



Frequency-Based Light &/or Sound Neurotherapy (LSN) Research: A Review of the Research

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Throughout time, people have learned to enjoy our brains' natural tendency to synchronize with pleasant rhythmic stimulation. Whether it is the beating of drums around campfires in aboriginal cultures, disco dancing to throbbing music and synchronized strobe lights in the 1970's and 80's, or being entranced by a fire's flickering flames while listening to jazz today, this rhythmic stimulation has the power to shape our thoughts, moods, and behaviors.

The earliest known clinical use of light stimulation was by Pierre Janet, a French psychiatrist in the early 1900's. Dr. Janet worked in a Parisian mental hospital and began exploring the effects of having patients stare at a light that flashed at a constant rate controlled by a fan spinning in front of a lamp. Dr. Janet found that this flickering light therapy had a profound soothing effect on them.¹

By using an early electroencephalographic (EEG) machine, in 1934 Adrian and Matthews were the first to document that this flickering light therapy changed subjects' brainwave activity.² Toman,³ followed by Walter and Walter,⁴ built on this discovery and found that the hertz (Hz) frequency that the light flashed at caused the same brainwave frequency to grow stronger.

Since these early pioneers, numerous neuroscientists have documented the ease with which our brains synchronize to the same frequency of light⁵⁻¹⁴ and/or sound^{6, 15-16} stimulation. For example, Frederick and colleagues compared 18.5Hz light stimulation alone, sound alone, and both combined in college students. They found that after only seven minutes, all three conditions significantly increased the identical 18.5Hz brainwave frequency by an average of 33.6% (range 26.7% to 48.8%).⁶

Using a variety of neuro-imaging measurement tools, researchers have also found that frequency-based light and/or sound stimulation increases brain metabolism and cerebral blood flow.^{11, 17-21} On the biochemical front, Kumano and associates found that multiple LSN sessions generated positive changes in the brain by increasing *B*-endorphin levels and decreasing plasma cortisol, a marker for stress.²²

A number of well-controlled studies have evaluated the clinical effects resulting from a single frequency-based light and/or sound stimulation session. Examples include studies showing that:

- Light stimulation reduced pain and discomfort for 90% of patients during follow-up endoscopy examinations compared to only 15% for control patients.²³
- Sound stimulation significantly reduced pre-operative anxiety in patients undergoing surgery compared to those listening to a relaxation soundtrack beforehand.²⁴
- During surgery, sound stimulation reduced by 77.4% the need for fentanyl—a narcotic drug used to control pain—compared to listening to classical music.²⁵
- High-frequency (beta) sound stimulation had significant positive effects on sustained attention and mood compared to low-frequency (delta) stimulation.²⁶

In 1999, Budzynski and associates took this research a step further.²⁷ They compared the effectiveness of academic counseling to 30 LSN sessions with academically struggling college students. Their study found that LSN not only had a positive EEG synchronization effect but that these changes persisted while the students performed mental tasks indicating that their brains had become less sluggish when cognitively challenged. There were no similar EEG changes in the comparison group. ***The LSN students went on to improve their GPA by an average of .7 points in the quarter following treatment termination while the***

comparison students' GPA dropped by .2 points suggesting that LSN treatment generated lasting effects.

More recently in a randomized placebo-controlled study comparing 20 LSN sessions to simulated treatment for patients with treatment-resistant depression, Cantor and Stevens found that improvement only occurred during active LSN treatment with patients averaging a 70.9% decrease in depressive symptoms.²⁸ When compared to a normative database, quantitative EEG (QEEG) pre/post testing demonstrated that LSN resulted in significant positive changes in cortical regions of the brain associated with improved mood regulation whereas these changes did not occur following simulated LSN. **LSN patients also maintained improvement after stopping active treatment when re-assessed one month later averaging an additional 33% decrease in depressive symptoms. This finding further supports the observation that LSN often generates enduring effects.**

Summarizing across these studies, researchers have documented that frequency-based light and/or sound neurotherapy (LSN):

- Strengthens the same brainwave frequency that corresponds to the light and/or sound stimulation;
- Increases brain metabolism and cerebral blood flow;
- Appears to generate positive biochemical changes in the brain;
- Often results in immediate clinical benefits after only a single session; and
- Multiple sessions may result in improved functioning that endures following treatment termination.

Review of LSN Treatment Studies

Clinical researchers have found that LSN is a robust treatment effective in facilitating relaxation, meditative, and hypnotic mental states²⁹⁻³⁷ as well as promoting improvement in numerous mental and physical disorders. **Table 1** below presents the key findings from 16 clinically-focused LSN studies.

These 16 studies—**eight randomized controlled studies and eight open clinical trials**—included 681 subjects and demonstrate LSN's effectiveness for numerous conditions ranging from anxiety, depression, and PTSD to pain-control, headaches, and pre-menstrual syndrome. In addition, four of the studies found LSN to be an effective adjunctive treatment for patients with co-morbid substance abuse disorders.

It is reasonable to ask why LSN is helpful with such a wide variety of conditions. Research and clinical experience going back to Pierre Janet in early 1900s has found that for many people LSN triggers a pleasant dissociative state similar to that achieved through deep meditation and/or hypnosis.

Therapeutic dissociation is simply a "disconnect" or interruption in one's awareness of thoughts and the passage of time thereby rejuvenating the mind. Kroger and Schneider found that LSN induced a hypnotic trance in nearly 80% of subjects within five minutes.³¹ In a large well-controlled study, Leonard and associates found that LSN was vastly superior ($p < 0.0001$) in triggering dissociation compared to dot staring, a common hypnotic induction technique.³² **LSN's ability to trigger therapeutic dissociation makes it an ideal tool for disrupting the ruminative thought processes that are common in most psychiatric disorders.**

The sustained improvement resulting from LSN treatment is seen in a randomized controlled trial of college students with pathological worry.³⁸ In this study 113 students were randomly assigned between LSN, two evidence-based treatments for pathological worry, and a wait-list control group. The researchers originally conceptualized LSN as a placebo intervention but re-conceptualized it as an active treatment following students' strong positive response to it.³⁹ This trial found that 12 LSN sessions (three times per week for four weeks) had the highest rate of clinically-significant change @ 67% with exposure therapy second @ 48%. **Furthermore, 65% of the LSN group had clinically-significant treatment gains in the follow-up assessment three months later even though there was no skill-training component as part of the LSN intervention.**

This level of sustained improvement is noteworthy since high levels of worrying is often a long-standing personality trait. When enrolled into the study, 31.2% of the students met the criteria for generalized anxiety disorder with lower rates for other disorders (e.g., 18.3% for social anxiety disorder, 11% for specific phobia, 5.5% for panic disorder, 3.7% for obsessive compulsive disorder, and 11% for major depressive disorder). **Students' high-level of sustained improvement strongly supports the durability of LSN treatment gains.**

Table 2 presents the findings from 10 studies enrolling over 500 people with ADHD and/or problems in learning. These 10 studies— **five randomized controlled ones and five open clinical trials**—document LSN’s effectiveness for many symptoms common in people with ADHD and/or learning disabilities. Summarizing across studies, these researchers found that LSN treatment:

- **Increased sustained attention;**
- **Improved impulse control;**
- **Decreased anxiety and depression;**
- **Improved essential learning skills including:**
 - Auditory memory
 - Mental processing speed
 - Verbal and non-verbal IQ
- **Improved academic performance;**
- **Generated improvements similar to psycho-stimulant medication; and**
- **Maintained the treatment gains for up to 16-months following treatment termination.**

Summary

LSN is an evidence-based treatment with over 75 years of basic and applied research. Tables 1 and 2 summarize the findings from 26 studies involving approximately 1,200 patients. ***These studies document that LSN is a robust treatment that often results in sustained improvement for a wide variety of difficult to treat conditions.***

While only 13 of the studies were randomized controlled trials, recent meta-analyses comparing open clinical trials to randomized controlled ones reveal that the results from the two approaches are highly concordant as they are in this meta-analysis.^{40,41} For example, in the ***New England Journal of Medicine*** Benson and Hartz analyzed the data from 136 published effectiveness studies of 19 different medical treatments and concluded, *“In only two of the 19 analyses of treatment effects did the combined magnitude of the effect from the observational studies lie outside the 95% confidence interval for the combined magnitude in the randomized controlled trials.”*⁴⁰

Benson and Hartz `s findings strongly argue that a balanced approach to assessing a treatment’s evidence-base should take into account the results from open clinical trials as well as randomized ones and call into question the empirical basis for only accepting as adequate findings from randomized controlled trials. This increasingly prevalent bias is an opinion that is not supported by the evidence.

LSN is an evidence-based treatment consistent with a balanced approach to evaluating its scientific basis. While more research is needed to better understand LSN’s mechanisms of action and identify its effectiveness parameters, waiting for such research is no reason to impede LSN’s clinical use today for depression, anxiety, PTSD, ADHD, pain-management, and addictive disorders. ***This is particularly true given that LSN is ideally used to augment and enhance the effectiveness of other proven treatments.***

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Table 1
Clinical Effectiveness Studies

Study	Subjects	Key Findings
1. Cantor & Stevens, 2009. ²²	Randomized placebo-controlled cross-over design trial of 16 adults with treatment-resistant depression. Patients took the Beck Depression Inventory and QEEG at baseline, 4 wks following either LSN or simulated treatment, and then again after an additional 4 wks following cross-over.	<p>Patients were randomly assigned into two groups of 8 (simulated LSN and active LSN). During active LSN, patients received LSN 30 minutes per day, 5 days per wk for 4 wks for a total of 20 sessions. During simulated LSN, patients wore the LSN goggles and headphones while listening to relaxing music on the same schedule as the active LSN treatment phase. Key findings were:</p> <ul style="list-style-type: none"> • Significant reductions in depression only occurred during active LSN treatment ($p > .01$) with patients averaging a 70.9% improvement on the BDI during this phase; • All patients had a $\geq 50\%$ reduction in depressive symptoms following active LSN treatment; • When compared to a normative database using z-scores, LSN patients' QEEG demonstrated significant positive changes in cortical regions of the brain associated with mood regulation whereas such changes were not observed following simulated LSN; and • The gains from active LSN were sustained for 4 wks following termination with an additional 33% average improvement on the BDI.
2. Wolitzky-Taylor & Telch, 2007. ³⁸	Randomized controlled trial of 113 college students with pathological worry conducted at the University of Texas' Anxiety Clinic.	<p>Students were randomly assigned between LSN, two evidenced-based treatments for pathological worry, and a wait-list control group. The LSN intervention was originally conceptualized as a placebo-control group but was re-conceptualized as an active treatment following subjects very strong positive response. The key findings were:</p> <ul style="list-style-type: none"> • 12 LSN sessions (three times per wk for four wks) had the highest rate of clinically-significant change after four weeks @ 67% and the same frequency of exposure therapy was second @ 48%; and • LSN's treatment gains were maintained in the three-month follow-up assessment despite no further treatment.
3. Nomura, et al, 2006. ²³	Randomized controlled trial of 40 patients having a follow-up endoscopy. Outcome measures were changes in EEG and patients' relative discomfort/pain felt during endoscopy compared to their one.	<p>The key findings were:</p> <ul style="list-style-type: none"> • Following slow-wave LSN, 18/20 (90%) of patients experienced reduced pain/discomfort during their follow-up endoscopy compared to only 3/20 (15%) of control patients ($p < 0.0001$); • The LSN patients' slow-wave EEG activity significantly increased compared to control patients ($p < 0.001$); and • The degree of discomfort/pain felt during endoscopy and the proportion of slow-wave activity was highly correlated ($p < 0.001$).
4. Padmanaban et al, 2005. ²⁴	Randomized controlled trial of 108 patients under going ambulatory surgery. The State-Trait Anxiety Index was used to assess changes in pre-operative anxiety.	<p>Pre-operative patients were randomly assigned to sound stimulation embedded in music; the identical music but without the added rhythmic tones; and a third group who received no intervention. The key findings were:</p> <ul style="list-style-type: none"> • Rhythmic sound stimulation resulted in an average 26.3% reduction in pre-operative anxiety compared to 11.1% for the music-only group and 3.8% in the no intervention group; and • Rhythmic sound stimulation was superior to music-only stimulation in reducing pre-operative anxiety at the $p < 0.001$ level.

<p>5. Kliempt, et al, 2000.²⁵</p>	<p>Randomized controlled trial of 76 surgery patients under general anesthesia. Fentanyl was given sufficient to keep the intra-operative heart rate and arterial blood pressure within 20% of pre-operative baseline values. The amount of fentanyl required was used to measure pain control.</p>	<p>Patients wore headphones while under general anesthesia and were randomly assigned to listen to rhythmic sound stimulation, classical music, or a blank audio tape. The key findings were:</p> <ul style="list-style-type: none"> • The sound stimulation patients required over 77% less fentanyl compared with patients listening to classical music or the blank tape (mean values: 28 microgram, 124 microgram and 126 microgram, respectively); and • These findings were significant at the $p < 0.001$ level.
<p>6. Lane, et al, 1998.²⁶</p>	<p>Randomized controlled trial of 29 adults. Used computerized continuous performance testing and the Profile of Mood States (POMS) to compare the effects of slow-wave delta sound stimulation to higher-frequency beta stimulation on these measures.</p>	<p>Subjects performed a 30-minute computerized vigilance task on three different days while listening to pink noise containing simple tones or binaural beats either in the beta range (16 and 24 Hz) or the delta range (1.5 and 4 Hz). The key findings were:</p> <ul style="list-style-type: none"> • Beta-frequency binaural beats yielded more correct target detections and fewer mistakes than stimulation in the theta/delta frequency; and • Beta-frequency stimulation was also associated with less negative mood as measured by the POMS.
<p>7. Berg & Seiver, 1999.⁴²</p>	<p>Randomized placebo-controlled trial of 74 adults with Seasonal Affective Disorder. The BDI was administered at baseline, two, and four wks.</p>	<p>The control group did not receive LSN. The LSN group 1st received a 1 Hz (sub-delta) LSN placebo frequency five days a wk for two wks followed by 20 Hz (beta) LSN treatment for 2 wks. Key finds were:</p> <ul style="list-style-type: none"> • The baseline BDI score averaged 20.1 for both groups; • The control group's average BDI score increased to 25.9 and 26.1 at the two and four wk assessments; • The LSN group's BDI score decreased to 15.9 and 7.3 at the two and four wk assessments; and • Following 20Hz LSN, 100% of the treatment group had reduced depression ($p < 0.001$) and 84% scored as being clinically non-depressed (BDI score < 10).
<p>8. Tan et al, 1997.⁴³</p>	<p>Randomized controlled trial of 15 geriatric patients with dementia. The Mattis Dementia Rating Scale (DRS) and POMS were used pre and post treatment.</p>	<p>Patients were randomized into three groups: LSN, Relaxation Attention-Control, and no treatment control. The LSN and Relaxation Attention-Control patients received twice daily 20-minute long sessions five days per wk for six wks. Despite the small N, key findings were:</p> <ul style="list-style-type: none"> • LSN patients made significant improvements in DRS's attention subscale compared to control groups ($p < 0.01$); and • LSN patients made significant improvements in mood (POMS) compared to both control groups ($p < 0.05$).
<p>9. Pigott et al, 2009.⁴⁴</p>	<p>Open clinical trial of 65 substance abuse inpatients. Patients took the BDI and State-Trait Anxiety Index following detox and after four wks of treatment.</p>	<p>Patients received LSN combined with mindfulness meditation training three mornings per wk for four wks in a group setting. Of the 65 patients, 44 scored in the moderate to more severely depressed range on the BDI (≥ 17) when assessed following detox. Key findings for these highly symptomatic clients were:</p> <ul style="list-style-type: none"> • 23 (65.7%) had a remission of their depressive symptoms defined as a final BDI score < 10; • 32 (91.4%) had a $\geq 50\%$ improvement on the BDI; • 23 (65.7%) scored within the normal range in Trait Anxiety when reassessed; and • Averaged two standard deviation improvement in Trait Anxiety

10. Weiner et al, 2008. ⁴⁵	Open clinical trial of 10 substance abuse inpatients with co-morbid depression and 7 patients in a comparison group. Patients took the BDI, Beck Hopelessness Scale (BHS), and Rosenberg Self-Esteem Scale (RSES) following detox and after two wks of LSN treatment.	Patients received LSN five afternoons per wk for two wks and also listened to audio coaching CDs during their 30-minute LSN group sessions. The 7 comparison patients received standard treatment group services. Key findings were: <ul style="list-style-type: none"> • LSN patients averaged a 75% decrease in their depression (BDI) and hopelessness (BHS) scores compared to a 50% decrease on these measures for the comparison group; • LSN patients averaged an 80% increase in their self-esteem (RSES) scores compared to a 25% increase for the comparison group; and • 9 (90%) of the LSN patients had a $\geq 50\%$ improvement on the BDI compared to 3 (42.9%) in the comparison group.
11. Weiner et al, 2008. ⁴⁵	Open clinical trial of 18 substance abuse inpatients with co-morbid depression. Patients took the BDI and Millon Clinical Multiaxial Inventory (MCMI) following detox and after two wks of LSN treatment.	Patients received LSN three afternoons per wk for two wks and also listened to audio coaching CDs during their 30-minute LSN group sessions. Key findings were: <ul style="list-style-type: none"> • 13 (72.2%) had a $\geq 50\%$ improvement on the BDI; and • LSN patients averaged a 34.1 point decrease on the MCMI Major Depression scale.
12. McIlveen et al 2008. ⁴⁶	Open clinical trial of 10 substance abuse inpatients with co-morbid PTSD. Patients took the Posttraumatic Stress Diagnostic Scale (PDS) and MCMI following detox and after two wks of LSN treatment.	Patients received bilateral LSN stimulation sessions twice per wk for two wks and also listened to audio coaching CDs during these 35-minute groups. Patients also received LSN three afternoons per wk for two wks and listened to audio coaching CDs during these 30-minute group sessions. Key findings were: <ul style="list-style-type: none"> • PTSD symptoms decreased by an average of 36.4% on PDS Symptom Severity scale and 10.3 points on MCMI's PTSD scale; and • LSN patients averaged a 24.2 point decrease on the MCMI's Major Depression scale.
13. Solomon, 1985. ⁴⁷	Open clinical trial of 21 patients with muscle-contraction type headache, 3 patients with acute sinusitis headache, and 4 patients with migraine. Study was conducted at Scott Air Force Base in Illinois.	Patients received slow wave (1-3 Hz) LSN for 5 minutes during headache. Key findings were: <ul style="list-style-type: none"> • 19 of 21 patients with muscle-contraction type headache reported complete relief after treatment; and • All patients with migraine and sinusitis headache reported no relief after treatment. <p>Study included a placebo-controlled trial for 4 patients with muscle-contraction type headache. None responded to placebo, but all responded to slow wave LSN.</p>
14. Anderson, 1989. ⁴⁸	Open clinical trial of 7 patients with long standing migraine headaches. Patients received variable frequency LSN that allowed them to control the stimulation rate (0.5 to 50 Hz) and intensity.	Patients self-administered LSN at onset of migraines. Key findings were: <ul style="list-style-type: none"> • Of the 50 migraine headaches reported, patients rated 49 as being helped and 36 as being stopped; • Median duration of LSN treatment was 30 minutes; • LSN reduced the median duration of migraines in all patients from 6 hours (range 4 to 48 hours) to 35 minutes (range 5 minutes to 6 hours); • The interval between migraines increased in the 2 patients with follow-up of more than 18 months; and • Patients reported faster relief when using LSN in the higher frequency range and brightest setting.

<p>15. Norton, 2000.⁴⁹</p>	<p>Open clinical trial of 55 patients with long standing migraine headaches.</p>	<p>Patients self-administered LSN daily for 30 days to determine if daily use decreased the frequency of migraine headaches. Key findings were:</p> <ul style="list-style-type: none"> • 44% reported that the frequency was 'Somewhat Less' or 'Much Less'; and • Of the 28 patients whose migraines were normally preceded by warning signs, 53% reported that the frequency was 'Somewhat Less' or 'Much Less.'
<p>16. Anderson et al, 1989.⁵⁰</p>	<p>Open clinical trial of 17 women with severe and long-standing Pre-Menstrual Syndrome (PMS). Patients recorded their symptoms daily for two menstrual cycles before treatment, three cycles during treatment, and one cycle after treatment was stopped.</p>	<p>Patients self-administered LSN daily for 15 minutes during the three treatment menstrual cycles. Key findings were:</p> <ul style="list-style-type: none"> • After the first treatment cycle, there were reductions in PMS symptoms for depression, anxiety, affective lability, irritability, difficulty concentrating, fatigue, change in appetite, breast tenderness, and bloating ($P < 0.05$); • Patients' median reduction in PMS symptoms was 64% after one cycle of treatment and 76% at the end of treatment; • At the end of the final treatment cycle, 13 of the 17 (76.5%) reductions in PMS symptoms of $\geq 50\%$ and 12 (70.6%) no longer met the criteria for PMS; and • Both the severity and duration of PMS symptoms tended to return towards pre-treatment levels in the follow-up menstrual cycle.

Table 2
ADHD and Learning Disability Studies

Study	Subjects	Key Findings
1. Carter & Russell, 1993. ⁵¹	Open clinical trial of 26 learning disabled boys. Measures used were the Peabody Picture Vocabulary Test (PPVT) for verbal IQ, Raven Progressive Matrices (RPM) for non-verbal IQ), the Auditory Sequential Memory (ASM), Wechsler Intelligence Scale for Children (WISC), Wide Range Achievement Test (WRAT), and Burk Behavior Rating Scale (BBRS).	<p>All measures were administered 1 week before and 1 week after LSN by blind raters. 14 boys were attended private school and 12 attended public school. The private school boys had 40 LSN sessions lasting 25 minutes during school while the public school boys had only 18 sessions. In addition, the private school boys had an additional 40 sound stimulation administered at home by their parents for a total of 80 LSN sessions. The groups were evaluated separately due difference in amount of LSN received. Key findings were:</p> <ul style="list-style-type: none"> • While both groups showed improvement, the private school boys did considerably better with a significant eight point improvement in non-verbal IQ as well significant improvements in reading, spelling, and auditory memory functioning; • The public school boys showed significant improvement in only IQ (5.5 points) and spelling; and • The private school boys also showed greater gains in behavior with significant improvement on 9 BBRS scales verses improvement on only 6 scales by the public school boys.
2. Carter & Russell, 1994. ⁵²	Randomized placebo-controlled trial of 40 learning disabled (LD) boys. Measures used were the PPVT, RPM, WRAT, and the Attention Deficit Disorder Evaluation Scale (ADDES). All measures were administered by raters blind to group assignment.	<p>The boys were randomly assigned into three groups: 20 received 40 LSN sessions, 10 into a language-attention placebo group, and 10 into a no treatment control group. In addition to pre/post assessments, subjects were reassessed midway through the study. Key findings were:</p> <ul style="list-style-type: none"> • As compared to the two control groups, the LSN group's verbal IQ showed a significant increase of 4.3 points after 20 sessions and 9.2 points after completing 40 LSN training sessions ($p < .01$); • A similar pattern of progressive improvement in reading after 20 and 40 sessions was also found for the LSN group as compared to the control groups ($p < .05$); • These progressive improvements supported Carter and Russell's 1993 finding that the number of LSN sessions is positively correlated with increased treatment effectiveness; and • As compared to the control groups, the LSN group showed significant improvement in their ability to sustain attention ($p < .05$) and inhibit impulsive behaviors ($p < .01$) as measured by the ADDES.
3. Patrick, 1996. ⁵³	Randomized controlled cross-over design trial of 25 children with ADHD. Measures used were the WISC's Distractibility Scale and Processing Speed Scale, Test of Variables of Attention (TOVA), Wechsler Individual Achievement Test (WIAT), and Achenbach Child Behavior Checklist (CBCL).	<p>Children were randomly assigned into either the LSN or waitlist control group. Treatment consisted of 15 40-minute LSN sessions. The waitlisted children received their 15 LSN sessions in the cross-over design when the 1st group had finished. Key findings were:</p> <ul style="list-style-type: none"> • The waitlist control group showed no significant improvements on any measure during this phase; • LSN significantly improved children's ability to sustain attention and decreased impulsivity; • LSN significantly enhanced scholastic achievement; and • The improved scholastic achievement scores were maintained at the three-month follow-up assessment.

3. Russell & Carter, 1997a. ⁵⁴	16-month follow-up to their 1994 study of 40 learning disabled boys	<p>Key findings were:</p> <ul style="list-style-type: none"> • Significant gains in verbal IQ and enhanced ability to sustain attention, were maintained for 16 months following LSN treatment termination ($p < .01$); and • The improvements in their ability to inhibit impulsive behaviors were not maintained.
4. Russell & Carter, 1997b. ⁵⁴	Replication of their 1994 randomized placebo-controlled study with LD boys but distinguished between those with Attention Deficit Disorder but without hyperactivity (ADD) and those with ADHD.	<p>Due to school conflicts, the LSN treatment groups were only able to complete 25 LSN sessions versus the 40 sessions in the 1994 study. Key findings were:</p> <ul style="list-style-type: none"> • Despite having only 25 LSN sessions, both the ADD and ADHD treatment groups showed significant improvements in verbal (PPVT) and non-verbal (Raven) IQ; • These IQ gains were maintained for 9 months following LSN treatment termination; and • There were no similar changes in the ADD and ADHD boys randomly assigned to either control group.
5. Russell & Carter, 1997c. ⁵⁴	Replication of their 1994 study with LD girls conducted by an independent researcher working at a different university.	<p>Key findings were:</p> <ul style="list-style-type: none"> • LSN resulted in significant increases in verbal (PPVT) and non-verbal (Raven) IQ for the girls in the LSN treatment group; and • There were no similar changes in the girls randomly assigned to either control group.
6. Russell & Carter, 1997d. ⁴⁹	Randomized controlled trial with 15 ADD/ADHD boys with 5 in the LSN-only group; 5 in the Ritalin-only group; and 5 in the combined LSN/Ritalin group. Measures used were the PPVT, RPM, and WRAT.	<p>Treatment occurred 5 days per wk for 8 wks. The small N per group made it hard to reach statistical significance on observed differences in performance. Despite this limitation, key findings were:</p> <ul style="list-style-type: none"> • The LSN-only group significantly improved ($p < .001$) their Raven IQ test performance from 105.9 to 115.0 while there was a less though still significant change ($p < .05$) on the Raven for the Ritalin only group; and • All though there were no significant changes on the PPVT, each of the five Ritalin-only boys declined in their PPVT IQ scores while each of the 10 boys in the LSN-only and combined groups improved in their PPVT IQ scores.
7. Micheletti, 1998. ⁵⁵	Open clinical trail comparing four groups of ADHD children: Self-selected control group (N=31); Stimulant medication (N=20); LSN (N=21); and Combined LSN and Medication (N=27). Measures used were the PPVT, RPM, WRAT, ADDES, & Intermediate Visual and Auditory Continuous Test (IVA). Testing was done pre and post treatment and 4 wks after treatment termination by raters blind to treatment conditions. There were no significant differences between groups on the measures administered prior to initiating training.	<p>LSN consisted of 40 20-minute sessions occurring 5 days per wk for 8 wks. The students' parents were trained to administer the LSN sessions at home. Key findings were:</p> <ul style="list-style-type: none"> • Overall, Micheletti found that both the LSN-only, and combined LSN/medication, treatments were superior to stimulant medication alone and the control group; • Cognitively, the LSN-only group showed significant improvements on the reading and spelling sections of the WRAT as well as on the Raven ((7.2 points); • Behaviorally, the LSN-only group showed significant improvement in their ability to sustain attention and decrease hyperactivity as measured by the ADDES and just missed having significant improvement on the IVA's sustained attention scale ($p < .058$); • The control group did not improve on any measure; and • All of the LSN group's cognitive and behavioral improvements were maintained one month after treatment termination.

8. Budzynski et al, 1999. ²¹	Open clinical trial of 16 college students seeking academic counseling. The 1 st 8 received LSN and the 2 nd group of 8 received standard services. Measures used were subjects' EEGs while performing various mental tasks and fall & spring quarter GPAs.	<p>LSN consisted of 30 15-minute sessions during the Winter quarter. Key findings were:</p> <ul style="list-style-type: none"> • LSN students' GPAs significantly increased by an average of .7 points in the quarter following treatment termination while the comparison students' GPAs decreased by an average of .2 points; and • LSN students showed a significant increase in both their A3/A1 alpha ratio and peak alpha frequency when cognitively challenged while there were no such changes in the comparison group.
9 Joyce & Siever, 2000. ⁵⁶	Open clinical trial of 34 children in special education classes at two schools. Measures used were the TOVA and Standardized Test for the Assessment of Reading (STAR).	<p>LSN consisted of 35 22-minute sessions. One school used the STAR assessment to evaluate its reading program and this provided a comparison group of 20 students. Key findings were:</p> <ul style="list-style-type: none"> • The LSN students demonstrated significant improvement in their ability to sustain attention, inhibit impulsive responding, and improved reaction times as measured by the TOVA; • After LSN training, the students' average score on each TOVA measure were within the normal range; and • The LSN students significantly improved their reading scores compared to the control group.
10. Joyce, 2001. ⁵⁷	Open clinical trial of 204 students from 7 public schools in 1 st through 11 th grades with a history of impulsivity, distractibility, and learning problems. Measures used were the Behavioral Dimensions Scale (BDS) and Slosson-R reading test.	<p>LSN consisted of an average of 30 22-minute sessions administered over three months. Key findings were:</p> <ul style="list-style-type: none"> • The LSN students showed significant improvement in anxiousness, depression, hyperactivity, and inattention as measured by the BDS; and • The LSN students showed significant improvement in reading as measured by the Slosson-R averaging an eight month gain in grade-equivalent reading scores following three months of LSN training.

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