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# EFFECTIVENESS OF SMART BRAIN EXERCISE AND LOVING TOUCH THERAPY ON BEHAVIOR AMONG CHILDREN WITH ATTENTION DEFICIT HYPERACTIVE DISORDER (ADHD)

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**Abstract**

**Background**. The prevalence of ADHD in the world is estimated to be 3 - 10% among school-age children, and the number tends to increase annually. The number of ADHD in Indonesia is around 16.3% (3.5 million) of the total population. A comprehensive and integrative measure in addressing ADHD is needed, as well as education and communication.

**Objective.** This study aimed to determine the effectiveness of Smart Brain Exercise (SBE) and Loving Touch Therapy (LTT), as well as the combination of both (LTT & SBE) on behavior changes among children with ADHD.

**Methods**. This study was a true experimental study with pre-test and post-test design. A total of 35 respondents were randomly selected based on class allocation, divided into four groups, including a control group. Behavior changes were assessed before and after intervention with the SNAP IV ADHD Score checklist; then, the data were analyzed using the Wilcoxon Test.

**Results**: The results of this study indicated that the intervention of SBE, LTT and the combination of both had a significant effect on improving ADHD behavior when compared to the control group. The combination of SBE and LTT intervention showed different effects on attentiveness behavior (p-value = 0.01).

**Conclusion**: It can be concluded that the SBE and LTT interventions are effective in changing the behavior of children with ADHD.

**Keywords**: loving touch therapy; smart brain exercise; ADHD; behavior
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## 1. INTRODUCTION

Attention Deficit and Hyperactivity Disorder (ADHD) is a heterogeneous behavioral disorder (Britto et al., 2018; Mbuya & Humphrey, 2016). ADHD is characterized by attention deficit, hyperactive, and impulsive disorders. This disorder can cause academic, social and emotional problems (Halperin & Healey, 2011). In general, children who have ADHD have high motor activity compared to their age, have difficulties to follow instructions in sequence, and they are easy to forget (Miller, Iosif, Young, Hill, & Ozonoff, 2018; Vibholm et al., 2018).

The IV Diagnostic and Statistical Manual of Mental Disorder (DSM) states that the prevalence of ADHD in school-age children is around 3% -5% (Judarwanto in Dewi et al., 2011). According to the Centers for Disease Control and Prevention (CDC), the number of ADHD children in the United States increased from 7.8% (2003) to 9.5% (2007). In 2013, as many as 6.4 million 11% of children aged 4 to 17 had ADHD. Bradley and Golden said that ADHD is the most common psychological problem recently, around 3-10% occurred in the United States, 3-7% in Germany, 5-10% in Canada and New Zealand. In Indonesia, based on data from the National Statistics Agency (BPSN), the prevalence of ADHD at school age is 3-5%. A survey from Saputro (2009) stated that the incidence of ADHD in the primary school children population was 16.3% (3.5 million) of the total population of 25.85 million children. Based on this number, 30% - 80% of the diagnosis remains until adolescence, and 65% until adulthood.

ADHD children generally experience learning disorders that can lead to behavioral and social disorders during adolescence and adulthood (Shaw et al., 2012; Kevill, 2012); failure to socialize could foster negative self-concept in children with ADHD. Besides, high activity levels can put them at risk for trauma. Proper treatment and therapy are needed to avoid the further impact of AHDH on educational, social and career development (E. J. Sonuga-Barke, Koerting, Smith, McCann, & Thompson, 2011).

Management of ADHD generally uses pharmacological therapy as primary therapy. However, this therapy is not recommended as a single therapy since, in the long term, it can lead to addiction and even drug dependence until adulthood (Martin GL, 2008). Therefore, a multidisciplinary approach is needed to get optimal results in the long term (Martin, 2008), one of which is a complementary therapy.

Touch therapy is one of the types of complementary therapy that could be used as a management strategy for children with ADHD (Fleeson et al., 2017; Richardson et al., 2015). The others are Brain Exercise (Benor, 2006; Sutini, 2018; Cortese, 2013)-to increase levels of serotonin and dopamine, which are brain neurotransmitters (Fleeson et al., 2017; Richardson et al., 2015; Sarsina, Vannacci, Costa, & Meuti,

2010).

Touch therapy for ADHD triggers an increase in neurotransmitters associated with impulsive, aggressive behavior and difficulty concentrating (S.-C. Chen et al., 2019). Research by Tiffany Field (2014) from the Touch Research Institute on massage therapy showed significant changes in behavior among children with ADHD (Field, 2014; Goldstein, 2017; S. C. Chen et al., 2019). Meanwhile, Brain Exercise is a movement combining balance, coordination, eye and sensory exercises that specifically involve the function of the cerebellum. Each program provides a series of exercises to develop the brain and facilitate communication between the two sides of the brain (Sarsina et al., 2010); Sutini, 2018). Those can improve concentration and focus, memory, academic ability, relationships, self-responsibility, organizational skills and behavior in children with ADHD (in Sarsina et al., 2010; A & Sutini, 2018; Cortese, 2013b).

Loving Touch Therapy (LTT) and Smart Brain Exercise (SBE) are part of a newly developed supporting therapy for ADHD children. LTT provides touch therapy or massage, which is adopted from the Nurturing Touch movement from Liddle Kidz by Tina Allen, that is modified by using touch or massage movements made with a softer and more comfortable love movement model. Meanwhile, the Smart Brain Exercise (SBE) is a brain exercise movement adopted by Denninson that is combined with breathing exercises and praying on a relaxed hook movement to be more concentrated and more focused. However, based on a preliminary survey, almost all special schools in Blora Regency only apply education and communication therapy, have not used LTT and SBE as supporting therapy for ADHD. This condition motivates researchers to research the effectiveness of Loving Touch Therapy (LTT) and Smart Brain Exercise (SBE) and their combination (LTT & SBE) on behavior change in children with ADHD.

This study aims to determine the effectiveness of Loving Touch Therapy (LTT) and Smart Brain Exercise (SBE) on behavioral changes in ADHD children.

## 2. METHOD

### Design

This research was an experimental research with a true-experimental method with pre-test and post-test, and control group design. This study tried to determine the effectiveness of LTT and SBE and LTT & SBE in ADHD children compared to the control group who only received educational and communication therapy.

### Participants

The research respondents were divided into four groups. They were randomly selected based on their class/grade through cluster random sampling technique. The first group received the Loving Touch Therapy (LTT) treatment; the second group received the Smart Brain Exercise (SBE) treatment; the third group received modified Loving Touch Therapy treatment and Smart Brain Exercise (LTT & SBE); and, the fourth group, as the control group, received education and communication therapy. Their behavior was measured using the ADHD Score checklist.

A total of 119 ADHD children aged 6-18 years were the target population in this study. Meanwhile, the affordable population in this study involved all 119 students enrolled in the Special Elementary School in Blora Regency in the 2019/2020 school year. Furthermore, a total of 40 children met the criteria as respondents in the study with the following inclusion criteria: Children with ADHD behavior disorders, aged 6-18 years, were actively registered as elementary school students in special schools for the 2019/2020 school year, the child was not suffering from upper tract infection or other infections, the child adheres to the prescribed diet, the child was not taking drug therapy. While the exclusion criteria in this study were ADHD children accompanied by other developmental behavior disorders, ADHD children who were not cooperative, parents/children were not willing to be the subject, children were sick. They dropped out during the study implementation time.

After one week of conducting the research, several respondents experienced drop out due to illness and circumcision. One respondent refused to continue the research process. In the control group, two respondents dropped out due to illness (1 in the first week, 1 in the second week). In the SBE group, one left in the first week. In the LTT, one respondent dropped out in the second week. Then in the combination group, one respondent dropped out in the first week due to illness. The total number of respondents who took part in the final research process was 35 respondents.

To get the desired sample or according to the inclusion and exclusion characteristics, the sample selection used a purposive sampling technique. Furthermore, the member of each group was determined using random cluster sampling based on the grade of school. This technique was conducted since the condition and character of the child who was not to give different treatments in one grade (class). It would be very difficult for the researcher (enumerator) to carry out the research. Besides, the field enumerators chosen were the accompanying teachers in each class or cluster.

### Settings

This research was conducted at special schools in Blora Regency, and data collection began from July to December 2019. The time required for the treatment of the intervention group as follows: collected data before treatment through pre-test at the beginning of the first week, implemented treatment for 4 weeks, and collected post-test data after the end of week 4.

### Data collection process

The data collection tools were: a Questionnaire to assess the characteristics of respondents; Swanson, Nolan, and Pelham-IV (SNAP IV) Rating Scale for ADHD assessment; the enumerators consist of 10 teachers/therapists at the Extraordinary Elementary School in Blora Regency. They assisted researchers when conducting research/intervention; assisted in data collection and retrieval; assisted in assessing behavior development using the SNAP IV Rating Scale ADHD instrument.

### Data Collection Procedures

#### Preparation

The preparation of data collection consisted of: managed the research permit to the related department in the Regency and provided an informed consent form to be signed by the parents of the subjects if the parents were willing to participate in the study.

#### Implementation

Implementation process followed this steps: introduced and explained the research to the subjects and their parents; determined the number of subjects with inclusion and exclusion criteria; then, the researcher randomized using computer media in the Excel program so that 40 subjects were selected which were divided into four groups, each group consisted of 10 subjects, group 1 was given loving touch therapy, group 2 was given Smart Brain Exercises, and group 3 were given modified loving touch therapy, and

Smart Brain Exercises and group 4 was given education and communication; conducted research and provided treatment according to the type of group.

On the first day, the researcher conducted pre-test by assessing the behavior of all respondents by filling in the SNAP IV Rating Scale for ADHD instrument. The next step was preparing the respondent to a calm state.

In the treatment groups, researchers provided loving touch therapy, Smart Brain Exercises and Modifying loving touch therapy and Smart Brain Exercises according to the procedure. Treatment was given three times a week: on Monday, Wednesday and Friday at the beginning of the learning process or during the break time of the class. The duration of each treatment was 30 minutes, consisting of 5 minutes of preparation, 20 minutes of implementation, and 5 minutes of closing.

On the other hand, participants in the control group received routine activities, namely providing educational and communication therapy according to the lesson schedule at the Blora special school.

The post-test was carried out in week 4 to evaluate behavior development.

**Data analysis**

Descriptive statistics were used to analyze the number of each variable. Wilcoxon and Mann Withney were used to analyze the difference between touch therapy and Brain Exercise on behavior changes depending on the type of data.

## 3. RESULT AND DISCUSSION

**Respondent Characteristics**

Table 1. Characteristic of respondents (n=35)

| Subject characteristic | Control group (n=8) | Brain Exercise (n=9) | Touch therapy n= 9) | Brain +Touch (n= 9) | P value* |
|---|---|---|---|---|---|
| Age | 13,25 ± 2,91 | 12,78 ± 1,20 | 9,78 ± 3,23 | 8,89 ± 1,76 | 0,001 |
| Sex, n (%) | | | | | 1 |
| Male | 5 (62,5) | 6 (66,7) | 4 (44,4) | 5 (55,6) | |
| Female | 3 (37,5) | 3 (33,3) | 5 (55,6) | 4 (44,4) | |
| Genetic history, n (%) | | | | | 1 |
| No | 7 (87,5) | 9 (100) | 8 (88,9) | 8 (88,9) | |
| Yes | 1 (12,5) | 0 (0) | 1 (11,1) | 1 (11,1) | |
| Smoking in pregnancy, n (%) | | | | | 1 |
| No | 6 (75) | 7 (77,8) | 5 (55,6) | 6 (66,7) | |
| Yes | 2 (18,2) | 2 (18,2) | 4 (36,4) | 3 (27,3) | |
| Labour history, n (%) | | | | | 1 |
| No Forceps/spontaneous | 7 (87,5) | 9 (100) | 8 (88,9) | 8 (88,9) | |
| Forceps | 1 (12,5) | 0 | 1 (11,1) | 1 (11,1) | |
| Prematurity, n (%) | | | | | 1 |
| < 37 w | 3 (37,5) | 3 (33,3) | 3 (33,3) | 4 (44,4) | |
| ≥ 37 w | 5 (62,5) | 6 (66,7) | 6 (66,7) | 5 (55,6) | |
| Birth weight, n (%) | | | | | 1 |
| < 2500 gr | 3 (37,5) | 3 (33,3) | 3 (33,3) | 4 (44,4) | |
| ≥ 2500 gr | 5 (62,5) | 6 (66,7) | 6 (66,7) | 5 (55,6) | |
| Head traumatic history, n (%) | | | | | 0,99 |
| No | 7 (87,5) | 9 (100) | 7 (77,8) | 6 (66,7) | |
| Yes | 1 (12,5) | 0 (0) | 2 (18,2) | 3 (27,3) | |
| febrile convulsion history,n(%) | | | | | 1 |
| No | 8 (100) | 5 (55,6) | 6 (66,7) | 8 (88,9) | |
| Yes | 0 | 4 (44,4) | 3 (27,3) | 1 (11,1) | |
| Sugar Consumption, n (%) | | | | | 0,16 |
| <3 x/week | 1 (12,5) | 4 (44,4) | 6 (66,7) | 6 (66,7) | |
| ≥ 3 x/week | 7 (87,5) | 5 (55,6) | 3 (27,3) | 3 (27,3) | |

Table 1. shows that overall, the subjects in the study were not different in each group. The respondents in this study were mostly male; this indicates that children who experience ADHD are primarily boys.

**The Differences in the behavior of ADHD children before and after treatments compared to the control group**

**Table 2.** Differences in ADHD behavior before and after giving Loving Touch Therapy (LTT), Smart Brain Exercise (SBE) and Combination of Loving Touch Therapy and Smart Brain Exercise (n = 35)

| Variables | Control Group | | | | SBE | | | | LTT | | | | SBE + LTT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | Pre | Post | nilai p* | n | Pre | Post | nilai p* | n | Pre | Post | nilai p* | n | Pre | Post | nilai p* |
| Attention | 8 | 16,5 | 16 | 0,1 | 9 | 24 | 21 | 0,007 | 9 | 19 | 17 | 0,007 | 9 | 23 | 19 | 0,007 |
| Hyperactivity | 8 | 12 | 11 | 0,08 | 9 | 14 | 12 | 0,007 | 9 | 11 | 9 | 0,006 | 9 | 15 | 12 | 0,006 |
| Impulsivity | 8 | 5,5 | 5 | 0,84 | 9 | 6 | 3 | 0,011 | 9 | 6 | 3 | 0,007 | 9 | 6 | 3 | 0,007 |
| * wilcoxon | | | | | | | | | | | | | | | | |

Table 2. presents that the average difference in decreasing inattention, hyperactivity and impulsive behavior was significant in the intervention group with the provision of Loving Touch Therapy, Smart Brain Exercise and Combination of Loving Touch Therapy and Smart Brain Exercise with a P-value <0.05. However, there was no difference in behavior in the control group where P-value ≥ 0.05.

**Table 3.** Changes in ADHD behavior after giving Loving Touch Therapy, Smart Brain Exercise and a combination of Loving Touch Therapy and Smart Brain Exercise (n = 35)

| | Control Group | | SBE | | LTT | | SBE+LTT | | nilai p* |
|---|---|---|---|---|---|---|---|---|---|
| | n | Median | n | Median | n | Median | n | Median | |
| Attention | 8 | 0 | 9 | 3 | 9 | 2 | 9 | 4 | 0,01 |
| Hyperactivity | 8 | 1 | 9 | 3 | 9 | 3 | 9 | 3 | 0,04 |
| Impulsivity | 8 | 0 | 9 | 3 | 9 | 3 | 9 | 3 | <0,001 |
| * Kruskal Walis | | | | | | | | | |

Table 3 indicates that there were significant differences in behavior change compared to all groups, but changes were more prevalent in the combined group between Brain Exercise and touch therapy where the p-value of attentional, hyperactive and impulsive were 0.01, 0.04, and 0.001, respectively (α <0.05).

**Table 4.** Effectiveness LTT, SBE and Combination of LTT and BRE on Behavior Change among Children with ADHD

| Children*Group* | *p-value** | | |
|---|---|---|---|
| | *Attention* | *Activity* | *Impulsivity* |
| Control group– Smart Brain Exercise (SBE) | 0,002 | 0,028 | 0,001 |
| Control group – Loving Touch Therapy (LTT) | 0,007 | 0,005 | <0,001 |
| Control group – SBE + LTT | 0,001 | 0,001 | <0,001 |
| SBE - LTT | 0,142 | 0,712 | 0,961 |
| SBE – SBE +LTT | 0,609 | 0,198 | 0,142 |
| LTT – SBE + LTT | 0,043 | 0,252 | 0,059 |
| *Mann Whitney | | | |

Table 4 shows that the treatments had a significant effect in improving ADHD behavior when compared to children who were only received educational and communication therapy (in the control group).

## DISCUSSION

**The Differences of the behavior of children with ADHD before and after treatments compared to the control group**

The results showed that, in the treatments group, there were significant differences in behavior, including the attention, hyperactivity. There were significant differences in behavior changes compared to all groups, but changes were more common in the combined Brain Exercise and touch therapy group.

ADHD is classified into disorders of concentration (inattention), hyperactivity and impulsivity-lack of behavioral control. DSM-V criteria confirmed the current diagnosis. Patients with ADHD exhibit persistent symptoms of neglect and/or hyperactivity and impulsivity that can affect functional and behavioral development. The commonly used and frequently used SNAP-IV scale is a revision of the SNAP Questionnaire.

In this study, the assessment of ADHD is a derivative of the signs and symptoms on the DSM-IV, consists of 18 items, and consists of 4 levels on a 0-3-point scale. The entire range of ADHD development is filled by the child's parents and teachers (Swanson et al., 2002). The classification level of behavior change in ADHD children is according to the concept of Swanson et al. (2006). In this study, teachers assessed the behavior of children. Meanwhile, parents did not assess the children response because the level of knowledge and awareness of parents was still low about the condition of child development. Moreover, based on interviews with parents, they only left it to the school completely.

There were significant differences in the intervention group as a whole, namely Loving touch therapy intervention, Smart Brain Exercise and a combination of both. This study shows that children with ADHD were not given enough education and communication. Still, they need an easy and straightforward non-pharmacological intervention that can be done by teachers and parents, namely Loving touch therapy, Smart Brain Exercises and a combination of Loving Touch Therapy and Smart Brain Exercise.

**Behavior differences before and after being given the Smart Brain Exercise intervention**

The results showed that there was a significant difference in giving Brain Exercise intervention for 30 minutes before or at rest time three times a week within four weeks. These findings support previous research that the Brain Exercise is effective in reducing hyperactive behavior in pre-school children with ADHD (p-value = 0.007) (A & Sutini, 2018). Brain Exercise affects hyperactive behavior, too (Harini, 2010). Behavior includes attention (attention), activity, and impulsivity. The movements of brain exercise based on the principle of the cross the midline movement is affecting behavior and emotional control of ADHD children.

In this study, behavioral changes in attention after being given Smart Brain Exercise intervention were supported by Taylor's (2010) study that Brain Exercise training increased academy achievement in fifth-grade children. Although the research did not focus on children with ADHD, an increase in scores in mathematics showed that brain exercise improved focus attention. Brain exercise can stimulate the hippocampus so that it affects the short-term memory abilities of people with mild mental retardation Gea (2016). Brain exercise can improve the short-term memory of people with mild mental retardation at SDLB-C Dharma Asih Pontianak.

Although there is no specific study focused on the effect of the Brain Exercise on impulsive behavior change, experts conclude that movements in brain exercise that are based on the cross the midline movements affect controlling behavior and emotions in ADHD children. It balances the child's brain: calming the mind, more cooperative, improving the ability of the brain, improving concentration, increasing coordination of motor movements, and controlling impulses (Ahmad, 2004 in Sarsina et al., 2010). Physical exercise such as Brain Exercise movement can reduce emotional behaviour and neuropsychological damage in ADHD children including hyperactive and impulsive behavior (Cortese, 2013)

Based on the brain system, it is hoped that the Brain Exercise can connect the right and left brain so that they can work integrally. Brain Exercise useful as control over aggressive, impulsive, and difficult to concentrate behavior (Dennison & Dennison, 2002). Brain Exercise balances every part of the brain and unblocks blockages in the brain. There are three dimensions of the brain that can be developed, namely the alterity dimension for the right and left hemispheres, the focusing dimension on the back of the front of the brain and the concentration dimension that balances the front and back

positions (limbic system) and the cerebrum (Dennison & Dennison, 2002).

Brain Exercise can open parts of the brain that are closed or blocked. When the nerves of the brain open and develop, through specific movements, the work system of the body and mind of the individual will create a sense of pleasure and harmony. This situation will provide comfort for students to develop cognitive abilities and pave the way for students to utilize all their potential (Dennison & Dennison, 2002).

**Behavior differences before and after being given Loving Touch Therapy**

There was a significant difference in the provision of touch therapy intervention for 30 minutes (attentional behavior, p-value 0.007; hyperactive, p-value=0.006, and impulsive behavior, p-value=0, 007).

The results of this study are consistent with Maddigan et al. (2003), where ADHD children who received touch therapy for 15 minutes were able to control anger emotions and enjoy more and can sleep better. Touch therapy given to ADHD children aged 7-18 years for 20 minutes a week two times within a month can increase feelings of pleasure and relaxation as well as a comfortable mood and behaviour in the classroom (Khilnani, S. et al. 2003). This finding suggests that feelings of relaxing, increasing happy mood, decreasing anger, feeling calmer, and feeling more comfort are signs of decreased hyperactivity and impulsivity in children with ADHD.

Another form of touch therapy using the Qi - Gong technique was done by Raquel, Marta Correia, Custódio (2015). They conducted Explanatory Multiple - Case Study in adolescents and adults with ADHD who were given 10 minutes of Qi - gong exercise twice a week for three months. Their study indicates that Qi Gong technique increases attention and concentration as well as the activity of the parasympathetic nerve becomes regular.

**Differences in behavior before and after given a combination of Brain Exercise and Touch Therapy**

The results showed that there was a significant difference in the combination of Loving Touch Therapy and Smart Brain Exercise interventions given together for 30 minutes before or at rest time, three times a week within four weeks (p values of attentional behaviour, hyperactive, and impulsive were 0.007, 0.006), and 0, 007 respectively). Further analysis using Kruskal Walis showed there were significant differences in behaviour changes compared to all groups. However, the more significant changes were in the combination group between Loving touch therapy and Smart Brain Exercise. It means that Loving touch therapy and Smart Brain Exercises are done together are effective in influencing behavior change in children with ADHD.

In the previous study, touch therapy indicates an effective way to reduce motor activity, regulate parasympathetic nerve regulation, relax, improve mood, and improve the feelings of calm and pleasure. These conditions are more likely to be associated with signs of hyperactive and impulsive behavior. Although research from Raquel, Marta Correia, Custódio (2015) shows that with exercise Qi-Gong attentions for ADHD children are increasing, Qi-Gong exercise must be done by a certified therapist because it is more challenging to be implemented.

Touch produced more improvement in ADHD symptoms in terms of effective rate compared to Ritalin (risk ratio: 1.39, 95 % CI: 1.16 - 1.66; P = 0.0004) (Chen, SC, et al. 2019). Individual RCTs suggested that touch was differed significantly from waitlist control in improving the conditions of anxious – passive (mean difference: −11.7; 95% CI [−17.84, −5.56]; P = 0.0002), and asocial behavior (mean difference = - 8.60; 95% CI [−15.87, −1.33]; P = 0.02).

**Effectiveness LTT, SBE and Combination of LTT and SBE on Behavior Change among Children with ADHD**

Overall, compared to the control group, the intervention of Loving Touch Therapy and Smart Brain Exercise provided significant effect in improving ADHD behavior; regardless they were given Brain Exercise and touched therapy separately or in combination. However, Brain Exercise that was given together with touch therapy had a more significant effect on attention behavior (p-value = 0.043).

The results of this study indicate that ADHD children do not only need medical therapy and education or communication but need non-pharmacological action to increase serotonin and dopamine levels in children with ADHD with touch therapy and brain exercise (Fleeson et al. 2017; Richardson et al., 2015; Sarsina, Vannacci, Costa, & Meuti, 2010). This therapy can stimulate serotonin and dopamine levels which are associated with impulsive, aggressive behaviour and difficulty concentrating (S.-C. Chen et al., 2019). The increase in this neurotransmitter will optimize the delivery of impulsive and information to and from brain neurons and the nervous system so that the child's learning process is more effective, more concentrated and calmer (Richardson et al., 2015; Field, 2019; S. C. Chen et al., 2019). Massage therapy can reduce impulsivity in children with ADHD (Field, 2014).

Brain Exercise can balance the right and left brain and help the rest brain development. The Brain Exercise movement combines balance, coordination, eye and sensory exercises that specifically engage the cerebellum. Each program provides a series of exercises to develop the brain and facilitates communication between the two sides of the brain through exercise (in Sarsina et al., 2010; A & Sutini, 2018). Brain exercise can improve concentration and focus, memory, academic ability, relationships, self-responsibility, organizational skills and behavior in children with ADHD (in Sarsina et al., 2010; A & Sutini, 2018; Cortese, 2013).

Research conducted by Setiadi and Swastika (2015) found that brain exercise has a significant effect on concentration in children with autism. According to Yanuarita (2012), brain exercise is used for children who experience hyperactivity disorders, brain damage, difficulty concentrating and depression. Brain exercise will make the brain work actively. People who use their brain routinely to think will be healthier overall than people who do not. An active organ would require a supply of oxygen and protein. If the supply is smooth, the organ will be healthy.

Brain exercise is an integrative movement that optimizes the work of the brain and balance of the right and left brain so that the emotions and behavior of ADHD children become more stable and controlled. Brain exercise affects behavioral changes in ADHD children by activating the right and left hemisphere bridges, stimulating the flow of information in the brain and nervous system so that the coordination of the right and the left brain becomes effective and efficient.

Based on the brain system, it is hoped that the Brain Exercise can connect the right and left brain so that they can work integrally. Brain Exercise movements can activate the neurotransmitters in it which function as control over aggressive, impulsive, and difficult to concentrate behavior (Dennison & Dennison, 2002; Sarsina et al., 2010; A & Sutini, 2018); Cortese, 2013).

To solve the brain problem in children (e.g.lack of concentration), the three dimensions in the child's brain must be stimulated so that they can run well. Communication, understanding and organizational functions are honed through the Brain Exercise. This method can compensate for the usual stimulus given to the child's brain. The brain will not only calm, but it also more cooperative, more concentrate,

more coordinated, and can control impulses well (Ahmad, 2004; Sarsina et al., 2010; A & Sutini, 2018; Cortese, 2013).

Brain Exercise is used to improve concentration and focus, memory, academic abilities, relationships, self-responsibility, organizational skills and behaviour (A & Sutini, 2018).

Harini (2010) also states that the Brain Exercise can increase the attention span of children with ADHD. The movements in the Brain Exercise that are based on the cross the midline movement affect controlling the behaviour of the Brain Exercise movement, stimulating neurotransmitters in the brain to regulate emotional balance.

Brain stimulation using brain exercise will change the structure of the brain drastically; improve the relationship between neurons, increase the blood capillaries that supply blood and oxygen to the brain. Eventually, it could improve memory function. Brain stimulation can also improve the performance of the hippocampus and unify motor and cognitive areas in the brain which can increase the production of neurotrophins which can increase the number of connections in the brain nerves (Brwon & Jean, 2013).

Stimulation accompanied by physical activity can increase the neurogenesis of cells in the dentate gyrus of the hippocampus, as well as improve the performance of the hippocampus in the learning process. One of the interventions that can be done is to do physical activity movements, such as Brain Exercise. The movement that causes the functions of the left and right hemispheres to work together will strengthen the relationship between the two hemispheres. Movements across the midline of the body can integrate the two hemispheres of the brain so that the brain is able to organize itself. This is possible because this activity will unify the motor and cognitive areas of the brain, namely the cerebellum, basal ganglia, and corpus callosum which in turn can stimulate the production of neurotrophins which can increase the number of synaptic connections and can also increase neurotransmitters.

The increase in neurotransmitters stimulates an increase in the secretion of dopamine, serotonin, norepinephrine, and glutamate which can cause the transfer and processing of impulses in the brain to be faster and better so that information can be transmitted, processed and stored in the brain properly. Using a Brain Exercise movement will help your ADHD child reduce hyperactivity, impulsivity and aggression.

Loving Touch Therapy is a form of therapy using gentle, systematic touch, which is focused on a specific part of the body or the whole, with the aim of healing and relaxation. Touch therapy is a form of treatment using a systematic gentle touch, which is focused on a specific part of the body or the whole, with the aim of healing and relaxation.

Massage therapy produces pressure on specific areas of the body which then results in reflex stimulation of the nervous system so as to form the ability to optimize the performance of body organs (Rianto & Sujono, 2005). Guyton (1997) states that stimulation of the surface nerve endings of the skin (mechanoreceptor nerves) will result in the permeability of the cell membrane thinning so that it will facilitate the exchange of sodium and potassium ions which will stimulate the action potential of nerves. This nerve action potential will stimulate the release of neurotransmitters at the presynaptic nerve axon ends. Neurotransmitters released due to potential neuronal action include serotonin and dopamine, which are linked to neurochemical-causing ADHD. Through touch therapy and Brain Exercise movements for ADHD, serotonin and dopamine levels in the brain increase in people with ADHD, so that it can optimize the associated brain function, namely by maximizing the transmission of impulses to and from brain neurons (Banerjee & Nandagopal, 2015; Fontana et al. 2019).

Dopamine has different roles in pathways in the brain, including in the frontal area (frontal cortex) to regulate the flow of information (in the form of impulses) coming from different regions of the brain. Impulses controlled and processed in this part consist of sensory and motor impulses (Schmaus, 1998). Motor impulses that enter the frontal area of the brain are processed in the primary motor cortex, which plays an important role in the formation and control of body movements (Anonymous, 2006). Increasing dopamine levels through massage therapy in people with ADHD can improve the primary motor cortex function in behaviour control so that symptoms of hyperactivity can be reduced. (Volkow et al., 2007; Tsuji et al., 2015; Field, 2019; Khilnani et al., 2003).

The frontal area of the brain that plays a role in processing sensory impulses is the pre-frontal cortex, so this cortex plays a role in memory formation, intelligence, and optimizes pre-frontal cortex function, including its role in maintaining attention (Aoki et al., 2017).

Serotonin is a neurotransmitter, will optimize the function of the limbic system, especially the amygdala, which plays a role in emotional responses. Serotonin at low levels can lead to impulsive and aggressive behavior (Deborah, 1995). An increase in serotonin levels in the brain through massage therapy will optimize the function of the amygdala, which creates a positive emotional response so that anxiety and impulsiveness will be reduced (in Sarsina et al., 2010; E. J. S. Sonuga-Barke & Fairchild, 2012).

According to our research findings, it could be concluded that loving touch therapy and Smart Brain Exercise are effective in improving the behaviour of children with ADHD. It could increase focus, reducing hyperactivity and impulsivity. However, this intervention will be more effective by combining loving touch therapy and smart Brain Exercise.

Nevertheless, there were limitations to this study. They were The sampling process and the time shortage of giving intervention. In terms of randomization per class, it probably caused bias in filling data because the enumerators are the teachers in the class. Besides, the implementation time should be longer because many studies take one to three months to see the long-term effect.

## 4. CONCLUSION AND SUGGESTION

Loving Touch Therapy (LTT), Smart Brain Exercise (SBE), and the combination of LTT and SBE have significant effects on behavior changes among children with ADHD. Health provider and educator should include those treatments to overcome ADHD problem as a complementary therapy supporting other therapies. Further researches with larger participants and longer time of treatment as well as with specific biomarkers such as serotonin and dopamine should be taken to gain better data.

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