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Neuropsychology Applied to Education: Theoretical Framework and Intervention Areas for the Reading Competence and Attention Difficulties

Resumen

La neuropsicología aplicada al contexto educativo se centra en la evaluación, el diagnóstico y la intervención con estudiantes en el entorno escolar. Esta disciplina proporciona a la comunidad profesional un conocimiento cada vez mayor sobre los procesos de aprendizaje, las bases neuropsicológicas y los niveles de neurodesarrollo de cada etapa educativa a fin de evitar dificultades y desarrollar habilidades tales como la competencia lectora. Dentro de este contexto, la siguiente revisión tiene como objetivo capturar la diversidad de las intervenciones existentes de lectura y atención basadas en neuropsicología en todos los niveles de las aulas escolares. El artículo ofrece múltiples sugerencias para mejorar el conjunto de conocimientos en esta prometedora área de neuropsicología. En conclusión, la intervención neuropsicológica centrada en herramientas esenciales de aprendizaje, como procesos de lectura y atención, es pertinente y útil para mejorar los logros de aprendizaje y prevenir las dificultades y los trastornos.

Abstract

Neuropsychology applied to education context is focused on the evaluation, diagnosis, and intervention with students within the school environment. This discipline is providing the professional community with increasing knowledge about learning processes, neuropsychological grounds and neurodevelopmental levels of each educational stage in order to prevent difficulties and develop abilities such as reading competence. Within this context, the following review aims to capture the diversity of existing neuropsychological-based reading and attention interventions in all the levels of school classrooms. The article offers multiple suggestions to improve the body of knowledge in this promising area of neuropsychology. In conclusion, the neuropsychological intervention focused on essential learning tools such as reading processes and attention processes, is pertinent and useful to improve learning achievement and to prevent difficulties and disorders.

Palabras claves

Neuropsicología, educación, trastornos de lectura, comprensión lectora, procesos de atención

Keywords

Neuropsychology, education, reading disorders, reading comprehension, attention processes

Child neuropsychology studies the cerebral functions related to cognitive formation during infancy and adolescence, because of (1) phylogenetic and ontogenetic development (Pérez, Escotto, Arango, & Quintanar, 2014), (2) developmental changes of the nervous system and its implications for behaviour, and (3) biochemical and environmental disruptions that may take place (Portellano, 2008).

Scientific development about the brain and its relationship with learning processes make it possible to better comprehend how students learn and how to intervene and apply programmes with a neuropsychological perspective to improve teaching and learning (Szucs, & Goswami, 2007; Varma, McCansliss, & Schwartz, 2008). It is necessary to establish links between neuroscience, neuropsychology, psychology and education in order to enrich scientific interpretations and work jointly in applied activities that build the necessary knowledge to improve education (Ansari & Coch, 2006; Benarós, Lipina, Segretin, Hermida & Colombo, 2010; Howard-Jones, 2011) and to work in a team environment for a better prepared society in the future (Caew & Magasamen, 2010).

In this regard, some experiences with innovative methodologies are already being developed in the framework of a relatively new developed sub-discipline within neuropsychology, known as Neuropsychology applied to Education. Some centres were specifically created for this goal, such as the Centre for the Brain and Transference of Learning at the University of Ulm (Germany), in which multidisciplinary work is being developed by neurologists, psychologists, experts in different neuropsychological processes, and teachers.

The most important challenge for the application of neuropsychology programmes in students at school age is the training of teachers (Martin-Lobo, 2012) and there are programmes and specific training centres that include teacher training in their programmes, such as the Master of Neuroscience and Education at the University College of London (UK) and the University of Bristol, research programmes such as the Centre for Neuroscience in Education at the University of Cambridge and research team in Cognitive Neuropsychology and Research on early ages and learning difficulties and disorders at the University College of London, Master in Neuropsychology and Education and the International University of la Rioja (UNIR), Spain and the Master of Education: Programme in Mind, Brain and Education (USA, University of Harvard).

School neuropsychology provides new assessment and intervention methods following the model of Luria, of which knowledge is now being established due to neuroimaging studies of brain processes in development (Manga & Ramos, 2011). The model of information processing provided by Luria is a key reference for the application of intervention programmes. Luria (1973, 1980) proposes three functional blocks for the explanation of cerebral functioning related to learning (see Table 1).

Table 1. Brain functional blocks related to learning (Luria, 1973, 1980)

Functional blocks	Activation of cerebral areas and circuits	Educational implications and relationship with learning
1. Optimal activation of cerebral cortex	Ascending and descending reticular activating systems are the most important structures, as well as connections to the frontal cortex.	Attention and maturational development.
2. Information input through senses, elaboration and storage of information in the brain	Regions from occipital, temporal and parietal lobes participate in order to develop visual, auditory and tactile processes	Application of methodologies of visual auditory, tactile and manipulative sensorization on learning.
3. Activity programming and control	Tertiary areas of frontal regions and frontal lobes that are related and have wide connections with different sectors of the cortex and subcortical structures.	Inhibition of irrelevant stimuli, intentionality and selectivity of processes, stability of voluntary activity, control for internal regulation of language. These processes may be affected by hyperactivity.

In order to design and apply neuropsychological programmes, it is necessary to have a theoretical background or design programmes related to the desired outcomes, keeping in mind cognitive developments and intelectual maturation of functional systems, their lateralization and the axis of ontogenetic development that go from inferior to superior structures, and from posterior to anterior structures (Roselli, Matute & Ardila, 2007). Moreover, it is necessary to organize activities in a hierarchical way, to provide opportunities for task repetition, to reorganize the plan once results are assessed, to apply long-lasting treatments as in cases of dyslexia (Duff, Holme, Grainger *et al*., 2014) and to adapt to each person´s conditions to ensure effectiveness (Solhberg & Mateer, 2001; De los Reyes, Arango-Lasprilla, Perea, & Ladera, 2014).

Programmes that follow the neuropsychological model of Luria, and that are being applied currently and are related to cognitive development and intelectual maturation, and are linked to different forms of learning acquired at the school age (Martín-Lobo, 2016), such as (1) programmes for attention development, (2) programmes to develop visual, auditory, tactile and sensorial integration abilities, (3) programmes for motricity, balance, lateral development and spatial-temporal domain development, (4) programmes for the development of language, reading comprehension, memory, high thinking abilities, multiple intelligences and creativity,

(5) programmes to overcome learning difficulties, dyslexia, dyscalculia and language difficulties, (6) programmes to improve Attention Deficit Hyperactivity Disorder (ADHD), developmental disorders and autism, and (7) programmes for the development of executive functions that imply visual, temporal and parietal areas, with connections to the frontal lobes, limbic system and reticular formation (Roselli, Matute & Ardilla, 2007) in order to gain executive control. These may be implemented from the early developmental stages (Chevalier, 2010) and may be implemented for literacy development (Fernández, 2016).

Programmes must be applied with adequately established sequences, rhythm, and regularity and should start from lower levels so that efficient and subsequent development of higher functions is achieved. Neuropsychology applied to school-age students could represent an excellent opportunity for clinical psychologists, neuropsychologists, school psychologists, teachers and the education system itself (Cleary & Scott, 2011).

With the aim of providing a detailed overview of this newly developed discipline of Neuropsychology Applied to Education, the current review aims to present some of the most relevant examples and programmes that have implemented reading neuropsychological procedures into the school environment. Concretely, this article is focused on the reading processes and put special attention to difficulties in students with Attention Deficit Hyperactivity Disorder (ADHD).

Processes and Programmes for Reading Improvement

The reading process, as shown by the research studies performed from the cognitive perspective of reading (Wolf, 2007) starts when the images projected on the retina are initially directed to the visual primary cortex in order to subsequently reach the secondary cortex, where the more complex visual information is decoded, and letter and graphemes are interpreted. Later, the information read is transferred to the angular gyrus in which a visual-auditory sensory exchange is produced, relating graphemes with letters. This new information is routed to the Wernicke area, which plays an important role in intellectual processes as it is in charge of comprehension.

Some studies, such as that by Rosselli, Matute and Ardila (2006; 2010; 2011) have shown that the reading process, and thus academic performance, is related to neuropsychological aspects. Hence, there is a need for a comprehensive assessment of reading processes that comprises neuropsychological tests aimed to analyse cognitive factors involved in the reading processes of children at school age. Some of the most widely used instruments for children of school age, widely studied and with high reliability and validity, are the ENI (Infant Neuropsychological Evaluation) (Matute, Rosselli, Ardila, & Ostrosky, 2007), LURIA-INICIAL (Neuropsychological assessment of pre-school age (Ramos & Manga, 2006), CUMANES (Questionnaire of Neuropsychological Maturity for school children (Portellano, Mateos & Martínez Arias, 2012) or the Neuropsychological Diagnosis Scheme (Ardila & Ostrosky, 2000).

In relation to the neuropsychological processes implied in reading, Table 2 presents a summary of some of the existing programmes targeting learning and improvement of the processes involved in reading.

Table 2. Summary of programmes targeting reading processes

Goal	Programme	Description
Auditory skills	*Berard Method*	Programme targeting people from 3 years old, and focused on the improvement of auditory perception and integration in order to achieve optimal auditory sensory processing by means of 20 auditory sessions of 30 minutes each.
Motor skills of balance and posture control	Methodologies based on Martín Lobo (2003)	A series of activities directed towards the improvement of motor abilities, balance and postural control in an integrated manner for children of school age.
Visual skills and reading speed	Neuropsychological programme for the improvement of Reading speed (Álvarez, 2014)	Programme comprising activities focused on eye motricity, visual relaxation and reading speed, applicable in school settings for a 9-month period.
Visual skills and reading comprehension	Neuropsychological intervention programme focused on the improvement of visual skills and reading comprehension (Tremp, 2014)	This intervention is developed in a coordinated manner between the school and the families of children of primary school in 30-minute daily sessions for 3 months. By means of an active and ludic methodology based on progressive control, it focuses on the improvement of eye motricity, the ability to focus and discriminate, accommodation and convergence/divergence, visual memory and reading comprehension.
Visual Health	*Educa Vision Programme (Bisquerra., Cortada, Antich, Timoteo & Rodríguez,, 1999)*	Visual accommodation, mobility, relaxation and reading programme and exercises for children between 2 and 12 years old.
Visual, auditory, tactile, motor, memory and language skills	*ADI* Programme of Dr. Pilar Martín-Lobo	Programme developed to optimize school performance from the areas of neuropsychological functioning to mental abilities. It is divided into two stages: 1. Neuropsychological domains related to vision, audition, touch, motricity, language and memory are exercised; 2. Programmes of thinking skills, learning basic instrumental skills, study and basic orthography techniques, etc. are included.
Phonological awareness	Adaptation of the Phonemic Awareness programme developed by Castro in 2003 (Cuadrado	The intervention is organized into sixteen 30-minute sessions in which different tasks are conducted in an order based on increasing difficulty: isolation,

	& Trías, 2008)	recognition, segmentation, synthesis, addition, omission, and substitution.
Laterality and spatial-temporal domains	Techniques for the treatment of laterality disorders (Ferre, Catalan, Casaprima, & Mombiela, 2006)	Techniques and exercises for the homolateral and contralateral stages, for visual and auditory stimulation, exercises for body scheme, to correct manual dominance, graphomotor training, and spatial and temporal organization
Metalinguistic abilities	*Let's play with ... words, syllables, sounds, and letters* (García Celada, 2010)	Programme designed for children from 3 to 10 years-old with ludic activities on a CD-ROM, focused on the improvement of metalinguistic skills (lexical awareness, syllabic awareness and phonemic awareness) and grapheme-phoneme correspondence.
Reading comprehension and metacognition	Neuropsychological intervention based on Luria's Functional Model, Lezak's Executive Function construct and on the Metacognitive Approach to Comprehension by Lopez and Arcienagas (Ramírez, 2014)	Programme based on the metacognitive approach of reading comprehension and on the development of executive function, with special emphasis on the planning, supervision and evaluation of reading processes.
Encourage reading, development of reading habits and reading comprehension	Encourage reading by means of popular traditional tales (Gómez, 2015)	Intervention focused on the encouragement of reading with children in the 1st year of primary school by means of reading popular stories in groups.

In addition to the summary presented in the table above, educational technology provides us with infinite technological resources that are of great use when it comes to training reading processes. Some of these tools, which have been applied successfully in different contexts and with students of different levels, include the following:

- Cognitive literacy: http://www.cognitivalenguacastellana.es/ A neuropsychological model for the acquisition of linguistic competence.
- Reading fund: http://www.juntadeandalucia.es/averroes/~cepco3/fondolector/ A computer programme for the improvement of reading comprehension.
- Read better (IDECC): http://idecc.net/LeaMejor/w/EntrenamientoLeaMejor Software based on the learning of concepts and subsequent start-up of reading strategies.
- Progrentis: http://www.progrentis.com/ Visual method centred on coding, comprehension, and retention that stimulates the neurovisual system in order to encourage reading competence.

In summary, intervention in reading processes, from a comprehensive perspective of Neuropsychology and Education, implies the assessment and subsequent strategic teaching of such processes by means of the programmes and technological resources that are offered to us, along with the involvement of the completely educational, familial and social community in cooperation, in order to maximize the resulting outcomes.

Processes and programmes to intervene in ADHD

There are programmes to develop attention and improve cognitive function in Attention Deficit Hyperactivity Disorder (ADHD), which is one of the most frequent neurodevelopmental disorders in childhood (Lora-Espinosa & Díaz-Aguilar, 2012), comprising a cognitive-behavioral, heterogeneous, genetically-transmitted and neurofunctional pattern, according to Artigas-Pallarés (2011). It may display different behavioral expressions in childhood, adolescence, and adulthood (Barkley, Fischer, Smallish, & Fletcher, 2002). It is characterized by attention lability, impulsive behavioral style, sterile hyperactivity and fragility of the mechanisms to adapt to the environment, without any other psychopathological problems that justify the presence of such symptoms (Narbona & Schulumberger, 2007). Individuals with ADHD may also experience difficulties in the areas of sustained attention, executive function and working memory (American Psychiatric Association, 2013). The most recent meta-analysis on the worldwide prevalence of ADHD estimates a range of 2.6 to 4.5% among children in school age (Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015).

Diagnosis of ADHD is essentially clinical, but, just as Crespo-Eguilaz and Narbona (2013) state, quantifying behavior is important for the diagnosis and follow- up after the establishment of potential treatments. Moreover, neuropsychological assessment has progressively become part of the protocol in an efficient approach to the understanding of an accurate diagnosis of the disorder (Holmes, Gathercole, Place, Alloway, Elliott, & Hilton, 2010). The lack of ecological validity of traditional tests, as criticised by Gualtieri and Johnson (2005), opens the door to non-conventional types of assessment such as computerized tests. Some examples, as reviewed by , Climent and Banterla (2014), are Conners' Continuous Performance Test (CPT;
Conners, 1995), Test of Integrated Visual and Auditory Continuous Performance Test (IVA; Tinius, 2003), or the Test of Variables of Attention (TOVA; Leark, Greenberg, Kindschi, Dupuy, & Hughes, 2007), as well as the AULA virtual reality based test (Climent & Banterla, 2011) whose normative data are published (Iriarte, Diaz-Orueta, Cueto & cols., 2012) and has shown good psychometric properties when compared to Conners' CPT (Diaz-Orueta, Garcia-Lopez, Crespo-Eguilaz, *et al.*, 2014) and has the ability to monitor pharmacological treatment (Diaz-Orueta, Fernandez-Fernandez, Morillo-Rojas, & Climent, 2016).
With respect to treatment, we will refer to neuropsychological intervention programmes aimed at improving specific cognitive functions such as attention, working memory or executive functions. This will include reference to the latest developments in computer-based adaptations and virtual reality environments for ADHD.
In recent years, the potential of cognitive and neuropsychological intervention as a treatment for ADHD has been the focus of major research. As pointed out by Cortese *et al*. (2015), focusing on neuropsychological processes is important for two reasons: (1) neuropsychological deficits are postulated as mediators between the aetiology and the onset of the disorder; hence improvement of cognitive functioning may be a prerequisite for symptom reduction in ADHD; and (2) these deficits are associated with functional decline, regardless of their association with ADHD symptomatology, particularly in social and academic contexts. Below we present some of the most widely used interventions in ADHD from the perspective of educational neuropsychology:

- **TEAMS** comprehensive programme (Halperin *et al.* 2013). This targets pre-school infants aged between 4 to 5 years. The acronym refers to Training Executive, Attention and Motor Skills. It aims to provide group-based cognitive training by means of games to improve cognitive and motor symptoms in ADHD. The programme is held in 90 min sessions, with parents and children split into different groups (3 to 5 families per group). Children are presented with games to improve inhibitory control (variations of "Simon says", dance of the statues...), working memory (memorize shopping lists or find "hidden treasures"), motor control (games with balls, jumping, jump rope), attention (three-card monte), visuospatial skills (puzzles) and planning (prepare what it is necessary for a picnic). New games are progressively introduced during the first 5 sessions, together with aerobic exercises in two separate, 5-minute blocks. Sessions with parents include 20 minutes of psychoeducation about topics related to ADHD (assessment, longitudinal course, evidence-based treatments), together with group support. However, sessions were mainly focused on (1) barriers and difficulties experienced during the week before when playing TEAMS games with their child, and (2) descriptions and showcases of new games shown to their child, skills trained within each game, and methods to modify the difficulty level. Parents were asked to spend at least 30-45 minutes per day on aerobic games with their instructed on how to increase cognitive and behavioral load while their children progressed with the games. Results of this TEAMS programme showed a significant improvement of ADHD symptomatology and a maintenance of obtained gains during 3 months after completion of the training.
- **ENGAGE** (cited in Halperin, Bedard and Curchack-Lichtin, 2012): The acronym stands for Enhancing Neurocognitive Growth with the Aid of Games and Exercise. It targets children from 3 to 5 years old problems. It involves parents and children playing prescribed games every day for a period of 5 weeks, with the goal of targeting three areas that show deficits in self-control in children with ADHD: behavior, cognition, and emotion. A preliminary test showed certain improvements in hyperactivity (as rated by parents) that were maintained for 12 months. Moreover, significant improvements in scores related to sensory and motor control and working memory were reported.
- **ETAM** (Tamm, Nakonnezny, & Hughes, 2014). The acronym stands for Executive Training of Attention and Metacognition. The overall goal is to teach parents to administer a metacognitive training programme for executive functions to their children, in order to promote positive interactions during activities designed to improve attention and self-regulation. The programme runs for 8 weeks with weekly sessions of separate parents and children groups, in which children perform gamified activities that promote executive functioning and self-regulation, and parents and children develop a language to speak about attentional control (look into each other's eyes, listen with their ears, think with the brain, keep the body still) that serves as a meta-cognitive framework for the intervention programme. Activities practiced with parents at home are focused on a series of executive functions. Participants attend 60 minute weekly sessions for 8 consecutive weeks, with children meeting in small groups (4 to 6 children of similar age, when possible) with two trainers that present them with activities (3 to 4 new activities per week). Children are trained in activities related to attention, inhibition, memory, coordination, balance, sensory awareness, auditory listening skills, visual focusing, etc. and included commercial games such as Jenga (http://www.jenga.com/) for behavioural inhibition or Highlights Search (https://www.highlightskids.com/hidden-pictures/interactive/ducky-day-beach) for selective attention. Moreover, behavioral modification principles are implemented (environmental organization, reward strategies, the establishment of limits, extinction, timeout). Meanwhile, parents in groups of 20 meet a psychologist to model desired

behaviors and to promote generalization (using multiple examples, videos, etc. on how to implement the programme at home). Parents practice at least one of the activities with their children and, in order to promote adherence to the intervention, trainers make follow-up calls to parents. In their study, Tamm . (2014) showed with a subgroup of 24 children that the intervention was feasible and widely accepted by the parents (with a high rate of assistance and adherence, low resistance, and high satisfaction). In terms of efficacy, improvements were observed in executive functions (visual and auditory attention, working memory and cognitive flexibility) with their corresponding improvements in parents' ratings.

In summary, there is potential for improvement in terms of educational neuropsychology interventions for ADHD. The meta-analysis conducted by Melby-Lervag and Hulme (2013) as well as that of Cortese *et al.* (2015) concluded that neuropsychological interventions with ADHD are (1) specific to trained areas, with short-term effects, no real potential for generalization to other cognitive functions, and (2) independent to ADHD symptomatology. Due to the wide neuropsychological heterogeneity in ADHD, future efforts should be directed towards the development of protocols that target a wider range of neuropsychological deficits. Moreover, it is necessary to develop a therapeutic innovation that encourages the considerable leap from specific neuropsychological gains to treating the patterns of functional decline in daily life by means of training approaches that have higher ecological validity.

Conclusion: Future trends in Neuropsychology applied to Education and School Environment

The aim of this work was to analyse current neuropsychological reading and attention programmes following Luria´s model that suggests three fundamental blocks to explain brain functioning related to learning processes. We understand that studies such as this one are relevant given that a great number of learning difficulties and disorders are diagnosed every year in school students. However, in spite of this, there is a lack of use of reading and attentional intervention programmes based on neuropsychology that could prevent and improve the reading comprehension and attention problems. Thus, we carried out an extensive analysis of published neuropsychological reading and attention programmes and selected those that provide the highest effectiveness. We took into account the need for each programme to meet certain criteria, along with the fact that its application would provide the desired outcome, such as an increase in the targeted neuropsychological function, and a decrease in the difficulty of the disorder, as reflected in several applied neuropsychological studies (Fernández-Guinea, 2001; Murga, Carrión, & Barroso, 2006).

This study provides information about a wide range of neuropsychological reading and attention programmes that are applied both to improve difficulties, and to prevent, develop, and deal with children's specific reading and attention needs that are currently present in educational centres (Cleary & Scott, 2011; Martín-Lobo, 2016; Roselli *et al*., 2007).

Furthermore, for the current neuropsychological and technological programmes, we have focused on the reading and attention processes that affect school performance, in order to provide an innovative and effective solution for the neurodevelopmental needs of children at school level.

The main conclusion of this study is that there are current neuropsychological programmes that can improve reading and attention processes in all students at school age, which can help to overcome reading and attention disorders. It is necessary to introduce them and to train

neuropsychologists and psychologists to apply them both at a clinical and scholar level, depending on the needs and possibilities of each case.

The main limitation of this study emerges primarily from the fact that it is impossible to reflect all neuropsychological programmes in a single study. However, this study provides information that is practical, and, at the same time, relevant and of current interest. In particular, we propose further research for developing innovative lines of inquiry for the selection and application of improved neuropsychological reading and attention programmes.

References

Álvarez, D. (2014). *Incidencia de los movimientos sacádicos en la velocidad y la comprensión lectora en alumnos de Educación Primaria*. (Trabajo de Fin de Máster, documento no publicado). Máster de Neuropsicología y Educación, Universidad Internacional de la Rioja. Logroño.

American Psychiatric Association. (2013). D*iagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Ansari, D. & Coch, D. (2006). Bridges over troubled waters: education and cognitive neuroscience. *Trends in Cognition. 4,* 146.151.

Ardila, A. & Ostrosky-Solís, F. (2000). *Diagnóstico del daño cerebral: Enfoque neuropsicológico*. México: Trillas.

Artigas-Pallarés, J. (2011). Trastorno de déficit de atención/hiperactividad. En: J. Artigas-Pallarés y J. Narbona (Eds.), *Trastornos del Neurodesarrollo* (pp. 365-408). Barcelona: Viguera.

Barkley, R.A., Fischer, M., Smallish, L., & Fletcher, K. (2002). Persistence of attention deficit hyperactivity disorder into adulthood as a function of reporting source and definition of disorder. *Journal of Abnormal Psychology,* 111, 279–289.

Benarós, S., Lipina, S.L., Segretin, M.S., Hermida, M.J., & Colombo, J.A. (2010). Neurociencia y educación: hacia la construcción de puentes interactivos. *Revista de Neurologia, 50,* 179.186.

Bisquerra, R., Cortada, P. J., Antich, M., Timoteo, M., & Rodríguez, A. (1999). *Educar la visión. Psicopedagogía para la prevención y el desarrollo de la salud visual*. Barcelona: Prensa Universitaria

Caew, T.J, & Magsamen, S.H. (2010). Neuroscience and Education: An ideal Partnership for producing evidence-based solutions to guide 21 Century Learning. *Neuron, 67*, 685-688.

Chevalier, N. (2010). Executive functions in cildren: concepts and developments. *Canadian Psychology-Psychology Canadienne*, *51*(3), 149-163.

Cleary, M.J. & Scott, A.J. (2011). Developments in clinical neuropsychology: Implications for school psychological services. *Journal of School Health*, *81*(1), 1-7.

Climent, G., & Banterla, F. (2011). *AULA. Evaluación ecológica de los procesos atencionales.* San Sebastián: Nesplora.

Conners, C.K. (1995). Conners' Continuous Performance Test. Toronto: Multi-Health Systems.

Cortese, S., Ferrin, M., Brandeis, D., Buitelaar, J., Daley, D., Dittmann, R.W., ..., Sonuga-Barke, E.J. Deficit/Hyperactivity (2015). Disorder: Cognitive Training Meta-Analysis for of Attention-Clinical and Neuropsychological Outcomes From Randomized Controlled Trials. *Journal of the American Academy of Child and Adolescent Psychiatry, 54*(3), 164-174.

Crespo-Eguílaz, N., & Narbona, J. (2013). Evaluación neuropsicológica del niño. En J. Peña-

Casanova (Ed.). *Manual de logopedia*, *4a Edición* (pp. 109-127). Barcelona: Elsevier Masson.

Cuadrado, A., & Trías, D. (2008). Desarrollo de la conciencia fonémica: Evaluación de un programa de intervención, *Revista Argentina de Neuropsicología, 11*, 1-8.

De los Reyes, C.J., Arango-Lasprilla, J.C., Perea, M.V., & Ladrea, V. (2014). *Alteraciones cognitivas, emocionales y comportamentales en personas con traumatismos craneoencefálicos.* In: Pérez, M., Escotto, E, Arango J.C. y Quintanar, L. Rehabilitación neuropsicológica. México: Manual Moderno (pp.143-162).

Diaz-Orueta, U., Fernandez-Fernandez, M.A., Morillo-Rojas, L., & Climent, G. (2016). Efficacy of lisdexamphetamine to improve the behavioural and cognitive symptoms of attention deficit hyperactivity disorder: treatment monitored by means of the AULA Nesplora virtual reality test [article in Spanish]. *Revista de Neurologia, 63*(1), 19-27.

Díaz-Orueta, U., Garcia-López, C., Crespo-Eguílaz, N., Sánchez-Carpintero, R., Climent, G., & Narbona, J. (2014). AULA virtual reality test as an attention measure: Convergent validity with Conners' Continuous Performance Test, *Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence, 20*(3), 328-342.

Diaz-Orueta, U., Lizarazu, B., Climent, G., & Banterla, F. (2014). Virtual Reality for Neuropsychological Assessment. In: Ma, M., Jain, L., White, A., & Anderson, P. (Eds.). *Virtual, Augmented Reality and Serious Games for Healthcare 1* (pp. 233-255). London: Springer-Verlag. ISBN 978-3-642-54816-1.

Duff, F.J., Holme, C., Grainger, K., Hardwick, S. J., Milles, J., & Snowlling, M.J. (2014). Reading and Language intervention for children at risk of dyslexia: a randomised controlled trial. *Journal of Child Psychology and Psychiatry, 55*(11), 1234-1243. DOI: 10.1111/jcpp.12257.

Fernández, R. (2016). *Neuropsicología aplicada a la Educación. Implicación de las funciones ejecutivas en el desarrollo lectoescritor. Programa de intervención.* Alicante: Área de Innovación y desarrollo.

García Celada, M. (2010). *Vamos a jugar con… las palabras, las sílabas, los sonidos y las letras* (5ª ed.). Madrid: CEPE.

Gómez, L.V. (2015). *Animación lectora a través de cuentos populares en primero de Educación Primaria* (Trabajo de Fin de Máster, documento no publicado). Máster de Neuropsicología y Educación, Universidad Internacional de la Rioja. Logroño.

Gualtieri, T., & Johnson, L.G. (2005). ADHD: Is objective diagnosis possible? *Psychiatry, 2(*11), 44–53.

Halperin, J.M., Bédard, A.V., & Curchack-Lichtin, J.T. (2012). Preventive Interventions for ADHD: A Neurodevelopmental Perspective. *Neurotherapeutics*, 9, 531–541.

Halperin, J.M., Marks, D.J., Bédard, A.V., Chacko, A., Curchak, J.T., Yoon, C.A., & Healey, D.M. (2013). Training Executive, Attention, and Motor Skills: A Proof-of-Concept Study in Preschool Children with ADHD. *Journal of Attention Disorders*, 17(8), 711-721.

Holmes, J., Gathercole, S.E., Place, M., Alloway, T.P., Elliott, J.G., & Hilton, K.A. (2010). The diagnostic utility of executive function assessments in the identification of ADHD in children. *Child and Adolescent Mental Health,* 15(1), 37–43.

Luria, A.R. (1980). *Higher cortical functions in man*. Nueva York: Basic Books.

Luria, A. (1973). *The working brain: An introduction to neuropsychology*. Nueva New York: Basic Books.

Manga, D., & Ramos, F. (2011). El legado de Luria y la neuropsicología escolar. *Psychology Society & Education 3*(1), 1-13.

Martín-Lobo, P. (2012). La neurociencia en la formación inicial de los educadores: una experiencia innovadora. *Participación educativa. La investigación sobre el cerebro y la mejora de la educación, 1*. 93-101.

Martín-Lobo, P. (2016). *Procesos y Programas de Neuropsicología Educativa*. Madrid: Ministerio de Educación de España. Centro Nacional de Investigación e Innovación, CNIIE.

Matute E., Rosselli, M., Ardila A. & Ostrosky-Solís F. (2007). *Evaluación Neuropsicológica Infantil (ENI). Protocolo, Material, Datos Normativos*. Manual Moderno.

Leark, R.A., Greenberg, L.M., Kindschi, C.L., Dupuy, T.R., & Hughes, S.J. (2007). *Test of variables of attention Continuous Performance Test: Professional manua*l. Los Alamitos, CA: TOVA.

Lora-Espinosa, A., & Díaz-Aguilar, M.J. (2012). Aspectos prácticos en la atención del niño y adolescente con TDAH. *Revista de Pediatría en Atención Primaria*, Supl(21), 83-86.

Melby-Lervåg, M., & Hulme, C. (2013). Is Working Memory Training Effective? A Meta-Analytic Review. *Developmental Psychology*, 49(2), 270–291.

Narbona, J., & Schulumberger, E. (2007). Déficit d'attention et hyperactivité. En C. Chevrie-Muller y J. Narbona (Eds.). *Le langage de l'enfant. Aspects normaux el pathologiques*. Paris: Elsevier-Masson.

Pérez, M., Escotto, E., Arango-Lasprilla, J.C., & Quintanar, Rojas, L. (2014). *Rehabilitación neuropsicológica. Estrategias en trastornos de la infancia y del adulto*. Méjico: Manual Moderno.

Polanczyk, G.V., Salum, G.A., Sugaya, L.S., Caye , A., & Rohde, L.A. (2015). Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. J*ournal of Child Psychology and Psychiatry,* 56(3), 346-365.

Portellano, J.A. (2008). *Neuropsicología infantil*. Madrid: Síntesis.

Portellano, J.A., Mateos, R. & Martínez Arias, R. (2012). *Cuestionario de Madurez Neuropsicológica Escolar (CUMANES)*. Madrid: TEA Ediciones.

Ramírez, P. (2014). El déficit en comprensión lectora a la luz del modelo funcional de Luria: una propuesta de intervención neuropsicológica, *Paideia, 54*, 57-73.

Ramos, F. & Manga, D. (2006). *Luria Inicial: Evaluación neuropsicológica en la edad preescolar*. Madrid: TEA Ediciones.

Roselli, M.; Matute, E, & Ardilla, A. (2007). *Neuropsicología del desarrollo infantil.* Méjico: Manual Moderno.

Roselli, M. & Matute, E. (2010). Evaluación neuropsicológica infantil. (ENI). Manual de aplicación. México: Universidad de Guadalajara.

Rosselli, M., & Matute, M. (2011). La neuropsicología del desarrollo típico y atípico de las habilidades numéricas. *Revista Neuropsicología, neuropsiquiatría y neurociencias, 11*(1), 123-140.

Rosselli, M. Matute, E. & Ardila, A. (2006). Predictores neuropsicológicos de la lectura en español. *Revista de Neurología, 42*(4), 202-210.

Szucs, D., & Goswami, U. (2007). Educational neuroscience: defining a new discipline for the study of mental representations. *Mind, Brain, Education, 3,*114-127.

Tamm, L., Nakonnezny, P.A., y Hughes, C.W. (2014). An Open Trial of a Metacognitive Executive Function Training for Young Children with ADHD. *Journal of Attention Disorders,* 18(6) 551-559.

Tinius, T.P. (2003). The integrated visual and auditory Continuous Performance Test as a neuropsychological measure. *Archives of Clinical Neuropsychology, 18*, 439-454.

Varma, S., McCansliss, B.D., & Schwartz, D.I. (2008). Scientific and pragmatic challenges for bridging education and neuroscience. *Educational Researcher, 3,* 140-52.

Wolf, M. (2007). *Proust and the squid. The Story and Science of the Reading Brain*. Londres: Harper.

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