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ORIGINAL RESEARCH

Seguin Form Board as an intelligence tool for young children in an Indian urban slum

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Abstract

Objective: The present study evaluates the concurrent and predictive validity of the Seguin Form Board Test (SFBT) as an intelligence tool for children in low- and middle-income countries.

Methods: In a cohort of normal children, followed up in South India, two cross-sectional analyses were done at 3 and 7 years of age on 95 children. The SFBT and Vineland Social Maturity Scale (VSMS) were done at 3 years of age and Malin's Intelligence Scale for Indian Children (MISIC) and the VSMS were done at 7 years of age, and the results were compared for concurrent and predictive validity for the SFBT.

Results: Intelligence quotient and social quotient had positive correlations at 3 years of age, indicating fair concurrent validity. The SFBT done at around 3 years of age had good positive correlation with MISIC at 7 years of age, indicating good predictive validity.

Conclusion: This study shows the utility of the SFBT as a community-based intelligence tool with acceptable concurrent and predictive validity.

Keywords: Intelligence tests; Seguin Form Board Test; Malin's Intelligence Scale for Indian Children; Vineland Social Maturity Scale

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Introduction

Child-developmental disabilities in the community need to be identified early for any corrective intervention. Identification of developmental delay and other neurodevelopmental disabilities in the early formative years in children is essential to promote prompt and appropriate intervention at the earliest opportunity to optimize the developmental potential of each child [1, 2]. Early screening and identification of such delays and disabilities are more critical in low- and middle-income countries (LMICs), where more than 200 million children younger than 5 years fail to achieve their full potential [3].

Several psychological assessment tools and screening measures are available to assess the level of functioning of the individual child, encompassing intelligence, learning profile, personality, and behavior of the child. Though widely used, most of the intelligence tests are limited, concrete, and specific in their assessments; many circumventing the 'multiple intelligences' proposed by Gardener [4]. The fact that intelligence is a complex construct comprising a range of functions from abstract reasoning to adaptation skills has also restricted our understanding and development of appropriate intelligence assessment tools [5].

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Furthermore, an important challenge in early identification of developmental disability is having tools that respond to local differences, including cultural perceptions in meaning of childhood ability levels, and that can be used across countries [2, 6, 7]. Besides the differences in the factor constructs, the performances and interpretations in intelligence measures differ furthermore between nations and cultural settings [8, 9]. While many standardized tools developed in Western countries have been validated in their settings, there are many practical limitations in score interpretation and implementation in resource-constrained settings in LMICs [6].

The conventional intelligence tests predominantly look at mathematical and verbal intelligences, and are difficult to execute and validate in very young children. Moreover, these tests require a trained child psychologist, and are arduous in community settings with respect to their duration, administration guidelines, and strict protocols. Consequently, there is a need for a short, easy-to-use test of ability that can be used as a quick screening tool in the preschool age of 3–5 years, especially in community settings in LMICs. The current study was undertaken in this context with the objective to evaluate the concurrent validity for the Seguin Form Board Test (SFBT), a culture-fair cognitive test, with the Vineland Social Maturity Scale (VSMS) at 3 years of age and the predictive validity with Malin's Intelligence Scale for Indian Children (MISIC) at 7 years of age.

Materials and methods

The present study is part of a wider study of a birth cohort of 452 children from a semiurban slum area in Vellore, South India [10], in whom diarrheal episodes were being followed up for 3 years for studies on rotaviral [11–13] and cryptosporidial [14] diarrhea. The study is designed as a panel study using a modified longitudinal design that performed cross-sectional analyses for intelligence and social maturity at 3 and 7 years of age in part of a birth cohort of children to evaluate long-term effects on cognition of early childhood diarrhea. A subsample of 116 children enrolled in the birth cohort underwent intelligence and social maturity assessments at 3 years of age, and 291 children were assessed at 7 years of age. Written consent was obtained from the parent/s about the assessment tools, what the child would have to do, and the approximate time required had been explained to them.

Assessment tools

Seguin Form Board Test

In 1856 Seguin developed a simple performance-based intelligence test using form boards to evaluate eye–hand coordination, shape concept, visual perception, and cognitive ability through nonverbal means. It is used to assess the participants' motor dexterity, visuomotor coordination, spatial organization, and speed and accuracy of performance, and can be used in children as young as 3 years [15, 16]. The form board consists of 10 differently shaped wooden blocks, and the participants are required to fit the differently shaped blocks into their respective slots on the form board. This culture-fair test, which can be easily administered in 10 min, is used for preliminary assessment of mental age in a normal population.

The task administration involved three consecutive trials with an instruction to start placement of blocks at the command "Start." Speed is stressed at the start of the test, with no further between cues or assistance being provided to the child. The best time from three trials was used to determine a mental age from the standard chart, which was subsequently used in determination of the intelligence quotient (IQ) [17].

Vineland Social Maturity Scale

The VSMS, originally developed by E.A. Doll in 1935, was adapted to the Indian scenario by Malin [18]. It is a semistructured assessment based on an interview of the caregiver and evaluates the social ability of the child.

In this questionnaire method, adaptive functioning is measured in the context of self-help skills, self-direction, socialization, and communication. The measure has eight social domains with 89 items, and can be used from birth to 15 years. The VSMS has good concurrent validity of at least 0.8 with intelligence tests in children with mental retardation [19, 20]. The maturity age associated with the level of functioning was calculated along with a social maturity age that is then converted to an index called the 'social quotient' (SQ).

Malin's Intelligence Scale for Indian Children

MISIC, the Indian adaptation of the Wechsler Intelligence Scale for Children [21], measures verbal and performance abilities, and can be administered by a trained psychologist to children to assess intelligence from 6 years onward [22–24]. The intelligence scale measured as the full IQ is obtained from six verbal subscales and five performance subscales. The verbal scale measures verbal information and language development and comprehension, using the following subtests: information, similarities, arithmetic, vocabulary, comprehension, and digit span. The performance scale has the following subtests: picture completion, coding, picture arrangement, block design, and object assembly. The raw scores obtained from the verbal subscales are converted into standardized scores to derive the verbal IQ. Similarly, the performance subscales yield the performance IQ, and the cumulative score of the verbal and performance subscales gives the full-scale IQ. The test has a reliability coefficient of about 0.9, and the concurrent and congruent validity scores are both around 0.6 [16, 17].

Procedure

Institutional ethics committee clearance was obtained for this study, and the institutional review board approved both assessment protocols. The 3-year assessment was performed between June and December 2005, and the 7-year assessment was performed between December 2009 and April 2010.

For the purpose of this study, all measures were translated to the local language, Tamil, and back-translated, and a pilot study was conducted for appropriateness of measures and items, before the commencement of individual assessments. At 3 years a medical research officer trained in testing evaluated the children with the SFBT and the VSMS. At 7 years a child psychologist assessed the children using MISIC and the VSMS. Both assessments were conducted in a distraction-free environment in a separate quiet room in the field clinic. The respective intelligence and social maturity tests were completed on the same day. The assessment of socioeconomic status was performed with the modified Kuppuswami scale [25].

Statistical analysis

All study variables were summarized with use of descriptive statistical methods. Analysis was done after adjustment of the data for socioeconomic status and sex. Concurrent validity was analyzed by evaluation of the relationship between IQ and SQ at 3 years of age with use of Pearson's correlation coefficient (r). Predictive validity was calculated with use of Pearson's correlation coefficient between IQ at 3 years of age and IQ at 7 years of age. Partial correlation coefficients were calculated to adjust the data for the effect of sex, socioeconomic status, and birth weight on the relationship between scores. A P value of less than 0.05 was considered statistically significant. All analysis was done with STATA 10.0 (StataCorp, College Station, TX, USA).

Results

For the 3-year assessment, 116 children were evaluated at an average age of 3.46 years (standard deviation 0.37 years). The 7-year assessment included 291 children at an average age of 7.23 years (standard deviation 0.38). Ninety-five children underwent both the 3-year assessment and the 7-year assessment (Fig. 1). Table 1 shows the sociodemographic profile of the 95 children. The children studied are representative of the total study population.

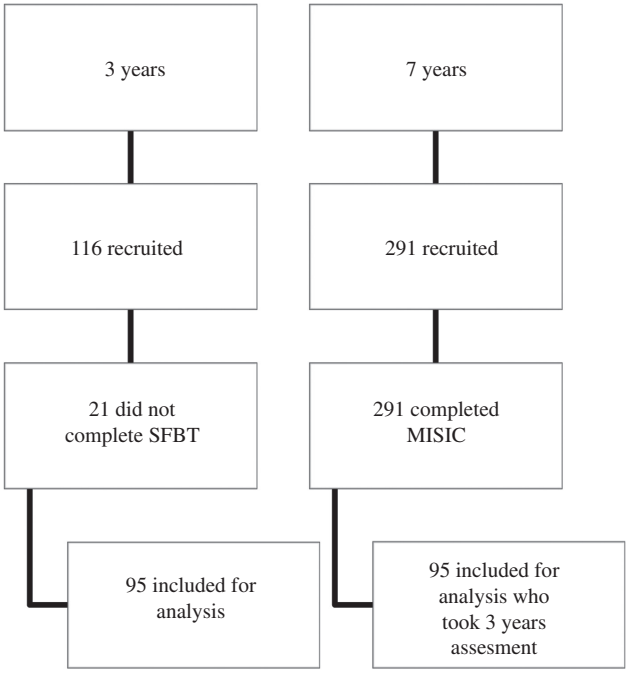

Fig. 1. Flowchart depicting numbers of participants in both assessments

Table 1. Comparison of sociodemographic characteristics between the study population and the birth cohort nonparticipants in the study

Variable	Nested study (*n*=95)	Others (*n*=357)	*P*-value
Male[a]	52 (54.74%)	175 (49.02%)	0.322
Socioeconomic status[a]			
Low	58 (61.05%)	223 (62.46%)	0.536
Middle	34 (35.79%)	114 (31.93%)	
High	3 (3.16%)	20 (5.60%)	
Housing[a]	17 (17.89%)	59 (16.53%)	0.870
'Pucca'	52 (54.74%)	191 (53.5%)	
Mixed	26 (27.37%)	107 (29.97%)	
'Kutcha'	17 (17.89%)	59 (16.53%)	
Maternal education[a]			
Nil	38 (40.00%)	101 (28.29%)	0.053
1–5 years	29 (30.53%)	98 (27.45%)	
6–8 years	15 (15.79%)	90 (25.21%)	
>8 years	13 (13.68%)	68 (19.05%)	
Maternal age at birth[b]	23.89 (4.45)	23.61 (4.09)	0.548
Family size[c]	5 (4–6)	5 (4–6)	0.061
No. of siblings[c]	2 (1–3)	2 (1–3)	0.089
Low birth weight[a,d]	9 (9.78%)	42 (12.03%)	0.548
Presence of domestic animals	14 (14.74%)	46 (12.89%)	0.636

[a]χ^2 test.

[b]Two-tailed *t*-test. The mean is given, with the standard deviation in parentheses.

[c]Mann-Whitney *U* test. The median is given, with the interquartile range in parentheses.

[d]Data not available for 11 children.

For the SFBT at 3 years of age, 21 children could not complete the test within the stipulated time. The internal consistency of the three trials for the SFBT was high at 0.906. The 3-year analysis showed an average mean intelligence (IQ) of 110.7 on the SFBT, significantly lower than the corresponding mean social maturity score (SQ) of 121.1 (t=–3.05, P=0.002). The 7-year analysis showed a low normal mean intelligence (IQ) of 85.5, significantly lower than the corresponding average social maturity quotient (SQ) of 101 (t=–8.97, P<0.001). Table 2 summarizes the IQs and SQs for children assessed at both 3 and 7 years of age.

Table 2. Summary of intelligence and social quotients in the children assessed at both 3 and 7 years (*n*=95)

Test type	Test and coefficient	3 years		Test and coefficient	7 years	
		Mean	SD		Mean	SD
Intelligence	SFBT (IQ)	110. 7	18.0	MISIC, full scale (IQ)	85.5	11.6
				MISIC (VQ)	84.0	11.1
				MISIC (PQ)	82.7	15.2
Social maturity	VSMS (SQ)	121.3	28.7	VSMS (SQ)	101.0	12.2

IQ, intelligence quotient; MISC, Malin's Intelligence Scale for Indian Children; PQ, Performance intelligence quotient; SD, standard deviation; SFBT, Seguin Form Board Test; SQ, social quotient; VQ, Verbal intelligence quotient; VSMS, Vineland Social Maturity Scale.

Concurrent validity for the SFBT

IQ had a moderate positive correlation with SQ at 3 years of age (r=0.39, P=0.04). After we had controlled for the effects of sex, socioeconomic status, and birth weight, the adjusted correlation between IQ and SQ at 3 years of age was 0.38 (P=0.04). For comparative purposes, the adjusted correlation between IQ and SQ at 7 years of age was 0.40 (P<0.001).

Predictive validity for the SFBT

There was a moderate positive correlation between the IQs measured by the SFBT and MISIC. Comparing the analysis at three and 7 years of age, the adjusted Pearson's correlation coefficient for IQ was 0.66 (P<0.001), after we had controlled for the effects of sex, socioeconomic status and birth weight. IQ at 3 years correlated with both Verbal IQ (r=0.57, P=0.001) and Performance IQ (r=0.54, P=0.003).

Discussion

The results of the study suggest that the SFBT has moderate concurrent validity with the VSMS and moderate predictive validity with MISIC at a later age. This tool can evolve as an effective community-based intelligence-testing tool in resource-limited settings. The brevity of the test, its portability, the ability to arouse attention or sustain interest, and the ease of administration are some of reasons that the SFBT lends itself to be used as a screening tool before further referral for early learning interventions [26]. To the best of our knowledge, this is the first study attempting to correlate an early assessment tool such as the SFBT with intelligence testing at a later age in resource-poor settings. The current study enhances the already existing literature by presenting good concurrent, and predictive validity for this measure in the community setting.

The children included in the present study are representative of the cohort population and consisted of an almost equal number of boys and girls. The mean SQs at both 3 and 7 years of age are higher than the corresponding mean IQs. The difference was statistically significant at both 3 years (P=0.002) and 7 years (P<0.001) of age. The children examined in our study scored well on the self-help items of the VSMS, giving them a better score than the corresponding intelligence scores.

Other comparative studies have also reported a similar finding of social score being better than the intelligence/developmental score. Bhave et al. [27, 28] showed that significantly higher mean SQs than mean developmental quotients were obtained on the same set of children. Song and Jones [29] reported an overestimation of social age by 1–2 years with the VSMS in normal children. However, studies by Raggio et al. [30] have shown comparable SQs and developmental quotients.

This study shows that there is a positive correlation between IQ and SQ at 3 and 7 years of age. The strength of the relationship was comparable at both 3 and 7 years of age. This is an important finding showing not just concurrent corroboration but also stable properties of the intelligence construct measured by the SFBT to later years, both valuable properties essential in intelligence assessments in community settings.

Indian studies have shown a good correlation of social ability with intelligence tests in children with intellectual disability or mental retardation [19]. Although social adaptability is different from intelligence, the VSMS can be used in resource-poor settings to pick up deviations, enabling the health worker to refer the child for further evaluations. However, the VSMS, as with other parent-report questionnaires, is a subjective interpretation of ability. The Vineland Adaptive Behavioral Scales (VABS) [31], an extensive revision of the VSMS, may be ideal to calculate social maturity, but is yet to be adapted to the Indian scenario. Further studies are required to standardize the VABS for resource-limited settings and its correlations with the VSMS and other intelligence/developmental tools.

Some studies have evaluated the SBFT norm in Indian children. Basavarajappa et al. [32] found that the SFBT continues to remain a valid and reliable speed test of intelligence in younger children. However, they advocate separate SFBT norms to account for differences in age, sex, socioeconomic level, and residential setting (rural/urban). Thangavel [33] found that sex tends to influence the performance in children. In 1968 Ramachandran et al. [34] found that Indian children had slower performance speed than their Western counterparts. Contrarily, in 1971 Bharatraj [35] reported that a sample of Mysore children studied were on average faster than children in other reports. Goel and Bhargava [36] replicated this result in their study with a sample of Delhi school children

aged between 3 and 15 years. Verma et al. [37] reported comparatively better performance in speed of same-aged children from upper-class schools. A study by Venkatesan [38] indicated that three trials might not be sufficient to determine the mental age equivalence of the child. According to that study, the optimum performance is observed at the sixth trial. Venkatesan also computed a 'decrement score and quotient' that showed an inverse relationship between increasing calendar age of the child and the time taken to complete the test.

Although the SFBT is easy to administer and takes a maximum 10 min, it is reported to be limited in measuring only the performance intelligence such as visuomotor coordination and does not assess verbal skills [16, 39]. However, the intelligence score from the SFBT in our study had moderate positive and comparable correlations with verbal and performance scores at 7 years of age. Nevertheless, because of the very young age at the initial assessment, a significant number (18%) of children did not cooperate or complete the tests during the stipulated time and could not be included in the final analysis. Despite these limitations, the present study establishes the prospect of using the SFBT as an intelligence tool in children as young as 3 years in resource-limited settings. The utility of this test in the community is highly promising, where a trained person can screen the ability of the child before further referral.

This study analyzed children at a very young age of 3 years, an age when most cognitive assessment tests cannot be performed. Despite the floor effects of the test, most of the study children completed the SFBT. The utility of the SFBT as a school-readiness tool in very young children starting kindergarten or school in LMICs needs to be explored further, as most schools in these settings do not use any scientific measures to assess the abilities of such children. Prompt identification of additional needs at school entry can help schools, teachers, families, and children themselves to optimize resources to accomplish the best learning potential for each child.

Conflicts of interest

The authors have no conflicts of interest.

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Significance statement

The Seguin-Form Board Test (SFBT) is an intelligence testing tool that is brief, portable and easy to administer, highlighting its utility as a community screening tool in resource-limited setting. The present study demonstrates acceptable concurrent validity for SFBT as early as three years of age as well as stable properties of the construct with acceptable predictive validity with intelligence assessment at seven years of age, both valuable properties of intelligence assessments in community settings.

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