



## Introducing First Screen: A Software Application for Students at Risk for Specific Learning Disabilities

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### ABSTRACT

This study examines the psychometric properties of First Screen, a free app to screen for Specific Learning Disabilities (SLD). First Screen measures nine domains: Reading, Writing, Oral language, Mathematics, Motor and Sensory, Social skills, Attention/hyperactivity, Executive Functioning, and Memory. Upon completion, the app immediately provides one of three recommendations: Full Assessment, Watch and See, or No Concern. A total of 284 parents or teachers in India completed First Screen to report on the abilities of children, ages 6 to 11. A subset ( $n = 84$ ) completed First Screen, and their children completed direct testing.

Cronbach's alphas of First Screen indicated good to very good internal consistency (0.84 to 0.94 per domain; 0.98 overall). The correlation between the categorical results of First Screen and direct testing was moderate to strong: Cramer's  $V = 0.44$ . Sensitivity reached an adequate level (0.81), while specificity was low (0.57). However, for screening purposes, high sensitivity is required, and lower specificity is tolerable (Bujang & Adnan, 2016). First Screen is a reliable and valid screening tool to help identify risk for SLD. Advantages to this tool are free access, ease of use, and availability in Hindi and English.

**Keywords:** Screening tool, identification, early intervention, India, SLD

### INTRODUCTION

Learning Disabilities, also referred to as Specific Learning Disabilities (SLD), has been defined in different ways among professionals, be it educators, psychologists, speech-language pathologists, teachers and even ophthalmologists. A well-established definition of SLD from the United States Individuals with Disabilities Education Act (IDEA, 1975) is "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself into the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations." Such a term does not include "a learning problem that is primarily the result of visual, hearing, or motor disabilities, of intellectual disabilities, of emotional disturbance, or of environmental, cultural, or economic disadvantage." 20 U.S.C Section 1401 (30).

As understood from this definition, children with SLD have difficulties in reading, writing, and/or mathematics in large part due to difficulties in spoken or written language. Robaey (2013) suggested that children with "true" learning disabilities are eligible for special education because their learning issues are intractable to general education instruction. Nonetheless, Sheldon Horowitz, the director of LD Resources at the United States National Center for Learning Disabilities (2014), remarks, "Learning disabilities are not a prescription for failure. With the right kinds of instruction, guidance and support, there are no limits to what individuals with LD can achieve."

Global estimates of the prevalence of SLD are difficult to find, and national-level estimates vary significantly. For example, a number of countries, including Germany, Australia, and the United States, report prevalence ranges from 5-17% (Kena et al., 2016; Moll et al., 2014; Prior et al., 1995; Shaywitz, Morris, & Shaywitz, 2008; Westwood & Graham, 2000). Other countries, such as Russia and Nigeria, report lower rates between 5-8% (Grigorenko, 2020; Onukwufor, 2016).

In India, awareness of SLD is emerging. Indian census data is often used to report on CWSN (children with special needs). However, the last census of 2011 did not reflect the Indian SLD population; Though it included five types of disabilities, SLD was not one of these (National University of Educational

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Planning and Administration, NUEPA, 2011). SLD was officially recognized in India in 2016. According to the Right of Persons with Disabilities (RPWD) Act, SLD was defined as “a heterogeneous group of conditions wherein there is a deficit in processing language, spoken or written, that may manifest itself as a difficulty to comprehend, speak, read, write, spell, or to do mathematical calculations and includes such conditions as perceptual disabilities, dyslexia, dysgraphia, dyscalculia, dyspraxia and developmental aphasia” (The Gazette of India, Ministry of Social Justice and Empowerment, 2018).

With the inclusion of SLD in the RPWD Act 2016, there has been a surge in the prevalence rate in India though the true picture is yet to emerge (Kuriyan & James, 2018). Prevalence of SLD in India is estimated at 5-10% of children (Gajre et al., 2015), with dyslexia (difficulty in reading) being the most common prototype. However, SLD identification rates in the Indian population can vary widely from 0.1-20% of the student population. The expected total number of children with SLD could be approximately 40 million (Gupta & Whitehead, 2014).

There are many challenges faced in India on supporting children with SLD. A major problem is the lack of availability of trained professionals for assessing and treating SLD. Considering SLD was only recognized as a disability in 2016, the number of trained professionals as compared to the population is very small (Agrawal, 2015). The shortage of professionals has been partially addressed with additional teacher training to promote more inclusive classrooms for children with SLD (e.g., Buli-Holmberg & Jeyaprabhan, 2016; Srivastava, et al., 2017).

Children with SLD are at risk of being misdiagnosed or labelled with derogatory names, sowing the seeds of inadequacy and low self-worth early in life. Without a proper diagnosis and intervention, children with SLD may even suffer from anxiety and depression, which have adverse effects on their physical and mental health (Huang et al., 2020). The need of the hour is to “catch them young” facilitating early intervention and equipping the children with coping strategies for their difficulties.

Screening tools can play a vital role in improving identification procedures by raising awareness about SLD and directing children at risk of SLD for more complete testing (Hayes et al., 2019). Less training is required to administer screening tools compared to full assessments. Additionally, access to screening tools can be substantially improved through the use of technology. To illustrate, Ekhsan and colleagues (2012) created a computer-based screening tool for dyslexia for use in Malaysia and found that it had comparable results to a paper-based version with the added benefit of being more engaging for students.

Finally, teachers and parents can be involved in screening procedures, thus, increasing the number of children who can complete screening. Teachers and parents play a critical role in identifying SLD as they are the most familiar with their child or student's abilities. For example, parents have been reliable reporters of their children's vocabulary and grammar in English-speaking samples (Thal et al., 1999) and many other languages

(Fenson, n.d.). Teacher report, in combination with direct measures of children's language, have been essential in identifying developmental language disorder, particularly in countries with a shortage of trained specialists (e.g., Pham et al., 2019). Indeed, teacher training has been highlighted as a top priority in the SLD field worldwide (Johnson & Webb, 2017). Thus, involving teachers and parents in SLD identification can substantially increase the number of children screened for the disorder, which in turn can increase awareness and motivation to seek further assessment when needed.

### Study Purpose and Research questions

The overall goal of this study is to introduce a newly created screening tool for SLD. In India there is no such screening tool available, a fact which laid the foundation of developing First Screen for the Indian populace. First Screen is currently available as an app in two languages, Hindi and English. A bilingual version helps to reduce the barriers of accessibility for both teachers and parents in India. Using technology to aide in screening is particularly useful for remote areas of limited resources. It is imperative to validate the First Screen app to ensure that the items are correctly understood and interpreted by the target audience, namely parents and teachers. The validation stage is crucial to ensure that the screening tool is psychometrically sound. In evaluating this new tool, we ask the following research questions:

1. What are the psychometric properties of the First Screen app?
2. How do the results of the First Screen app, a report measure, correspond to results from direct testing?

## METHOD

### Participants

Respondents to the First Screen app reported on the skills of 284 children, ages 6-11, from grades 1-5 receiving formal schooling in North India. The target child sample consisted of more males (65.1%) than females (34.9%). However, this uneven gender distribution was consistent with the student body in the Indian education system where enrollment of males is higher than females (Ministry of Human Resource Development, 2018). The sample was distributed across all income levels: 20% of the sample belonged to the Economically Weaker Section (EWS) of the society.

### First Screen App

The First Screen app has 90 items which are spread across 9 domains, including Reading (13 items), Writing (14 items), Oral language (8 items), Mathematics (11 items), Sensorimotor (13 items), Social skills (4 items), Attention/hyperactivity (14 items), Executive Functioning (7 items) and Memory (6 items). The scoring for each item is a 3-point scale, i.e., 0 = never, 1 = sometimes, 2 = always. Wherein, 2 stands for negative, i.e., the child has a difficulty in the given items which is consistent, and 0 stands for a positive, i.e. the child does not have any difficulty in the given item. A score of 1 indicates that the child has some difficulty in the given item. Figure 1 displays a sample item from the First Screen app in the Mathematics domain.

Figure 1. Sample item of the First Screen app

**FIRST SCREEN**

22/90

Has difficulty remembering math facts, like addition, subtraction and especially the multiplication tables.

No/NA ☐ Yes ☐

Sometimes ☐

**18** **NEXT**

Responses are recorded as 0 = No/NA; 1= Sometimes; or 2 = Yes.

Because each domain had a different number of items, raw scores were converted to percentages to compare performance across domains. Based on the information gathered during piloting, we derived an operational definition of concern: A domain that is of no concern is highlighted in green (score of 0-40%), domains highlighted in yellow (40-60%) means the child needs more practice, and domains highlighted in red (60-100%) means that there are significant concerns.

Upon completion, the First Screen app immediately provides one of three recommendations:

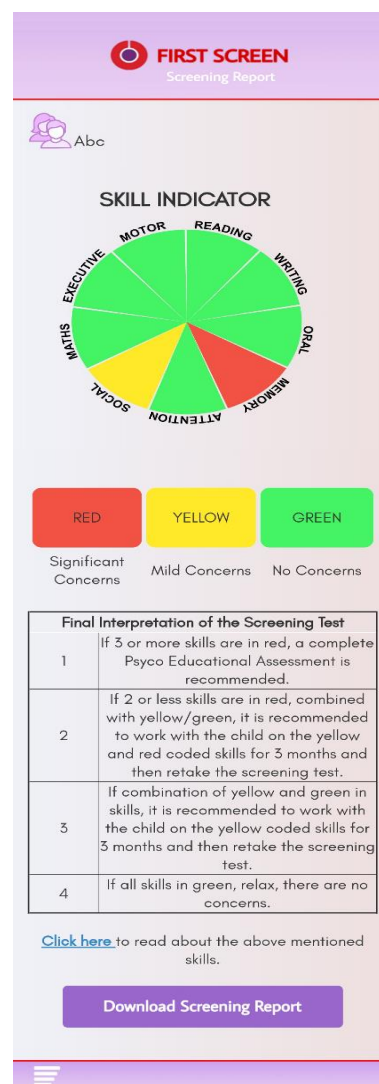
- No Concern: If all domains are flagged as green, then it means that the child's skills are age appropriate. No further action is needed.
- Watch and See: If any domain is flagged as yellow or if there is a combination of domains in red (2 or less) and yellow flags, it is recommended to provide the child with additional practice and review after 3 months.
- Full Assessment: If 3 or more domains are red flagged, it is recommended that the child complete formal psychometric assessment along with a vision and hearing evaluation.

Figure 2 displays the feedback report of the First Screen app that includes the colored highlights and a summary of how to interpret the results.

### Procedures

The First Screen app was completed by teachers or parents of school-age children. Parents and teachers were recruited with approval from collaborating schools. All instructions on the usage of the app appeared on the screen before the teachers/parents took the screening. Written consent was taken prior to the screening. Upon completion, a feedback report for each child was generated with a suggested plan of action (see Figure 2).

Figure 2. First Screen Results pages



Direct testing was conducted on a subsample of children (N=84) randomly selected from the full sample to validate the screening results generated by First Screen App. Information about children's native language and spoken language were collected from the school records. A combination of two psychometric assessment tools were used to confirm the presence of SLD.

Raven's Progressive Matrices (RPM): Intelligence Quotient (IQ) assessment tool originally developed by John C. Raven in 1936. The tool estimates nonverbal fluid intelligence and abstract reasoning for individuals ranging from 5 to 80 years of age. The RPM consists of 60 multiple choice questions listed in order of difficulty. In each item, the test taker is asked to identify the missing element that completes a pattern (Raven & Raven, 2003). This IQ tool was chosen as it is a performance-based tool which eliminates the barrier of language bias. As per Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5: American Psychiatric Association, 2013), there is no longer a requirement to document an IQ-achievement discrepancy. Thus, the RPM was used to rule out intellectual disability (i.e., exclude children with a standard score of 70 or below).

National Institute of Public Cooperation and Child Development (NIPCCD) Educational Assessment Battery for Scholastic Backwardness: Educational assessment battery developed in India. The battery comprises assessment of basic academic skills in the English language, Hindi language, and Arithmetic for children up to grade 5. The English Language component uses Brigance Diagnostic Comprehensive Inventory of Basic Skills and Schonell Graded Spelling Test for assessment of reading and spellings skills, and written expression skills developed by the NIPCCD Child Guidance Centre. The Hindi Language component uses tasks developed and tested by the NIPCCD Child Guidance Centre along the graded curricular demands in a format similar to the Brigance Inventory and Schonell Test. The tasks for arithmetic skills were developed and tested by the NIPCCD Child Guidance Centre along the minimum learning levels developed by National Council of Educational Research and Training (NCERT). The skills were designed to assess children's knowledge of arithmetic concepts, operations, computational skills and application skills for each grade level. The current battery was chosen for psychometric assessment because it is bilingual in English and Hindi and was designed for use in Indian academic settings (National Institute of Public Cooperation and Child Development, 2003).

Based on the above-mentioned tools, children were diagnosed with SLD when their IQ score on RPM was within the average range and their scores on the NIPCCD in both languages (Hindi and English) were below 2 or more grade levels.

#### Data Analysis

To evaluate the psychometric properties of the First Screen app (Research Question 1), we measured the internal consistency reliability and concurrent validity. Internal consistency reliability was measured by calculating Cronbach's coefficient alphas for the First Screen total score (90 items) and each of the nine domains. Cronbach's alphas of 0.70 or higher are considered acceptable (DeVellis, 2003). We evaluated concurrent validity using ANOVAs to determine group differences in the total score and nine domains. We predicted that the No concern group would score the lowest, the Full assessment group would score the highest, and the average scores of the Watch and See group would fall in between.

To compare First Screen results to direct testing (research question 2), we calculated Cramer's V to examine the correlation between the categorical results of the First Screen (No Concern, Watch and see, and Full Assessment) and categorical results from standardized testing (SLD, low performance, or no difficulties). Cramer's V was based on a subset of participants ( $n = 84$ ) who completed both the First Screen and direct testing. We qualitatively described the First Screen results as related to the testing outcomes. Finally, we calculated diagnostic accuracy measures of sensitivity and specificity to quantify the alignment between First Screen and the standardized test.

## RESULTS

### Research Question 1: Psychometric Properties

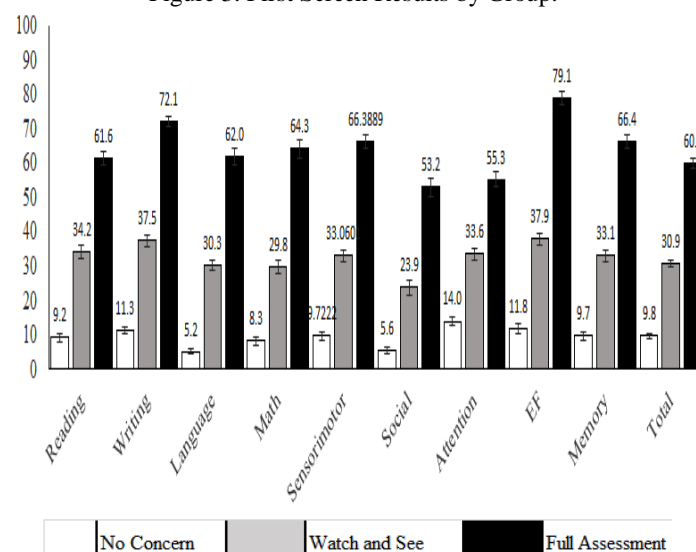
Table 1 displays Cronbach's alphas for the total score and each of the 9 domains. Alpha values ranged from 0.835 to 0.943 for the domains, and 0.979 for the total score, indicating very good internal consistency.

Table 1. Cronbach's Alphas for First Screen.

Domains	#Items	Alpha Value
Reading	13	.932
Writing	14	.926
Oral language	8	.883
Mathematics	11	.943
Motor and Sensory	13	.849
Social	4	.835
Attention	14	.890
Executive Functioning	7	.912
Memory	6	.852
<b>Total Items</b>	<b>90</b>	<b>.979</b>

Figure 3 displays the mean percentage scores and standard error bars for the total score and 9 domains by the three categories resulting from the First Screen: No Concern, Watch and See, and Full Assessment. All ten one-way ANOVAs were statistically significant ( $p < 0.001$ ). All post-hoc comparisons revealed the following results for the total score and each of the nine domains ( $p < 0.001$ ): No Concern < Watch and See < Full Assessment. As predicted, the No Concern group scored the lowest followed by the Watch and See group. The Full Assessment group scored the highest, indicating the highest level of concern.

Figure 3. First Screen Results by Group.



All group differences were statistically significant: No Concern < Watch and See < Full Assessment. Items were scored on a 3-point scale: 0 = No/Never, 1 = Sometimes, 2 = Yes/Always. Because each domain had a different number of items, the Y-axis represents the sum of scores converted to a percentage. EF = Executive Function.

### Research Question 2: Correspondence with Direct Testing

In order to examine how First Screen performs as a screening tool, a randomized sample of 84 participants completed the First Screen app and direct testing. Results from the RPM showed that all 84 children scored 80 or higher, indicating nonverbal



intelligence within the average range. Based on the NIPCCD, children were classified into three categories: No difficulties, low performance, and SLD. Children classified as having “low performance” showed academic difficulties due to second language exposure. Low performance was operationally defined as children who performed below 2 grade levels in English but showed Hindi skills that were age appropriate, or vice-versa.

A chi-square test of independence between the categorical results of the First Screen and standardized test, NIPCCD, showed a statistically significant association,  $\chi^2(4) = 32.003$ ,  $p < .001$  (see Table 2). According to (Cohen, 1988), this association corresponded to a medium to large effect size, Cramer's  $V = .436$ , indicating a high correspondence between First Screen and direct testing.

Table 2. Cross-Tabulation of the Categorical Results of First Screen and Direct Testing.

Cross Tabulation		Direct Testing			Total
		No Concerns	Low Performance	SLD	
First Screen	No Concerns	14	3	0	17
	Watch and See	11	5	5	21
	Full Assessment	5	20	21	46
	<b>Total</b>	30	28	26	84

Note. Cross Tabulation was used to calculate Cramer's  $V$ . Direct testing was based on the NIPCCD achievement test. Low performance indicated low scores in one language (English or Hindi) but not the other. SLD= Specific Learning Disability.

Table 2 presents the cross-tabulation table of classification results from the First Screen and standardized testing. The following is a qualitative description:

- Out of 17 children predicted to have No Concern by the First Screen app, 14 were confirmed to have no difficulty based on standardized testing. Three samples showed low performance on the standardized test. However, low performance in these cases were due to limited second language exposure and not considered to be indicative of a disorder. No children in the No Concern group were identified with SLD by the standardized test. In most cases (14 or 17), the No Concern recommendation by the First Screen app aligned with direct testing to confirm the absence of SLD.
- Out of 21 children in the Watch and See group, 11 had no difficulty based on standardized testing, 5 showed low performance, and 5 were diagnosed with SLD. Standardized test results reflected the ambiguity expressed by the Watch and See category of the First Screen app.
- Out of 46 children for which Full Assessment was suggested by First Screen app, 5 had no difficulty based on standardized testing, 20 showed low performance, and 21 were diagnosed with SLD. For most cases (41 of 46), the concern expressed by the Full Assessment recommendation of First Screen was

reflected in the low scores from direct testing, whether the low scores were due to second language exposure or to SLD.

To further analyze the data for diagnostic accuracy, we collapsed classification categories into a 2x2 cross-tabulation table (see Table 3). We considered the “Full Assessment” group as the positive screening result because this category corresponds to the recommendation to seek a full evaluation. We considered the results of “No Concerns” and “Watch and See” as a negative screening result because these categories correspond to recommendations to take no action or to hold off on taking further action. The psychometric assessment was considered the reference standard. We considered the results of “SLD” to indicate the presence of the condition, learning disability, and the results of “No difficulty” or “Low Performance” to indicate the absence of a disorder.

Table 3. Cross-Tabulation to Calculate Diagnostic Accuracy Measures

	Condition		Totals
	Absent	Present	
Test Positive	25	21	<b>46</b>
Test Negative	33	5	<b>38</b>
<b>Totals</b>	<b>58</b>	<b>26</b>	<b>84</b>

Using this 2x2 cross-tabulation (Table 3), we calculated diagnostic accuracy measures of sensitivity, specificity, positive likelihood ratio (LR+), and negative likelihood ratio (LR-). According to Plante and Vance (1994), sensitivity and specificity values above 0.80 are considered adequate and above 0.90 are considered good. According to Dollaghan (2007), LR+ of 1 is uninformative and 3 is a moderately positive test; for LR-, 1 is uninformative, and less than 0.30 is a moderately negative test.

As shown in Table 4, sensitivity reached an adequate level, indicating that 81% of students with SLD were correctly identified using the First App screen. However, only 57% of students without SLD were correctly identified as typically developing (specificity).

Table 4. Diagnostic Accuracy Results of the First Screen.

Measure	Value	95% Confidence Interval
Sensitivity	0.81	0.60-0.93
Specificity	0.57	0.43-0.70
Positive Likelihood Ratio	1.87	1.32-2.66
Negative Likelihood Ratio	0.34	0.15-0.76

## DISCUSSION

The purpose of this study was to introduce a new computer software application, First Screen, to screen for SLD in India. This new screening tool is currently available in English and Hindi. The psychometric properties presented here are from the

English data because Hindi data collection ceased prematurely due to the Covid-19 pandemic.

First Screen shows strong internal consistency. Cronbach's alpha values ranged from 0.835 to 0.943 for the nine domains and ensured very good internal consistency. The three categories that corresponded to the app's recommendations to parents and teachers (No Concern, Watch and See, and Full Assessment) performed as expected at the group level: The No Concern group had the lowest scores in each domain, the Watch and See group had higher scores than the No Concern, and the Full Assessment group had the highest scores, indicating the most significant concern.

Further, the results of the first screen app corresponded to direct measures from a randomised sample of 84 participants. In most cases (14 or 17), children who were recommended by the First App as having No Concern also did not show any concern from direct testing. Also, no child in the No concern group was later identified with SLD from direct testing. Additionally, most cases that the First Screen recommended as Full Assessment (41 or 46) showed concern from direct testing, whether it was SLD or low performance related to second language exposure.

Finally, diagnostic accuracy calculations revealed adequate sensitivity (0.81) indicating that the First screen app was able to screen the students with SLD. Specificity did not reach an adequate level (0.57), indicating that students without SLD were incorrectly detected to be at risk for the disorder. Nonetheless, the purpose of a screening tool is to detect risk. Thus, having higher sensitivity than specificity is consistent with this purpose, as screening tools should lean towards over-detection than under-detection. Detecting more children than needed is one way to ensure that children are referred for further testing to diagnose SLD. This result is to be expected as screeners such as First Screen were not designed to replace full diagnostic assessment. Rather, the purpose of First Screen is to indicate when there could be a risk for SLD (i.e., sensitivity) so that parents can follow up with a full assessment.

## STUDY LIMITATIONS AND FUTURE DIRECTIONS

One study limitation is that teacher and parent responses were analyzed as one sample. The current analysis did not allow for the comparison between parent and teacher responses. Larger samples of parent and teacher report and corresponding direct child measures are needed to examine potential differences based on respondent characteristics.

This paper focuses on the English version of the First Screen app. Data collection for the Hindi version was stopped midway due to the Covid pandemic 2019-2020. Once we are able to return to data collection, we aim to report on the validity of the Hindi version. Additionally, there is current work to translate the tool to additional Indian languages including Urdu, Punjabi, Marathi, Gujarati, Assamese, Tamil, Telugu, Kannada, Malayalam and Bengali. This translation process will undergo back translation to ensure linguistic accuracy. Future investigation is needed to validate this tool across multiple languages and to consider potential cultural and linguistic differences in how diverse populations respond to items.

## CONCLUSION

From the above results it is evident that the benefits of First Screen are multifold, ranging from early identification of 'at-risk' children, which in turn can facilitate early intervention. This freely available screening tool can help to reduce the barriers of time, distance, professional services, and monetary resources. Both teachers and parents in cities and towns as well as remote regions can easily access the app with a mobile device.

The need of the hour is a coordinated effort on the part of the policy makers, service providers, teachers and parents to contribute towards helping children who are steadily slipping through the cracks in our education system. It is the constitutional right of every child in India to access education and become independent constructive citizens and this very much includes children with SLD.

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**Conflict of Interest:** The first two authors are affiliated with Orkids Foundation, the organization that created the screening tool under study. To promote objectivity and high research rigor, the fourth author, who was not involved in the creation of the tool or in data collection, conducted an independent analysis of the data.

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