Comparison on testability of visual acuity, stereo acuity and colour vision tests between children with learning disabilities and children without learning disabilities in government primary schools

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Context: Children with learning disabilities might have difficulties to communicate effectively and give reliable responses as required in various vision function testing procedures. Aims: The purpose of this study was to compare the testability of visual acuity using the modified Early Treatment Diabetic Retinopathy Study (ETDRS) and Cambridge Crowding Cards, stereo acuity using Lang Stereo test II and Butterfly stereo tests and colour perception using Colour Vision Test Made Easy (CVTME) and Ishihara's Test for Colour Deficiency (Ishihara Test) between children in mainstream classes and children with learning disabilities in special education classes in government primary schools. Materials and Methods: A total of 100 primary school children (50 children from mainstream classes and 50 children from special education classes) matched in age were recruited in this cross-sectional comparative study. The testability was determined by the percentage of children who were able to give reliable respond as required by the respective tests. Unable to test was defined as inappropriate response or uncooperative despite best efforts of the screener. Results: The testability of the modified ETDRS, Butterfly stereo test and Ishihara test for respective visual function tests were found lower among children in special education classes ($P < 0.001$) but not in Cambridge Crowding Cards, Lang Stereo test II and CVTME. Conclusion: Non verbal or “matching” approaches were found to be more superior in testing visual functions in children with learning disabilities. Modifications of vision testing procedures are essential for children with learning disabilities.

Key words: Colour perception, learning disabilities, school children, stereo acuity, testability, visual acuity

Visual acuity, stereo acuity and colour perception had been commonly tested in vision screening program.[1-3] Snellen notation or logarithm of the Minimum Angle of Resolution (log MAR) acuity chart were commonly used as vision screening tests for reporting distance visual acuity, pseudo isochromatic plates for identifying colour vision deficiency and random-dot stereogram for measuring stereo acuity. However, less reliable responses to vision tests among children with learning disabilities has been reported.[4]

Background

The definition of children with learning disabilities varies among countries. For example in the United States, children with learning disabilities do not include learning problems that are primarily due to motor disabilities or mental retardation.[5] However, more general definition was used in Malaysia similar to the United Kingdom which included children with mental retardation as learning disabilities.[6,7] Despite the definition assist in classifying the children, the diagnosis and intervention should be specific to the individual child as they may have combination of expressive and receptive deficits (sensory and motor).[8] These problems could affect the communication and learning ability among this group of children and therefore hinder their ability to accurately respond to vision test.

In Malaysia, visual acuity (Snellen notation or log MAR charts) and colour vision (Ishihara test) screening are conducted among children aged 7, 12 and 15 years old as a part of the school health program. However, vision screening test among children with learning disabilities remained inconclusive as developmental delay especially in communication abilities affect the testability of vision tests. Evaluation on the suitability and testability of vision test is important prior to inclusion in vision screening program for any target population. Therefore, comparing the testability of the vision screening tests between children without learning disabilities in mainstream classes and children with learning disabilities in special education classes was aimed to provide additional information for vision screening design and plan especially for children with learning disabilities studying in the government primary schools.

Materials and Methods

Sample selection

In this cross-sectional comparative study, a total of 100 school children (50 from mainstream classes and 50 children from special education classes) matched in age (6 to 12 years old) were recruited. The subjects were selected using non-probability convenience sampling from four schools in Kuala Lumpur area. Children with learning disabilities were grouped based on classification by the Ministry of Education, Malaysia which included Down syndrome, mild autism, attention deficit hyperactive disorders (ADHD), attention deficit disorders (ADD), mild mental retardation and specific learning disabilities such as dyslexia.[9] The information of

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children with learning disabilities was obtained from student profile records in schools. Children who were diagnosed as low vision and blind were excluded from this study. This study was approved by Research Ethics Committee, Universiti Teknologi MARA, Malaysia in accordance with the Declaration of Helsinki of 1975. Informed consent was obtained from parents prior to this study.

Evaluation on testability of visual functions

In order to evaluate the testability of visual acuity, stereo acuity and colour perception, six tests were chosen in this study. The visual acuity of the subjects were tested using the modified ETDRS with Sloan Letters visual acuity chart (Lighthouse International, Catalogue no. C110) and Cambridge Crowding Cards (Clement Clarke, Catalogue no. 4116022). The stereo acuity was evaluated using the Butterfly Stereo acuity Test with Lea Symbols® (Vision Assessment Corporation, Catalogue no. P/N 1010) and Lang Stereo test II® (Bernell, Catalogue no. LTEST #2). The colour perception was tested using the Colour Vision Testing Made Easy® (Bernell, Catalogue no. P-227269) and Ishihara's Test for Colour Deficiency 24 Plates Edition 2009 (Kanehara Trading Inc., Tokyo, Japan). All tests were performed under full correction and room illumination of between 80 to 320 cd/m².[9]

The modified ETDRS with Sloan Letters was chosen because it is a widely recommended visual acuity test for adults. It provided a repeatable measure of visual acuity among children as similar to that reported in adults.[10] However, the finding was found inversely associated with cognitive ability of the children.[10] The Cambridge Crowding Cards were selected as an alternative visual acuity test for children with communication and learning disabilities as they could be tested using “matching” response. The Cambridge Crowding Cards were introduced mainly to address the problem of contour interaction as similar to the modified ETDRS for better detection of amblyopia.[11]

The Butterfly Stereo acuity Test and Lang Stereo test II were chosen in this study because both tests are a random-dot stereogram and they were designed to screen for gross level stereopsis without monocular depth cues.[12] Lang stereo test is one of the random-dot stereo tests that could be used without Polaroid filter while most of the tests require the use of Polaroid filter. The disadvantages of using Polaroid filter are that, the examiners are unable to observe the child’s eye during testing and some children may refuse to use the filter.

The Ishihara colour vision test was included in this study because it is a common screening tool and it was reported to have high sensitivity and specificity to detect red-green colour vision deficiency.[13] Another test with similar design of pseudoisochromatic plates is the Colour Vision Test Made Easy (CVTME). It is a recommended test for young children or mentally disabled person.[14,15] All vision assessments were using “pre-testing” approach to assure the ability of the children to understand the instruction given by the examiner in order to improve the accurate response to the respective tests.

Cambridge crowding cards

In pre-testing procedure, the model plate was placed at a 50 cm. Identical letters on a plate was placed before the subjects and they were required to match the letters on the plate similar to that was shown by the examiner. The subjects who were testable in the pre-test were then presented to the largest letter of the Cambridge Crowding Cards at a 3 m distance monocularly.

Modified ETDRS with sloan letters acuity test

The subjects were asked to identify at least one letter in the first line (Largest letters) at 50 cm in the pre-testing procedure. Then, monocular visual acuity was measured at 4m for those who were testable in the pre-test.

The butterfly stereo acuity test with lea symbols®

The Butterfly Stereo plate was presented at 40 cm before the subjects with polarized spectacle in the pre-testing procedure. Then, the subjects were asked to identify the object on the plate or grasped the object on the plate. Those who were testable in the pre-testing procedures were introduced to Lea Symbols and they were asked to recognise the symbols.

Lang II stereotest®

In the pre-testing procedures, a model picture similar to the object on the Lang Stereo test II plate was printed on a white paper and was presented at 40 cm in front of the subjects. Identical pictures were printed on a card and it was placed on the subject’s lap to be matched with the model pictures shown by the examiner. Then, the match card on the subject’s lap was replaced by the Lang Stereo test II and the examiner showed the ‘star’ model picture to be matched by the subject. Those who were testable in the pre-testing were asked to match all model pictures with the objects seen on the Lang Stereo test II plate.

Colour vision testing made easy® (CVTME)

The subjects were required to match the “car” picture in the section II with the picture on the demonstration plate in the pre-testing procedure. Then, if they were testable in the pre-testing procedure, three plates were presented sequentially and the subjects were required to match the pictures with the demonstration plate.[15]

Ishihara’s test for colour vision deficiency 24 plates

In the pre-testing procedure, the subjects were asked to trace the line presented in the last plate (plates number 24) either using a blunt pointer or using their fingers.[16] The assessment was proceeded to plates number 21 to 23 if the subjects were testable in the pre-testing procedure.

Analysis of data

Data entry and analysis was used Statistical Package for the Social Sciences (SPSS) version 15.0. The testability was determined by the percentage of children who were able to follow the instruction in the pre-test and able to respond to the tests. ‘Unable to test’ was defined as inappropriate response either due to communication problems, poor attention or uncooperative children despite best efforts of screener. Fisher’s exact test value was used in the statistical significance test of independence because it is more accurate than Chi-squared test when the expected numbers were small and the data were very unequally distributed among the cells in the table which resulted in low expected values.[17]

Results

The demography of the subjects was shown in Table 1. Children in special education classes comprised slow learner or minimum intellectual impairment (30.0%), Attention Deficit Disorder (ADD)/Attention Deficit Hyperactive
Disorder (ADHD) (20.0%), Down syndrome (22.0%), Cerebral palsy (8.0%), Dyslexia (10.0%) and Autism (10.0%). The testability of each test among children in mainstream classes and children with learning disabilities in special education classes was shown in Table 2. All children in mainstream classes were able to carry out all the vision tests giving rise to 100% testability. The testability among children with learning disabilities varied with types of test. Cambridge Crowding Cards and Lang Stereo test II showed higher testability of more than 90% while modified ETDRS acuity test, Butterfly stereo acuity test and Ishihara Test showed less than 80% testability. The testability of modified EDTRS acuity test, Ishihara Test and Butterfly stereo acuity test was found to associate with types of children ($P < 0.001$) while no statistically significance association for Cambridge Crowding Cards, Lang Stereo test II and CVTME ($P > 0.05$).

**Discussion**

The Cambridge Crowding Cards showed higher testability than the modified ETDRS acuity test among children with learning disabilities. As the Cambridge Crowding Cards does not need verbal response, children with communication difficulties and problems in identifying letters might be able to perform the test better than the modified ETDRS acuity test. Most of children with learning disabilities in the government primary schools (96%) was found able to respond to the recognition acuity task since only two children were unable to be tested using the Cambridge Crowding Cards. The use of recognition acuity task (such as in the modified ETDRS and Cambridge Crowding Cards acuity tests) is more superior than resolution acuity task (usually used in Forced-Choice Preferential Looking acuity test) because it involves not only the ability to resolve the spatial element of the stimulus, but also to perceive the element as a whole object. Therefore the letter-matching test could be recommended for children with learning disabilities who attending the government primary schools. Furthermore, the use of visual acuity test with crowding-phenomenon design such as the Cambridge Crowding Cards should be suggested for better detection of amblyopia.

Lower testability of the Butterfly stereo acuity test in children with learning disabilities compared to children in mainstream classes was found to be due to communication problems and uncooperative children who refused to use the Polaroid filter. Previous research in preschool children showed that the testability of Random Dot E, Preschool Randot and Stereo Smile after pre-training were 90%, 80% and 85% respectively. Therefore, higher testability of picture-matching techniques in the Lang Stereo test II among children with learning disabilities suggested that pre-training and two-choice procedures improved the testability in children with learning problems as similar to pre-school children.

High testability of the CVTME in both groups of children suggested its suitability as a screening tool. Children with learning disabilities was found unable to complete the tracing task in the Ishihara Test because some of them have a very short attention span such as in ADHD and some of them have difficulties to hold objects and trace the line due to fine muscular problems such as in children with cerebral palsy. Thus, four plates picture-matching test in the CVTME could be proposed as a good choice for screening tool as it is fast and easy to perform besides it has 100% compatibility with Ishihara Test.

Findings from this study recommended that vision screening tests for children should be appropriate to their learning ability and should be chosen based on their communication capability. Modifications of certain testing procedures are essential when dealing with children especially in children with learning disabilities. Proper documentation of the modified procedures is recommended as a guideline for the screeners especially among lay screeners.

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**References**

2. Chui L, Fraser T, Hoar K, LaRoche GR. Negative predictive value of a vision screening program aimed at children aged 3 to 4 years old. J AAPOS 2004;8:566-70.


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