Review Article

The Treatment of Learning Disabilities

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Abstract

The child neurologist, developmental pediatrician or child psychiatrist involved in the care of children with learning disabilities has a crucial role that extends beyond diagnosis. The goal of the medical professional involved in the care of a child with learning disabilities is to attempt to identify which areas of the brain are dysfunctional and to suggest a specific educational intervention based on that knowledge. The prevailing view of the biologic correlates of reading disabilities is that it is a phonolinguistic problem. Interventions that increase phonological awareness are an essential first step in the remediation of learning disabilities. The primary use of medications for children with learning disabilities is to open up a window of opportunity for educational intervention. Our increased understanding of brain function and brain plasticity hold promise in the development of future neuroeducational interventions for children with learning disorders. *Int Pediatr. 2000;15(2):91-96.*

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Introduction

It is estimated that about 5 to 10% of the school-aged population in the United States has been identified with learning disabilities and that up to 5% of all office visits to a pediatrician and up to 50% of children evaluated in mental health clinics have learning disabilities.[1] Studies have shown that less than 40% of children with learning disabilities complete grade 12 and unemployment rates, social adjustment, marital problems, and delinquency are higher in adult individuals with learning disorders.[2] The frequency of learning disorders and the poor outcome associated with learning disabilities makes it imperative that professionals involved in providing medical care to children be active participants in the management strategies and treatment plans of individuals with learning disabilities.

Dyslexia is the most common type of learning disability and it affects 80% of children diagnosed as learning disabled.[3] The prevailing view of the biologic correlates of reading disabilities is that it is a phonolinguistic problem.[4,5] There is some evidence for visual processing deficits in dyslexia but no causal relationship between this abnormality and reading deficits has been established.[6] Disorders of learning such as dyslexia are likely secondary to deficits in parallel and distributed modular brain systems. One would therefore expect that there are multiple points within these systems where dysfunction may lead to specific learning problems.

There is no single treatment or intervention approach targeted at remediation of learning disorders that has been shown to bring about reproducible long-term gains in children diagnosed with learning disabilities.[7] The clinician faced with a child with a disorder of learning has to be aware of a multitude of intervention strategies and "cures" most of which are based on scant if any scientific support and which are offered by a variety of different professionals. As intimidating and frustrating as the task of making treatment recommendations may be, the lack of involvement by the clinician in the management of learning disabilities can have significant deleterious effects on the outcome of the child and family faced with specific problems in learning.

Definitions

Reading as a process involves visual-perceptual and phonologic systems working together to extract meaning from print. Developmental dyslexia is an innate inability to read. Reading requires visual processing of the written word (decoding) followed by an understanding that these symbols can be broken down into underlying phonologic elements. Fulbright et al, have summarized the current theories of word identification into three distinct computational systems: 1) orthographic processes: that is those processes that result in letter identification, 2) phonologic processes: those processes that result in the identification of the phonemic parts of the printed text, 3) lexical-semantic: those processes that result in identification of the word's meaning.[8]

Phonemes are the sounds representing the most elementary unit of speech and graphemes are the symbols used to represent the inventory of phonemes within a language.[8] Evidence from numerous studies has converged to indicate that poor reading skills are related to deficient skills in understanding that words are made up of phonemes and that within this phonological model, the continuum of reading disability reflects the distribution of phonologic processing skills.[3] This neurophysiological processing problem of hav-

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ing difficulty in segmenting phonemes within spoken syllables and words has been termed phonemic awareness and is the central problem characterizing deficiencies in the decoding aspect of reading.[9]

Reading by definition requires that the printed word be identified and decoded prior to it being understood. Thus a deficit in phonemic awareness even in an individual with otherwise intact cognitive proficiency will not allow an individual to use their higher-order cognitive-linguistic skills to access the meaning of text.[10] Despite some emerging research to suggest an independent contribution of visual processing deficits to dyslexia the overwhelming consensus among investigators in the field is that the core problem in developmental dyslexia is a phonologic deficit.

Despite the lack of sound scientific studies on treatment interventions for children with learning disabilities the child neurologist, developmental pediatrician or child psychiatrist involved in the care of these children has a crucial role that extends beyond diagnosis. This role includes making specific recommendations regarding early intervention strategies, putting into a neurological perspective the types of educational interventions that will maximize a child's potential, discussing the role of medications in the management of learning disorders, as well as using medications in appropriate situations, and coordinating the multimodal approach which is essential to the long term treatment of all children with learning disabilities.

Early Intervention

The established relationship between language disorders and dyslexia allows for early identification of children at risk. Thus if a child is talking late, has difficulty pronouncing words, has slow vocabulary growth or trouble finding the right word he should be referred for further language assessment and intervention. Specific remediation techniques for children with language disorders may prevent or minimize the risk that these children have for future learning disabilities.[11]

Specific interventions are now being explored for children with language disorders. Research suggests that there is a subgroup of children with language dysfunction, which is secondary to defective temporal processing of auditory stimuli and to deficits in speech discrimination.[12, 13] Computer games have been devised in which the intensity of the consonant sounds are enhanced relative to the vowels and in which the duration of the speech signal is prolonged. After one month of training children working with these computer programs have been reported to improve in their language test scores by as much as 2 years and these changes are maintained for at least 6 weeks post intervention.[12, 13]

Further research into the use of computer game interventions that have a neurophysiological foundation is needed to determine their impact on the long-term outcome of children with language-based learning disabilities such as dyslexia. It is likely that early identification of children with language disorders combined with our growing understanding of the neurophysiology of language dysfunction will lead to effective long-term interventions for children with language based learning disabilities.

Neuroeducational Intervention

The most common and most accepted treatment for learning disabilities has been educational intervention. There has been significant controversy over how to best educate children with learning disabilities over the years. This debate has not flowed into the medical world and there exist serious gaps of communication between educators and medical professionals.

In the education field, controversy over how to teach reading skills has raged among those advocating the phonics methods, the sight word method, and those advocating the whole language approach. In the phonics approach the students are taught to say the sound of the letter and not the letter name, while in the sight word approach the students are taught through flash cards to memorize the words as a visual configuration.[9] In the whole language approach students are taught reading through the use of a natural context format in whereby a child's language skills are matched with the literacy demands of specific books.[14] It is the whole language approach, which is presently in favor in terms of teaching literacy skill. There is also recent interest in using a balanced approach which embraces all of the above remediation techniques.

Studies on mathematical remediation have focused on underlying cognitive deficits or on specific operations or skills.[15] Writing disorders are related primarily to language disturbances and the remediation of the language disorder is essential to treatment. Handwriting disorders (dysgraphia) are felt to be secondary to deficits in fine motor movements. The treatment of dysgraphia has centered on remediation of the fine motor skills needed for writing and less emphasis has been given to treating possible underlying motor sequencing, visuospatial, or attentional deficits.[2]

Intervention strategies in schools for children with dyslexia, dyscalculia and dysgraphia are centered on instruction of specific cognitive strategy techniques. The purpose of these techniques is to teach students strategies or tricks to overcome specific deficits. These cognitive strategy techniques are combined with study skill instruction in areas such as time management, learning to keep notes or lists, how to listen to key points in a lecture, and retention strategies to improve recall of material studied.[14] Specific recommendations to promote positive behavior and remediate specific deficits are also available for children with the neuropsychologically defined nonverbal learning disability syndrome.[16]

The neuropsychological approach to identification of specific deficits and remediation of these deficits with individualized treatment plans is beyond the scope of most school systems. Nevertheless, multifaceted treatment programs for children with learning disabilities that attempt to incorporate individualized and intensive teaching methods in a cost-effective manner have recently been studied with encouraging results.[17, 18] This approach carried out in Chile compared two groups of children the first group participated in a structured multifaceted cognitive treatment program and the second group received an enriched environment and supervision of school tasks. After one year of treatment both groups improved their performance significantly on measures of cognition, school achievement, and behavior.[17,18]

Several types of educational interventions for children with learning disabilities are effective in remediation at least certain subgroups of children with learning disorders. Educational techniques seem to work best in small groups and even better if the remediation techniques are individualized and intensive. What appears to be lacking from the majority of educational remediation techniques is neurobiological based hypothesis that attempt to explain how specific remediation technique work. These type of hypothesis driven neuroeducational models of intervention for children with learning disabilities are needed in order to develop remediation techniques that take full advantage of our understanding of brain function.

The goal of the medical professional involved in the care of a child with learning disabilities is to attempt to identify which areas of the brain are dysfunctional and to suggest a specific educational intervention based on that knowledge. This in fact is the basis for a neuroeducational model of intervention. An example of this is the recent motor-articulatory feedback hypothesis, which attempts to explain the neurological deficits present in one type of developmental dyslexia.[19] This hypothesis postulates that dyslexic children are unaware of the position of their articulators during speech and that this inability impairs the development of phonological awareness which leads to deficiencies in the ability to of these children to convert letters (graphemes) into speech sounds (phonemes).[19] These researchers postulate that this deficiencies are secondary to programming or feedback deficits (a representational deficit for the articulatory apparatus) possibly due to functional deficits in the anterior perisylvian region.[19]

The practical implications of the motor-articulatory feedback hypothesis are that there are specific educational interventions available, which are successful at remediation of this specific deficiency.[20] The Auditory discrimination in Depth (ADD) program trains individuals in oral motor awareness. This is followed by phonological awareness training, which teaches an individual how to associate graphemes with the articulatory gestures that produce the target phonemes.[20] Improvement in phonological awareness and reading skills has been demonstrated using this type of program.[21] This educational intervention program has been expanded to incorporate concept imagery. Concept imagery is believed to be essential in comprehension and in the ability to form mental images for the concepts and ideas expressed in language.[22] The combination of these programs has been shown to be an effective method of remediation for children with learning disabilities.[9] The Lindamood-Bell programs develop specific sensory-cognitive functions that allow for enhanced oral and written language processing and an excellent model illustrating the type of neuroeducational intervention needed for effective long-term remediation of individuals with learning disabilities.

Medications

The primary use of medications for children with learning disabilities is to open up a window of opportunity for educational intervention. There is a significant overlap between attention deficit hyperactivity disorder and learning disabilities. The usual figure of overlap between these two disorders is 20 to 25% but some estimate that attention deficit and hyperactivity disorder coexists in 40% of the population of children with learning disabilities.[23, 24] Treatment with medications such as neurostimulants (methylphenidate or dexedrine) may allow a child with a learning disability to be less impulsive and more able to receive remediation through educational interventions. Furthermore affective disorders such as anxiety disorders, depression, mania or phobias may coexist with learning disabilities. These comorbid conditions can than be targeted with appropriate medications, which will open a window of opportunity to allow effective educational interventions to take place.

Another treatable condition in a child with a learning disability is clinical seizures. In addition, despite the fact that the EEG in the majority of children with learning disabilities does not usually demonstrate epileptiform activity there is increasing evidence that in some children subclinical epileptiform discharges do cause transient cognitive impairment (TCI).[25,26] Transient cognitive impairment may not be clinically evident but can be documented when specific neuropsychological testing is done simultaneously with ongoing EEG monitoring. Specific functions such as perception, reaction time and scholastic performance have been shown to be disrupted by brief epileptiform discharges in the absence of clinical seizures.[27-29] There are reports of children with learning disabilities and a severely epileptiform EEG but without clinical seizures in which treatment with valproic acid resulted in improvement in cognitive performance and this improvement was proportional to the reduction in epileptiform discharges.[30-32]

It is also possible that medications used to treat specific disorders that coexist with learning disabilities may have di-

rect positive effects on learning.[33] Medications such as methylphenidate, antidepressants such as Fluoxetine and mood stabilizers such as lithium carbonate or valproic acid may directly enhance certain cognitive processes.[33] The evidence for this is still scant but further research into the cognitive enhancing potential of selective medications is needed. Specifically there is ongoing controversy both in the adult and pediatric literature on the cognitive enhancing effects if any of compounds known as nootropics.

Piracetam is the most widely researched nootropic compound although it is not approved for clinical use in the United States. A recent Medline search on Piracetam revealed over 450 articles with the most accepted use being for the treatment of myoclonic seizures. There are however several studies on the use of Piracetam in children with learning disabilities.[34-38] The most recent of these studies did not show any significant difference between piracetam and placebo in any aspect of reading.[38] A recent double-blind placebo controlled studies using piracetam as an adjunct to language therapy in adult aphasic patients did find that Piracetam had a significant positive effect on the recovery of aphasia in patients receiving intensive language therapy.[39] There is also research suggesting that Piracetam may have positive cognitive effects on individuals with Alzheimer's disease, in recovery of stroke, and in a variety of affective and behavioral processes.[39-41]

At the present time medication in children with learning disabilities should be used to treat specific targeted symptoms such as attention, anxiety or seizures. However, there is growing interest in the direct role that medications may play in enhancing cognitive processes. We need to continuously reassess the role of medications as specific adjunctive treatment in the remediation of children with learning disabilities and continue to search for effective pharmacotherapeutic agents with positive cognitive enhancing properties.

Multimodal Approach

Learning disabilities affect not only the child but also the family structure. Learning disabilities are silent (physically non-stigmatizing) life-long disorders that impact all aspects of a child's life and by default, the life of a family. The physician involved in the care of children with learning disabilities has to be cognizant of the impact this disorder is making on the family and be able to guide the family through the maze of information and misinformation available to the professional and lay public. It is a mistake to make the diagnosis and "abandon" the child. It is important not only to realize what the physician can actively do i.e., make recommendations regarding appropriate educational intervention and use medications when appropriate but also to inform the family of interventions that have no scientific or proven basis.

An understanding of the controversial therapies in learning disabilities is essential knowledge for all professionals working with individuals with developmental disorders. Silver [42] has defined a controversial therapy as any therapy that is advocated and "sold" to the public prior to any research or in the case of preliminary research in the absence of replication. In addition, a controversial therapy is one that goes beyond what the research data support or is used in isolation when a multimodal approach is called for. These therapies include patterning, optometric visual training, cerebellar-vestibular dysfunction, applied kinesiology, auditory processing training, tinted lenses, megavitamins, trace elements therapy and treatment of allergies. No clinical or research studies have been done to confirm or support the claims of any of these interventions for either the short or long term remediation of children with learning disabilities.[42] Silver does point out that there is a relationship between brain function and nutrition, as well as one between brain function and allergic conditions or reactions, but at the present time there is no scientific understanding of these relationships that allow for treatment recommendations.[42]

A multimodal approach to the child with learning disabilities includes making recommendations regarding educational strategies, discussing and using medications when appropriate, and developing a relationship with the family that will allow for a continual dialogue in regards to the types of interventions that have been proven to be effective in learning disorders. Recommendations regarding treatment should take into consideration the child in the context of the family and his peer environment. Reassessment on a continual basis is needed to assess the child's progress and to determine if any modifications in treatment need to be made.

Conclusions

The future of treatment strategies for individuals with learning disabilities lies in our continued quest to map specific behavioral functions to regions of the brain. Shaywitz et al,[5] have recently demonstrated a specific functional disruption in the brain of individuals with dyslexia using a series of language tasks that made demands on visual-spatial processing, simple and complex phonologic analysis, and lexical semantic judgement. They demonstrated that as measured by fMRI dyslexic readers showing relative underactivation in Wernicke's area, the angular gyrus, and striate cortex and relative overactivation in the inferior frontal gyrus. They suggest that the impairment in dyslexia is phonologic in nature and that the brain activation patterns found in this study may provide a neural signature for dyslexia.[5]

A recent study in an adult with acquired dyslexia suggests that it is possible to alter brain physiology with therapy for acquired language disorders.[43] In this case study fMRI was performed during a reading task before and after treatment.

Prior to therapy, the main focus of brain activation was in the left angular gyrus. After therapy, it was instead in the left lingual gyrus. In addition prior to treatment the patient had a whole-word (lexical) reading approach and following therapy she preferred a decompositional (sublexical) strategy.[43]

One would expect that the type of brain plasticity described above would be even more evident in children with developmental dyslexia. The promise of our increased understanding of brain function is that effective treatment strategies for individuals with learning disabilities will be based on sound scientific principles.

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