

Application possibilities of the Mesulam Continuous Performance Test as a diagnostic screening device for Attention-Deficit/Hyperactivity Disorder (ADHD)

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Attention-Deficit/Hyperactivity Disorder (ADHD) has been researched for many years from many diverse perspectives. This multi-disciplinary interest in the disorder has resulted in diverse and often contrasting theories regarding its aetiology, diagnosis, and treatment. Unfortunately this has led often to inadequate diagnostic and intervention practices. The aim of this research was to determine whether the Mesulam Continuous Performance Test could be applied as a user-friendly, but reliable, diagnostic screening device in the process of identifying children with ADHD. A sample consisting of a diagnosed group of ADHD learners and a control group of non-diagnosed learners was drawn from the 6–10 year old learner population of the Nelson Mandela Metropolitan Area. Both groups were subjected to the Mesulam Continuous Performance Test. Statistical analysis of the results yielded the following conclusions: the test discriminated effectively between ADHD and non-ADHD learners and the test can be used as a reliable diagnostic screening device during the process of identifying ADHD learners.

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) has been researched for many years from many diverse perspectives. This multi-disciplinary interest in the disorder has led to diverse and often contrasting viewpoints regarding the aetiology, nature, and scope of the disorder that has contributed to diagnosis of ADHD becoming a problematic and controversial issue (Nordby, 1994; Lawson, 2004; Carey, sa).

Excerpts from a press release issued by the National Institute of Health in 1998 after a conference on ADHD, reflect the problematic issues surrounding diagnosis of the disorder (Carey, sa):

- "The disorder has remained controversial in many public and private sectors"
- "Basic research is needed to better define ADHD"
- "A more consistent set of diagnostic procedures and practice guidelines is of utmost importance"

According to Carey (2002) the problems with the diagnosis of ADHD can be ascribed *inter alia* to (1) limitations in the construction of diagnostic criteria for ADHD and (2) the subjective nature of the diagnostic procedures that are implemented during the diagnosis, especially with regard to certain diagnostic tests or media.

The diagnostic criteria for ADHD as they appear in the DSM-IV (American Psychiatric Association, 1994:92-93) can be summarised as follows:

The child must display six or more of the nine symptoms of inattention and/or six or more symptoms of hyperactivity-impulsivity for a period of at least six months to a degree that is maladaptive and inconsistent with the child's developmental level. Some of the symptoms of inattention and/or hyperactivity have to be present before the age of seven years in a variety of settings, such as at school or at home, and should have resulted in clinically significant impairments in the child's social and academic functioning. These symptoms cannot be ascribed to Pervasive Developmental Disorder, Schizophrenia, or other psychotic or mental disorders.

On the basis of the above criteria, three types of ADHD can be diagnosed:

- Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type: (six or more symptoms of inattention present)
- Attention-Deficit/Hyperactivity Disorder, Predominantly Hyperactive-Impulsive Type: (six or more symptoms of hyperactivity-impulsivity present)
- Attention-Deficit/Hyperactivity Disorder, Combined Type: (six or more symptoms of both inattention and hyperactivity-impulsivity present)

The following points of criticism against the DSM-IV diagnostic criteria are documented:

According to Carey (2002) the diagnostic criteria do not effectively distinguish between "normal" behaviour, which falls within the generally accepted continuum of temperamental differences, and "ab-

normal" behaviour. People differ from one another in their attention span, concentration skills, adaptability, memory, organisational ability, and commitment. If a person is prone to being forgetful, disorganised, and easily distracted it does not imply a diagnosis of an attention deficit disorder. These behavioural symptoms are characteristic of many people who are caught up in the fast lane of our modern world. This could be one of the reasons why almost 20% of Americans responded that ADHD is a bogus disorder in an opinion poll on the disorder (Lawson, 2004).

Other points of criticism that Carey (2002) raises against the DSM-IV diagnostic criteria for ADHD revolve around the formulation of the behavioural symptoms and the cut-off point of six or more symptoms which is applied in the diagnosis of the various types of the disorder. The descriptive word "often", which appears in the formulation of all the behavioural symptoms, serves as an example. According to Carey (2002), "often" is a very subjective term and no guidelines are given for determining how "often" the behavioural items should appear. The cut-off point of six or more inattention and hyperactivity-impulsivity symptoms is problematic in the sense that, should the child present with five of these symptoms, the diagnosis is not indicated. The fact that diagnosis of the disorder depends on the presence of one additional behavioural symptom is controversial.

According to the DSM-IV (American Psychiatric Association, 2004:88-89) there are no reliable tests or assessments that have been specifically developed for clinical diagnosis of ADHD. Therefore a multitude of opinions exist about the correct diagnostic procedure for the disorder and the different types of diagnostic tests/media which should be administered during the diagnostic process. In certain cases a comprehensive diagnostic battery is compiled, which consists of a number of different tests, whilst in other cases only a single behaviour rating questionnaire is administered.

A brief description of two of the most commonly used diagnostic methods is given:

- Diagnostic interviews: These interviews are normally conducted with the child, parent(s) or a teacher and imply a thorough knowledge and understanding of the diagnostic criteria of the disorder as it appears in the DSM-IV. Unfortunately the interviewer must often rely on the subjective opinions and feedback of the interviewees and this information cannot be compared with normative data (Power & Ikeda, 1996).
- Behaviour Rating Scales: Usually these scales contain behaviour items and they are completed by either the teacher or the parents. These items are usually representative of the inattention and/or hyperactivity-impulsivity dimensions of ADHD. Some behaviour rating scales also include items that focus on the emotional and social behaviour of the child. Some examples of these scales are: the Abbreviated Connors Parent/Teacher Rating Scale (Connors, 1987), the Connors Teacher Rating Scale (Connors, 1969), and

the Attention Deficit/Hyperactivity Rating Scale (DuPaul, Power, Anastopoulos, Reid, McGoey & Ikeda, 1997).

Carey (2002) identifies the following limitations of behaviour rating scales: (1) most of these scales do not meet the criteria for psychometric tests, (2) the items in most of these questionnaires are formulated in a subjective and impressionistic manner, (3) parents and teachers are not only expected to report on a child's behaviour, but also to make clinical judgements regarding the normality of the behaviour, (4) the results of the different questionnaires correlate poorly with each other, and (5) the inter-rater reliability levels are low. These limitations of behaviour scales often result in over- or under-diagnosis of ADHD and therefore the clinical diagnosis of the disorder cannot rely solely on the results of a behaviour rating scale.

In order to compensate for the subjective nature of diagnostic interviews and behaviour rating scales, the focus of research shifted to the development and the applicability of more objective tests for the diagnosis of ADHD. The so-called continuous performance tests are results of this. Most of these tests require that the testee must concentrate with sustained attention on visual and/or auditory stimuli and respond differently to target and non-target stimuli. Computerised and pencil and paper versions of these continuous performance tests were developed and research results indicate that these tests have diagnostic application potential for the diagnosis of children with ADHD (Barkley & Grodzinsky, 1994 ; Aman & Turbott, 1986).

Research method

Problem statement

In the light of these problems surrounding diagnosis of ADHD, the diagnostic application potential of a continuous performance test, the Mesulam Continuous Performance Test (Mesulam, 1985), was determined. The research problem was formulated as follows:

Can the Mesulam Continuous Performance Test discriminate significantly between children with a diagnosed Attention-Deficit/Hyperactivity Disorder and children who have not been diagnosed with the disorder?

Research aim

The aim of the research was (1) to determine the diagnostic application potential of the Mesulam Continuous Performance Test and (2) to determine whether the test can discriminate significantly between children who have been diagnosed with ADHD and children who have not been diagnosed with the disorder.

Hypotheses

In accordance with the above research problem and aim, the following hypotheses were formulated:

Null hypothesis (H_0):

The Mesulam Continuous Performance Test cannot discriminate significantly between a group of children who have been diagnosed with ADHD and a control group of children who have not been diagnosed with the disorder.

Alternative hypothesis (H_a):

The Mesulam Continuous Performance Test can discriminate significantly between a group of children who have been diagnosed with ADHD and a control group of children who have not been diagnosed with the disorder.

The sample

Two groups of six to ten year-old subjects in the Foundation Phase, Grades 1 to 3, were involved in the research, namely, a control group ($n=1\ 144$) of children who had never been diagnosed with ADHD and an ADHD group ($n=125$) who had been independently diagnosed with the disorder and placed on stimulant medication. The following procedure was followed in the compilation of the control group:

Table 1 Biographical information on subjects in the control group

Criteria	Number	Total
Racial group		1 144
white	527	
black	292	
coloured	198	
Indian	127	
Home language		1 144
Afrikaans	359	
English	497	
Xhosa	288	
Gender		1 144
Male	560	
Female	584	
Age (years) *		1 144
6	89	
7	364	
8	381	
9	251	
10	59	
Grade		1 144
1	311	
2	480	
3	353	

Table 2 Biographical information on subjects in the ADHD group

Criteria	Number	Total
Racial group		125
white	98	
black	13	
coloured	13	
Indian	1	
Home language		125
Afrikaans	37	
English	73	
Xhosa	15	
Gender		125
Male	102	
Female	23	
Age (years) *		125
6	6	
7	28	
8	41	
9	30	
10	20	
Grade		125
1	37	
2	49	
3	39	

* The birth dates of the subjects were obtained from their cumulative record cards and their chronological ages are expressed as the number of completed years up to the date of testing.

- A random, stratified sample of six primary schools was drawn from the population of primary schools in the Nelson Mandela Metropolitan Area. The following stratification criteria were implemented: (1) area in which the schools were situated (lower socio-economic, middle class, or higher socio-economic) and (2) the predominant racial composition of the learners in the school (black, coloured, Indian, white)
- At each of the selected schools, all the Grades 1–3 learners between the ages of six and ten years who had not previously been diagnosed with ADHD were included in the control group.

In order to compile the ADHD-group, the following procedure was followed:

- A random, stratified sample of 10 primary schools was drawn from the population of primary schools in the Nelson Mandela Metropolitan Area. Socio-economic status and racial composition of the schools were again implemented as stratification criteria.

- At each of the selected schools all the Grades 1–3 learners between the ages of six and ten years who had been diagnosed with ADHD by independent professionals and placed on stimulant medication were included in the ADHD-group.

Biographical information on the subjects in the control and ADHD-groups is presented in Tables 1 and 2.

The Mesulam Continuous Performance Test was administered to all the subjects in the control (n=1144) and ADHD groups. A more detailed description of the test follows.

The measuring instrument

Background

The test was developed by Mesulam and Weintraub in 1985 as an instrument to assess the visual attention and spatial abilities of brain-injured patients. It is a pencil and paper test which requires the testee to find a visual target amongst surrounding visual stimuli.

Since the development of the test, a number of researchers have investigated its diagnostic application potential. Landau, Gross-Tsur, Auerbach, Van der Meere & Shalev (1999) included the test in a psycho-neurological test battery and found that the test discriminated significantly between children with right-hemispherical syndrome, children with ADHD, and children with no history of neurological or developmental problems. Sandson, Bachna & Morin (2000) administered the unstructured format of the Mesulam test to samples of ADHD and non-ADHD subjects and found that the two groups differed significantly with regard to the laterality of their errors of omission.

Test material

The test consists of two A4 pages on which capital letters of the alphabet are printed. On the one page the letters appear in structured rows and columns (Structured Form). On the other page the letters are printed in an unstructured, haphazard fashion (Unstructured Form). On both pages (structured form and unstructured form), 60 As are printed among the other letters. On both of the pages, the As appear in the same position in four quadrants of 15 As each. Portions of the test pages are displayed in Figures 1 and 2.

Administration procedure

The test can be administered individually or to groups. The Structured Form is placed face down in front of the testees and the following instructions are given to them:

"As soon as I ask you to turn the page, I want you to find all the As on the page and circle them with your pencils as quickly as you can. When you think that you have circled all the As, I want you to turn the page and write your name on the back."

The children get 7 minutes to complete the task. Because the test is administered to a group, individual test times are not recorded. As soon as the children have completed the Structured Form, the Unstructured Form is placed face down in front of them and the same test instructions and administration procedure are repeated.

Scoring procedure

The protocols (Structured and Unstructured forms) of each child are scored by calculating the number of As which were not circled (errors of omission) on the particular page. Errors of commission, such as half-circled letters, corrections, or alternative letters that were circled are not considered in calculating the score. Three types of scores are calculated, namely:

- A Structured Score: The total number of As that were not circled on the Structured Form.
- An Unstructured Score: The total number of As that were not circled on the Unstructured Form.
- A Combined Score: The total number of As that were not circled on both the Structured and the Unstructured forms.

Psychometric properties of the test

According to Dawes (2000) the Mesulam test has been under-utilised

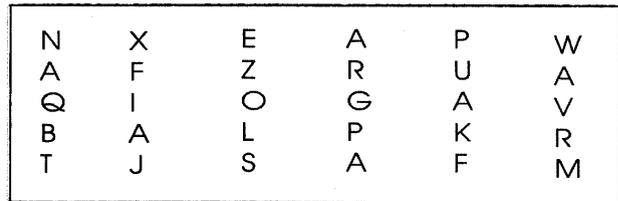


Figure 1 Structured Form

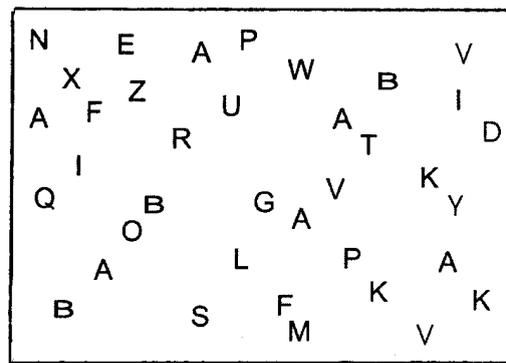


Figure 2 Unstructured Form

in clinical studies, possibly due to a lack of normative data and information regarding the psychometric properties of the test. In an attempt to develop normative data for the test, Dumont, Stevens, Dawson, Guare & Weiler (sa) administered the Mesulam test to a sample of 1 371 American children between the ages of 6 and 14 years. The subjects had no history of learning disabilities, physical or cognitive impairment. Means were calculated for each age group and for both administration procedures (structured and unstructured). The effects of gender, age and order of administration were also investigated. No significant differences were found between the test scores of boys and girls, but two-factor analysis of variance revealed significant effects with regard to order of administration and age. Because of these results, Dumont *et al.* (sa) developed separate norm tables based on order of test administration and age.

Dumont *et al.* (sa) compared the test results of 170 diagnosed ADHD subjects (between the ages of 6 and 14 years) with the above normative data of the non-ADHD subjects. The results of the two-tailed *t* tests indicated that the ADHD subjects had made significantly more errors than the non-ADHD subjects and the researchers concluded that the Mesulam test has the potential to be used as an inexpensive and quick diagnostic screening device for identifying learners with attention deficits at school. However, Dumont *et al.* (sa) recommend that the test should be seen as only one component of a multimodal diagnostic process and that further research should be done to develop normative data for other populations.

Test procedure followed in this investigation

In order to ensure that a uniform test administration procedure would be followed, the researchers trained the test administrators (teachers, intern psychologists, and remedial teachers) themselves.

Because the test requires letter recognition skills and to make sure that the subjects would possess the anticipated letter recognition abilities the tests were administered during the last term.

In order to control the effects of stimulant medication, the tests were administered after 12:00 to the ADHD subjects. On the basis of the short half-life of the medication (approximately 4 hours), it was assumed that the ADHD subjects' test performances would not be influenced by the effects of the medication.

The test protocols were scored by means of scoring stencils and the correctness of the scores was checked by the researchers.

Table 3 Error scores: ADHD and non-ADHD groups

Age (completed years)	ADHD			Non-ADHD		
	n	\bar{x}	σ	n	\bar{x}	σ
Structured Form						
6	6	11.33	11.91	89	4.80	4.30
7	28	5.39	5.52	364	4.01	5.54
8	41	3.24	3.57	381	3.02	4.29
9	30	3.43	3.49	251	1.79	2.90
10	20	3.75	4.78	59	1.95	2.55
Total	125	4.24	5.11	1 144	3.15	4.51
Unstructured Form						
6	6	6.17	6.52	89	2.83	5.01
7	28	2.93	3.84	364	2.11	4.03
8	41	2.51	3.48	381	1.35	2.31
9	30	1.50	2.16	251	1.21	2.12
10	20	1.65	2.56	59	1.15	1.65
Total	125	2.40	3.46	1 144	1.67	3.20
Combined						
6	6	17.50	14.02	89	7.63	7.59
7	28	8.32	7.81	364	6.12	8.63
8	41	5.76	5.39	381	4.37	5.89
9	30	4.93	5.05	251	3.00	4.08
10	20	5.40	7.08	59	3.10	3.66
Total	125	6.64	7.20	1 144	4.81	6.79

Statistical analysis

Descriptive statistics were calculated for the ADHD and control (non-ADHD) groups. In order to test the hypothesis, an analysis of co-variance was made, with age as a co-variant.

Results

Table 3 provides descriptive statistics for the error scores obtained by the two groups (ADHD and non-ADHD) on the Structured and Unstructured forms of the test.

Tables 4, 5, and 6 reflect the results of the analyses of co-variance based on the error scores that the subjects obtained on the Structured and Unstructured forms of the test, as well as their Combined error scores. For all the analyses, age was used as a co-variant.

Discussion of results

In Table 3 a marked decline in the error scores of both groups (ADHD and Non-ADHD) is seen as the subjects get older. This tendency was observed for the error scores on both the Structured and Unstructured forms of the test as well as the Combined error score. Thus, it appears that the ability to pay attention improves with the age of the subjects. This tendency is supported by the findings of Serfontein (1994) and Smith (1995), that attention and concentration abilities of ADHD children improve with age.

From Table 3 it appears that the subjects achieved better on the unstructured form of the test, which was administered second. This tendency was also observed by Dumont *et al.* (sa) and led to the development of separate norms for a reversed administration order. Therefore, it appears that subsequent exposures to stimulus material with visual similarities lead to the improvement of the subjects' ability to pay attention.

It also appears in Table 3 that the subjects in the ADHD group made more errors than the subjects in the non-ADHD group. Therefore, it appears that the presence of ADHD exerts a negative influence on the affected subjects' test performances.

On the basis of the results of the analyses of co-variance as reflected in Tables 4 to 6, the null hypothesis is rejected. The results indicated that the test discriminated significantly between ADHD and non-ADHD children. This finding supports the results that Dumont *et al.* (sa) obtained in the USA.

Tables 4 to 6 indicate also that age does play a role in the diagnosis of ADHD children by means of the Mesulam Continuous Per-

Table 4 Analysis of co-variance: Error scores on Structured Form

	Group (ADHD and Non-ADHD)	Age (co-variant)
Mean of squares	243.369	968.834
Degrees of freedom	1;1 262	1;1 262
<i>F</i> value	12.63	50.26 *
<i>p</i> value	0.0004 *	0.0000
Regression coefficient		-0.8771

* $p < 0.01$

Table 5 Analysis of co-variance: Error scores on Unstructured Form

	Group (ADHD and Non-ADHD)	Age (co-variant)
Mean of squares	67.387	277.487
Degrees of freedom	1;1 262	1;1 262
<i>F</i> value	6.76	27.83 *
<i>p</i> value	0.0093 *	0.0000
Regression coefficient		-0.4694

* $p < 0.01$

Table 6 Analysis of co-variance: Combined error scores

	Group (ADHD and Non-ADHD)	Age (co-variant)
Mean of squares	566.880	2283.315
Degrees of freedom	1;1 262	1;1 262
<i>F</i> value	13.23	53.27 *
<i>p</i> value	0.0003 *	0.0000
Regression coefficient		-1.3465

* $p < 0.01$

formance Test. Therefore, the child's performance on this test must be interpreted against the background of his/her age.

Conclusions and recommendations

On the basis of the results, the following conclusions are drawn:

- The Mesulam Continuous Performance Test can be used as a reliable screening device for the diagnosis of ADHD. The utility value of the test is as follows:

- It is quick to administer, because the administration time per form is 7 minutes
- The scoring process is objective
- The test can be administered individually or in a group situation. It is inexpensive to administer and the testees need only a test page, pencil, and eraser
- The test administration does not require specialised training and any class teacher can administer it by following the simple instructions.
- The age of the testee must be taken into consideration in interpretation of the test results.

The following recommendations stem from the research:

- The Mesulam Continuous Performance Test can be used as a diagnostic screening device when a learner's behaviour displays symptoms of ADHD.
- When the test is administered, it should be part of a multi-modal diagnostic process. In this way the possibility of a faulty diagnosis can be eliminated.
- The professional person in private practice can use the test as a time-saving and objective diagnostic tool and it should become part of the battery of tests that the practitioner would normally administer during the diagnosis of ADHD.

This research indicates that the Mesulam Continuous Performance Test has diagnostic application potential for the diagnosis of ADHD, and it is recommended that national norms be developed for the South African learner population.

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