

## Research Report

# DEVELOPMENT AND PRELIMINARY VALIDATION OF A SCREENING TOOL FOR SPECIFIC LEARNING DISORDER IN CHILDREN

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### ABSTRACT

**Background:** Delay in early diagnosis of Specific learning disorder (SLD) is influenced by various factors, including the lack of simple yet validated tools for assessment.

**Objective:** We aimed to develop and validate a screening questionnaire in English and Malayalam for SLD in children aged 7-11 years, which can be used easily. This paper deals with the initial development and preliminary validation of the tool, which was subsequently validated in a larger sample and had already been published.

**Materials and methods:** The tool was validated using a case-control methodology. It was developed after ensuring face and content validity, and suitable modifications were done based on the internal consistency measure and factor analysis results. The tool was applied in children with SLD and two groups of controls. ROC curve analysis was done to find the optimum cut-off, and validity parameters were estimated.

**Results:** A total of 21 SLD, 42 normal and 37 borderline intelligence children, were studied. The final tool with 26 items had good Cronbach's alpha (0.95) and area under the curve values (0.96). The tool had good sensitivity (100 %) and specificity (77.2%), i.e., if the score is <10, we can rule out SLD.

**Conclusions:** We propose a new screening tool for SLD with promising reliability and validity characteristics that need to be evaluated further.

**Keywords:** Specific learning disability, Validation, Specific learning disorder, Screening tool.

### INTRODUCTION

Specific learning disability has been included as one of twenty disability conditions by the Government of India in 2016 in the Revised Persons with Disability act (RPWD).<sup>1</sup> This condition has been recognised in clinical

population for quite some time, but its awareness among general public and teenagers is inadequate. The addition of this condition to the category of disability necessitates systematic efforts in identification and intervention. There is a need for simple

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validated screening and diagnostic tools in vernacular languages; we had developed a screening tool in Malayalam that is simple and easy to use by parents, teachers and mental health professionals.<sup>2</sup> In this paper we concentrate on development of the tool and initial validation part, which was done on a sample of 100 students with scholastic backwardness in Calicut district, Kerala, India.

Specific learning disorders (SLD) are a group of neurodevelopmental disorders characterised by persistent and impairing difficulties in learning foundational academic skills for reading, writing, and/or maths.<sup>3</sup> These difficulties should not be better accounted for by intellectual disabilities, uncorrected visual or auditory acuity, other mental or neurological disorders, psychosocial adversity, lack of proficiency in the language of academic instruction, or inadequate educational instruction. SLDs includes disorders of reading, written expression and mathematics.

SLD occurs in students irrespective of their mother-tongue and medium of instruction<sup>4</sup>. This is a major cause of academic underachievement in young children. The early detection of SLDs is often affected by many factors like poor classroom conditions, multilingualism, different syllabi, socio-economic backwardness and medium of instruction. Lack of simple yet validated tools for assessment are issues that impede early diagnosis. Early detection helps in developing individualised learning strategies for each child, thereby helping them to overcome their deficits. Poor detection can be due to the stigma perceived by parents to consult mental health professionals who are the key stakeholders in learning disorders for

evaluation of academic backwardness. Early detection could be achieved by a valid and reliable screening tool that can be used by teachers or parents. To the best of our knowledge, most of the available tools available can only be used by a trained mental health professional and are time consuming<sup>5</sup>.

Moreover, such tools are not available in the local languages of India, which has about 22 major languages. If a tool is developed in any local Indian languages, it would be an ideal tool to validate in other Indian languages too. Such a tool can also be used with advantage for screening all school students to find out the hidden morbidity.

An ideal screening tool suited for any population should be culturally sensitive, able to be used by parents, teachers and mental health professionals, should be inexpensive, valid, reliable, and easy to administer so that we can identify at-risk children who need further definitive assessment. This study aims to develop and validate screening questionnaire in English and Malayalam for learning disorder in children aged 7-11 years, which can be used by parents, teachers, mental health professionals, and others who work in this field.

## **METHODOLOGY**

### **Tool development**

This is the initial development and preliminary validation part of the tool, which was subsequently validated in a larger different sample and already published.<sup>2</sup> Authors searched for terms 'specific learning disorder, learning disorder and learning disability, India' in electronic journals and other online platforms. Also searched books and made personal communication with experts in this field. The search yielded tools

like screening instrument to predict learning disorder in children aged 6 to 14 years, screening checklist for specific learning disability<sup>6</sup> and the *Sarva Shiksha Abhiyan* Screening Checklist for Learning disability. Items for the screening tool were prepared based on existing instruments to ensure content validity. The tool was first prepared in English as the available diagnostic and screening tools were in that language. This was later translated to Malayalam using WHO translational method.<sup>7</sup> Initial forward translation to Malayalam was done by first author and back translation by two qualified and experienced psychiatrists. All of them were proficient in both languages. Consistency between original and translated version was ensured by consensus among investigators and translators. This tool was then sent to five experts (including two Psychiatrists and three clinical Psychologists) to ensure face validity. The tool was modified after obtaining suggestions from these experts. Questions with items spanning different domains were included (Reading, Writing/spelling/language, and Arithmetic), and this initial tool had 37 items covering these domains.

### **Study sample**

Both cases and controls were recruited from school-going children between ages of 7-11 years attending government and private schools financially aided by the Government in Calicut educational district. Children with a minimum age of seven and above were selected because of poor diagnostic reliability below this age. Data collection was done between April and August 2015, and the sample size was 100. For sensitivity and specificity of 60% each with 20% absolute precision, a sample size of 20 cases and 20

controls were needed. We planned to take 20 LD cases, 40 students referred for poor academic performance, and 40 normal controls. The study was approved by the Institutional Ethics Committee of the institution. Informed consent was obtained from parents and assent obtained when required in the local language. We decided to use a case-control design as a cross-sectional study which is ideal for evaluating a new tool, will require a large number of students to be evaluated to detect this much number of SLD cases. The tool was applied in 3 groups of children, one case group and two control groups. The case group were school children who satisfy learning disorder criteria as per Diagnostic and statistical manual-5 (DSM-5)<sup>3</sup> attending child guidance clinics of multiple hospitals in Calicut district. The first control group were children with borderline intelligence who were selectively included in the study to know about the ability of the newly developed tool to differentiate between learning disorder and closely mimicking condition like borderline intelligence. These children were also selected from same clinics from which the cases were selected. The second controls were a group of normal school children, and they were also evaluated by DSM-5 criteria for absence of learning disorder and were of the same age group. This tool was introduced to the students either by the teacher for the normal children selected in the school and by parents for children with borderline intelligence and learning disorder. All subjects were evaluated by DSM-5 criteria and diagnosis was made by the principal investigator who is a psychiatrist with training and experience in diagnosing and managing children with LD. IQ assessment was mainly based on clinical

assessment with the help of DSM-5 criteria. Those children with criteria not sufficient for mild intellectual disability but at the same time had a global delay in adaptive functions, and scholastic impairment was included under borderline intelligence. The researcher was blinded to the scores obtained in the screening tool of all the three groups of children. Data were entered into Microsoft excel sheet by an independent person and analysis was done using Statistical manual of social sciences version 17(SPSS-17).

**Tool assessment**

Inter item correlation and item-total correlations were assessed for all items in the tool and were used to remove relatively less important items. Cronbach’s alpha was calculated to assess internal consistency. Factor analysis was done to assess the construct validity of the tool. Domains having initial Eigenvalue more than one were selected. Loading of individual items into different domains was assessed by varimax rotation of the loaded items. Any score > 0.6 in the rotated solution was taken as the cut off for loading of the items. If any item was cross loaded in two domains with values less than 0.6 in each domain, it was eliminated if it was not an important item, after obtaining consensus among researchers.

**Validity Measurement**

Receiver operating characteristic (ROC) curve analysis was done to find out the best cut off points for differentiating the learning

disorder children from others. The area under the curve (AUC) was calculated to find out the accuracy of the tool. Validity parameters like Sensitivity, Specificity, and Positive and Negative predictive values (PPV and NPV) and Likelihood ratios (LR) for different ranges were calculated along with their 95% confidence interval. The total score with this refined tool was calculated and was summarised as mean and standard deviation (SD). Scores were compared between cases and controls using the Mann Whitney U test or Kruskal Wallis test.

**RESULTS**

A total of 21 SLD patients, 42 normal controls, and 37 borderline intelligence patients were recruited for the study. The socio-demographic characteristics of the study groups are shown in table 1. The initial tool with 37 items was tested in this group. Of the original tool, 11 items were removed after the initial internal consistency assessment and factor analysis. Cronbach’s alpha of the modified tool (with 26 items) was 0.95, indicating excellent internal consistency of the tool. Factor analysis with varimax rotation yields a five-factor model, which explained 74.3% of the total variability without much cross-loading. The results of the factor analysis are shown in table 2. ROC curve analysis showed good agreement of the tool with an AUC (95% CI) of 0.96 (0.92 to 0.99) for LD versus the total controls, as shown in figure 1a.

Table 1. Demographic characteristics of the study population

Study characteristics	LD patient, n (%)	Borderline Intelligence controls, n (%)	Normal controls, n (%)	Total controls, n (%)
Age >=9 yrs.	16 (76.2)	8 (21.6)	11 (26.2)	19 (24.1)
Males	11 (52.4)	26 (70.3)	26 (61.9)	52 (65.8)

Table 2. Results of factor analysis

Domain	Item number	Loading value	
Domain 1	Q1	0.87	
	Q4	0.74	
	Q5	0.83	
	Q6	0.64	
	Q7	0.58	
	Q8	0.66	
	Q9	0.56	
	Q10	0.87	
	Q11	0.88	
	Q13	0.74	
	Q15	0.87	
	Q16	0.70	
	Q17	0.77	
	Q18	0.84	
	Q19	0.65	
	Q20	0.76	
	Domain 2	Q12	0.79
		Q14	0.77
		Q*21	0.50
Q25		0.76	
Q26		0.69	
Domain 3	Q21*	0.52	
	Q22	0.79	
	Q23	0.81	
Domain 4	Q24	0.77	
	Q3	0.81	
Domain 5	Q2	0.89	

\*Q 21 was cross loaded in domains 2 and 3 but was retained as it was considered as an important item.

The Final tool was equally good for differentiating LD cases from normal control (AUC (95% CI) =0.98 (0.96 to 1.00)) and from Borderline intelligence control (AUC (95% CI) =0.93 (0.86 to 0.99)) as shown in figure 1b and 1c. An optimal cut-off was derived from the ROC analysis, and a score of >10 had the optimum validity parameters for differentiating LD cases from normal

controls, borderline intelligence control, and the total controls as shown in table 3.

A score of 20 or more has a negative LR of 17.6, while the negative LR for a score of 11 to 19 was 1.8 and that for a score of less than ten was 0. Mean (standard deviation or SD) of the tool in the three different study groups are shown in table 4. LD patients have significantly higher scores than normal control and patients with borderline intelligence as shown in table 4.

## DISCUSSION

We have developed a tool in both English and Malayalam to screen students aged 7 to 11 years for learning disorder after studying all available tools and discussion with experts. In this initial part, preliminary validation and development of the tool have been completed. After this initial study final validation was done, and we found that the tool has good validity to differentiate SLD patients from normal subjects and other mimicking conditions. The final tool in Malayalam consists of 26 items and takes around 25 minutes for introduction and evaluation of a child. This tool showed good internal consistency and five domains emerged during factor analysis. It is available in local language as well as English. If the cut off score  $\leq 10$ , we can rule out the disease, thus can be effectively used as a screening tool. If the Score is 11-20, then we need a definitive assessment to confirm LD and if score > 20 indicates a diagnosis of LD. The final tool showed good sensitivity and specificity to differentiate children with LD from normal subjects. Any screening tool should have good sensitivity and a high negative predictive value so that the people who have the disease are not missed, and any subject

Table 3. Validity measures for the final tool

Parameter	LD patient Vs. Normal controls	LD patient Vs. Borderline Intelligence	LD patient Vs. Total controls
Sensitivity (95% CI)	100 (84.5 to 100)	100 (84.5 to 100)	100 (84.5 to 100)
Specificity (95% CI)	90.5 (77.9 to 96.2)	62.2 (46.1 to 75.9)	77.2 (66.8 to 85.1)
PPV (95% CI)	84.0 (65.4 to 93.6)	60.0 (43.6 to 74.5)	53.9 (38.6 to 68.4)
NPV (95% CI)	100 (90.8 to 100)	100 (85.7 to 100)	100 (94.1 to 100)
+ LR	10.50 (6.43 to 17.14)	2.64 (2.30 to 3.04)	4.39 (3.94 to 4.89)
- LR	0	0	0

CI – confidence interval; PPV – Positive predictive value; NPV – Negative predictive value; LR- Likelihood ratio

Table 4. Summary measures for scores in different groups

Parameter	LD patient, n (%)	Borderline Intelligence controls, n (%)	Normal controls, n (%)	Total controls, n (%)
Mean (SD)	20.3 (3.2)	10.1 (5.9)	3.6 (5.6)	6.6 (6.6)
Range	11 to 23	2 to 23	0 to 20	0 to 23
P-value		<0.001 <sup>#</sup>	<0.001 <sup>#</sup>	<0.001 <sup>§</sup>

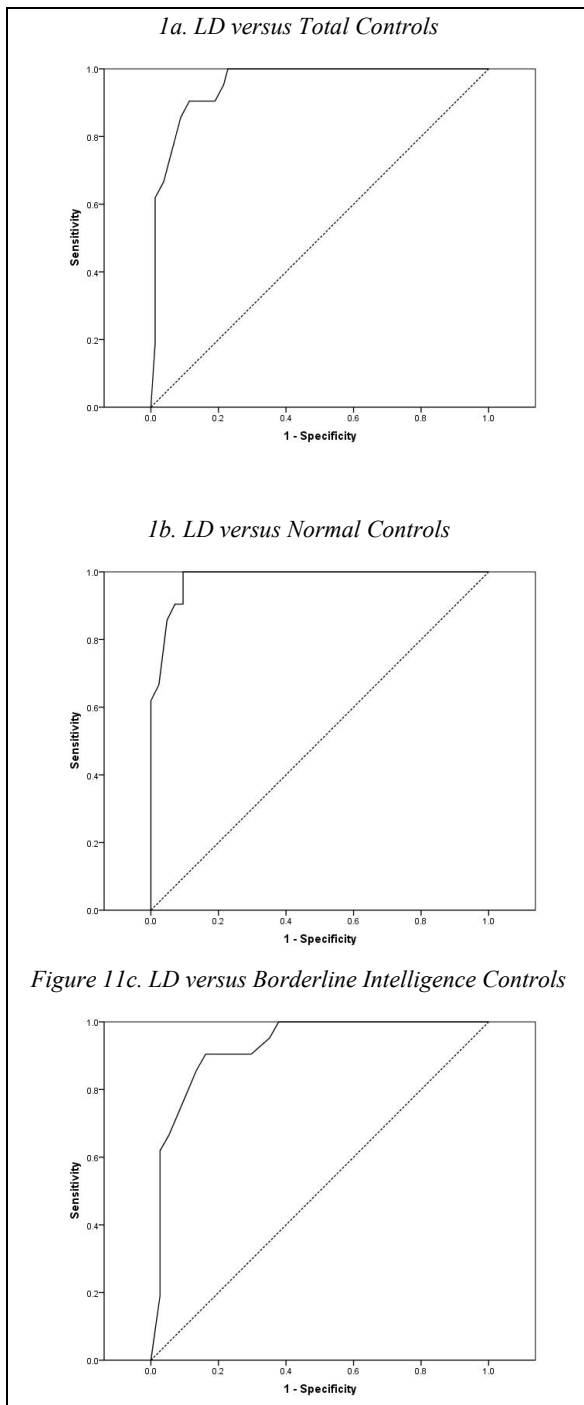
# - p-value obtained by Kruskal Wallis test followed by post hoc analysis using the Bonferroni test.

§ - the p-value obtained by Mann Whitney U test, SD-standard deviation

who comes as negative should be free from the disease. This screening tool has good sensitivity and good negative predictive value while the specificity and positive predictive values were moderate to good. Here the positive and negative predictive values are applicable only in settings that have an SLD prevalence of around 20%. One limitation of this initial work is the use of the case-control methodology. Ideally, tool evaluation should be done in a cross-sectional manner in a school set up. We had to adopt a case-control study as the chance of obtaining a reasonable sample of pure LD cases are relatively difficult if we used a cross-sectional method.

Our tool was applied in the 7-11 year age group only and its utility in other age groups has to be studied further. As the participants were recruited from child guidance clinics, there is a chance of them getting remedial training. This is another limitation and participants from non-intervention group were ideal for a screening tool development. The distinction between subjects with borderline intelligence and mental retardation was based on clinical observation, and this is another limitation. We believe that screening of school children for LD would become easier with the availability of such a reliable and valid tool. This would lead to early detection and appropriate interventions.

Figure 1. ROC curve of the tool



## CONCLUSION

We have developed a new tool in assessing learning disorder, and this tool showed promising reliability and validity characteristics for future evaluation.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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