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EXECUTIVE FUNCTIONS: EFFECT OF YOGIC INTERVENTION AMONG ADOLESCENT GIRLS IN DELHI REGION

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Abstract

This study investigates the executive functions of adolescent girls, evaluated by Behaviour Rating Inventory of Executive Function-Self Report Version (BRIEF-SR), and the effect of yogic intervention of the adolescent girls' executive function skills. We evaluated 50 adolescent girls, between the ages of 12 and 15 years, with control diagnosed of any physical health disorders or neurological disorders, any medication or treatment which alters the functions of the nervous system. Results of the paired-samples t-test show that mean **Global Executive Composite (GEC)** differs before Yogic Intervention (M = 127.94, SD = 11.75) and after yogic intervention (M 95.58, SD = 12.15) at the .05 level of significance (t = 23.91, df = 49, n = 50, p< .01, 95% CI for mean difference 29.64 to 35.08, r = .68). On average **Global Executive Composite (GEC)** was about 5.44 points lower after yogic intervention. It shows that Yogic intervention helps adolescent girls in removing of obstacles that hamper the executive functioning of our systems and improves the perspective of their life.

These results add to prior research findings which indicated that diverse activities have been shown to improve girls executive functions like computerized training, aerobics, martial arts, and school curricula. In the sequence we found yogic intervention programme contributes to the development of adolescents and additionally support the hypothesis that yogic intervention programme plays a significant role in developing executive functioning skills.

Key words: Executive Functions; adolescent girls; yogic Intervention

I. Introduction

In CBSC, Students Global Aptitude Index 'teachers manual 2012', it is mentioned about adolescents that: During school, a student passes through the most important phase of life termed as 'Adolescence.' Apart from mental, physical and emotional transition, adolescence is also a time of exploration and choices which direct an individual's future. It is often seen that career decisions are based on parental and peer influences. They may lead adolescents to achieve higher positions in the field of work later in life but not the desired satisfaction. This is due to the gaps between aspirations and actual potential. It becomes difficult to take a u-turn and search for one's interest or passion in life. Many children find role models in the school and home environment and start building specific career aspirations. At this stage, they need to be guided so as to match their unique interests and values with academic and vocational choices**.(** ***Sh. Vineet Joshi, Chairman, CBSE, 2012)***

"1.2 billion Individuals aged 10–19 years residing in this world. India is home to more than 243 million adolescents and world's largest national population of teenage girls, who account for almost 20 percent of the country's population. **National Institute of mental health: "Teenage Brain, A work in Progress." NIH Publication No. 01-4929, 26 June 2008.** The newfound appreciation of the dynamic nature of the teen brain is emerging from MRI (magnetic resonance imaging) studies that scan a child's brain every two years, as he or she grows up. Individual brains differ enough that only broad generalizations can be made from comparisons of different individuals at different ages. But following the same brains as they mature allows scientists a much finer-grained view into developmental changes. In the first such longitudinal study of 145 children and adolescents, reported in l999, NIMH's Dr. Judith Rapoport and colleagues were surprised to discover the second flow of excess of gray matter, the thinking portion of the brain—neurons and their branch-like extensions—just before puberty. Possibly related to the influence of surging sex hormones, these thickening peaks at around age 11 in girls, 12 in boys, after which the gray matter actually thins some. ***(NIMH, September 10, 2010)***

The term executive function defines complex cognitive processing requiring the co-ordination of several sub processes to achieve a particular goal. ***Welsh and Pennington (1988) defined executive*** functioning as a broad range of abilities, serving the purpose of maintaining an appropriate problem-solving set for attainment of a future goal. The term has also been used as an umbrella term for the functions of the prefrontal cortex ***(Pennington, Bennetto, McAleer, & Roberts, 1996).***

To save the future of our nation, it is must to make sure that youth should be physically and mentally perfect, and for this our 1st responsibility is to track the health of our children and adolescents being parents and teachers. Adolescents with Executive Dysfunction have difficulty reading social cues and may feel overwhelmed in large group situations. Executive Function can cause pervasive problems as this disability does not affect only one area of learning like Dyslexia, Dysgraphia, or Dyscalculia. Every subject can be affected by Executive Dysfunction issues, particularly any academic area that requires sequential processing.

At the stage of adolescence if someone experiences these difficulties it may cause development of two types of behaviour: either he become violent, anti-social and drug addicted or he adopt depressive behavior and feel low self-confidence and insecurity. In both conditions an adolescent suffers and led to ruin his future life because it is said that "Adolescence is a highly important transition phase between childhood and adulthood, marked by significant physical, social, cognitive and emotional changes (Dahl & Gunner, 2009; Steinberg, Albert, Cauffman, Banich, Graham & Woolard, 2008)."

Research shows that the three parts of the brain that are most heavily involved in Executive Function are the areas of the brain that also control motor activity. Due to the overlap between motor and mental control, activities that encourage aerobic exercise, strengthening, and stretching, stimulate the executive brain, priming the "executive pump." Also, there is evidence that motor control can be improved through patterned programmed movements thought to be particularly beneficial for executive functioning, which include martial arts, yoga, dance, swimming and aerobics. ***(A Report from the Recent IECA Conference By Loi Eberle, M.A., Educational Consultant).***

A Cat Samson MS, MPH, PMHNP-BC 2008 ONA/NPO Annual Education Conference October 19, 2008, indicated: About 15% of children have some problems with executive functioning, but about 30% or so of children and adults with ADHD have problems. They are extremely common in autism and fetal alcohol syndrome. If a child has brain damage from slowed growth in the womb or was very premature, they are not too uncommon. In brain injured children, infections of the brain and those with tumors, they are common, along with a host of rarer diseases.

As with all interventions, it is important to be aware of how they affect the person with executive functioning disorder. If the person is not helped with the strategy or is making no progress after a reasonable amount of time, look for a better way. Older children and adults may be able to help identify more effective strategies or ways to adjust strategies for more effectiveness. One of the most important things to remember about executive functioning disorders is that this is as much of a disorder as any other. Although it is an invisible disability, it can have a profound effect on all aspects of a person's life. Be prepared to share this information with teachers, co-workers, or supervisors as needed to ensure the disorder is not mistaken for laziness or carelessness. ***(Anne Logsdon, School Psychologist, 2013)***

The framework laid out by ***McCloskey et al. (2009)*** describes a holarchical model of executive functions. The model categorizes executive function into five levels. These levels are (1) self-activation, (2) self-regulation, (3) self-realization and self-determination, (4) self-generation, and (5) trans-self-integration. The first level, self-activation, precedes the levels of self-control and describes how executive functions are awakened after a non-conscious state such as sleep. The second level is self-regulation, which is comprised of at least 23 executive functions that are separate from each other.

Research has shown that the EF develops rapidly during the preschool years ***(Anderson & Reidey, 2012***) as a result of expeditious neural development, especially in the prefrontal cortex ***(Zelazo & Carlson, 2012).*** Also, while EF in adults is a diverse set of many processes, recent research has pointed to EF in childhood being a more unitary concept, with most EF at this stage being focused in a self-directive mode, consisting of inhibitory control and working memory ***(Weibe, Sheffield, Nelson, Clark, Chevalier, & Espy, 2011).***

II.Types of difficulties adolescent face due to poor EF skill

SKILL: Inhibit
Definition: Not acting on an impulse or appropriately stopping one's own activity at the proper time
Dysfunction: Has trouble "putting the brakes" on behavior; acts without thinking
SKILL: Shift
Definition: Freely moving from one situation, activity, or aspect of a problem to another as the situation demands Dysfunction: Gets stuck on a topic or tends to perseverate
SKILL: Emotional control
Definition: Modulating/controlling one's own emotional response appropriate to the situation or stressor
Dysfunction: Is too easily upset, explosive; small events trigger big emotional response
SKILL: Self-monitor
Definition: Checking on one's own actions during, or shortly after finishing, the task or activity to assure appropriate attainment of goal
Dysfunction: Does not check work for mistakes; is unaware of own behavior and its impact on others
SKILL: Working memory
Definition: Holding information in mind for the purpose of completing a specific and related task
Dysfunction: Has trouble remembering things, even for a few minutes; when sent to get something, forgets what he or she is supposed to get.
SKILL: Plan
Definition: Anticipating future events, setting goals, and developing appropriate steps ahead of time to carry out an associated task or action
Dysfunction: Starts assignments at the last minute; does not think ahead about possible problems
SKILL: Organize
Definition: Establishing or maintaining order in an activity or place; carrying out a task in

a systematic manner
Dysfunction: Has a scattered, disorganized approach to solving a problem; is easily overwhelmed by large tasks or assignments
SKILL: task Completion
Definition: Completing a task or activity successfully
Dysfunction: Has trouble getting finish the homework or projects

Research shows that the three parts of the brain that are most heavily involved in Executive Function are the areas of the brain that also control motor activity. Due to the overlap between motor and mental control, activities that encourage aerobic exercise, strengthening, and stretching, stimulate the executive brain, priming the "executive pump." Also, there is evidence that motor control can be improved through patterned programmed movements thought to be particularly beneficial for executive functioning, which include martial arts, yoga, dance, swimming and aerobics. As with all interventions, it is important to be aware of how they affect the person with executive functioning disorder. If the person is not helped with the strategy or is making no progress after a reasonable amount of time, look for a better way. Older children and adults may be able to help identify more effective strategies or ways to adjust strategies for more effectiveness. One of the most important things to remember about executive functioning disorders is that this is as much of a disorder as any other.***(Ann Logsdon February , 2016)***

Although it is an invisible disability, it can have a profound effect on all aspects of a person's life. Lets be prepare to share this information with parents and teachers and try to make the nation's youth more powerful and goal oriented. Yoga intervention is a highly effective way to improve the executive function disorders, researches indicates.

Indian yoga constitutes one of the oldest and most important scientific spiritual legacies of humanity and has been preached as well as practiced uninterruptedly since the dawn of human history." It is the most important sector of knowledge because it is needed by all. Anyone at any age can be benefited through its practice without any limitation of caste,creed, sex, colour and nation.

Yoga is considered as the right art of living which is to be incorporated in daily life because it works on physical, mental, psychic and spiritual level. We can say that Yoga has a complete message for humanity i.e. it has a message for human body, mind and soul. It is the most important sector of knowledge because it is needed by all. Anyone at any age can be benefited through its practice without any limitation of caste, creed, sex, colour and nation.

In ancient Vedic time yoga techniques were kept secret and were not written down and exposed to public view, the techniques were passed on from teacher or guru to the disciple. But again yoga arose with the beginning of human civilization; yogic techniques were slowly evolved and developed by ancient sages all over the world in the form of different symbols, analogies and languages. The yoga tradition is a divine gift of ancient sages to the mankind to make them realize the divine energy of yoga.

Yoga can be performed through the practice of *asana, pranayama, mudra, bandha, shatkarma* and *dhyan* (meditation) etc. The aim of *yoga* is to bring the body and mind into perfect coordination so that one can spend a perfect life with healthy body, mind and soul. Through *yoga* one can cope with the physical, mental and emotional disorders like phobia, stress, hypertension, heart diseases, neuroses etc. Success of *yoga* is established in curing of diseases like asthma, diabetes, high and low blood pressure etc. Also *yoga* has proved very effective in cases of epilepsy, hysteria, rheumatism and many other chronic and acute ailments. The most unique and important fact about this system is that it works on the principles of harmony and unification.

The three principles on which this therapy is based are:-

1. Conferring absolute health to a part or system of the body, thereby, influencing rest of body.
2. Balancing the positive and negative energy poles *(ida/pinpla, prane/apan)*
3. Purifying the body from three type of wastes (*doshas*)

III. Method

3.1. Participants

Participants were selected and recruited from public and private schools of Delhi region. A detailed list of public schools from the selected location was prepared and the Principal/ director of the school were approached to seek permission for the study. Through quota sampling total 50 adolescent girls have been selected for the study.

The inclusion criteria: Female, aged 12-15 years, enrolled in a school and readiness to participate in the trial. Exclusion criteria: cognitive dysfunction, neuropsychiatric disorders, developmental delay complaints, and historical or current consumption of psychotropic medication, alcohol or drugs, as reported by the parents. According to these criteria, 50 girls, aged between 12-15 years.

3.2 Tool of the Study

Behavior Rating Inventory of Executive Function® - Self-Report Version (BRIEF-SR®)
Steven C. Guy, PhD, Peter K. Isquith, PhD, and Gerard A. Gioia, PhD ;
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The 80 items yield information for eight non overlapping clinical scales that measure different aspects of executive functioning: Inhibit, Shift (with Behavioral Shift and Cognitive Shift subscales), Emotional Control, Monitor, Working Memory, Plan/Organize, Organization of Materials, and Task Completion. The clinical scales form two broader indexes--the Behavioral Regulation Index (BRI) and the Metacognition Index (MI)--and yield an overall summary score, the Global Executive Composite (GEC).

3.3 Procedure

3.3.1 Data collection: When enrolled female students have done with pre data collection, they had been introduced with a 40 minute session of yoga techniques. Students regularly practiced yoga for a period of 3 months (excluding Sunday) in yogic intervention classes conducted in their school premises as per the instructions of researcher.

S.No.	*Treatments*	Duration
1	*Gayatri mantra*	01 minute
2	*Surya-namaskara*	12 minutes
3	*Pranayama*	05 minutes
4	*Meditation followed by Trataka*	06 minutes
6	*Yog-nidra*	15 minutes
7	*Om chanting*	01 minutes
	TOTAL	40 minutes

Post data was collected from the students only who were regular in classes throughout the period of 3 months during yogic intervention. Now finally 50 students were tested for post data collection. Post data was taken on the same questionnaire (BRIEF-SR rating form) to see the effect of yogic intervention on the target group.

3.3.2 Data analysis:

After the collection of pre-post data the entire attention was paid to the analysis and interpretation. For statistical analysis of data t-test has been used. The aim of the analysis is to summarize the observation in such a manner that they yield answer to the hypothesis of research by linking them to certain variables. The software SPSS version 15.0 was used to derive the results.

- A basic description of the study population was prepared by means of frequency distributions and the basic statistics like mean, median, mode, standard deviation, etc;
- Correlation coefficients and their significance between the important parameters under group study;
- Paired sample t-tests were performed to assess the statistical significance of these variables in predicting the level of significance among variables:

IV. Results

Table 4.1: Descriptive Statistics and t-test Results for subscales of BRIEF-SR among adolescent girls:

	Pretest		Posttest			95% CI for		
Outcome	M	SD	M	SD	n	Mean Diff.	r	t
Behavioral Regulatory Index (BRI)	63.66	9.43	49.94	8.15	50	12.06, 15.33	.79**	16.79**
Metacgnition Index (MI)	64.30	7.82	45.64	8.06	50	16.79, 20.52	.66**	20.15**
Global Executive Composite (GEC)	127.94	11.75	95.58	12.15	50	29.64, 35.08	.68**	23.91**

Values are M(SD), r and t scores: Behaviour Rating Inventory of Executive Function(BRIEF)-SR: eight Scale parameters including Behavioral Regulatory Index (BRI), Metacognition Index (MI) & Global Executive Composite (GEC).

**p<0.05, **p<0.01.*

N=50: df=49.

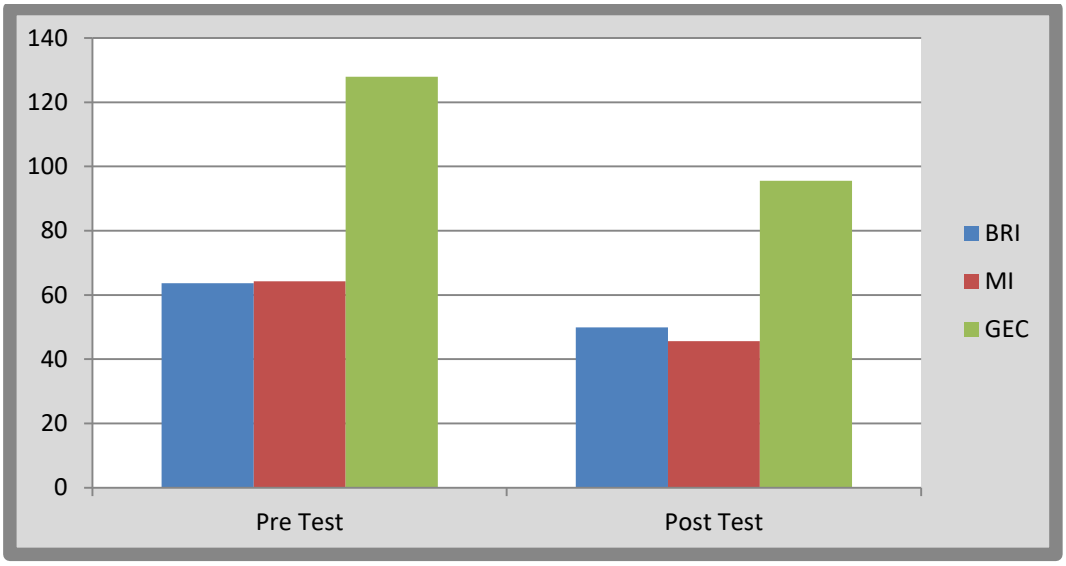

Chart 4.1: Comparative bar diagram to show Pretest-posttest Mean (BRI. MI, GEC) of BRIEF-SR

When interpreting the data, it is important to remember that all results "should be viewed in the context of a complete evaluation". Clinical information gathered from the BRIEF-SR questionnaire is best understood within the context of a full assessment.

Accordingly, high scores obtained on the BRIEF do not indicate a "disorder of executive function" but rather suggest a higher level of dysfunction in a specific domain of executive functions.

Finding 4.1:

Table 4.2: Descriptive Statistics and t-test Results for subscale Behaviour Regulation Index (BRI) of BRIEF-SR among adolescent girls:

BRI	Mean	SD	r	**t Score**
Pretest	63.66	9.43	.79	16.79
Posttest	49.94	8.15		

Results of the paired-samples t-test show that mean Behavioral Regulatory Index (BRI) differs before Yogic Intervention (M = 66.66, SD = 9.43) and after yogic intervention (M = 49.94, SD = 8.15) at the .01 level of significance (t = 16.79, df = 49, n = 50, p< .01, 95% CI for mean difference 12.06 to 15.33, r = .79). On average the level of Behavioral Regulatory Index (BRI) was about 3.27 points lower after practice of yogic intervention. (Table 2)

Results show a statistically significant difference in mean Behavioral Regulatory Index (BRI) before and after Yogic intervention. Level of Behavioral Regulatory Index (BRI) appears to drop an average of about 3.27 points following the regular practice of Yogic Intervention programme.

The null hypothesis formulated has been rejected at 0.01 level of significance. This indicates that there is significant effect of the yogic intervention on Behavioral Regulatory Index (BRI) among adolescent girls. Hence it can be concluded that yogic intervention significantly helps adolescent girls to enhance the level of Behavioral Regulatory Index (BRI).

Finding 4.2:

Table 4.3: Descriptive Statistics and t-test Results for subscale Metacognition Index (MI) of BRIEF-SR among adolescent girls:

MI	Mean	SD	r	**t Score**
Pretest	64.30	7.82	.66	20.15
Posttest	45.64	8.06		

Results of the paired-samples t-test show that mean **Metacognition Index (MI)** differs before Yogic Intervention (M = 64.30, SD = 7.82) and after yogic intervention (M = 45.64, SD = 8.06) at the .01 level of significance (t = 20.15, df = 49, n = 50, p< .01, 95% CI for mean difference 16.79 to 20.52, r = .66). On average **metacognition Index (MI)** was about 3.73 points lower after yogic intervention. (Table-3)

Results show a statistically significant difference in mean **Metacognition Index (MI)** before and after Yogic intervention. **Metacognition Index (MI)** appears to drop an average of about 3.73 points following the regular practice of Yogic Intervention programme.

The null hypothesis formulated has been rejected at 0.01 level of significance. This indicates that there is significant effect of the yogic intervention on **Metacognition Index (MI)** among adolescent girls. Hence it can be concluded that yogic intervention significantly helps adolescent girls to enhance the level of **Metacognition Index (MI)**.

Finding 4.3:

Table 4.4: Descriptive Statistics and t-test Results for subscale Metacognition Index (MI) of BRIEF-SR among adolescent girls:

GEC	Mean	SD	r	**t Score**
Pretest	127.94	11.75	.68	23.91
Posttest	95.58	11.54		

Results of the paired-samples t-test show that mean **Global Executive Composite (GEC)** differs before Yogic Intervention (M = 127.94, SD = 11.75) and after yogic intervention (M 95.58, SD = 12.15) at the .05 level of significance (t = 23.91, df = 49, n = 50, p< .01, 95% CI for mean difference 29.64 to 35.08, r = .68). On average **Global Executive Composite (GEC)** was about 5.44 points lower after yogic intervention. (Table-4)

Results show a statistically significant difference in mean Inhibit before and after Yogic intervention. **Global Executive Composite (GEC)** appears to drop an average of about 5.44 points following the regular practice of Yogic Intervention programme.

The null hypothesis formulated has been rejected at 0.01 level of significance. This indicates that there is significant effect of the yogic intervention on **Global Executive Composite (GEC)** among adolescent girls. Hence it can be concluded that yogic intervention significantly helps adolescent girls to improve the level of **Global Executive Composite (GEC)**.

V. Discussion

As discussed earlier, executive dysfunction is associated with a range of neurological and psychiatric disorders. The ubiquity of executive impairments, often in the absence of structural damage to the prefrontal cortex, is intuitively consistent with the network view of executive function. A dynamic and flexible neuronal network could be compromised in many different ways, and to different extents. ***(Br Med Bull, 2003)***

Based on theoretical and empirical factor analytic findings, the clinical scales were combined to form two indexes, the Behavioral Regulation Index (BRI) and the Metacognition Index (MI) and one composite summary score, the Global Executive Composite (GEC). The Global Executive Composite was a summary score that incorporated all eight clinical scales of the BRIEF. This summary score would be an accurate reflection of the child's executive dysfunction level. The Behavioral Regulation Index represented the ability to shift cognitive set and modulate emotions and behavior via appropriate inhibitory control. It is comprised of the Inhibit, Shift and Emotional Control scales. Behavioral regulation enables the metacognitive processes to successfully guide active, systematic problem solving, and more generally, supports appropriate self-regulation. The Metacognition Index represented the child's ability to initiate, plan, organize and sustain future-oriented problem solving in working memory. This index was interpreted as the ability to cognitively self-manage tasks and reflects the child's ability to monitor his or her performance. The MI related directly to a child's ability to actively problem solve in a variety of contexts.

In today's fast life, it is Yoga Nidra which relaxes the mind in very less time span without any medication. In the practice of yoga nidra the body is progressively relaxed, which in turn releases the accumulated muscular tensions. When the awareness is rotated in the same sequence again and again, it induces a flow of pranic energy within the neuronal circuit of the motor homunculus of the brain ***(Siddhartha Bhushan).*** According to **Swami Satyananda (1998),** "a single hour of yoga nidra is as restful as four hours of conventional sleep". Chanting Om & Gayatri mantra before yog nidra improves our concentration, gives peace and steadiness to our mind, reduces mental stress and clears all worldly thoughts. Within minutes the mind get relaxed, negative thoughts swept away to release the life force that heals the self. These practices prepare the mind and brain for better input and stimulation that improve the executive function ability.

Yoga promotes a mindfulness of internal bodily sensations as a way of "knowing" in relation to the effect specific mental states have on bodily sensations (Schiffmann, 1996). Bodily sensations are thought to affect our thought processes and overall decision-making. in the last two decades, research on the philosophy of yoga and the physical practice (hatha) has increased to provide empirical data demonstrating its effectiveness in treating a myriad of diseases including depression and anxiety (Forfylow, 2011; Rae, 2011; Streeter, Gerbarg, Saper, Ciraulo, & Brown, 2012), posttraumatic stress disorder (Libby, Reddy, Pilver, & Desai, 2012), and physical ailments such as headaches, heart disease, and high blood pressure. It has further been shown to decrease cortisol levels in the body (Banasik, Williams, Haberman, Blank, & Bendel, 2011; Bowden, Gaudry, An, & Gruzelier, 2012; Monnazzi, Leri, Guizzardi, Mattioli, & Patacchioli, 2002).

Both parents and teachers have an urgent need for specific advice on how to cope with and help the child with specific attention and working memory deficits at school or in daily life. Up till now, clinicians provided such advices based on their theoretical and clinical experience, without a standardized method or practical guide to use. With the study we hope to gain insight in the short and long-term effects of the yogic intervention on executive function , neuropsychological functioning, academic performance, behaviour in class, behaviour problems and functioning in everyday life. This way we can offer health care professionals, teachers and other educational staff members a more standardized and evidenced based guideline in how to approach and treat children with EF disorders. ***(Marthe LA van der Donk, Anne-Claire Hiemstra-Beernink, Ariane C Tjeenk-Kalff, Aryan V van der Leij and Ramón JL Lindauer, 2013)***

Meditation is, after all an active form of brain training. "A lot of people have this idea that meditation means sitting down and doing nothing," says Goyal. "But that's not true. Meditation is an active training of the mind to increase awareness, and different meditation programs approach this in different ways." A review study last year at Johns Hopkins looked at the relationship between mindfulness meditation and its ability to reduce symptoms of depression, anxiety, and pain. Researcher Madhav Goyal and his team found that the effect size of meditation was moderate, at 0.3. If this sounds low, keep in mind that the effect size for antidepressants is also 0.3, which makes the effect of meditation sound pretty good.

Godse AS, Shejwal BR, Godse AA. Effects of suryanamaskar on relaxation among college students with high stress in Pune, India. Int J Yoga 2015;8:15-21. This study will have implications in terms of use of suryanamaskar as a relaxation strategy for high stress college students and to reduce stress at a dispositional level. With a regular practice of Surya Namaskar and meditation, the solar plexus increases from the size of an almond to the size of a palm. This expansion of solar plexus, also known as the second brain, develops our intuitive ability and makes us more clear and focused. You will thus see that the Namaskars possess the unique feature of co-ordinated actions of all the vital organs, nerves, muscles and other parts of the system, which are stimulated, developed and strengthened simultaneously, a result not achieved by any other single exercise. ***(Alice .Walton , CONTRIBUTOR, I cover health, medicine, psychology and neuroscience, 2015).***

So what should parents and teachers do with this new information?

1) Identify a) the student's specific learning problems (e.g. written expression or math) and b) their executive function deficits (e.g. working memory, disorganization, forgetfulness, or impaired sense of time) with the help of BRIEF questionnaire and **2) provide yogic intervention with counseling** in both areas!

"Succeeding in school is one of the most therapeutic things
that can happen to a child!
So do whatever it takes to help the child succeed in school."

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