

New Sensory-Motor-Integration-Training for Students with Attention-Deficit/Hyperactivity Disorder, and Maladjustments in The Schools and at Homes

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ABSTRACT

Objective: In Taiwan, many parents of children with attention-Deficit/hyperactivity disorder (ADHD) are hesitant about choosing pharmaceutical treatment. As a non-pharmaceutical alternative, we explored the effects of 3 months of Sensory-Motor Integration Training (SMI-Tx) in elementary school students with ADHD.

Method: We compared scores on the ADHD Test (ADHDT), the Sensory-Motor Integration (SMI) checklist, the Test of Nonverbal Intelligence (TONI-2), and the Teacher Rating Scale (TRS) in 94 students with ADHD before and after 3 months of SMI-Tx.

Results: With the exception of students suffering from cold/influenza and neuritis pain, we found that SMI-Tx improved ADHD symptoms in all 94 students. School teachers' ratings indicated that ADHD symptoms improved by 79%. Higher frequency of SMI-Tx sessions was associated with greater improvement in ADHD symptoms.

Conclusion: SMI-Tx represents an effective non-pharmaceutical treatment for students with ADHD. However, further studies with larger cohorts and a double-blind crossover design are needed.

Keywords

ADHD, SMI-Tx, Dyspraxia, Nonverbal intelligence test (TONI-2).

Introduction

For an accurate diagnosis of attention-deficit/hyperactivity disorder (ADHD), a child must exhibit six or more symptoms of inattention and symptoms of hyperactivity, impulsivity, and/or distractibility for a minimum of 6 months. Most children present with a form of ADHD that combines other elements, which appear noticeably more often than in other children of the same age. Children with ADHD frequently encounter problems with temperament, motor skills, learning skills, and social skills, both at home and in the classroom.

While the causes of ADHD are still unclear, research suggests that genes, physiological or biochemical malfunctions, brain injury, and environmental factors during pregnancy (i.e., smoking or drinking

alcohol) can all play a role. An earlier study with a 33-year follow-up assessment period reported that men diagnosed with ADHD as children had significantly worse educational, occupational, economic, and social outcomes [1].

People diagnosed with ADHD are commonly treated with pharmaceutical regimens in addition to receiving psychological support and behavioral modification therapy [2]. In our experience, psychological and behavioral treatments often produce acceptable short-term results but may not have long-term effects.

To the best of our knowledge, in 2013, Pan, a prominent Taiwan psychiatrist stated in a press conference for the Taiwanese Society of Child and Adolescent Psychiatry that only 1 in 20 children with ADHD received proper stimulant treatment [3,4]. Some parents in Taiwan are quite hesitant to use pharmaceutical treatments in ADHD children. Use non-pharmaceutical treatments, such as specialized exercise may therefore be a viable alternative. Indeed, exercise has

been found to improve behavioral, neurocognitive, and scholastic performance in children with ADHD [5]. There is growing interest in alternative therapies for ADHD that involve exercise, such as sensory-motor integration training (SMI-Tx). Such activities are promising because they appear to improve prefrontal function [6] and increase activation in the frontal neocortical association pathway (Figure 1). In this study, we evaluated the effect of SMI-Tx on elementary school aged children. We have doing SMI-Tx to students with ADHD for 37 years.

Methods

Participants

In the 4 years leading up to December 2013, 115 cases with complete datasets were available for analysis. Ninety-four of these cases were grade-school students (82%) with ADHD, and 21 (18%) were kindergarten pupils with ADHD. As the kindergarten pupils were evaluated using checklists that were different from those used for the grade-school students, we focused our analysis on the 94 grade-school students with ADHD.

Thus, we evaluated the effects of SMI-Tx exercises on 94 students with ADHD (71 males 76%; 23 females 24%) who ranged in age from 7.5 to 10.1 years when they began treatment. The data were collected from December 2009 to December 2013. Before commencing the therapy, parents and class teachers evaluated the children, and we performed a uniform follow-up assessment after 3 months of SMI-Tx.

After admission to our study, 5 of the 94 students dropped out (5%) after SMI-Tx for 2 months, mainly due to interpersonal conflicts between the spoiled students and their nagging parents, regarding the number of exercises and correction of posture. There were 5 students with ADHD (5%) taking Ritalin on admission to SMI-Tx program. We did not make any comments or prohibition of taking Ritalin on period of training; 4 (80%) of them quitted Ritalin on mid-way of training. One male (20%) student kept on Ritalin during 2 months of SMI-Tx and still keep on it 2 years later on telephone interview. Father is of rigid personality trait, and mother is of nagging and histrionic personality. Above 10 students included in this study.

The Therapeutic Ethics Committee at the Everspring Foundation approved this study (SMI-Tx 14-Years Review No. 4). Verbal informed consent was obtained from parents of participants, including those who were videotaped, along with written consent from their parents.

Screening instruments

We recruited students who had behavioral problems at homes and in the schools. For admission to the training program, students were evaluated by their school teachers and parents using the following four established evaluation instruments: the ADHD Test (ADHDT) [7], the Sensory-Motor Integration (SMI) checklist [8], the Test of Nonverbal Intelligence (TONI-2) [9], and the Teacher Rating Scale (TRS) (Table 1). Levels of maladjusted behavior at schools were assessed via the 21 sub-items of the TRS. At home,

the students were assessed by parents using the 36 sub-items of the ADHDT-C (Chinese version of ADHDT) and 64 sub-items of the SMI checklist (see below). (For retail assembling of each syndrome, and how to use meaningful contents and statistical analysis, please see reference [15].

	Behavioral Presentations in School Life	* / **	Improved %
1	Talks a lot, endless speech XXX	29/66	44%
2	Impulsive; irritable XXX	46/53	87%
3	Interrupts others' speech	34/58	59%
4	Demonstrates attack behavior XXX	28/28	100%
5	Gets frustrated easily	36/63	57%
6	Creates chaos during class	30/35	86%
7	Talks to few people, has few friends, poor peer relations	25/39	64%
8	Very sensitive to environment; cannot tolerate changes in plans or results	39/56	70%
9	Clumsy movements, keeps falling down	29/29	100%
10	Movements slow and slack, not active, not efficient	30/61	49%
11	Reacts strongly to the touch of others	40/49	82%
12	Untidy desk and schoolbag	28/57	49%
13	Difficulty following class teacher's instructions	39/56	70%
14	Frequently forgets to bring books or reports to school	45/56	82%
15	Easily distracted, poor concentration, restless XXX while attending class, glancing left and right	74/87	85%
16	Difficulty with dictation or listening and writing, does not easily understand conversational speech	26/30	87%
17	Very clumsy at manual labor in the school and at home	32/34	94%
18	Jumps words, lines, or paragraphs while reading	29/42	69%
19	Great difficulty in understanding questions and transcribing formulas in mathematics	28/48	58%
20	Frequently jumps words, lines, or paragraphs when copying	31/44	70%
21	Eyes drift while in class, not able to concentrate fully	30/68	44%
*Number of students who improved on this sub-item after 3 months of SMI-Tx.		Mean=72%	
**Number of total students with defects on this sub-item.		SD=18%	

Table 1: Teacher Rating Scale (rate of symptom improvement).

Note: 1. We assessed a total of 94 students with ADHD over a 4-year period.

2. XXX indicate 4 symptoms of ADHD with mean of improvements 79%.

Intervention methods (For retail intervention method, see reference [15])

SMI-Tx series of exercises mainly involving prone extension postures. Dr. Ayres indicated this posture are thought to be beneficial for low vertebrate evolution into higher grade vertebrate. Specifically, the exercises that comprise SMI-Tx are thought to enhance kinesthetic and vestibular impulses, thus activating the neocortical association pathway in the prefrontal lobes [6]. As this region corresponds to cortical dysfunction in people with

ADHD, enhanced activation has the potential to facilitate positive behavioral change. Here we introduce simple forms of 3 steps of SMI-Tx. Intensive SMI training 3 months for students with ADHD, and maladjustments at homes and in the schools.

Chief 3 steps of Sensory-Motor Integration-training (SMI-Tx).

Ages & hit ball amounts:

- For age 2-3 year-old: Stage flat & prone on board with sl., Extension. Just push plastic, or dodgeball 5-10times come and go, much more play for touch.
- Age 4-6, up to 20- 50. Accord.to body weight, sex. subject to teacher adjustment.
- Starting students, May up 50-100, with variety activities from past experiences.
- 4th~6th grade, may up to 500 or more. Direct shoot ball to wall come & go, without hit on floor.
- Some like to play 3 balls in sometimes. If having slight hot & float in prefrontal lobes, students will be more concentrated; body organs, emotion more mature, & excellent coordination over whole body. Overt increase in Toni-2. use of whole body.



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Adapted with permission from Taiwan Special Education Quarterly 101, 2006.

Figure 1: BOLD fMRI before or after SMI-Tx3 months.

Legend of BOLD fMRI with/ without intensive SMI training ADHD for 3months:

1) The upper two images are control group (8 students with ADHD problems, (Diagnosed by special educational teachers and discussed with parents), showing pale color from low activation s of vessels, neurons, and biochemical material in the prefrontal areas in students with ADHD, before SMI-Tx These students showed severe distracted, impulsive, clumsy disorganized, emotionally

unstable, and exhibiting poor organization, and execution. Not yet received group SMI-Tx.

2) The middle two images are experimental group (8 students with same problems), showing much pink color, with much activation in a vessel, neurons, and biochemical material in the prefrontal areas in students with ADHD after intensive SMI-Tx for 3 months. These students exhibited full concentration, and were coordinated, emotionally stable, moderately organized, and had improving ability in execution. There are hot-tight feeding in the prefrontal region; within 2 weeks, there are behavior changes. Esp. change in full concentration and execution aspects.

3) The lower two images show full red color and are contrast group (8 students without any problems) with normal levels of activation in the prefrontal areas in normal students without SMI-Tx. These students exhibited full concentration and were coordinated, emotionally table, fully organized, and had good execution.

Results Statistical analyses

A total of 94 elementary school students with ADHD completed 3 months of SMI-Tx, with complete datasets for the ADHDT, SMI checklist, TONI-2, and TRS before and after treatments.

We used Statistical Package for the Social Sciences (SPSS) for this article studies. If you do have difficulty in understand the statistical terms, you can neglect the terms and see the results (For the detail, please see [reference 15]).

Discussion

Table 2 shows the results of the Student's t-test, which revealed improvements in TONI-2, ADHDT-C, and TRS scores between the two assessments (spaced 3 months apart). We also found improvements in post-SMI-Tx scores associated with deficiencies in SMI- syndrome ($P < 0.001$).

Our data indicate that intensive SMI-Tx sessions multiple times per week can lead to significant improvements in ADHD-C symptoms. We used the SMI-checklist to evaluate factors associated with the degree of frontal cortical hypersensitivity [2,3] and clumsiness or incoordination [1,4,5], which are associated with control deficits, because we expect that these elements are related to ADHD, and could thus be treated with SMI-Tx. We found significant improvement in these factors, indicating that SMI-Tx had a positive effect.

In terms of the SMI-checklist, we found that the higher the frequency of SMI-Tx sessions per week (5-7 sessions per week), the greater the improvements in ADHD symptoms. With respect to the TRS (Teacher Rating Scale-Table 1), we found that the mean improvement in 4 ADHD symptoms (items 1, 2, 4, and 15) after 3 months of SMI-Tx was 79%. Overall, our findings indicate that frequent SMI-Tx can have a positive effect on ADHD and ADHD-related symptoms in elementary school students.

N	T	S1	S2	S3	S4	S5	S6	S7	S8	S9	A1	A2	A3	A4	T1	T2	T3
1	15	-2	6	-1	1	1	-2	1	6	9	7	7	1	14	-3	-3	5
2	7	1	-1	3	-11	1	5	1	3	1	3	0	-2	1	4	0	-2
3	11	-2	2	5	1	-3	5	-1	4	12	5	6	7	19	1	-3	-1
4	10	2	3	3	-3	1	1	-2	-1	6	2	2	-7	-4	-1	5	1
5	11	1	4	10	9	-6	7	3	-1	24	-1	-1	-8	-13	0	-2	4
6	17	6	-8	0	10	2	2	0	2	14	0	1	3	4	-7	-4	-7
7	8	4	8	8	5	-1	3	4	4	31	3	7	8	19	2	-1	1
8	17	6	9	5	0	1	2	-3	-1	22	-2	-1	-6	-11	0	-1	5
9	13	4	5	-2	-10	-2	-5	-1	0	-10	4	2	6	13	-4	1	3
10	-22	3	4	-2	-11	-3	0	-3	-2	-11	-8	-7	0	-16	7	3	5
11	5	-5	2	-1	-7	-7	0	-6	-3	-21	-4	-3	-6	-13	1	-3	-3
12	0	-9	-5	-7	1	-3	-6	-2	0	-29	-3	-2	-2	-8	-4	0	-5
13	-8	-5	-8	-14	-15	-9	-10	1	-3	-64	-8	1	-1	-12	-2	-3	-2
14	0	1	-5	-17	-4	-4	-4	-7	-3	-36	-7	-4	-1	-12	-1	3	-2
15	19	-5	-6	-2	-1	-8	0	0	1	-21	-6	-2	-5	-14	-2	0	-3
16	8	-1	2	-7	-14	-7	-8	-1	0	-35	-8	-9	-13	-32	0	1	3
17	-5	-11	-4	-10	-20	-7	-18	-6	-2	-72	-2	-1	3	0	-1	0	2
18	0	2	-1	-2	-2	-2	-3	0	0	-8	-1	1	0	0	-14	1	-2
19	0	-5	-11	-8	1	-1	-6	0	-1	-31	0	5	6	13	-3	2	1
20	10	1	-4	-13	-5	-3	0	2	0	-24	-9	-2	-2	-14	-6	3	3
21	10	-10	-5	-4	-3	1	-1	-2	-1	-23	-5	-4	-4	-14	-12	2	-6
22	15	-8	2	-2	-19	-4	-5	3	2	-34	-5	-1	-5	-13	-5	1	-1
23	19	-3	1	1	-8	-2	-15	-2	-1	-27	3	-2	2	2	-4	-2	-5
24	4	3	-1	-1	1	-2	-8	-1	0	-8	-4	0	-1	-11	-8	0	-5
25	13	-8	-1	-6	3	-2	-1	1	2	-13	-1	-2	-1	-4	-2	-6	-4
26	20	-14	-6	-15	-13	-7	-10	-1	-4	-69	-4	-6	-3	-13	-4	-4	-7
27	1	-6	-2	-5	-4	-4	-5	-1	-1	-27	-7	-7	-5	-20	1	1	5
28	12	-8	-6	-2	-10	-1	-5	-2	-1	-33	-11	-7	-17	-34	0	1	-1
29	2	-9	0	-1	-3	-6	1	0	0	-18	-14	-7	-10	-32	-9	2	-5
30	-6	-20	-5	-13	-24	-9	-10	-4	1	-80	-11	-5	-8	-26	-5	4	7
t-Test P<		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Table 2: Student t-Test results showing improvement on TONI-2, and SMI (9 syndromes), ADHDT (4 syndromes), and TRS (3 syndromes).
Note: Total student numbers 94; with space limitation, only showed 30 students.

Legend:

N: Student No.	A: Improved hyperactivity
T: Improved scores of TONI-2	A2: Improved impulsions
S1: Improved vestibular dysfunction	A3: Improved inattention
S2: Improved frontal control deficits	A4: Improved sum of ADHDT
S3: Improved sensory process disorder	T1: Improved score of pan-hypersensitivity & control deficits
S4: Improved childhood dyspraxia	
S5: Improved form & space disorder	T2: Improved score of eye drift, jumping, poor scholastic scores
S6: Improved gravitational insecurity	
S7: Improved short temper & grading	T3: Improved score of dyspraxia, clumsiness, & in-coordination
S8: Improved self-esteem & confidence	
S9: Improved sum of SMI syndromes	

In 2006 a research group conducted a BOLD fMRI study of students with ADHD [13] and found that students with ADHD had very limited activation in the frontal regions prior to SMI-Tx. Three

months after SMI-Tx, BOLD fMRI revealed increased activation in the frontal and prefrontal regions, and the patterns of activation were more similar to those observed in a group of healthy contrast. According to observations and ratings by teachers and parents, the individuals in this experimental group exhibited improved symptoms in terms of ADHD-C scores as well as improved motor skills and motor execution after 3 months of SMI-Tx (Figure 1).

The underlying theoretical framework of SMI-Tx

In our SMI-Tx program, students perform three types of activities in a prone extension position on a scooter board. Exercises involving prone extension postures produce strong kinesthetic nerve impulses from muscles, ligaments, and joint surfaces in face, mouth, nose, ears, eyes, 4 limbs, neck, and back. Maintaining one's balance, even subconsciously, involves focal and large-scale body movements that produce plentiful vestibular and strong kinesthetic nerve impulses that are transmitted immediately to the entire body

[14], including the brain.

Cortical brain regions are activated by strong kinesthetic nerve impulses resulting from whole body movements (strong neuron exercises), and new neuronal pathways are established in frontal and prefrontal brain (highest position in position of prone extension posture). The kinesthetic system works to send messages throughout body parts, providing a direct connection to the cortex of the brain. Improved signal transmission in the frontal and prefrontal neuronal pathways decreases hyperactivity, impulsiveness, severe distraction, and eye drifting, improves general hypersensitivity associated with control deficits (sensory processing disorder), and facilitates fine motor control and coordination of hand fingers, mouth, face, eyes, and ears, covering all chief and accessory symptoms and signs of ADHD.

Vestibular system on the other hand, allows us to stand upright (in our prone extension exercise posture, frontal and prefrontal lobes are tip upright posture), maintain balance, and move through space by means of its direct connection to the brain. The vestibular system coordinates information from all of the vestibular organs. These organs include the inner ear, the eyes, the muscles and joints, the fingertips, the palms of the hands, the soles of the feet, pressers of the jaw, and lastly gravity receptors (which are located on the skin and work to adjust a number of things including heart rate, blood pressure, muscle tone, limb position, immune responses, arousal and balance). Those are call “Brain Training”.

If daily morning before going to school and immediate after school before doing homework take 20-40 minutes, doing following mentioned “high-speed ball exchange” play. The classes and home will be much smooth.

Implementing SMI-Tx

About the contents of the value of home therapy, very low self-esteem and self-confidence, & high-speed ball exchange, please see reference [15].

Not only intensive SMI-Tx can treat grade students, it can also treat pupils’ maladjustments in the kindergartens.

16 Kindergarten Pupil with Maladjustment at Homes & In the Schools Were Send to Ever spring Training Center for Summer SMI-Tx 60 days program in 2018.

	Observed maladjustment Items	Disorder No.	Satisfactory No.	IMP Red%
1	Hyper- or Ex-activity	12	8	67%
2	Impulse; Oral- Impulse Violent.	12	8	67%
3	Distract, No or insufficient of concentration.	19	15	79%
4	Tactile-defensiveness- (Face & Body) body skin over sensitivity. Control Difficulties.	20	14	70%
5	Poor peer correlation.	13	12	92%
6	Perseveration.	11	10	91%

7	Very short temper.	13	12	92%
8	Slow learner or Learning Disability.	14	9	64%
9	Hand & finger stiffness, poor coordination	10	9	90%
10	Jump lines or paragraph (freq. bit jumper).	12	10	83%
11	On meal clumsy, freq. drop rice or vegetable on floor.	15	8	53%
12	Put on shoe slowly and clumsy.	12	10	83%
13	Child dyspraxia (clumsy, incoordination).	16	12	75%
14	Speech dyspraxia (Dysarthria)	4	3	75%
15	Gravitational insecurity (HIGH PHOBIA)	5	5	100%
16	Overt introverted personality	7	5	71%
	Positive percentile and improved rates	183	142	78%

Legend

Members have 13 boys, 3 girls, total 16 on 2018 Summer SMI-Tx Special Training for 60 days.

- 16 Pupil with problems in the schools and at homes are from 5 kindergartens in Taipei city and suburbs. Age 3-5yrs, an average of 4.2 years. Perform SMI-Tx 3-5times/ week.
- Maladjustment behavior are coming down in one month, then normal adjustments appear, mostly by enhancement in prone extension posture.
- Score method of teachers & parents range from 1 to 6 points; 5-6 are worst; 1-2 are best; first score minus last week score are improved scores. Only improved 2 points on both sides (teachers & parents) then counted.
- Some 70% (11 pupils) parents repeat the program at home. Total improved 78%, with prefrontal sl. hot and float sense will improve concentration and sudden appearing of sounds like pizza fortnite and behaviors. Family duplicated SMI-Tx are at home, being a very powerful weapon.
- For SMI-Tx detail, theory, from Dr. Ayres, & physical therapy, with slight prone extension posture.
- After SMI-Tx the the brain waves are still irregular. ADHD miner symptoms may appear. You can do NeuroFeedBack (NFB or NF or ever Local NF LNF) 10 times, brain function will be the best.
- Group training in the schools, will do the best. In School always can find some ADHD or other maladjustments. Intra-group competition is important factor in successful. How to make scooter board is described in references [15].

Conclusion

SMI-Tx represents an effective non-pharmaceutical treatment for students with ADHD and maladjustments. Three months of SMI-Tx led to improvements in ADHD symptoms that were noted by parents and class teachers (Table 1), validated by the TONI-2 (Table 2), and are supported by a previous study that reported corresponding changes in BOLD fMRI activity (Figure 1) before and after 3 months of SMI-Tx. The more intensity of SMI-Tx (5-7/ week), the results are quicker and better. However, further studies

with larger cohorts and a double-blind crossover design are needed.

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Ethical Statement

The treatment ethics committee of the Everspring Culture and Education Foundation approved the protocol for the SMI-Tx study as well as the EEG diagnosis and neurofeedback training. We obtained verbal informed consent from the parents of each participants.

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