Regulating the Diagnosis of Learning Disability and the Provision of Test Accommodations in Institutions of Higher Education[1]

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The vast diversity of operational definitions of learning disabilities (LD) and practices used for its diagnosis threaten standardization, objectivity and fairness in the diagnosis of LD and the provision of test accommodations. The current paper describes an endeavor to overcome this problem by regulating and standardizing the diagnosis of learning disability (LD) in tertiary education and the provision of test accommodations. This endeavor, conducted by The National Institute for Testing and Evaluation (NITE) in cooperation with the Council of Higher Education in Israel, included: (1) development, validation and norming of MATAL: a computer-based test battery for the diagnosis of LD; (2) development of statistical decision rules for determining diagnosis based on test results; (3) development of guidelines for the provision of test accommodations; (4) establishment of diagnostic centers within institutions of higher education; and (5) establishment of a professional network of all parties involved in the diagnosis and support of students with LD in institutions of higher education.

Key words: fairness, higher education, learning disability, test accommodations, test standardization.

Definition and prevalence of learning disabilities

"Learning disabilities (LDs) represent a general category composed of disabilities in specific academic domains" (Fletcher, Lyon, Fuchs & Barnes, 2008). Multiple definitions of LD have been published in the professional literature since the phenomenon was recognized by the scientific community and by federal agencies in the 1960s. The most recent, and perhaps most widely used, are the definitions suggested in the DSM-IV (APA, 2000), ICD-10 and the definition published by the National Joint Committee on Learning Disabilities (1997).

Sparks & Lovett (2009a) reviewed close to 400 studies in order to provide an up-to-date review of the literature on the criteria used to ascertain whether postsecondary students could be classified as having learning disabilities. Their findings showed

[1] An earlier version of this paper was presented at the 34th International Association for Educational Assessment (IAEA) Annual Conference, Cambridge, September, 2008.

that a wide range of criteria that suggests a lack of consensus among diagnosticians and researchers about how LD should be defined and diagnosed.

Kavale, Spaulding & Beam (2009) claim that the definition of specific learning disabilities (SLD) has not changed since first proposed in 1968. They further state that "… although the operational definition of LSD has responded to new knowledge and understanding about the construct, the formal definition remained static for 40 years, creating schism between theory and practice." Finally they demonstrate why change in the SLD definition is necessary and propose one that restores integrity between theory and practice. In 2010, 58 leading experts from various affiliated disciplines published, in collaboration with the Learning Disabilities Association of America (LDA), "an expert white paper consensus pertaining to the identification of and intervention to LD" (Hale, et al., 2010). Three different theoretical approaches to LD were presented and reviewed and an integrative approach for the diagnosis of LD and the provision of services was suggested. The conclusive recommendation emphasized the need for comprehensive evaluation of psychological processes that take into account ability and achievement.

Given the vast diversity in the operational definitions of LD and the practices used for its diagnosis, estimation of the prevalence of learning disabilities is a tricky endeavor. Al-Yagon et al., (2012) in their international survey, report the following prevalence of Specific Learning Disabilities (SLD) and ADHD in K-12 students: Australia 10%-15%, Germany 3%-7%, Greece 1.2%-1.6%, Israel 5.3%-15%, Spain 4.9%-16.9%, Taiwan 10% reading disability and 6.3%-12% ADHD, UK 3%-5% AHDD, USA 5% SLD and 5%-9% ADHD. The study also highlighted the vast differences between the countries in the procedures used for diagnosing LD.

Vogel & Holt (2003) compared adults with and without (self-reported) learning disabilities from six English-speaking populations that participated in the first administration of the International Adult Literacy Survey (IALS). The prevalence of LD students reported was: 3.7% in English-speaking Canada, 5.4% in Great Britain, 3.2% in The Republic of Ireland, 7.7% in New Zealand, 4.0% in Northern Ireland, and 3.5% in the US. According to The National American Resource Center (HEATH) and the National Center for Education Statistics (2000) about 9% of all college students in the U.S. reported having LD. Steele & Wolanin (2004) suggest that 4% of the students in higher education have a LD and that the number of students in higher education with LD is large and growing both absolutely and as a share of all students with disabilities. Sparks & Lovett (2009a) reported that the percentage of LD students in US colleges ranges from 1% to 5%. They also examined the consequences of using different diagnostic models (objective sets of criteria) for classifying postsecondary students as learning disabled and found that agreement between diagnostic models was often low, both in terms of the proportion of students identified as well as which students were identified (Sparks & Lovett, 2009b). Finally, Kavale, Spaulding & Beam (2009) suggest confining the new definition of LD to only 2%-3% of the school population.

In Israel, enrollment of students with LD in higher education institutions was estimated to be 3% in 1998 and 6.7% in 2007 (The Israeli Council for Higher Education).

Fairness issues in the diagnosis of LD for the provision of test accommodations

In a typical clinical situation, the clinician adopts one of various definitions LD. Based on this choice he/she selects the diagnostic tools (about 10-20 achievement and cognitive tests) that are administered to the client. Since each test may yield several performance scores, a few dozen such scores are typically produced. The final diagnosis of LD takes into account the performance scores along with rich personal information (e.g., medical and learning history), and is ultimately a subjective clinical judgment. Thus, clinicians often assess different academic and cognitive functions, using different diagnostic tools, normed on different populations or even un-normed. Also, they use different cutoff points to determine deficiency in a given function and assign different weights to the many sources of evidence to determine the final diagnosis. While such a procedure may be adequate in a clinical setting (which focuses mainly on identifying strengths and weaknesses for the purpose of designing an assistance or rehabilitation plan), it is highly inappropriate in a diagnostic setting which determines eligibility for test accommodations or financial aid, contexts in which standardization, objectivity and fairness must not be compromised.
The variation in diagnostic practices is often accompanied by variation in the criteria used for the provision of test accommodations. Clinicians not only differ in their leniency-stringency tendencies but also in their awareness of the possible effects of various accommodations on test validity.

Since, in many cases, diagnosis of LD is done for profit, the cost of the diagnosis is often excessively high, making it inaccessible to students of low socio-economic status (SES). In Israel, surveys conducted by the Ministry of Education revealed marked differences between high-SES and low-SES schools, in the percentage of students with LD who received accommodations on their Matriculation Exams. This aroused serious concern that LD is under-diagnosed in students from low SES. A similar trend was reported in the US (e.g., Steele & Wolanin, 2004).

The final threat to fairness stems from the growing number of feigners reported by practitioners and researchers, a phenomenon reflected both in sub-optimal performance on tests and, in extreme cases, even impersonation.

All of the above call for extra caution in the diagnosis of LD for the provision of test accommodations.

Diagnosing LD in tertiary education in Israel

Until the late 20th century, few institutions of higher education had their own diagnostic centers, others employed the services of one or two private diagnostic institutions, and the rest accepted any diagnosis submitted by the student regardless of its quality or the soundness of its recommendations. Consequently, the processes on

the basis of which the diagnosis was approved and the accommodations determined were often vague, invalid, non-standardized and based on un-normed tests.

In 1997, the Israeli Council for Higher Education (CHE) appointed a committee whose primary purpose was to estimate the incidence of students with LD in higher education and to suggest a policy for their care and support. One of the principal recommendations of the committee was to standardize the diagnostic procedure and to regulate the provision of accommodations and assistance (Margalit, Breznitz, & Aharoni, 1998). To this end, the CHE commissioned the National Institute for Testing and Evaluation (NITE) to develop a sound and valid standardized procedure for the diagnosis of learning disabilities (for provision of test accommodations) which would be accessible to all candidates and students at a relatively low cost.

The current paper describes an endeavor to develop policy and procedures for standardizing and regulating the diagnosis of LD, both in applicants to higher education institutions and in currently enrolled students, and to regulate the provision of test accommodations and other types of assistance.

Standardizing the diagnosis of learning disabilities in tertiary education

A comprehensive, standardized, computer-based test battery for the diagnosis of LD (MATAL[2]) was developed, validated and normed with the objective of standardizing the diagnosis of learning disabilities (MATAL, 2007; Ben-Simon & Inbar-Weiss, 2012).

Guiding principles for the development of MATAL

The following were established as guiding principles for the development of MATAL:

- *Target population* – MATAL would diagnose adults aged 16-30;
- *The disabilities diagnosed* – MATAL would focus mainly on diagnosing: Dyslexia, Dysgraphia, Dyscalculia and Attention Deficiency & Hyperactivity Disorder (ADHD). Deficits in the cognitive domains of memory, attention, visual perception and speed of processing would be diagnosed only to the extent that they might assist in a causal interpretation of the four specific difficulties observed.
- *Data collected* – the data collected and used for diagnosis would include: performance on achievement and cognitive tests, medical and educational history collected via a personal questionnaire, previous diagnoses of LD, and other relevant documents. The final diagnosis of LD would be conducted by an expert clinician and based on all the above data, including examiner's observations documented during the testing sessions and information gathered in an intake interview.

[2] MATAL is a Hebrew acronym for a Learning Functions System

- *Test administration mode* - all tests would be administered by computer. A trained examiner would be present throughout the entire examination session.
- *Detection of malingering* - MATAL would include several measures to detect subjects whose claims of disability were not bona fide.
- *Accessibility* – MATAL-based diagnostic centers would be established in institutions for higher education across the country and the diagnostic procedure would be offered at a relatively low cost.
- *Central database* – a central database would be developed to facilitate research. Data collected from all MATAL-based diagnostic centers would be transferred to the central database.
- *Transparency* – the features of MATAL that are related to diagnostic procedure would be made public.
- *Legal admissibility* – the criteria used for the diagnosis of a learning disability would be defined so as to be legally admissible in a court of law.
- *Periodic updating* - MATAL would be constructed so as to allow relatively simple updating in accordance with developments in the field.

MATAL development process

The development process comprised eight stages. An advisory committee consisting of professional experts in learning disabilities was involved in all aspects of the test-battery development process.

1. Mapping the main academic skills and basic cognitive functions associated with learning processes.
2. Establishing an operational definition of learning disability.
3. Identifying the main learning disabilities that are relevant to the higher education context and can be accommodated for in psychometric and academic tests.
4. Mapping the specific academic skills associated with each disability as well as their underlying cognitive functions.
5. Identifying and developing appropriate diagnostic tools for the assessment of the above-mentioned academic skills and cognitive functions.
6. Validating the diagnostic tools and identifying the performance measures that best discriminate between students with LD and those with no LD.
7. Developing population norms.
8. Developing a decision-making algorithm (criterion) for determining each disability and its severity.

MATAL diagnostic tools

MATAL consists of 20 tests (53 performance measures) assessing achievement and abilities in six domains: reading, writing, math, attention, visual perception and verbal memory as well as two questionnaires (see appendix 1 for a detailed description of MATAL diagnostic tools). Instructions for all tests appear on-screen and are also available in audio mode, each test is preceded by a training session, oral responses are recorded by the computer and can be accessed at any time, and response time is recorded with ±7ms accuracy.

To examine and ensure the psychometric properties of MATAL, a pilot study was conducted in which the test-battery was administered to 205 participants. About half of the participants had LD and comprised the four clinical groups (dyslexia, dysgraphia, dyscalculia and ADHD). They were recruited by means of academic support centers catering to their needs. The rest of the participants served as a control group. For the validation of the diagnostic tools both groups were further screened for appropriate classification, leaving 68 participants in the clinical group (11-42 persons in each clinical category) and 95 in the control group. Finally, all MATAL tests were normed on a representative sample of 508 non-LD students and applicants to higher education.

The results obtained from the pilot and the norming studies were used to generate a statistical model for the diagnosis of the abovementioned four disabilities. The weights attached to the different performance measures in this model were estimated using a logistic ridge regression model for the prediction of the relevant disability. The model was optimized on the number of explanatory variables and the ridge coefficient. The sensitivity indices obtained ranged from 82.6 to 100 and the specificity indices ranged from 89.7-96.8 (Ben-Simon & Inbar-Weiss, 2012).

Given the small size of the clinical samples used in the pilot study to validate MATAL tests, a second validation study was conducted in 2011-12 (Ben-Simon, Inbar-Weiss, Barneron & Polacheck, 2012). Participants in this study were 563 students and applicants to tertiary education who applied for LD diagnoses by means of the MATAL test-battery. The norming sample was used as control group.

Table 1 presents the psychometric characteristics of the MATAL tests: the reliability coefficients reported are from the pilot study while the validly indices (discriminative size effects) are from the second validation study.

MATAL diagnostic procedure

The MATAL diagnostic procedure comprises eight stages (see Flowchart 1):

Stage 1. Application for diagnosis.

Stage 2. Submission of personal questionnaire and supporting documents. Each applicant fills out the 'Personal Questionnaire' and submits relevant documents such as school reports, previous diagnostic reports and medical reports.

Stage 3. Verification of applicant's qualifications for diagnosis. Upon receipt of the application and background materials, the applicants' eligibility for undergoing diagnosis is verified according to the following criteria: applicant age is between 16 to 30; he/she is proficient in the Hebrew language, does not have a physical or mental disorder that may hinder his/her performance on the tests and has not taken MATAL's tests in the preceding five years. Once the application is approved, the applicant's name and ID are entered into a central internet-based database.

Stage 4. Administration of MATAL tests. The computerized test battery is administered in two separate sessions by a trained examiner. Verbal (oral and written) responses are recorded and scored by the examiner. In addition, the examiner completes a structured observational report documenting the applicant's behavior during the test.

Stage 5. Generation of computerized report. A summary report that includes the applicant's performance on each MATAL test, and a final diagnosis for each of the four disabilities diagnosed by MATAL is produced automatically.

Stage 6. Review and integration of test results and background information. An expert clinician reviews MATAL's computerized test report (test results, final computerized diagnosis), the examiner's observational report, the Personal Questionnaire and all other background information submitted by the applicant.

Stage 7. Intake session for in-depth inquiry and feedback. An expert clinician meets with the applicant to further explore the reported difficulties, resolve discrepancies between these difficulties and the test results, provide feedback, and discuss potential accommodations and means of assistance in accordance with the difficulties observed.

Stage 8. Writing of final diagnostic report. The clinician writes a final report which includes a verbal summary and interpretation of the test results, as well as a final diagnosis with regard to each of the four disabilities diagnosed by MATAL. In addition, where appropriate, the clinician suggests suitable test accommodations and other means of support which should be granted to the applicant in his/her academic studies.

Insert Flowchart 1 about here

Standardization of the provision of test accommodations

In order to standardize procedure for provision of test accommodations in colleges and universities and facilitate the work of the support centers, detailed guidelines were developed by a committee composed of the heads of 20 support centers, expert clinicians and the MATAL development team (NITE & CHE, 2009).

The resulting document presents the general principles governing the provision of test accommodations, as well as a list of accommodations and detailed guidelines for their

provision. Each accommodation is classified by: (1) accommodation level: the extent to which it compromises validity, and (2) accommodation type: its cost and applicability. For each accommodation, the document also lists specific criteria for its application with respect to each of the four disabilities diagnosed by MATAL and with respect to the presence of other cognitive deficits (e.g., in visual perception, memory).

The accommodation guidelines document was made available to support centers in all institutions for higher education as well as to clinicians. The implementation of the guidelines is not obligatory – every institution is autonomous and free to adopt the guidelines or not, in accordance with its general policy, the availability of appropriate resources, and the specific requirements of each academic program.

Dissemination of the diagnostic procedure and provision of accommodations

To disseminate the MATAL-based diagnostic procedure, 12 diagnostic centers were established in institutions of higher education across the country. Specific criteria were set with respect to the qualifications of the personnel employed and the required facilities and equipment.

Two instructional guides were developed to facilitate and standardize the diagnostic procedure. The Examiner Guide includes instructions regarding test administration, scoring of vocal and written responses, and documentation of examinee behavior during the test sessions. The User Guide includes a complete manual for the test battery and guidelines for arriving at a differential diagnosis. Extensive training workshops prepare clinicians and examiners to operate MATAL.

Two additional steps were taken: (a) data collected is periodically transmitted to a central database for monitoring purposes and for further research; (b) a nationwide network of clinicians who use MATAL was established to facilitate communication among experts and to resolve professional dilemmas.

MATAL's implementation is closely monitored by NITE's development team. Any problem encountered is duly noted, and suggestions for improvements are collected and carefully documented. The test-battery is periodically updated in accordance with technological advances and the diagnostic guidelines are updated in accordance with advances in learning disability research, specific research that applies to MATAL and data needs expressed by MATAL users.

By January 2013, over 12,000 students and applicants to tertiary education had been diagnosed by MATAL in 12 diagnostic centers. Both clinicians and support center officers have expressed great satisfaction with the regulation process.

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Table 1: MATAL psychometric properties of the diagnostic tools

Tests	Perform. measures	Reliability[1]	Effect Size[2]			
			Dyslexia N=296	Dysgraphia N=261	Dyscalculia N=141	ADHD N=317
Vocal Text Reading	Accuracy	.72*	**-2.35**	-2.25	-1.64	-1.51
	RT	.89*	**-2.15**	-2.07	-1.95	-1.82
Non-word Reading (production)	Accuracy	.89	**-2.17**	-1.95	-1.88	-1.33
	RT	.98	**-2.72**	-2.46	-2.48	-2.16
Non-word Reading (Identification)	Accuracy	.85	**-2.39**	-2.11	-2.34	-1.59
	RT	.96	**-2.54**	-2.31	-2.43	-2.03
Phonemic Deletion	Accuracy	.87	**-1.37**	-1.14	-1.10	-0.74
	RT	.97	**-2.03**	-1.70	-1.95	-1.43
Phonemic Count	Accuracy	.95	**-0.35**	-0.30	-0.35	-0.13
	RT	.97	**-1.32**	-1.29	-1.51	-1.19
Dictation	Handwriting	.57*	**-0.34**	**-0.69**	-0.06	-0.31
	Writing pace	.69*	**-3.16**	**-3.56**	-2.95	-2.65
	Homophonic spl. err.	.90*	**-2.62**	**-2.96**	-2.10	-1.53
	Morpho-phono. spl. err.	.28*	**-3.23**	**-3.59**	-2.55	-2.59
Rapid Automatic Naming (RAN)	objects	.73	**-2.03**	-1.95	-2.15	-2.04
	letters	.80	**-1.17**	-1.01	-1.30	-1.10
	numbers	.86	**-1.25**	-1.11	-1.56	-1.23
Verbal Fluency	phonological cue	.79*	**-0.82**	-0.72	-0.87	-0.64
	semantic cue	.80*	**-0.84**	-0.69	-0.83	-0.65
Syntactic Awareness	Accuracy	.64	**-2.65**	-2.52	-2.65	-2.25
	RT	.93	**-2.32**	-2.17	-2.33	-2.01
Reading Comprehension	Accuracy	.76	**-2.43**	-2.03	-2.63	-1.90
	RT	.90	**-2.93**	-2.64	-2.98	-2.56
English Reading Comprehension	Accuracy	.92	**-1.66**	-1.37	-1.74	-1.12
	RT	.96	**-2.48**	-2.13	-2.39	-1.87
English Listening Comprehension	Accuracy	.91	**-1.31**	-1.05	-1.39	-0.90
	RT	.93	**-2.03**	-1.80	-2.00	-1.81

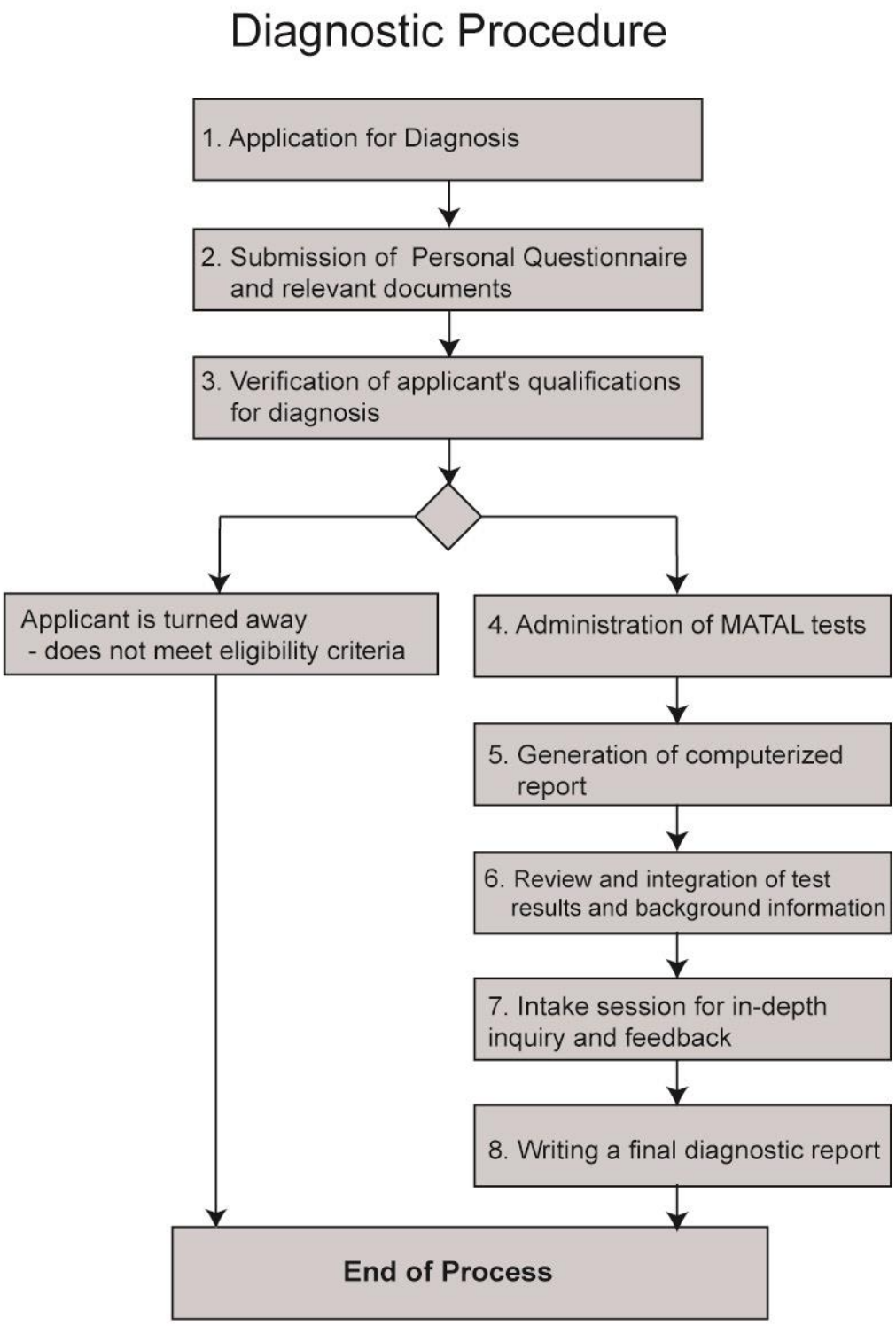
Table 1: MATAL psychometric properties of the diagnostic tools (cont.)

Tests	Perform. measures	Reliability[1]	Effect Size[2]			
			Dyslexia N=296	Dysgraphia N=261	Dyscalculia N=141	ADHD N=317
Continuous Performance Task (CPT)	Omissions	-	-1.50	-1.54	-2.22	**-2.08**
	Commissions part-1	.23	-1.56	-1.67	-2.06	**-2.10**
	Commissions part-2	.70	-0.81	-0.97	-1.20	**-1.28**
	RT	.95	-0.66	-0.65	-1.02	**-0.95**
	RT variability	-	-1.50	-1.54	-2.22	**-2.10**
Attentional Network (ANT)	Accuracy	-	-1.50	-1.54	-1.98	**-1.82**
	RT	.89	-2.13	-2.00	-2.72	**-2.60**
	Executive attention	.93*	-1.19	-1.11	-1.40	**-1.31**
	Alerting attention	.06*	-0.16	-0.11	-0.18	**0.02**
	Orienting of attention	-.13*	0.03	0.18	0.05	**0.03**
ADHD self-report questionnaire	Att. in adult.	.92	-1.99	-2.10	-2.17	**-2.75**
	Imp/hyper. in adult.	.86	-2.74	-2.79	-2.84	**-3.22**
	Att. in child.	.87	-0.96	-1.04	-0.92	**-1.57**
	Imp/hyper. in child.	.83	-1.20	-1.27	-1.10	**-1.62**
Computational Automaticity	Accuracy	.85	-2.26	-2.24	**-4.63**	-2.25
	RT	.98	-2.48	-2.45	**-4.06**	-2.44
Procedural Knowledge	Accuracy	.91	-2.14	-1.94	**-3.66**	-1.91
	RT	.97	-1.67	-1.48	**-2.44**	-1.58
Number Sense	Accuracy	.95	-1.24	-1.13	**-2.12**	-1.11
	RT	.97	-0.73	-0.71	**-0.98**	-0.75
	Distance-related accuracy	-	-0.25	-0.25	**-0.44**	-0.26
Auditory Verbal Memory	Immediate recall	.69*	-0.61	-0.56	-0.60	-0.57
	Delayed recall	.41*	-0.19	-0.25	-0.21	-0.26
	Delayed recognition	.36*	-0.96	-0.92	-1.21	-1.04
Visual Perception:	Parallel processing	-	-1.00	-0.87	-1.40	-1.05
	Temporal processing	-	-1.40	-1.25	-1.99	-1.37

(1) The reliability reported is Cronbach α (N=205). In a few cases in which internal consistency coefficient could not be calculated due to test format (marked by *) tests-retest reliability is given (N=20).

(2) The validity coefficient reported is effect size. The high effect sizes obtained for non-designated clinical groups are due to the high rate of comorbidity (e.g., 93% of participants with dyslexia had additional disability.

Flowchart no. 1: MATAL diagnostic procedure



Appendix 1: MATAL diagnostic tools: tests, questionnaires and supporting materials

Diagnostic tools and supporting materials	Skill/Function	Task description	Performance measures
Background Questionnaire			
Language (reading & writing)			
Vocal Text Reading	Phonological decoding	Vocal reading of a non-vocalized text	▪ Accuracy ▪ RT
Non-word Reading (production)	Phonological decoding	Vocal reading of vocalized non-words	▪ Accuracy ▪ RT
Non-word Reading (Identification)	Phonological decoding & lexical retrieval	Identification of a non-word that sounds like a common word in Hebrew	▪ Accuracy ▪ RT*
Phonemic Deletion	Phonological awareness	Phonemic deletion in non-words	▪ Accuracy ▪ RT
Phonemic Count	Phonological awareness	Phoneme count in non-words	▪ Accuracy ▪ RT
Dictation	Grapho-motor efficiency Spelling	Writing a text vocalized by the computer	▪ Handwriting ▪ Writing pace ▪ Homophonic spelling errors ▪ Morpho-phonological spelling errors
Rapid Automatic Naming (RAN)	Lexical retrieval	Rapid naming of objects, letters and numbers	▪ Naming rate
Verbal Fluency	Lexical retrieval	Words retrieval by phonological cue and by semantic cue	▪ Number of words retrieved in each category
Syntactic Awareness	Syntactic awareness / Mastery of syntax	Reading a complex sentence with irregular syntax and then identifying a very short sentence which has a similar meaning.	▪ Accuracy ▪ RT
Reading Comprehension	Reading comprehension	Reading 3 passages and answering 30 MC questions	▪ Accuracy ▪ RT
English Reading Comprehension	Reading comprehension in 2nd language	Sentence completion	▪ Accuracy ▪ RT
English Listening Comprehension	Listening comprehension in 2nd language	Sentence completion	▪ Accuracy ▪ RT

Diagnostic tools and supporting materials	Skill/Function	Task description	Performance measures
Attention			
Continuous Performance Task (CPT)	Sustained attention	Responding to a two-dimensional target stimuli (shape & color)	▪ Omissions ▪ Commissions in 1st part ▪ Commissions in 2nd part ▪ RT ▪ Variability of RT
Attentional Network (ANT)	▪ Alerting attention ▪ Orienting of attention ▪ Executive attention ▪ Sustained attention	Determining the direction (left/right) of a target symbol (arrow) presented with or without various cues	▪ Accuracy ▪ RT ▪ Executive attention ▪ Alerting attention ▪ Orienting of attention
ADHD self-report questionnaire	▪ Attention difficulties in adulthood & childhood ▪ Impulsivity and hyperactivity in adulthood & childhood	Self-reporting of behavioral symptoms	▪ Attention in adulthood ▪ Impulsivity-hyperactivity in adulthood ▪ Attention in childhood ▪ Impulsivity-hyperactivity in childhood
Mathematics / Numeracy			
Computational Automaticity	Retrieval of simple arithmetic facts	Judging the correctness of simple arithmetic equations	▪ Accuracy ▪ RT
Procedural Knowledge	Mastery of basic arithmetic procedures	Judging the correctness of arithmetic equations	▪ Accuracy ▪ RT
Number Sense	Number-line representation	Determining which of two number values presented on a number-line is located at the correct point.	▪ Accuracy ▪ RT ▪ Distance-related accuracy
Memory			
Auditory Verbal Memory	Short-term memory Long-term memory	Free recall of words from a given list Identification of words from a previously presented word list	▪ Immediate recall ▪ Delayed recall ▪ Delayed recognition
Visual Perception			
Visual Perception: parallel processing	Spatial perception	Discrimination between two spatial frequencies presented simultaneously	▪ JND threshold
Visual Perception: temporal processing	Working memory Visual perception	Discrimination between two spatial frequencies presented one after the other	▪ JND threshold
Supporting materials			
Individual testing booklet			
Examiner's Guide			
Clinician's Guide			
Guidelines for the provision of test accommodations			