulty.

Table No 4.15

Classification Results[a]

			Predicted Group Membership		
		LD	0	1	Total
Original	Count	0	113	13	126
		1	7	16	23
	%	0	89.7	10.3	100.0
		1	30.4	69.6	100.0

a. 86.6% of original grouped cases correctly classified.

This is the summary table. It provides a particularly useful summary of the success or otherwise of our discriminant function. It shows a cross tabulation of the category membership.(earning difficulty or not) against that we would have predicted using our discriminant function. In this case we can see that 113 cases the discriminant function

correctly predicted that the child would not have learning difficulty and in 16 cases it correctly predicted that they would have learning difficulty. Thus, 129(113+16) of our 149 cases were correctly classified – a success rate of 86.6% as noted in the foot note of the table." However , the table also shows us that 30.4% of the children predicted not to have learning difficulty had learning difficulty and that 10.3 % of the children predicted to be learning disabled were not learning disabled.

Psychologists have made extensive use of discriminant analysis especially in the areas of personnel and education setting.

4.8 Discriminant Report

A Discriminant analysis is performed with learning difficulty as the discriminating variable and age, visual discrimination, spatial orientation, left and right, top and bottom, test of proximity, similarity, closure, visual motor skills, visual memory, auditory discrimination, auditory memory, language- receptive and expressive, picture sequencing and story sequencing test, literacy readiness test, phonemic awareness test, letter and the beginning sound test, letter and phoneme matching test, rhyming, blending, rapid naming objects. A total of 149 cases were analyzed.

Univariate ANOVAs revealed that the children with and without learning difficulty differed significantly on each of the thirty predictor variable. A single discriminant function is calculated. The value of this function is significantly different for the children with and without learning difficulty (chi square = 67.829, df=30, $p < 0.0005$).

The correlation between predictor variables and the discriminant function suggested that visual memory test and picture sequencing test were positively correlated and is the best predictor of future learning difficulty. The rapid naming test is negatively correlated suggesting that children who made no errors in this test would not have learning difficulty in future. Overall the discriminant function successfully predicted outcome for 86.6% of children, with accurate predictions being made for 89.7% of children who do not have learning difficulty and 69.6% of children who have learning difficulty.