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Processes and tools for diagnosing learning difficulties

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Abstract

The article focuses on the processes and tools used to diagnose learning difficulties, emphasizing the importance of early detection and personalized assessment. A key priority is the collaboration between various professionals, such as child psychiatrists, speech therapists, and psychologists, to accurately identify and diagnose learning difficulties. Additionally, the significance of diagnostic tools, such as standardized and non-standardized tests, is highlighted, as they detect difficulties in areas such as reading, writing, and mathematics. Effective diagnosis leads to the development of individualized intervention programs aimed at improving learning outcomes.

Keywords: Specific learning difficulties; Screening Tools; Diagnostic Tools; Assessment Tools; Intervention Tools

1. Introduction

Specific learning difficulties are directly related to the school environment and are usually diagnosed officially in the early years of education, typically at the age of 7-8 years. However, in cases of children with high intelligence, the problems may emerge later, around the age of 9, when academic demands increase. Generalized learning difficulties can be detected earlier, even before the first grade, through clinical observation by specialized therapists. Specific learning difficulties are considered a lifelong condition, although their clinical manifestations may change throughout life, affecting different areas of daily life.

For school use, and according to Law 4823/2021, the diagnosis and evaluation of specific learning difficulties are issued by the Centers for Interdisciplinary Assessment, Counseling, and Support (K.E.D.A.S.Y.). Public Medical-Pedagogical Centers (I.P.D.) provide a more clinical approach, addressing a broader spectrum of needs and issues. Additionally, the Special Diagnostic Evaluation Committee (E.D.E.A.Y.) of Special Education Units is also responsible for diagnosing and evaluating students with special educational needs. Once the diagnosis is completed and difficulties are discovered, the child follows the intervention process. The child may be placed in the school's integration classes (T.E.), which function as a supportive structure for students with special educational needs (Article 3 Law 3699/2008) attending educational units.

The diagnosis of learning difficulties is not the work of a single specialist but requires the collaboration of a team of professionals. Each specialty provides its own perspective and practical assistance to the others. The specialties contributing to the diagnosis and management of learning difficulties include child psychiatrists, speech therapists, occupational therapists, special educators, and psychologists.

According to Porpodas (2003), the evaluation process must adhere to certain principles:

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- The evaluator must be familiar with the ethical code that applies during the evaluation, to create appropriate conditions with respect for the examinee's personality.
- The evaluator must keep in mind that the evaluation is for the benefit of the child, aiming to assist with their weaknesses and develop their abilities.
- The evaluator must maintain confidentiality about both the evaluation results and the reactions of the examinee.

Key Criteria for the Evaluation and Identification of Learning Disabilities According to DSM-5 (American Psychiatric Association, 2013):

- For the diagnosis of specific learning difficulties, there must be at least one of the following symptoms for at least six months, even after interventions aimed at addressing these difficulties: difficulties in reading, difficulties in understanding text, difficulties in writing (spelling, grammar), difficulties in mathematics (arithmetic operations, understanding numerical concepts).
- The problems in academic skills must be significant and exceed what is expected for the individual's age. These problems must present significant barriers to academic or professional performance or daily activities. This assessment is based on standardized performance measures and overall clinical evaluation.
- The difficulties begin during the early school years, but become more apparent when the demands for specific academic skills increase. Students with these difficulties usually struggle to meet the time limits of typical written exams and assignments and face difficulties with academic requirements.
- These difficulties are not due to intellectual disability, sensory issues (vision or hearing), mental or neurological disorders, psychosocial adversities, lack of proficiency in the language of instruction, or insufficient teaching.

Various assessment tools have been created for detecting learning difficulties, which may be standardized or non-standardized. Standardized tools have been tested on broad population groups, ensuring their reliability and validity. They provide data that can be compared to benchmark data or population norms. The evaluation tools are divided into three main categories: screening, diagnosis, and assessment. Each category serves different purposes and provides specific information that is vital for understanding and supporting the individual.

Concluding, we emphasize the significance of all digital technologies in the field of education and in learning difficulties training, which is highly effective and productive and facilitates and improves assessment, intervention, and educational procedures via mobile devices that bring educational activities everywhere [141-144], various ICTs applications that are the main supporters of education [145-167], and AI, STEM, and ROBOTICS that raise educational procedures to new performance levers [168-174]. Additionally, the development and integration of ICTs with theories and models of metacognition, mindfulness, meditation, and the cultivation of emotional intelligence [175-199] accelerates and improves more educational practices and results, especially in children with learning difficulties, treating domain and its practices like assessment and intervention.

2. Screening Tools

Screening tools are used for the initial assessment and identification of potential problems or difficulties in an individual or a group of individuals. Their purpose is to identify who needs further evaluation or intervention. Typically, these tools are quick and easy to use, offering a general overview of an individual's skills or needs.

Examples of screening tools include questionnaires and brief tests that assess basic skills or behaviors. Below are some examples of screening tools:

- Reading Ability Screening Test (ΤΑΦΑ):

This tool is designed to assess the reading ability of students in the early grades of elementary school. The goal of the test is to identify students who have difficulty with reading, so that appropriate support and interventions can be provided to improve their reading skills (Karamanis, 2021).

- The 12 Screening Tools:

In 2007, for the first time in Greece, the University of Patras, in collaboration with the Universities of Athens, Crete, and Thessaly, as well as the Institute of Language Processing (ΙΕΛ), undertook a project for the standardization of 12 investigative and screening tools for learning disabilities. This project was co-financed by the Ministry of Education and

the European Union, with the aim of developing reliable tools for assessing and supporting students with learning disabilities (Paidagogiko, n.d.; Tzivinikou, 2015).

- Screening and Investigation of Reading Difficulties in Kindergarten and First and Second Grade (Porpodas, 2007):

This tool aims to diagnose the development level of cognitive and linguistic factors in preschool children that are necessary for future reading learning. Additionally, it contributes to the early detection and identification of children with insufficient development of these factors, so potential reading difficulties in first grade can be addressed. The test can be applied to all students aged four to six and evaluates which children might face or overcome reading difficulties.

- Investigation of Writing Expression Difficulties in Third to Sixth Grade Students (Oikonomou et al., 2007a):

This tool analyzes the challenges students face in producing and processing written language. The test includes two parts: the production and processing of written language by students.

- Screening of Speech and Language Disorders through Narrative Language in Preschool Children (Panteliadou & Antoniou, 2007a):

This language and speech test is a psychometric assessment tool used to identify and examine speech disorders related to learning difficulties. The main objectives of the test include detecting speech difficulties in preschool children, recording progress in speech development, and providing a means to compare children's performance at different educational stages.

- Screening and Investigation of Memory Disorders in Kindergarten and Elementary School (Mpezevegis, Oikonomou, Mylonas, 2007):

The Memory Test is used to identify and assess memory disorders related to learning difficulties in preschool children and elementary school students. The goals include recording performance and changes in memory development and comparing results with other standardized tests.

- Screening and Investigation of Learning Process and Categorization Disorders in Kindergarten and Elementary School (Oikonomou et al., 2007b):

The tool was created to identify children who have difficulties with language acquisition and understanding concepts and relationships. Additionally, this test records the expected performance and changes in learning, conceptual organization, and categorization. The test includes two scales: learning and categorization. The learning scale concerns the acquisition of new information, while the categorization scale evaluates the ability to perceive, evaluate, and manage information, helping in the enrichment of the individual's vocabulary.

- Detection of Psychosocial Adjustment in Preschool and School-Age Students (Chatzichristou et al., 2007).

The Psychosocial Adjustment Test evaluates the skills and deficits of preschool and school-age children, primarily focusing on the social and emotional domain, as well as the adjustment of children with learning difficulties in the school environment.

- Recognition of Learning Difficulties in the Classroom for Students Aged 8-15 (Panteleiadou & Antoniou, 2007b).

The tool for detecting Learning Difficulties by Teachers (LDT) aims at the initial recognition of learning difficulties in students aged 8-15. It covers not only written language but also spoken language, reasoning, and mathematics.

- Identification of Reading Errors in Students Aged 8-15 (Panteleiadou & Sideridis, 2007).

The Test-A aims at the comprehensive assessment of the reading ability of students from 3rd grade to 3rd grade of secondary school, identifying students who face severe reading difficulties during compulsory education. It consists of four main components: decoding, fluency, morphology-syntax, and comprehension.

- Detection and Assessment of Executive Functions in Primary School (Simos, Mouzakis & Sideridis, 2007a).

The tool for Assessing Executive Functions (AEF) is intended for children aged 6-10 years and is used to detect potential learning difficulties, primarily in 1st grade. In 2nd to 5th grade, the tool assesses in detail potential deficits in specific cognitive areas contributing to learning difficulties. The ultimate goal of using this tool is to provide reliable and sufficient data for better design of individualized intervention programs, taking into account the cognitive peculiarities of the student, for the prevention or resolution of learning difficulties.

- Detection and Evaluation Tests for Attention and Concentration Function in Primary School (Simos, Mouzakis & Sideridis, 2007b).

The detection and assessment test for concentration and attention (ASYP) is aimed at primary school children, specifically aged 6 to 10 years. The purpose of ASYP is to detect difficulties in attention and concentration, primarily in 1st grade of primary school. Additionally, it provides a detailed assessment of potential deficits in these two dimensions in 2nd to 5th grades.

- Automated Investigation (with Special Software Development) of Specific Learning Difficulties in the Production and Reception of Written and Oral Language for Students in 2nd-4th Grade (Skaloubakas & Protopapas, 2007a).

The detection test largely evaluates skills in written and spoken language. Through this test, the educator or other responsible person can form a general image of the student's performance profile. The Lambda software system is based on the multiple-choice system.

- Automated Investigation (with Special Software Development) of Specific Learning Difficulties in the Production, Processing, and Reception of Written and Oral Language for Students in 5th Grade - 2nd Year of High School (Skaloubakas & Protopapas, 2007b).

The purpose of Lambda is the "automated" detection of learning difficulties in written and spoken language. This means that the process is controlled by the computer, without the need for a full clinical assessment. Instead, a profiling of the areas where students face difficulties is created in order to identify students who need further evaluation and potentially specialized educational support (Tzivinikou, 2015).

- «Dyscalculia Screener»

The "**Dyscalculia Screener**" developed by Butterworth (2003) is a quick and reliable tool for detecting dyscalculia. It operates on a computer and uses the keyboard for responses in three tests: dot enumeration, number comparison, and achievement in arithmetic. It is primarily used by educators and psychologists to assess children's mathematical skills, using reaction time in the tests as a key criterion. This tool is useful for the early detection and support of children with learning difficulties in mathematics (Drigas et al., 2016).

- «LADS (Lucid Adult Dyslexia Screening)»

The "**LADS (Lucid Adult Dyslexia Screening)**" is a software tool designed for detecting dyslexia in adults. LADS assesses various cognitive skills, such as memory and phonological coding, in just twenty minutes, helping individuals receive the necessary support. It is a self-administered test and is currently used in over a thousand institutions (Singleton, 2009).

3. Diagnostic Tools

Diagnostic tools are used for detailed evaluation and documentation of specific issues or disorders. This category includes more specialized and extensive tests that help in understanding the nature and severity of the individual's problems. Below are some examples of diagnostic tools:

- WISC-V

This tool includes five specific intelligence indices, in addition to the general intelligence index: the verbal comprehension index, the visual-spatial reasoning index, the fluid reasoning index, the working memory index, and the processing speed index (Karampatzaki, 2021).

- TOPR (Test of Reading Performance)

Created in 2000 by Padeliadou and Sideridis (Zafeiropoulou & Papadopoulou-Farmaki, 2004, as cited in Karampatzaki, 2021), it assesses whether a child can convert graphemes into phonemes and stress words correctly (Mouzaki, Sideridis, Simos & Protopapas, 2007, as cited in Karampatzaki, 2021).

- The Bangor Test

In 1997, Miles created a test consisting of ten exercises designed to detect signs of dyslexia. Specifically, the student must follow instructions such as "right and left," repeat multisyllabic words, perform mental subtractions, and recite multiplication tables. Additionally, the student is required to name the months of the year in order and backward, repeat a series of numbers forwards and backwards, write words containing the phonemes "b" and "d," and note if any family member has been diagnosed with dyslexia (Karampatzaki, 2021).

- "Athena Learning Disabilities Diagnosis Test"

This is a psychopedagogical diagnostic tool that identifies children who are unable to meet their school requirements. It is intended for children aged 5 to 8 years. This standardized test evaluates four main developmental areas: cognitive ability, sentence completion, grapho-phonological awareness, and neuropsychological maturity (Karamanis, 2021).

- Bangor Dyslexia Test

This test is used to understand and examine the difficulties a child faces, mainly as part of the diagnostic process in combination with other tests. It also includes an intervention program with the same name for children with dyslexia attending elementary and secondary school (Karamanis, 2021).

- School Readiness Test

This test focuses on assessing early learning skills in children entering the first grade, aiming to determine whether they are cognitively and emotionally ready for this transition (Karamanis, 2021).

- RAVEN IQ TEST

This tool is used to assess practical intelligence in the field of education and clinical practice. It is designed to provide both verbal and non-verbal assessments of the general mental ability of children aged 4 to 12 years. The results help in evaluating the individual's ability to store information and manage problems (Karamanis, 2021).

- DEST TEST

The "DEST test" (Fawcett, 1993, as cited in Drigas, 2013) has been developed for the more accurate diagnosis of preschool dyslexia. Since theoretical diagnostic tests fail to define dyslexia before a child learns to read, early diagnosis is achieved through carefully designed tests focusing on information unrelated to reading. Additionally, new-generation computers have proven effective, as carefully designed programs reflect results that are comparable to those obtained by traditional methods (Drigas & Dourou, 2013).

- ViSS

A study on visual stress (unpleasant visual symptoms that occur during reading) has identified a connection with individuals who have dyslexia. The research introduced **ViSS**, an electronic visual stress detector that uses a visual search process similar to reading. Dyslexic children were found to have significantly higher sensitivity to visual stress, displaying both critical and non-critical symptoms. Moreover, visual stress was found to occur more frequently in children with dyslexia compared to those without it (Drigas & Dourou, 2013).

- ANN

Another study explored the use of **Artificial Neural Networks (ANN)** for identifying students with dyslexia. The research developed and tested a neural network model that analyzes various factors and symptoms related to dyslexia. The results showed that the ANN application can effectively differentiate dyslexic students from non-dyslexic ones by examining reading and writing patterns. This method aims to provide an effective and accurate tool for the early diagnosis of dyslexia (Kohli, 2010).

- Non-verbal Graphic Tests

A study explored the use of genetically fuzzy systems for diagnosing dyslexia, even when data quality is low. Non-verbal graphic tests, evaluated by specialists, are used for diagnosing dyslexia in young children. The study proposed a genetic collaborative-competitive algorithm for creating a rule-based understandable classifier that can handle data uncertainty and improve the diagnosis of dyslexia (Palacios, 2007).

- CoPS (Cognitive Profiling System)

CoPS is a diagnostic software used to evaluate the cognitive abilities of children aged 4 to 8 years. Designed to detect learning difficulties such as dyslexia, **CoPS** assesses various cognitive skills, including memory, attention, and information processing. It uses games and interactive activities to collect data about children's abilities, creating detailed profiles of their strengths and weaknesses. These profiles help teachers and parents adjust teaching methods and support strategies to improve educational development and address learning difficulties. The system includes eight game-like tests, and the total evaluation time does not exceed twenty minutes (Drigas & Dourou, 2013).

- ΒΛΕΜΑ

The **ΒΛΕΜΑ** tool was developed to identify learning difficulties in children of third and fourth grade using a computer and a mouse. This is done through four exercises: reading and comprehension, pseudo-word reproduction, image-word identification, and letter memory. Research by Protopapas and colleagues showed that **ΒΛΕΜΑ** is a reliable tool for detecting children with potential learning difficulties (Protopapas, 2006).

- LAMDA

The **LAMDA** software was developed for the automatic detection of learning difficulties in both written and spoken language. It contains exercises that resemble games, which students perform on a computer without supervision, providing a performance profile for each student. The software is used by children from second grade in elementary school to second grade in high school. The format and content of the exercises are age-appropriate, ensuring that they remain engaging while maintaining the validity of the results (Protopapas, 2006).

- Fuzzy Expert System-based Model

Jain et al. (2012) proposed a **Fuzzy Expert System-based model** for classifying learning disabilities into subtypes. Unlike traditional diagnostic methods that simply identify whether a child has a learning disability, this model, which includes the fuzzifier, rules of classification, inference engine, and defuzzifier, can specifically diagnose whether a child has dyslexia, dysgraphia, dyscalculia, or a combination of these, with approximately 90% accuracy. The system is implemented in Java, and data is recorded in Excel sheets. The researchers noted that with the right combination of algorithms, the accuracy could be further improved (Drigas et al., 2016).

4. Assessment Tools

Assessment tools are used for the continuous monitoring and evaluation of an individual's progress or performance in specific areas. These tools provide information about the effectiveness of educational programs or interventions and assist in decision-making for future actions. Below are some assessment tools.

- Portfolio Assessment

A portfolio is an organized collection of a student's works, which are selected with their consent and based on specific learning goals and criteria. These works serve as evidence of the student's progress and performance in specific learning activities (Mylonas, 2021).

- ePortfolio Assessment

This contains the same information as traditional portfolios, but the information is collected, stored, and used electronically (Mylonas, 2021).

- Peer-Assessment

Peer-assessment is defined as the process in which one or more learners assess the performance of their fellow learners, identify errors, and suggest ways for improvement (Mylonas, 2021).

- Self-Assessment

This process allows learners to assess their progress, recognize their weaknesses, and suggest improvements (Petropoulou et al., 2015, as cited in Mylonas, 2021).

- Observation

Observation of students is one of the basic techniques used by teachers for collecting, analyzing, and evaluating data related to learning. Through this technique, teachers can monitor students' progress and issues, and draw important conclusions about their learning (Petropoulou et al., 2015, as cited in Mylonas, 2021).

- Diary

According to the diary method, the student must record in a personal diary their efforts, the techniques and tools they used, the problems they faced, their thoughts during teaching, and the self-assessment of their knowledge (Mylonas, 2021).

- Project

The modern learning environment considers group work as an extremely effective tool for assessing and teaching students. It includes organized activities that are developed freely and aim to explore, organize, and manage knowledge and materials that interest the students (Petropoulou et al., 2015, as cited in Mylonas, 2021).

- Quiz Self-Assessment

These are developed through software like ClassMarker, Free QuizMaker, Quizizz, Educandy, and have become popular in the educational community. They offer many advantages over traditional tests, such as the simultaneous evaluation of many learners, reduced time for test administration and correction, and the attractiveness of the examination format for students (Mylonas, 2021).

- Rubrics Assessment

Rubrics are defined as descriptive grading guides consisting of predetermined performance criteria. A rubric takes the form of a table in which the learning criteria for a task or learning process are outlined (Mylonas, 2021).

- Concept Maps

Concept mapping is a technique for representing and visualizing the relationships between various concepts. It is a graphical means of representing knowledge, which corresponds to how knowledge and concepts are organized in human thought (Mylonas, 2021).

- CITO Monitoring Test

In 2008, Peltenburg and colleagues conducted a study with 37 students with learning difficulties in mathematics, from two special education schools in Utrecht, with an average age of 10.5 years. They used the "**CITO Monitoring Test**" for Mathematics, a widely used assessment tool developed by Janssen, Scheltens, and Kramer in 2005. The test included seven subtraction problems with numbers up to 100. Additionally, they used a specially developed digital assessment environment called Flash ICT, which included digital representations of the problems and voice guidance from a computer. The ICT environment incorporated a dynamic visual tool with virtual objects that could be used by students during the problem-solving process. Comparing the results from the two formats showed that participants answered more questions correctly in the ICT version of the seven problems compared to the traditional test format (Drigas et al., 2016).

- Dys-Calculium

In 2006, Beacham and Trott developed "**Dys-Calculium**," an online evaluator that examines the understanding of numerical concepts and quantitative comparisons, to identify students with learning difficulties due to dyslexia, neurodevelopmental disorders, or dyscalculia. It is aimed at school-age children, ages 6-14, and includes interactive exercises aimed at improving their mathematical skills through personalized education and customized learning experiences. The student completes the Dys-Calculium without a time limit, and the results are automatically analyzed. The **Dys-Calculium** creates an individual profile for each student with 11 subcategories, showing areas of weakness and providing an overall score that determines whether the student is at risk of dyscalculia (Drigas et al., 2016).

- Dyscalc

"**Dyscalc**" is a free online evaluation tool developed and provided by the Wadeson Street Dyslexia Center and the directors of Educational Psychologist Ltd. It is designed for students over 14 years old with moderate academic ability and includes twenty questions that assess basic mathematical skills such as numerical logic, computation, and number sense. Upon completion, the system provides the user with information regarding whether they are at risk for dyscalculia, based on correct answers and completion time. A group of students with dyscalculia and a control group tested Dyscalc, and the results showed that it is a useful evaluation tool for students with mathematical disorders (Drigas et al., 2016).

- "MCAT"

The "**MCAT (Computerized Dynamic Assessment Model)**," as described in the research of Hung and Su (2010), is a computerized dynamic assessment model. The goal of MCAT is to collect and analyze data related to the spatial and numerical working memory of students in order to evaluate their learning progress in mathematics. This system also includes a two-phase intervention enriched with ICT, aimed at improving the learning outcomes for students with difficulties in mathematics.

- Online Analysis System

Livne et al. (2007) developed an online analysis system that automatically evaluates students based on their responses to mathematical questions. The system compares students' answers with those entered by the teacher and stores them in a database. The process is carried out in three phases: identification, arithmetic evaluation, and analysis. The system classifies each element as correct, incorrect, incomplete, or redundant, and categorizes errors as structural, conceptual, or computational. The results indicate that natural language and artificial intelligence can be combined to detect student errors, offering an evaluation comparable to human assessment (Drigas et al., 2016).

5. Intervention Tools

- "Ensfimnomata"

"**Ensfimnomata**" is a software designed for addressing learning difficulties and autism, consisting of three versions:

  - **Ensfimnomata 1:** For preschool education, special education, and first grade. It includes 76 applications with matching tasks, sorting, puzzles, colors, shapes, and memory exercises.

- **Ensfimnomata 2:** For numbers 0-20. It includes 33 applications focused on addition and subtraction sensitization, digital games, and teaching tools.
- **Ensfimnomata 3:** For mathematics up to 100. It includes 18 tools-activities and 9 games (Apostolopoulos, 2022).

- "The Verb Train"

The educational software "**The Verb Train**" was developed to support the teaching and learning of ancient Greek verbs. It is mainly designed for secondary school students, with a focus on those who have learning difficulties. The software can be used by teachers in the classroom or independently by students through the "Teach-Me-Achieve" and "Practice-Apply" functions. Teachers can use the software to analyze and explain grammatical phenomena, helping students understand and assimilate new concepts. They can also prepare feedback activities to assist students in mastering concepts they have not fully grasped (Xesternou, 2007).

- "The Land of Lenu"

The software "**The Land of Lenu**" is an educational program aimed at students with learning difficulties in the early grades of primary school. It includes 70 activities and games that support the understanding and consolidation of concepts in language and mathematics. The software creates a supportive and motivating learning environment, offering personalized teaching and immediate feedback. Results show that the software helps in developing cognitive and metacognitive skills, improving student performance in basic academic skills (Spantidakis, 2008).

- "Xefteris and Grammar"

The software "Xefteris and Grammar" is an advanced multimedia educational program designed for children aged 6 to 8 years. Through an interactive and stimulating environment, the program presents modern Greek grammar topics in a fun and original way. The modules cover small and capital letters, accents, spelling, punctuation marks, syllables, syllabification, combinations, nouns, verbs, adjectives, antonyms, and sentence construction. The software includes 17 educational and entertaining games and provides a friendly and pleasant environment with attractive graphics and professional dialogues.

- "Socrates"

The software "**Socrates**" is an educational program that includes 102 activities for reading, writing, and arithmetic, aimed at children aged 4-8 years, with three levels of difficulty. The modules include measurement, calculations, reading, writing, thinking, memorization, combination, and creation. The graphics are real images and do not contain cartoon drawings, while the answers are accompanied by a human voice that pronounces the correct result, without variations in sound for correct or incorrect answers.

6. Conclusion

The diagnosis of learning difficulties requires a comprehensive approach that combines clinical evaluation with screening and diagnostic tools. Early diagnosis and intervention can significantly improve the academic performance and personal development of students with learning difficulties. The collaboration of different specialties and the use of technological tools provide the best possible solutions for supporting these students.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors proclaim no conflict of interest.

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