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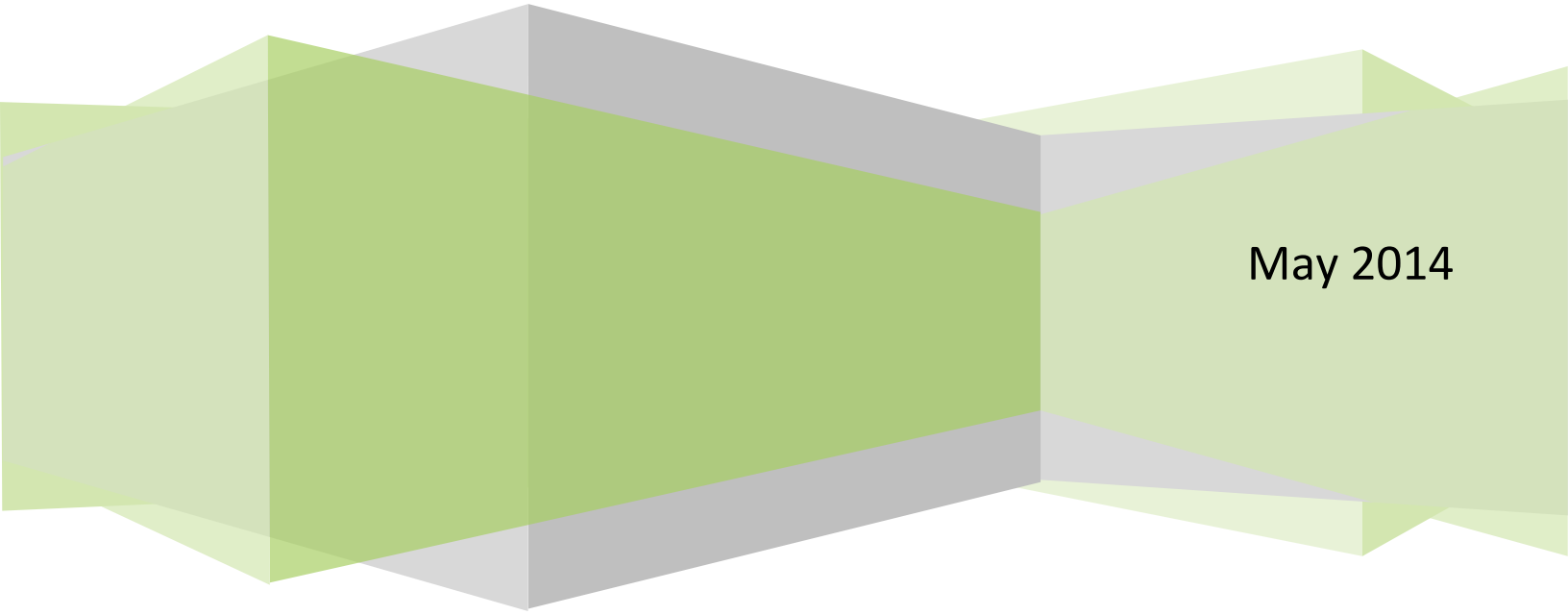
Barry Carbol, Ph.D.



May 2014

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REPORT AUTHOR

This report has been prepared by Barry Carbol, Ph.D. (Educational Measurement and Evaluation) of the Schmidt & Carbol Consulting Group. Dr. Carbol has an extensive background in the development and evaluation of standardized measurement tools and online learning applications for education.

PURPOSE OF THIS REPORT

This report provides a preliminary overview of the results of the use of the Dyslexia Quest (DQ) screening tool app at the Bristol Dyslexia Centre (BDC) and the Belgrave School in Bristol, U.K. The report briefly outlines the background of the Dyslexia Quest app and the dimensions it purports to measure, the trial process and data that resulted from the trials, and an analysis of the data and conclusions concerning the relationship between Dyslexia Quest and other standard measures.

BACKGROUND ON DYSLEXIA QUEST

SCREENING TEST DESIGN

The Dyslexia Quest app was designed to measure a number of aspects of cognitive learning that have been demonstrated through research to have an impact on literacy. The publisher of the Dyslexia Quest indicates that the app has six (6) sub-tests that measure key aspects of cognitive learning.

These are:

1. Working Memory
2. Phonological awareness
3. Processing speed
4. Visual Sequential Memory
5. Auditory Sequential Memory
6. Visual Memory

Each sub-test has ten questions (except 2 and 4, which have five questions each).

The publisher also provided the following descriptive information about the Dyslexia Quest app.

> *The 6 sub-tests are usually completed within 20 minutes. Each sub-test is given an explanation of how it impacts upon cognitive learning functions. A very weak performance is an indicator commonly associated with dyslexia. The sub-tests are presented to students in a game format. Each sub-test*

examines a different cognitive-linguistic learning ability and ends in a brief report giving an ability score. When all sub-tests have been completed an overall diagnosis is given with a more detailed explanation of strengths and weaknesses. This report can be emailed or screen-captured.

The student's age determines which set of questions they will be given (under 10 years, 11-16 years, 17+) The tests do not have to be taken all at once and if the program is exited, when resumed it will store their responses and resume at the point the activity was left. In addition to the sub-tests, the app also contains an activity of 10 multiple-choice questions that ask the student to subjectively identify how their learning is being affected. Each question set contains an option which is commonly associated with dyslexia, and if selected by the student will produce a positive indicator in the final analysis.

BACKGROUND ON THE DEVELOPMENT OF DYSLEXIA QUEST

The publishers of Dyslexia Quest have developed the app while considering the research evidence which suggests that the "most common forms of severe reading problems are caused by deficits in one or more aspects of the following cognitive linguistic abilities: phonological coding, working memory, visual sequential memory, auditory sequential memory and the cognitive speed at which symbol sound relationships can be processed."[1]

According to the publisher, app development was undertaken in collaboration with the staff at the Bristol Dyslexia Centre, in Bristol, U.K. (http://www.dyslexiacentre.co.uk/). The Centre is a part of the Belgravia School (http://www.belgrave-school.org/bdc.php) and serves a population of approximately 300 students. The Centre and its approximately 20 staff provide a range of teaching and assessment services for children and adults with a variety of learning disabilities including dyslexia.

The publisher drew on the expertise of the teachers and educational specialists at the Centre to provide advice on the development of the game-based screening tool. A number of standardized assessment tools (most notably the WISC) were also reviewed and used as a basis for the DQ app. This resulted in the 6 sub-test screening tool that makes up the current version of Dyslexia Quest.

The advice provided resulted in descriptions of student assessment activities. The following activity description relates to the visual memory sub-test:

The student is presented with a target word. When they are ready, they slide the screen up to show a column of four similar looking words and then select the correct one as quickly as they can, e.g. find 'an' from 'am ann an au' . The words selected for this sub-test are those that are most commonly misspelled. The player can take another look at the hidden word by sliding it

[1] Rationale provided by the publisher (May 2014)

back down. The number of times the student looks back is recorded as an indicator of a visual memory weakness. A selection can be changed but not once the next question has been started. Each question becomes progressively harder as more characters are introduced. There are 10 questions in three sets, one for each of three age ranges. If played again the questions change to another set (B) and reverts to the first set (A) if played a third time. The player can look back at the original word. The scoring takes account of the number of incorrect responses and the number of times the student had to refer back to the target word.

A CAUTIONARY NOTE

It is important to remember that Dyslexia Quest was designed as a low cost mobile learning app that could be used by non-professionals as a quick screening tool to identify individuals who seem to display the characteristics of those with dyslexia. As such, it is not expected to meet the same rigorous standards of measurement development that standardized assessments meet. However, it is important that the users of the DQ app have confidence in the app as a reasonable predictor for individuals displaying dyslexia systems which may warrant additional more detailed assessment.

BACKGROUND ON THE DYSLEXIA QUEST TRIALS

As a part of its development of the Dyslexia Quest app, the publisher worked with Belgravia School and Bristol Dyslexia Centre staff to administer a trial of the app and to collect data from standardized assessments. The Wechsler Intelligence Scale for Children (WISC) (along with a number of other standardized assessments[2]) was used as a comparator. The WISC (4th edition) was individually administered by a qualified educational psychologist. It is a test of cognitive ability that includes four specific cognitive areas: verbal comprehension, perceptual reasoning, working memory and speed of processing.

The majority of the trial data obtained by the publisher "compares the WISC sub-tests Digit Span and Coding with the app sub-tests for Working Memory and Processing Speed as these were the most similar in application and the trial students had all been given these assessments."[3]

The initial trial included 40 students. Ages of the students varied from 7 through 15 years. All trials were conducted at the Belgrave School and the Bristol Dyslexia Centre by the teaching staff initially in 2011. Since that time, additional data have been gathered for the purposes of further refining the screening tool and to ensure that the scoring criteria align with those of standard measures. All students participating in the trial also had an individual assessment that was conducted by the school psychologist.

[2] While a number of assessments were used, the primary standardized assessment that is the focus of this research report is the WISC (4th edition). The Comprehensive Test of Phonological Processing (CTOPP) is also used in the analysis of data related to phonological awareness.
[3] As reported by the publisher.

ANALYSIS OF THE TRIAL RESULTS

As mentioned above, the original trial data has been supplemented with additional data since 2011. The analysis of the result reported below includes data up to the spring of 2014 and includes the records of 69 students based on data provided by the publisher and the Bristol Dyslexia Centre.

The analysis considered the following relationships:

1. DQ and WISC – Working Memory[4]
2. DQ and CTOPP – Phonological Awareness
3. DQ and WISC – Processing Speed

Other data was rejected, not because it might yield useful relationships but because there were generally too few numbers to warrant an analysis which could lead to spurious conclusions.

FINDINGS AND CONCLUSIONS

A multiple regression analysis was undertaken to determine whether there was a strong enough relationship between student performance on the DQ and performance on either the WISC or the CTOPP for the three variables considered.

As can be seen in the table below, there are reasonably strong positive correlations between performance on the DQ and the CTOPP phonological awareness subtest (0.79) and between the DQ and the WISC processing speed subtest (0.73). This degree of positive correlation explains about half of the variance between the two measures. In other words, the DQ is a reasonably good predictor of results on the WISC processing speed dimension and on the CTOPP phonological awareness dimension. There is a lower correlation between the DQ and the WISC working memory (0.44). The correlations of interest are highlighted in the table on the next page.

[4] Descriptions of working memory, phonological awareness, and processing speed are found in the appendix

Table 1: Regression Analysis Illustrating the Relationship between the DQ, WISC, and CTOPP on Selected Measures (n = 69)

	DQ Working Memory	***WISC Working Memory***	***DQ Phonological Awareness***	***CTOPP Phonological Awareness***	***DQ Processing Speed***	***WISC Processing Speed***
DQ Working Memory	1					
WISC Working Memory	0.438626	1				
DQ Phonological Awareness	0.366996	0.299663	1			
CTOPP Phonological Awareness	0.120791	0.187676	0.785351	1		
DQ Processing Speed	0.422471	0.049163	0.33891	0.134772	1	
WISC Processing Speed	0.345614	0.075878	0.177698	0.072536	0.727458	1

Based on the data from the trials that were provided to this researcher, it is reasonable to conclude that the DQ app represents a very promising, quick, easy-to- use early screening tool for dyslexia. While more research is warranted, it would be reasonable for schools and districts seeking an effective screening tool for dyslexia to consider using Dyslexia Quest.

APPENDIX: DESCRIPTIONS OF WISC & CTOPP SUB-TESTS

WORKING MEMORY

This sub-test is based upon the principles of assessment used by the WISC psychological assessment sub-test**,** Digit span, which is the principle sub-test used to determine Working Memory. Digit Span Forward is the first part of this sub-test. The student is asked to repeat numbers in the order as presented by the assessor. This aspect of the sub-test involves memory, attention and auditory processing. Digit Span Backward is the second part of this subtest; it involves repeating a sequence of numbers, spoken aloud, backwards. This aspect of the sub-test involves working memory, transformation of information in memory, mental manipulation and visuo-spatial imaging. This sub-test is a core aspect of the working memory assessment and also requires auditory short term memory, sequencing skills, attention, and concentration. The Dyslexia Quest app contains a similar assessment. The student sees and hears a sequence of numbers with a half second pause between each. The sequence must then be recalled and entered from memory. The sequences to recall become gradually longer, advancing from 2 to 6 digits. After 5 questions the sub-test requires the student to recall the sequence in reverse. Scoring is the discrepancy between recall of the digits forward and back. An element of distractibility is included so that while the student is listening a small character becomes visible and makes some background sounds.

PHONOLOGICAL AWARENESS

Phonological awareness refers to an individual's awareness of the phonological structure, or sound structure, of spoken words. Phonological awareness is an important and reliable predictor of later reading ability and has, therefore, been the focus of much research. The Dyslexia Quest sub-test used to assess phonological awareness uses a similar approach to the sub-tests of Blending and Elision in the Comprehensive Test of Phonological Processing (CTOPP) assessment. The CTOPP blending sub-test presents a sequence of sounds that then have to be combined by the student into a word. The CTOPP Elision sub-test requires the student to omit or add a phoneme to make a new word. The Dyslexia Quest sub-test is made up of three different elements. Phoneme Reversal requires the repetition of a word, reversing the order of sounds, and spelling the resultant word, e.g. the student hears ‘pot’ and spells it backwards to produce ‘top’. Phoneme reversal requires the coordination of phonologic, strategic, and memory processes. The second element of the sub-test requires the student to listen to a word, omit a phoneme (beginning phoneme, end phoneme and middle phoneme) and spell the remaining word. The final element of the sub-test plays a sequence of phonemes that the student must blend and spell into a complete word.

PROCESSING SPEED

The WISC sub-test Coding requires the student to use a key to copy symbols that are paired with numbers; and draw them within a specified time limit. Coding is a core sub-test for processing speed. In addition to the speed of processing, the sub-test measures short term memory, learning ability, visual perception, visual motor coordination, visual scanning ability, cognitive flexibility, attention and motivation.

The Dyslexia Quest app Processing Speed sub-test is based upon a similar principle. The sub-test displays a key of symbols with a corresponding number. The key is hidden and the subject has to match a sequence of 20 symbols to the numbers. As a number is selected it appears above each symbol. To prevent the student from pressing all the numbers until they get the right one, once an answer has been

selected it cannot be undone. Once all the numbers have been entered, the next sequence of symbols slides on. At any time the player can slide the screen to see the key linking digits to symbols but the more times they do this the longer they will take to complete the activity. The speed of completion affects the resulting score. Timing starts when the first symbol is linked to a number and ends when the last symbol is completed.

There is no directly comparative assessment for visual and auditory memory and not enough trial students to provide comparative data but it was decided by the focus group that these were key indicators of dyslexia and should be included as part of the screening. Further research as part of a longitudinal study is required.