REVIEW **OF LITERATURE**

The Effects of Chiropractic Care on Individuals Suffering from Learning Disabilities and Dyslexia: A Review of the Literature

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ABSTRACT

Objective: To present current mainstream and alternative theories about learning disabilities, with a special emphasis on dyslexia, as well as to systematically review the chiropractic and related literature about the effects of chiropractic care in people suffering from learning disabilities and dyslexia, and to compare chiropractic causal theories to accepted medical models.

Methods: Computerized and hand searching of the various databases Mantis, ICL, CRAC as well as the Proceedings of the International College of Applied Kinesiology were conducted with the following index terms: "dyslexia", "learning", "learning disabilities", "learning disorders", "applied kinesiology", and "neurologic disorganization". The retrieved literature was selected or rejected according to predetermined inclusion and exclusion criteria and was subsequently classified according to level of evidence and critically reviewed on predefined methodologic criteria. We also compared the various causal chiropractic theories to accepted mainstream science causal theories of learning disability and dyslexia.

Results: Eight studies met our criteria. Four of them belonged to the lowest class of evidence, for a total of 25 anecdotal reports. The remaining four were before/after studies. None of the studies met all of our predefined methodologic criteria. Points of interests and methodologic weaknesses are discussed.

Conclusion: All studies reviewed suggested a positive effect of chiropractic care in individuals suffering from learning disabilities and dyslexia. However, the various methodological weaknesses of those studies preclude any definitive conclusions and all the results are therefore to be considered preliminary. Within those limitations, there seem to exist a potential role for chiropractic care in improving various cognitive modalities known to be essential in learning. The model of vertebral subluxation and its effects on cognitive function may serve as a link between the field of chiropractic care and the neuroscience of those disorders.

Key words: *Learning disability, dyslexia, chiropractic, ADHD*

Introduction

Learning disabilities

Although the prevalence varies according to sources, it is estimated that between 3-10% of the school-age population in the United States is considered learning disabled.[1-4] However, the definition used to classify children as learning-disabled is a contentious issue that results in problems for identification, service provision and research.[5] In consequence some authors have estimated the prevalence of school children having difficulty performing at an age-appropriate level to be 15.5%[6] and even 20%.[7]

Despite issues concerning the definition, the most cited and utilized definition[8] is that of the National Joint Committee on Learning Disabilities (NJCLD), which states:

> "Learning disabilities is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviors, social perception, and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (e.g. sensory impairment, mental retardation, serious emotional disturbance) or with extrinsic influences (such as cultural differences, insufficient or inappropriate instruction), they are not the result of those conditions or influences".[9]

While this definition appears relatively simple, there remains however some serious conceptual and pragmatic issues.[5] For example, the specific methods used to define a discrepancy (the difference between the child's ability and his/her academic

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achievement) can be different, and each approach will therefore identify a different group of children as learning-disabled.[10] If, for example, we take dyslexia, this means that not all children receiving remedial assistance in, for example, Vermont, which defines dyslexia as a 22-point discrepancy between I.Q. and reading achievement scores, would qualify for help in California, which defines it differently; in fact, only about a dozen of the 50 States apply the same criteria.[11]

What makes learning disabilities very difficult to define is that every individual has a unique combination of cognitive talents and deficiencies. Therefore, the concept of learning disability presumes a deviation from an ideal norm that is determined by a specific culture or society at a certain point in time of history.[3]

Those issues notwithstanding, most definitions of learning disabilities require the fulfillment of three basic criteria:

a. The learning problem is due to some deficiency in cognitive skills rather than intellectual impairment;
b. The child's academic achievement is below expectancies based on his/her IQ;
c. The learning problem is not due to either other handicapping conditions (e.g. visual impairment) or to environmental factors (e.g. inadequate educational experiences).[6]

The issue of the definition of learning disability is also reflected in the classification and subtype systems used to clarify the various disorders that are considered to be part of learning disabilities. Moreover, classification may differ according to whether the analysis is based on an analysis of the errors involved (such as errors in reading, writing, …) rather than on an evaluation of the neuropsychological profile of the individual.[6]

According to the former classification, learning disabilities can be divided into three broad categories[7]:

a. Developmental speech and language disorders
b. Academic skills disorders
c. Others (including certain coordination disorders and learning handicaps not covered by the other terms). This category is sometimes referred to as motor skill disorders.

Each category includes a number of more specific disorders. (See Table 1)

Table 1. Classification of Learning Disabilities[7]

Developmental speech and language disorders
Developmental articulation disorder
Developmental expressive language disorder
Developmental receptive language disorder

Academic skills disorders
Developmental reading disorder (dyslexia)
Developmental graphic disorder (dysgraphia)
Developmental arithmetic disorder (dyscaculia).

Other (Motor Skills Disorder)
Developmental coordination disorder
Attention deficit disorder (ADD)
Attention deficit hyperactivity disorder (ADHD)

Developmental speech and language disorders is a set of disorders where people have difficulty producing speech sounds, using spoken language to communicate, or understanding what other people say. It includes more specific diagnosis such as developmental articulation disorder, developmental expressive language disorder, and developmental receptive language disorder

Academic skill disorders include developmental reading disorder (dyslexia), developmental arithmetic disorder (dyscalculia) and developmental graphic disorder (dysgraphia). Dysgraphia contains further subtypes such as dyslexic dysgraphia, dysgraphia due to defect in understanding of space and dysgraphia due to motor clumsiness. The latter sometimes appear in the motor skills disorder category.[12]

Other learning disabilities include developmental coordination disorder, as well as two very prevalent disorders: attention deficit disorders (ADD) and attention deficit / hyperactivity disorders (ADHD). Although these two disorders are frequent and have an important societal impact, they will not be considered in this present paper.

Using neuropsychological models[6], learning disabilities are broken down into three subtypes:

a. A language-based subtypes with prominent symptoms related to language expression (oral or written) and language comprehension, with relatively intact nonverbal skills – dyslexia being the most common type
b. A mixed subtype with problems in both language and nonverbal abilities.
c. A social-emotional subtype with prominent difficulties in comprehending social-interpersonal cues and in the pragmatics of language and social intercourse.

This later subtype is a nonverbal disability associated most strongly with arithmetic and with a pattern of deficits in neurocognitive and adaptive functions most often attributed to the right hemisphere, including problems in spatial cognition, visuoperceptual/ simultaneous information processing and social-emotional functioning.[5] These disabilities are often referred to as "right hemisphere developmental learning disability" or "social-emotional learning disability".[13]

Learning disabilities usually affect the individual for a lifetime. The same areas of neurological dysfunctions that interfere with learning also interfere with life skills, sports, activities, and family and peer relationships.[14]

Because of the academic struggle caused by learning disabilities, the child may develop problems of low self-esteem, diminished motivation, loss of interest in school and problems in social functioning.[6]

The co-occurrence of learning disabilities and other disorders is also of importance. We will cover this aspect later in our discussion of dyslexia.

Dyslexia

The most common type of learning disability is dyslexia, which affects 8 in 10 children diagnosed as learning disabled[15]. It is defined as "a specific and significant impairment in reading abilities, unexplainable by any kind of deficit in general intelligence, learning opportunity, general motivation or sensory acuity".[16]

Recent studies[17-18] have challenged the traditionally held notion that dyslexia affects boys more than girls. Previously reported differences may rather be the consequence of referral practices by schoolteachers, in which boys with disruptive disorders are preferentially referred for assessment, whereas girls with identical reading difficulties, but without classroom disruptive behavior, are often overlooked for referral.[5] However, Habib[16], in a recent review, still declares, "it is widely recognized, although not universally, that dyslexia is more frequent in males".

It was thought until recently that dyslexia represented a discrete entity[15], but new data has appeared that support the idea that dyslexia rather represents the lower tail of a normal distribution of reading ability[18]. This means that there is in a fact a continuum of reading ability that encompasses good and poor readers, and that it is the cutoff point chosen along that continuum that determines the label of "reading-disabled". Children along this continuum differ by degree and not by kind.[15]

Etiological theories, core deficits and neurobiologic correlates of dyslexia.

As far as etiological theories of learning disorders and dyslexia are concerned, we have to distinguish theories generally accepted by mainstream science and the theories developed in the field of alternative health care, which are considered controversial by mainstream medicine.

Presented below are accepted theories. Theories related to "controversial" alternatives, will be presented with their corresponding treatments later on in this paper.

There is more and more agreement in the scientific community that dyslexia is a disorder of genetic origin with a basis in the brain. In other word, dyslexia – and other learning disabilities - is a disorder of neurodevelopmental origin.[19] It has been shown that between 35% and 40% of first-degree relatives of reading-disabled children also have reading disabilities.[20] The interested readers should refer to Pennington[19] for more information on the genetics of learning disabilities.

Although the results are often time contradictory, in vivo studies of the brain of dyslexic children have demonstrated differences (compared to non reading-disabled subjects) in hemispheric asymmetries of the corpus callosum, temporal lobe and planum temporale.[21] More recent imaging studies have shown that dyslexics exhibited significantly smaller right anterior lobe of the cerebellum and brain volume.[55] Overall, the cerebellum is the most consistent location for structural differences between dyslexics and controls in imaging studies.

Moreover, it has been demonstrated recently that the neurocognitive basis of dyslexia is universal despite cultural diversity.[22] Differences in reading performance among dyslexic individuals of various countries are therefore due to differences in orthographies.[22] A complete review of brain differences among dyslexics and non-dyslexics is beyond the scope of this paper and has been presented elsewhere.[16, 21]

At this time there are five leading hypotheses of developmental dyslexia: the phonological theory, the auditory theory, the visual theory, the cerebellar theory and the magnocellular theory. The interested reader is referred to Ramus[56, 57] and Habib[16] for a more complete review of those theories The following summary of theories is taken from the aforementioned authors.

Phonological theory

This theory postulates that dyslexia is a deficit that affects the ability to manipulate in an abstract form the sound constituents of oral language, as well as to represent, store and/or retrieval of speech sounds. This ability is called "phonological awareness". Whereas most children are able to perform tasks requiring segmenting words in smaller units (syllables and partly phonemes) well before reading age, dyslexic children are still unable to do so even after several month of reading and writing.[16]

Auditory theory

This theory claims that dyslexia is secondary to a deficit in the ability to perceive short or rapidly varying sounds. Dyslexics have been shown to have poor performance on a number of auditory tasks - including frequency discrimination and temporal order judgment – and abnormal response on to various auditory stimuli.

Visual theory

In this view, dyslexia is secondary to a specific visual impairment that gives rise to difficulties in processing letters and words on a page. It also postulates that the magnocellular pathway of the visual system is selectively disrupted, a hypothesis that has been demonstrated at least in some dyslexics. Moreover, dyslexics have also been shown to exhibit deficit in the perception of rapid, high contrast visual information [16].

Cerebellar theory

This theory postulates that the cerebellum is dysfunctional. The role of the cerebellum in motor control can therefore lead to deficit in speech articulation, which would then lead to a deficient phonological representation. Moreover, because the cerebellum is playing a role in the automatization of overlearned tasks, its dysfunction could lead to abnormal learning of the grapheme-phoneme correspondence.

These three previous theories are sometimes represented under the umbrella of the temporal processing theory, which suggests that the different deficits observed in dyslexia may all stem from a unique basic deficit involving the ability of the brain to process the rate and temporal features of various stimuli.[16] In other words, the brain of dyslexic children seems incapable of processing rapidly changing or rapidly successive stimuli from either visual or auditory inputs. It has been proposed that dyslexia may in fact be more precisely called "dyschronia".[23] The deficit might therefore lie in the ability of the brain to synchronize and/ or coordinate brain signals from different, even remote, neuronal zones. It appears that the cerebellum is one of the best candidates to carry out the task of "pacemaker", homogenizing activity.[23] In fact, it has also been shown recently that dyslexics performing a motor learning task have reduced cerebellar activity.[24] Moreover it has also been repeatedly shown that dyslexic children differ significantly from reading-age controls in tasks involving automation of motor skills[25], motor reaction times[26], and pure body motor balance[27].

Magnocellular theory

This theory attempts to integrate the various other theories. A generalization of the visual theory, it postulates that the

Table 2 Reading disability and Comorbidity (taken from Beitchman[5])

Attention-deficit/hyperactivity disorder

Conduct disorder/ delinquency
- Conduct disorder and delinquent behavior
- Aggression
- Antisocial behavior
- Underachievement

Internalizing disorders
- Less positive academic self-concept
- More internal attribution of success and failure
- Higher levels of traits anxiety
- Higher prevalence of minor somatic complaints
- High rates of depression
- Suicide (link has been suggested but empirical data unavailable)

Social competence
- Problems in social competence, especially in their ability to understand other's affective states.
- Lower self-esteem

magnocellular dysfunction is not restricted to the visual pathways but is generalized to all modalities. The cerebellum is also predicted to be affected by this dysfunction because it receives massive inputs from various parts of the magnocellular system.

Although all theories are supported by clinical and imaging evidence, a recent study gave further support to the phonological theory, while at the same time demonstrating that some dyslexics also suffer from deficit predicted by other theories.[57] Moreover, one dysfunction can aggravate another.

Comorbidity

Recent studies have demonstrated there exists comorbidity, or overlap, between reading disabilities and other types of disorder, especially "psychiatric" disorders.

One of the most common comorbid conditions in childhood is that of reading disabilities and attention-deficit/ hyperactivity disorder (ADHD).

Estimates of learning disabilities in ADHD range from 9% to 80% and estimates of the rate of ADHD in the learning-disabled population range from 41% to 80%.[28]

Table 2 describes the comorbidity of reading disabilities.

Neuropsychological assessment

A neuropsychological assessment is based on the assumption that problems in achieving normal academic competence can reflect an underlying brain dysfunction.[6] The major interest in performing such an assessment is that it provides information about the functional integrity of the child's central nervous system, an area of central interest to the chiropractor.

Table 3 describes some commonly used neuropsychological tests.

Approaches to treatment and remediation.

In this section, we review the most commonly used treatments and approaches to learning disabilities in general and dyslexia in particular.

We have divided those approaches into those generally accepted within the field of mainstream medical science and those presented in the field of alternative health care, with an emphasis on causal theories proposed by the chiropractic profession.

Before to go on, it is interesting to note the common a priori bias of mainstream medical science towards alternative approaches. For example, the latter are often referred to as "controversial"[14] or even to "common myth"[5], in part because published research is unavailable. On the other hand, pharmacologic approaches to learning disabilities, which lacks as much scientific support, is termed "experimental'.[5] This difference in labeling has obvious psychological influences on the categorization of approaches. On one hand, "controversial" approaches are wildly critiqued, if not scorned at ("common myth"), and medical practitioners are encouraged to "educate" the "vulnerable parents of children or adolescent with disabilities" against those therapies [14]. On the other hand, unsubstantiated statement such as "in many cases, the neurologist will be tempted to undertake a trial of stimulant medication. There are probably good and justifiable reasons to do so. It is sometimes difficult to predict the effects of stimulants in a particular child and circumstance. No test can predict the result with certainty; with such a harmless agent as methylphenidate (Ritalin), the best test may be a therapeutic trial"[39] or "although the reliability and validity of some special educational testing and treatment approaches remain in question, it is generally agreed that the best intervention for learning disabilities is special education"[4] very often go unchallenged.

Table 3. Commonly used neuropsychological tests (from Fennel[6])

Intelligence
- Wechsler Intelligence Scale for Children – III[28]

Memory and learning
- Wide Range Assessment of Memory and Learning[29]

Language
- Comprehensive evaluation of Language Functions – Revised[30]
- Boston Naming Test[31]
- Verbal fluency[32]

Sensory perception
- Sensory Perceptual Examination[33]

Motor
- Finger – Tapping Test[33]
- Grooved Peg Board Test[33]

Visuospatial functions
- Visual analysis – Hooper Test of Visual Organization[34]
- Construction – Beery Test of Visual Motor Integration[35]

Frontal-executive
- Search and sequencing – Trail Making Test[36]
- Response inhibition – Go-No-Go[36]
- Vigilance – Continuous Performance Test[37]
- Rule abstraction – Wisconsin Card Sorting Test[38]

Table 4. Controversial Therapies (from Silver[4, 14]).

Neurophysiologic Retraining
Patterning
Optometric
Visual Training
Cerebellar-Vestibular Dysfunction
Applied Kinesiology
Auditory Processing Training
Tinted Lenses
Orthomolecular Medicine
Megavitamins
Trace elements
Hypoglycemia
Food additives and preservatives
Refined sugars
Allergies

Generally accepted therapies[4]:

Mainstream approaches to the remediation of learning disabilities and dyslexia can be classified into three categories: special education, pharmacotherapy and psychological therapies [4, 5]. In general, only special education through direct instruction of component reading skills is accepted as a direct treatment of learning disabilities. This type of treatments is usually performed by speech therapists or logopedist.

The use of medication, especially stimulant medication, has been advocated when reading disability co-occur with "psychiatric" disorders such as attention-deficit disorder or attention-deficit/ hyperactivity disorder. However, the use of stimulant medication as a direct treatment of learning disabilities or dyslexia - that is in the absence of concurrent disorders - is considered experimental.[4, 5] The same can be said of psychological therapies, which can be of help to manage learning disabilities secondary to social, emotional, or family problems, but not as a direct treatment of primary learning disabilities.[4]

Table 6. Inclusion and exclusion criteria

INCLUSION CRITERIA (Retained document)

1. Document must have been published in indexed or non-indexed literature
2. Document must pertain to "chiropractic care" (defined as an intervention used by a chiropractor, but must include at least the use of chiropractic adjustment or correction of a reversible structural dysfunction for the purpose of normalizing nerve function) or spinal manipulation.
3. Document must be in English.
4. Document must be a journal article.
5. Document must be an experimental study or case report.

EXCLUSION CRITERIA (Rejected documents)

1. Document does not fulfill inclusion criteria
2. Document is a re-print of a previously published document.
3. Document is a book or textbook.
4. Document describes a therapeutic intervention used b a chiropractor but not involving at least a structural intervention.
5. Document presents the technical aspects of a procedure or a proposed biological mechanism of action.

Table 7a. Retained documents according to level of evidence.

Level of evidence	Number of retained studies
Randomized controlled trial	0
Cohort studies	0
Case control studies (retrospective)	0
Cross sectional studies	0
Single subject time series studies	0
Case studies (before/ after studies)	4
Case report	0
Anecdotal report	4

Controversial Therapies[4,14]

Silver[14] proposes that a treatment approach can be considered controversial if :

a. The approach is proposed to the public before any research is available or preliminary research has not been replicated
b. The proposed approach goes beyond what research data support
c. The approach is used in an isolated way when a multimodal assessment and treatment approach is needed.

Silver[4,14] has grouped these types of therapies in two broad categories: neurophysiologic retraining and orthomolecular medicine.

Neurophysiologic retraining refers to approaches based on the notion that stimulating specific sensory inputs or exercising specific motor patterns can retrain the central nervous system.

Orthomolecular medicine refers to the treatment of mental disorders by the provision of optimum concentration of substances normally present in the human body.

We will only discuss theories inasmuch as they have been presented as a proposed causal hypothesis in the chiropractic field. We refer the reader to Table 4 for a summary of controversial therapies and to the work of Silver[4, 14] for further details and description.

Chiropractic care in the field of learning disabilities and dyslexia.

Historically, a segment of the chiropractic profession has offered its services in the care of children and adults suffering from learning disabilities and dyslexia.[47,48]

Table 7b. Number of cases per report.

Study#	Author	Study type	Case Number
1	Barras	Case study	70-117
2	Corwin	Anecdotal reports	4
3	Durlacher	Anecdotal reports	4
4	McCord	Anecdotal reports	4
5	Lefkowitz	Case study	21
6	Mathews	Case study	10 (20 with controls)
7a	Walton	Anecdotal reports	13
7b	Walton	Case study	24 (24 with controls)

Table 5 Causal LD and dyslexia theories in AK and NOT

Applied Kinesiology[49]
Neurological disorganization
Ocular Lock
Hypoadrenia
Hypoglycemia
Food and chemical sensitivities

Neural Organization Technique[44]
"Switching" of reflex mechanisms (cloacal, labyrinthine and ocular righting)
Cranial faults (especially sphenoid and temporal bones)
Aberrant eye motion (ocular lock)

Traditionally, it appears that chiropractic practitioners specializing in Applied Kinesiology are the ones who have developed protocols of care designed specifically for the treatment of people suffering from learning disorders. Indeed, Applied Kinesiology, and more precisely the work of Dr. Carl A. Ferreri, has been cited in the indexed literature.[14,40]

Notwithstanding the use of nutritional therapies by some practitioners such as the ones described under the headline of "orthomolecular medicine" (see above), the proposed chiropractic causal theories of the effect of chiropractic adjustments of the spine and related structures on learning disabilities and dyslexia can be divided into two models: the vertebral subluxation/ hemisphericity model and neurological disorganization model.

Vertebral subluxation/hemisphericity model

Whereas the vertebral subluxation model is intrinsic to classic chiropractic, the hemisphericity model has been proposed by Dr. Frederick Carrick, a chiropractic neurologist and outlined in details in the excellent book written by Melillo.[58]

In this perspective, learning disabilities are hypothesized to be a potential consequence of central nervous dysfunctions, which might themselves result from vertebral subluxations and other environmental factors. The vertebral subluxation is a complex of functional and / or structural dysfunction in the motion or alignment of a motor segment of the spine which alters the integrative properties of the nervous system. This theory proposes that altered mechanics of the spine results in dysafferentiation or reduction in the quantity and quality of neural inputs to the CNS.

Vertbral subluxation can - associated to other factors, such as sedentary lifestyle, injury and illness, inappropriate diet and negative parental modeling - result in suboptimal thalamo-cortical stimulation. This result in an asymmetric function of brain hemispheres – hence the name hemisphericity – characterized by hypofunctional cerebral areas that prevent the achievement of temporal coherence between the two hemispheres.[58]

Consequently it is hypothesized that reduction of vertebral subluxation by chiropractic adjustments – complemented if necessary by other type of non-invasive neurological stimulation, such as light, sounds or proprioceptive exercices - restores proper joint and CNS function. Recent research has suggested that chiropractic adjustment may be associated with increase or decrease in brain function as assessed by manual perimetry.[46,50] Moreover, it has also been suggested that the presence of vertebral subluxation impairs motor balance [51] and that its correction improves reaction time[52], two modalities that have recently been shown to be dysfunctional in dyslexics[26, 27] according to the recent cerebellar deficit theory.[53] It has also been suggested that chiropractic adjustment impacts cerebellar function through specific neurological pathways.[54] However, the precise potential effects of vertebral subluxation correction on central nervous system deficit such as the ones suspected to play a role in learning disabilities and dyslexia has not been investigated.

Vertebral subluxation/Neurologic disorganization

The concept of neurological organization and its relationship to reading was first introduced in 1959 by Delacato.[42] This author theorized that in children with dyslexia and learning disabilities there was a functional disturbance to the appropriate organization of higher centers of the central nervous system.[43] This lack of proper neurological organization is termed neurological disorganization. The treatment approach used was based on a series of specific exercises – called cross crawl exercises- designed to attempt to restore proper neurological organization. This technique is usually called Patterning (see table 4).

The concept of neurological disorganization was taken up and further elaborated upon by Applied Kinesiology. Applied kinesiology is a method of diagnosis and treatment developed by Goodheart in 1964. AK theorizes that neurological disorganization can be produced by various body malfunctions, but most particularly by a dysfunction of the cranio-sacral primary respiratory mechanism.[49] In addition to ND, other factors hypothesized by AK researchers to participate in LD and dyslexia are shown in Table 5. Other researchers in AK have developed method to correct neurological disturbances that may lead to ND. One most often used is Neural Organization Technique (NOT), a methodology developed by Carl A. Ferreri, D.C.[44]

The basic causal theory of NOT relies on three basics phenomena: disorganization of cloacal, labyrinthine and ocular centering/ righting reflex mechanisms, specific cranial faults and dysfunction of the fascia of the eye muscles (resulting in the so-called ocular lock, a failure of the eyes to work together effectively).

Table 8. Summary of evaluation factors.

Study Author	Sample size	Inclusion criteria	Control group	Reliable test	Blind assessment	Naïve subjects	Statistical analysis
Barras	N	N	N	Y	Y	Y	N
Lefkowitz	Y	Y	N	Y	?	Y	N
Mathews	Y	Y	Y	Y	Y	Y	N
Walton	Y	Y	N*	?	Y	Y	N

* Control group did exist, but no results are reported in the paper .

For this author[44], the various learning disabilities are all stemming from the same peculiar disorganization of the central nervous system, and the presence of the aforementioned three dysfunctions is confirmatory of the disorder.

Methods

The main aim of this literature review was to investigate the clinical evidence for the effect of chiropractic care in people suffering from learning disorders and dyslexia.

We were also interested in discovering ways used by chiropractors to define learning disorder and dyslexia, the explanation used to describe the link between their causal model and their treatment, and how this causal model differs or agrees with accepted medical models.

We conducted a computer-assisted literature search on Manual, Alternative and Natural Therapy Information System (Mantis), a database from 1880-present, and Index to Chiropractic Literature (1985-2001).

In addition, we also reviewed the Chiropractic Research Archives Collection (CRAC) 1984-1986, and performed a manual search of the Proceedings of the International College of Applied Kinesiology (ICAK) Annual Meetings by reviewing the Index of Collected Papers of the Members of the ICAK (summer 1976 to Summer 1991) and individual volumes of the Proceedings (winter 1991 – summer 2000). In addition, we also performed a secondary search across the bibliographies of journal articles retrieved, as well as chiropractic textbooks.

Index terms for this search included "dyslexia", "learning", "learning disabilities", "learning disorders", "applied kinesiology" and "neurologic disorganization".

The search yielded a total of 27 documents, which were screened for eligibility according to a predetermined set of criteria. Inclusion and exclusion criteria are listed in Table 6. All retrieved (retained and rejected) documents can be found in Appendix 1.

We then categorized the retained documents according to their level of evidence.

It came out of the search that many authors declared having treated a certain number of individuals suffering from LD and dyslexia, but that their papers only reported on a limited number of individuals. Out of curiosity, we also decided to determine the total number of declared patient treated (although not even anecdotally reported) in order to obtain an idea of the magnitude of patient reportedly seen by a chiropractor for LD or dyslexia.

Case studies were also reviewed for the presence of seven important methodological criteria essentials for them to be considered scientifically sound, namely sample size description, inclusion criteria, control group, reliable test method, blind assessor, blind and naïve subjects and statistical analysis.[41]

Results

Of the 27 documents retrieved, 7 (26%) met the inclusion criteria for our review. One document [Walton] had two distinct studies in it, which gave us a total of 8 "studies".

The number of documents according to their level of evidence is presented in Table 7a.

All retrieved documents belong to the anecdotal report and case studies (before/after studies) level of evidence.

We defined a case report as a report following the guidelines proposed by Keating.[45]

Four documents were case studies (before/after).

None of the remaining reports met the Keating's proposed guidelines and were consequently included in the anecdotal reports category.

The 4 documents pertaining to the anecdotal level of evidence reported on a total of 25 cases.

Table 7b reports on the number of patients reported in each retained document.

Considering the total number of patients claimed to have been under chiropractic care for LD or dyslexia (although not necessarily reported), our review amounted to a total of 204 cases.

Anecdotal reports

Anecdotal reports ranged from a few descriptive lines accompanied by subjective testimonial to more systematized descriptions and outcome assessments, including objective testing and testimonial letters.

Case studies

The study by Barras is a descriptive study of pre- and post-treatment objective evaluations of cognitive functions necessary to learning used in the assessment of the correction of neurological disorganization. It is therefore not a study of the direct treatment of LD or dyslexia, but since it is presented in an outline similar to case studies, we decided to include it in this review

The results of our critical review of the four case studies according to our pre- defined necessary methodological criteria are summarized in Table 8.

Sample size

Three out of four studies appropriately described the sample size.

Barras used a battery of 8 tests assessing for 20 cognitive functions. It seems that the combination of tests used may be dependent upon the age of the subject. He therefore describes a sample of 70 to 117 children, which we did not consider adequate.

Inclusion criteria

Three studies described inclusion criteria. Barras does not explicitly define inclusion criteria, although we can implicitly deduce it to be the presence of a neurological disorganization, independent of the clinical symptomatic picture. Lefkowitz mentions a history of dyslexia or learning disorder, although how and by whom this was diagnosed is not reported. Mathews included children diagnosed as dyslexics, without further precisions. Walton uses a history of failure or poor academic performance.

Control group

Two studies had a control group. The study by Mathews used a control group matched for age, IQ and social background. Walton also mentions a control group; all taking medications, but no data for that group is reported, making comparisons impossible to a reviewer.

Reliable test method

In this section, we need to differentiate outcome measure used to assess for the correction of dysfunction and objective treatment outcomes. In three studies, manual muscle testing was used as an assessment of dysfunction correction.

However, all four studies used some type of external, objective testing method to determine outcomes. Barras used a battery of 8 tests. Lefkowitz used the Woodcok Reading Mastery Tests and Mathews used a standardized test of intelligence, the Wechsler Intelligence Scale for Children. Although, no validity or reliability is mentioned, these tests are used widely in the field of special education and psychology. Walton used a series of clinically administered tests (no further precision), symptoms, school-administered achievement test. However, the validity and reliability of these outcomes is not known.

Blind assessment

Three of the four studies mentioned using a specialized professional for the purpose of outcome measurement. There is no mention of an external assessor in the study by Lefkowitz.

Blind or Naïve subjects

All subjects of the four studies were cognizant of the fact that they belonged to the treatment group. We can therefore consider the patients to be naïve to the procedure but not blind to it.

Statistical analysis

None of the studies had appropriate statistical analysis nor mentioned statistical or clinical significance. Barras presents average percentages of improvement. Lefkowitz only provides the raw data and what he considered to be significant, although there is no mention of whether this is universally accepted. Mathews showed average improvement in IQ. Walton only reports on percentage improvement.

Discussion

None of the reviews fulfilled all of the 7 basic methodological criteria that we considered necessary to be acceptable.

Inclusion criteria are often ill-defined. Barras uses the presence of neurological disorganization, regardless of symptomatic expression, as an inclusion criteria. Lefkowitz and Mathews speak of diagnosed learning disability and dyslexia but do not precise how those were defined, nor diagnosed. We feel that there are three reasons for that. First is the definitional issues encountered in this field of study, as discussed in our introduction. Secondly, the uniqueness of the combination of various deficits affecting an individual makes it difficult to find homogenous groups of individual all exactly meeting the diagnostic or inclusion criteria. Thirdly, the approach taken by chiropractors working in that specific field is one that suggests that all symptomatic expressions falling under the umbrella of learning disabilities stem from a particular type of neuro-spinal dysfunction and/or patterns of dysfunctions. The practitioner, then, does not attempt to include subjects meeting "medical" or neuropsychological diagnostic criteria of LD but rather individual suffering from those specific dysfunctions proposed to cause LD, as diagnosed by chiropractic examination. For example, Lefkowitz declares that the diagnosis of LD was confirmed by his examination, meaning that according to NOT Protocol, the presence of the pattern of dysfunction (reflexes, cranial faults,..) confirms that the individual is learning disabled. In studies where no "mainstream medical" diagnosis is performed, the issue arises of knowing if individuals treated are truly learning-disabled subjects (in a medical sense) or individuals suffering from suboptimal learning abilities. We feel it is important to make the distinction between pretending to treat an learning disabled individual for his/her specific disorder and helping an individual achieve his/her learning potential.

Another issue is the one of the use of a control group. Only two studies used a control, and only one study attempted to have the control group match the intervention group.

We may challenge the necessity of a control group by arguing that learning disabilities are disorders that are not known to spontaneously resolve over time.

However, it is necessary to assess for the possibility of confounding factors. For example, Lefkowitz advised his patients to practice reading and writing at home while also under care. Although he affirms that most subjects had already received special program in writing and reading with limited or no results, we cannot draw the conclusion that improvement resulted from the care he offered.

Mathews also had both of his groups undergo individual remedial. Ferreri[44] emphasizes that the LD child may have fallen behind in his/her academic skills as a result of, for example, neurological disorganization, and that the correction of the latter does not preclude a educational remediation program to catch up on the lag.

Another common interesting fact to note is the use of a specialized professional in three studies to assess or diagnose the children, as well as the use of tests usually widely used and accepted in the field of psychology, learning or special education. This raises the issue of which tests to administer. Preliminary results from the studies we reviewed suggest that some individuals respond to different parts of the tests administered. In Mathews for example the treated group improved significantly on the performance subscale of the IQ test, but not on the verbal subscale. The study by Barras suggests that improvement in visual memory is much better than, for example, immediate recall capacity. What remains unclear however is the impact of improvement of some cognitive functions on the symptomatic picture, i.e. the disorder itself. For example, does an improvement in, for example 16 out of 20, cognitive tests used by Barras necessarily means that the subject improves in the specific area where he/she is affected?

What appears from our review is that the chiropractor is not so much interested in the cure of the disorder itself, but rather in the correction of an underlying CNS dysfunction assumed to underlie the disorder(s) affecting the patient. This is very much in line with traditional chiropractic principles. For example, Barras does not seem to be interested in curing dyslexia or LD per se, but rather in improving cognitive functions known to be important in learning skills; the improvement in those function on post-treatment testing serving as a demonstration of the correction of the underlying dysfunction (in this case neurological disorganization).

This perspective is of great interest as it allows for multidisciplinary work, where the chiropractor does not attempt to take over the role of a speech therapist or educational psychologist or neuropsychologist in diagnosing or treating the disorder, but rather offers a unique perspective by attempting to correct a CNS dysfunction thought to impair the individual's potential to learn appropriately.

The last issue in need to be addressed is the one of statistical significance. No study made the effort to perform adequate statistical analysis. Mathews and Lefkowitz defined some levels of significance but they do not discuss if those are relevant and valid. No study attempted to define p value or to define the sample size that would be necessary to reach statistical or clinical significance.

Conclusion

Our review addressed an area of health care that has not been widely investigated within the field of chiropractic. In fact, the interest in the field of learning and learning disorders seems to have been restricted to specific groups within the chiropractic profession.

The chiropractic theoretical causal model to learning disabilities includes a series of assumptions that have often been borrowed and expanded upon from various other sources from within the field of alternative and complementary health care; a field that is still considered controversial by mainstream medical science.

However, recent basic science research into the role played by various cerebral structures in LD and dyslexia, as well as chiropractic research on the impact of the correction of vertebral subluxation by chiropractic adjustments on cerebral or cognitive functions suggests that it is not irrational to propose that the vertebral subluxation may play a role in engendering various CNS deficits that may be directly or indirectly related to impairment in learning or even to learning disabilities and dyslexia per se.

The various documents reviewed in this study, showed a large proportion of patients having received chiropractic care with the idea of improving upon a significant problem affecting them, namely learning disability. However, from a clinical outcome point of view, the research reviewed in this article belongs to the lowest level of evidence and demonstrates numerous methodological weaknesses that prevent us from drawing definite conclusions.

In the future, we recommend that chiropractors interested in this important area of health care should consider the following:

1. The need to publish adequately written case reports.
2. The need to perform studies using appropriate methodological designs.
3. The need to publish those reports and studies in peer-reviewed, indexed journals.

Moreover, we suggests that the role of chiropractic needs to be investigated not as a pretended cure for learning disabilities and dyslexia per se, but rather as a unique service attempting to improve or correct deficits in neurological functions that impair cognitive functions essential to learning skills. This perspective will position chiropractic care as a necessary partner in the multidisciplinary approaches required to care for individuals suffering from learning disability or dyslexia.

We therefore conclude from this review that evidence for the effect of chiropractic care in children suffering from LD and dyslexia has to be considered preliminary.

Within the limits of the studies reviewed, there seems to be a potential role for chiropractic care to improve various cognitive modalities known to be essential in learning. Further research in this important area of health care is greatly needed.

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Appendix I

RETRIEVED DOCUMENTS

AUTHOR	TITLE	PUBLICATION
Barras M	Objective evaluation of the effects of neurological disorganization and potential subsequent learning disability and/or dyslexia	PICAKAM, Summer 1999, p25-30
Corwin MR.	Learning difficulties in the light of applied kinesiology	PICAKAM, Summer 1986, p 61-67
Durlacher JV.	Dyslexia and learning disorders	PICAKAM, Winter 1985, p 83-88
Lefkowitz H.	Study of applied kinesiology in the treatment of learning disorders and dyslexia	PICAKAM, Summer 1989, p207
McCord KM.	NOT: an observation	PICAKAM, Winter 1988, p 261-97
Mathews MO	A pilot study on the value of applied kinesiolgy in helping children with learning disabilities	British Osteopathic Journal 1993; vol 12: 26-27
Walton EV.	The effect of chiropractic treatment on students with learning and behavioral impairments resulting from neurological dysfunction	ACA J of Chiro Dec 1977, vol XI

REJECTED DOCUMENTS

AUTHOR	TITLE	PUBLICATION	REASON FOR REJECTION
Backman ZM	The relationship between learning disabilities and behavioral manifestations with toxicity and cerebral allergy	Dig Chiro Econ 1985; 27(6): 18-19	Proposed etiological model
Duffy DH.	Scotopic sensitivity, dyslexia and Applied Kinesiology	PICAKAM, Summer 1989, p 133-135	Proposed etiological model
Farkas J.	Dyslexic and learning disabilities children	PICAKAM, Summer 195, p 91-99	Proposed treatment protocol
Ferreri CA	Dyslexia and learning disabilities cured	Digest Chiro Econ 1983; 25(6): 74, 148	Proposed etiological model and treatment protocol
Ferreri CA.	A cure for dyslexia and learning disability - update	PICAKAM, Summer 1986, p 133-150	Proposed etiological model and treatment protocol
Ferreri CA.	A cure for dyslexia and learning disorders	PICAKAM, Summer 1984, p 105-113	Proposed etiological model and treatment protocol
Ferreri CA.	Protocol to effect the best results for dyslexia and learning disorder technique	PICAKAM, Summer 1986 p151-156	Proposed treatment protocol
Fryman VM	Learning difficulties viewed in light of osteopathic concept	JAOA 1976; 76(8):103-118	Proposed etiological model
King FJ	Children's health and homeopathy: learning disabilities and hyperactivity	Am Chiro 1995; 17(5):18-19	Homeopathy
Koren T	Learning disorders and chiropractic	Dig Chiro Econ 1991; 34: 40-41	Overview
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Lefkowitz H.	A proposed protocol for a learning disorder practice	PICAKAM, Winter 1989 p 6-9	Proposed treatment protocol
Mantoya JA.	Nutrition and learning disorders of children	PICAKAM, Summer 1977, p 274-286	Proposed nutritional protocol
Null G	Hyperactivity and learning disabilities	J Chiro 1988: 25(12): 34- 38	Overview
Sherman JG	A case report of neurological disorganization	PICAKAM, Summer 1999 p 15-18	Magnets as only treatment modality
Sprieser PT	Learning disabilities – part 1	Dig Chiro Econ 1987; 29(6):34+	Proposed etiological model
Sprieser PT	Learning disabilities – part 2	Dig Chiro Econ 1987; 30(3):20+	Proposed etiological model
Sprieser PT.	Learning disabilities	PICAKAM, Winter 1984, p 265-91	Proposed etiological model
Upledger J	Relationship of craniosacral findings in grade school children w/ devel. problems	JAOA 1978; 77: 738-54	Proposed etiological model
Upledger JE	Craniosacral function in brain dysfunction	Osteop Ann 1983; 11: 318-24	Proposed etiological model