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Pediatrics in Review 2011;32;e18
DOI: 10.1542/pir.32-2-e18

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Complementary, Holistic, and Integrative Medicine: Therapies for Learning Disabilities

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Author Disclosure
Dr Galicia-Connolly and Ms Shamseer have disclosed no financial relationships relevant to this article. Dr Vohra has disclosed receiving salary support from the Alberta Heritage Foundation for Medical Research and Canadian Institutes of Health Research. This commentary does contain a discussion of an unapproved/investigative use of a commercial product/device.

Background
Between 5% and 10% of schoolchildren have learning disabilities (LD), and up to 80% of such children have some form of dyslexia. (1) The diagnosis is based on significantly lower academic achievement than the intelligence quotient (IQ) would suggest. (2) Although disorders of learning and attention frequently occur together, this review specifically examines the effectiveness of complementary and alternative medicine (CAM) interventions for children who have LD. The studies might include children who have comorbid conditions such as attention-deficit/hyperactivity disorder (ADHD).

Existing interventions for LD focus on remedial teaching in the early years and offering compensatory mechanisms and lifestyle adjustments at later ages. The most robust predictive factors correlating with the success of LD interventions are attention and behavior, general verbal ability, prior level of component reading skills, and total IQ. (1) In a survey of 148 schoolchildren who had dyslexia, Bull found that 55.4% had used CAM for dyslexia, most commonly nutritional supplements or special diets, homeopathy, and osteopathy or chiropractic manipulation. (3)

Methods
We conducted a search for articles related to learning disabilities and CAM therapies on MEDLINE, Embase, AMED, PsycInfo, the Cochrane Database of Systematic Reviews, and Cochrane’s Central Register of Controlled Trials. Search terms were: (learning disorders OR learning disabilities) AND (complementary therapies), with terms varying by database and no limits on language or date. Studies were included if they examined a strictly pediatric population (0 to 18 years) of individuals who had LD and who experienced CAM as the intervention.

Results
Eleven articles were relevant to this review (Table).

Nutritional Supplements
POLYUNSATURATED FATTY ACIDS (PUFAS). The PUFAs eicosapentaenoic acids (EPA) and docosahexaenoic acid (DHA) are believed to be critical for brain development and function. (16) Kairaluoma and associates (4) conducted a double-blind, placebo-controlled, randomized, controlled trial (RCT) evaluating the effects of single daily supplementation with 500 mg EPA and 400 mg carnosine over a 3-month period on the reading-related skills of 61 children (mean age, 10.6 years) who had dyslexia. They found no significant differences in the two groups in measures of reading accuracy or speed, spelling, decoding, fluency, arithmetic skills, reading-related language skills, and attention or behavioral problems.

A double-blind RCT evaluated the effect of supplementation of highly unsaturated fatty acids on ADHD symptoms of 41 children (mean age, 10.25 years; standard deviation [SD]=0.74 years) who had both literacy problems and features of ADHD. (5) Although the authors reported that the studied children were not formally diagnosed as having ADHD, the Connors Parent rating scale for ADHD was employed as the primary endpoint.

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NOTE: The agents discussed in this series are designated as dietary supplements rather than drugs. Although dietary supplements are regulated by the United States Food and Drug Administration (FDA), their manufacturers may make claims with little evidence and need not prove safety prior to marketing. The burden is on the FDA to monitor safety after the product is on the market. Readers are referred to the 1994 Dietary Supplement Health and Education Act (www.cfsan.fda.gov/~dms/dietsupp.html).
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<td>I. Nutritional Supplements</td>
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<tr>
<td>A. Polyunsaturated Fatty Acids (PUFAs)</td>
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| Kairaluoma, 2009 (4)   | Double-blind, placebo-controlled RCT | n=61 children with observed reading difficulties; mean age, 10.6 years | EPA 500 mg/day + carnosine 400 mg/day versus Placebo=triglycerides + cellulose administered over 3 months | • No differences in reading, spelling, or reading-related skills between treatment and control groups  
• 2 children in placebo group reported abdominal pain and difficulty swallowing pills | • Well-designed study  
• Sample size planned to detect treatment effect with >80% power at P=0.05 level  
• Dosing and duration of observation comparable to previous studies  
• High dropout rate (9/41=22%)  
• Mild adverse effects reported: digestive upset (1 each in HUFA group and placebo group), swallowing problems (1 in HUFA), noncompliance (3 in each group), incomplete end evaluation for 3 (2 HUFA, 1 placebo) |
| Richardson, 2002 (5)   | Double-blind, placebo-controlled RCT | n=41 8- to 12-year-old children diagnosed with dyslexia; mean age, 10.25±0.74 years | 12 weeks of daily supplementation of HUFA (EPA 186 mg, DHA 480 mg, GLA 96 mg, vitamin E 60 IU, cis-linoleic acid 864 mg, AA 42 mg, and thyme oil 8 mg) versus Placebo (olive oil) | • Significant symptom reduction only in Conners' ADHD index (P=0.03); no significant improvement in cognitive problems (P=0.07) or other ADHD subscales after 3 months of HUFA supplementation | • 76% of children showed significant improvement in word-chain tests (P<0.04), with 60% improvement in reading speed (P<0.01) and 23% improvement in motoric-perceptual speed (P<0.05)  
• Significant improvement in manual dexterity (P<0.007), ball skills (P<0.02), static/dynamic balance (P<0.03)  
• Significant improvement in total impairment score (P<0.0001) and checklist score  
• No placebo or control group  
• No randomization  
• Recall/reporting bias with self- and parent assessments  
• 21% dropout rate  
• Pharmaceutical-sponsored study  
• No placebo or control group  
• No randomization  
• No blinding  
• Reporting bias with parent assessments  
• 13% dropout (n=2) |
| Lindmark, 2007 (6)     | Open-label pilot study        | 19 children with dyslexia; mean age, 12 years | 5 months of supplementation with 8 capsules daily containing 480 mg DHA, 108 mg EPA, 96 mg GLA, and 35 mg AA |                                                                                  |                                                                                           |
| Stordy, 2000 (7)       | Open-label pilot study        | n=15 children with dyspraxia, 5 to 12 years old | 480 mg DHA, 35 mg AA, 96 mg linoleic acid, 80 mg vitamin E, and 24 mg thyme oil daily administered over 4 months |                                                                                  |                                                                                           |
Table 1. Literature Review of Complementary and Alternative Medicine Therapies for Learning Disabilities—continued

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| B. Gingko Biloba Extract | Open-label pilot study     | n=15 children, 5 to 16 years old (mean, 10.7 years) with DSM-IV-diagnosed dyslexia | Daily 80-mg morning dose of standardized plant extract of gingko biloba administered for 34.4 days | • Significantly improved scores in reading accuracy (list of words $P < 0.01$, list of nonwords $P < 0.02$, and reading text $P < 0.05$), but no change in reading speed  
• Brief period of headache reported by parents in 2 children | • No control group  
• No blinding or randomization  
• Small sample size  
• Short duration of treatment |
| Fernandez, 2003 (9) | Double-blind, placebo-controlled trial | n=10 children with LD and abnormally high EEG theta/alpha ratio for age  
 n=5 experimental  
 n=5 control | NF 30-minute sessions, biweekly over 10 to 12 weeks (20 sessions total) | • Total IQ ($P=0.02$), verbal ($P=0.03$) and performance ($P=0.04$) WISC scores increased significantly only in the experimental group despite no significant changes in EEG recordings before and after treatment  
• No changes noted in control group  
• Significant increase in global IQ ($P=0.04$) and performance scores ($P < 0.05$) but decrease in verbal scores in NF group; remission of LD symptoms in 80% of children (4 of 5) 2 years after NF treatment  
• No significant differences in WISC-R or ADHD scores from TOVA for control group  
• Small sample size  
• No mention of adverse events | • No randomization  
• Small sample size  
• 16% dropout rate (n=2)  
• No mention of adverse events |
| Becerra, 2006 (10) | Prospective interventional study (2-year follow-up period) | n=9 children with LD  
 n=5 NF (mean age, 11.2 years)  
 n=5 placebo (mean age, 12.1 years) | No new interventions since previous investigation | • Significant reduction of parent-reported inattentive behavior in treatment group ($P=0.04$)  
• Significant improvement in IQ scores posttreatment ($P=0.02$)  
• No significant differences in parent-reported oppositional behavior posttreatment | • Sample size inadequate to detect changes in IQ, inattention, and oppositional behavior  
• Authors attributed treatment effects to enhanced attention  
• No mention of adverse events |
| Linden, 1996 (11) | Single-blind RCT            | n=18 treatment-naive children with LD or ADD/ADH, 5 to 15 years old  
 n=9 NF  
 n=9 waiting list as control | Forty 45-minute twice-weekly sessions of EEG biofeedback over 6 months | |
### Table 1. Literature Review of Complementary and Alternative Medicine Therapies for Learning Disabilities—continued

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| III. Chiropractic | Bull, 2007 RCT (12)           | n=70 children 6 to 13 years old with dyslexia and no other medical, developmental, or behavioral difficulties (mean, 9.9±1.8 years) | Eight sunflower therapy (applied kinesiology, osteopathic manipulation, massage, herbal remedies, and neurolinguistic programming) sessions lasting 40 minutes over 15 weeks | • No statistical differences in performance of children in any of cognitive or literacy tests between groups  
• Statistically significant improvements in academic ($P<0.001$) and reading self-esteem ($P<0.001$) for treatment group  
• Improvement in 8 psychometric tests and 20 areas of cognitive function  
• No adverse effects  
• Short observation period may not have been sufficient to detect the treatment effect (13)  
• Unclear method of randomization and allocation  
• No mention of adverse effects  
• Heterogeneous study population  
• No control group  
• No randomization | |
| Cuthbert, 2009 (14) Prospective interventional study | n=157 children 6 to 13 years old with developmental delay syndromes over a 14-year period | Individualized chiropractic multimodal (applied kinesiology) technique, ranging from 2 to 50 sessions | • Improvement in 8 psychometric tests and 20 areas of cognitive function  
• No adverse events occurred | |
| IV. Music | Register, 2007 (15) Prospective interventional study | Group 1: n=8 children with reading disability  
Group 2: n=17 students in an intact grade 2 class assigned as treatment class  
Group 3: n=16 students in an intact grade 2 class assigned as control class | 12-lesson music/reading program for 4 weeks | • Significant improvement in word decoding ($P=0.04$), word knowledge ($P=0.01$), and reading comprehension ($P=0.01$) in children with reading disability  
• Greater gains on all subtests in treatment group, but significant improvement only in word knowledge in treatment group compared with control | • Small study sample  
• No randomization  
• Suggested extending curriculum to 6 weeks  
• Used both parametric and nonparametric tests without describing data  
• No mention of adverse events |
and measured at 12 weeks. PUFA supplementation appeared to alleviate ADHD-related symptoms in dyslexia.

An open-label pilot study of 24 children who had dyslexia and whose mean age was 12 years evaluated a patented single daily supplement containing tuna fish oil (480 mg DHA, 108 mg EPA) and primrose oil over a 5-month period. (6) The authors reported that 76% of children showed significant improvement in word-chain tests ($P<0.04$), with 60% improvement in reading speed ($P<0.01$) and 23% improvement in motoric-perceptual speed ($P<0.05$) at the end of the study. Both parents and children reported improvement in speed of reading and schoolwork. Although this treatment appears promising, it would benefit from more rigorous study with a placebo control group to reduce potential bias.

An open-label pilot study examined administration of the same supplement to 15 children who had dyspraxia over a 4-month period. (7) Motor skills using the Movement Assessment Battery for Children were measured as the primary outcome at 4 months. The authors reported statistically significant differences in all the children's movement skills. Unfortunately, in the absence of a control group, the potential for biased estimates of treatment effect is high.

**GINGKO BILOBA.** Gingko biloba has traditionally been used in Chinese medicine as a memory “booster.” An open-label trial examined the effect of a single morning 80-mg dose of gingko biloba over a 34-day period in 15 children (mean age, 10.8 years, SD = 2 years) who had a Diagnostic and Statistical Manual of Mental Disorders, 4th edition, text revision (DSM-IV-TR) diagnosis of “dyslexia not taking psychotropic medications or undergoing rehabilitative treatment.” (8) The authors found a significant improvement in reading accuracy but not reading speed. A double-blind, placebo-controlled RCT would be helpful to confirm these preliminary results.

**Neurofeedback**

Children who have LD have higher values of theta activity on encephalography (EEG) than unaffected children, (17) and neurofeedback has been described as an “operant conditioning procedure” that allows an individual to learn to modify the electrical activity of his or her own brain. (18) Quantitative EEG evaluation attests to the heterogeneity of children who have LDs, and studies on the efficacy of neurofeedback remain sparse, needing larger sample sizes to replicate their findings. (19)

A double-blind RCT evaluated neurofeedback in 10 children ages 7 to 11 years who had a diagnosis of LD. (9) Participants were assigned to either 40 45-minute biweekly neurofeedback sessions during which participants were “trained” to inhibit their brain’s theta activity over 10 to 12 weeks or to placebo sessions that were comprised of similar sessions but with random and non-contingent feedback. Tests of variables of attention (TOVA) and EEG were obtained after 20 sessions and the Weschler Intelligence Scale for Children (WISC) was readministered after 6 months. The authors reported a significant improvement in WISC performance, with no corresponding significant changes in the EEG readings of the treatment group.

Nine of the 10 children from the previously mentioned cohort were subsequently followed for 2 years to examine the long-term effects of neurofeedback. (10) The authors reported a significant increase in global IQ and performance scores and a remission of LD symptoms in four of the five children who had undergone neurofeedback. In contrast, all of the children in the control group continued to exhibit LD. Further studies with larger sample sizes would be helpful.

One RCT evaluated the efficacy of 40 45-minute neurofeedback sessions given over 6 months to enhance beta activity and suppress theta activity in 18 treatment-naive children ages 5 to 15 years who had received a diagnosis of LD or ADD/ADHD. (11) Fifty percent of the children on a wait list acted as a control group. There was a significant improvement in IQ scores ($P=0.02$) and parent-reported inattention ($P=0.04$) in the children who underwent neurofeedback, but there were no differences in parent-reported oppositional behavior between groups. The authors attributed the improvement in the children’s IQ scores to enhanced attention.

**Chiropractic Therapies**

An RCT evaluated an intervention called “sunflower therapy” (described as a integrative course of treatment that combines applied kinesiology, osteopathic manipulation, massage, herbal remedies, homeopathy, and neurolinguistic programming) administered over 15 weeks by using cognitive, literacy, and self-esteem tests in 70 children ages 6 to 13 years who had dyslexia. (12) Participants were randomized to either eight 40-minute sessions of sunflower therapy or a control group and were retested within a mean of 15.7 weeks (SD 2.3). The author found no differences between groups in cognitive or literacy tests but noted statistically significant improvements in academic self-esteem ($P<0.001$) and reading self-esteem ($P<0.001$) scores within the treatment group. We concur with the author that a control group with sham treatment to exclude placebo effects would be helpful. This study has been criticized.
for too short of a treatment period to detect treatment effects. (13)

Applied kinesiology is a chiropractic diagnostic method that evaluates muscle function using manual muscle testing, based on the premise of a link between motor impairments and developmental delay. A case series of 157 children ages 6 to 13 years who had developmental delay syndromes, including children who had ADHD, involved psychometric testing that monitored cognitive function, including patient- or parent-reported improvements in school performance, social interaction, and sporting activities before and after chiropractic treatment. (14) The authors reported enhanced cognitive performance in this group of children based on 6.6% to 33.2% improvement between scores from psychometric tests that were administered within 5 days to 18 months after 2 to 50 chiropractic sessions. These promising results would benefit from further rigorous study, ideally including a less heterogeneous sample, a randomized control group, and blinded outcome assessment.

Music Therapy
The effect of music in enhancing reading skills of second-grade students and students who had reading disabilities was examined in a prospective interventional study. (15) A class of eight children who had reading disability underwent a specially designed 4-week curriculum using music to target reading comprehension and vocabulary skills. The authors used two intact second-grade classes for comparison. One participated in their normal reading program as a control class and the other underwent both the music-augmented reading program and their normal reading program as a treatment class.

The authors reported significant improvements in word decoding \( (P=0.04) \), word knowledge \( (P=0.01) \), and reading comprehension \( (P=0.01) \) in the children who had LD and attributed these findings to increased attention and more active participation because of the smaller class size. For second graders, the treatment group had significantly greater gains in word knowledge compared with the control group. The music/reading curriculum appeared to be an effective supplement to the current reading program. It would be more compelling if children who had a reading disability had been included in the control group for better assessment of the effect of music therapy in this population.

Adverse Events
Of the 11 studies included in this review, only four explicitly reported on the presence or absence of adverse events during the study. Adverse events associated with PUFAs include nausea, nosebleeds, and mild fever. (20) (21)(22) Other potential adverse events are gastrointestinal upset, altered immune response, reduced blood pressure, and increased risk of bleeding at high doses. (23)(24) Potential drug interactions may occur with anticoagulants and antiplatelet drugs. (25)(26)

The use of gingko biloba generally has been associated with mild and transient effects, the most common being headache. Reported serious adverse effects include seizures, spontaneous bleeding, and intracerebral hemorrhage. (27)(28)(29)

None of the studies (9)(10)(11) reported adverse effects during neurofeedback. However, with 20 or more sessions, reported adverse effects have included headaches, dizziness, increased irritability, moodiness, loss of attention, and hyperactivity in children who were being concomitantly treated with stimulants. (30)

A systematic review on the safety of pediatric spinal manipulation identified 14 serious adverse events that resulted in hospitalization, permanent disability, or death. Others involved delayed diagnosis or inappropriate provision of chiropractic care. (31) The estimated risk of a serious adverse event is 0.13% in adults, (32) but an accurate estimate from high-quality pediatric studies is not available. (33)

Summary
• Preliminary evidence suggests possible positive effects of neurofeedback, PUFAs, and music in the treatment of LD, but more rigorous data are needed.

ACKNOWLEDGMENTS. The authors would like to acknowledge the invaluable assistance of Connie Winther and Soleil Surratte in the literature search for this manuscript.

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