

*Chapter VIII*

---

## **Effect of Mind/Body Training on Children with Behavioral and Learning Problems: A Randomized Controlled Study**

---

*Agnes S. Chan<sup>1\*</sup>, Mei-chun Cheung<sup>2</sup> and Sophia L. Sze<sup>1</sup>*

<sup>1</sup>Centre for Neurocognitive Function Enhancement, Neuropsychology Laboratory,  
Department of Psychology, The Chinese University of Hong Kong, Hong Kong SAR

<sup>2</sup>Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Hong Kong  
SAR

### **Abstract**

**Objective:** To evaluate the effect of mind/body training on low-achieving children with behavioral problems and poor academic performance.

**Method:** Sixty children, of whom twenty-eight were low-achievers, were randomly assigned to the experimental (i.e., mind/body training) and control groups (i.e., tutorial class). For each group, a total of forty 30-minute sessions were conducted after formal school curriculum. The children's behavioral and emotional problems, academic performance, and cognitive functioning were measured before and after the program. Behavioral and emotional problems were evaluated by the school teachers who were blinded to the experimental design with Chinese version of the Teacher's Report Form (TRF) of the Child Behavior Checklist (CBCL). Students' academic performance was measured by their grade point averages, and their cognitive functioning was assessed with some neuropsychological tests.

---

\* Correspondence to: Agnes S. Chan, Ph.D., Department of Psychology, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong SAR, Phone: (852) 2609-6654, Fax: (852) 2603-5019; E-mail: aschan@psy.cuhk.edu.hk

**Results:** Children in the experimental group showed significant reduction in some behavioral problems including withdrawn behaviors, somatic complaints and attention problems, and improvement on cognitive functioning including learning and memory. Regarding the academic performance, while the maximum improvement of grade point average for the low-achieving children in the tutorial group was 2.87, 42% of the low-achieving children in the experimental group showed improvement above this level. This distribution was statistically significant.

**Conclusions:** The present results support the notion that mind/body training is an effective intervention for children, particularly with behavioral problems and poor academic performance.

**Key words:** mind-body exercise, children, behavioral and learning problems

## Introduction

Mind-body exercise is a specific type of exercise characterized with continuous gentle rhythmic movements. A unique characteristic of mind-body exercise, as compared with aerobic exercise, is that it emphasizes the conscious control of each bodily movement. Unlike aerobic exercise which usually results in an increase in heart rate and blood circulation, mind-body exercise emphasizes on training self-awareness and concentration with a relaxed mind. The movements involved in mind-body exercise tend to be gentle and slow so that the individual can concentrate and pay attention to every movement in order to increase self-awareness and achieve integration of the mind and the body. Moreover, individuals who practice mind-body exercise are requested to maintain a peaceful and relaxed state of mind. Mind-body exercise is a common practice used in ancient China to improve both physical and mental health, and Tai Chi exercise is probably the best known type of mind-body exercise. Although mind-body exercise is originated from the East, some methods such as the Pilates method and the Alexander technique have also been developed in the West in the past century. At present, there may be over 20 different types of mind-body exercise but the principles behind them are very similar. They all emphasize the connection among and integration of emotions, thoughts, behaviors, and physical function. Based upon the understanding that as motor function and psychological well-being is strongly related, training psychological (mind) and neuromuscular (body) systems will achieve the goals of enhancing mental and physical health.

There has been increasing interest during recent years in the therapeutic effect of mind-body exercise in clinical and normal population (see Klein & Adams, 2004 for review). In the clinical practice, an increasing number of empirical studies have reported positive effect of mind/body training on various mental and physical problems, such as depression (Nakao et al., 2001; Tsang, Cheung, & Lak, 2002), anxiety (Deckro et al., 2002), obsessive-compulsive disorder (Nakao et al., 2001; Schwartz & Begley, 2002), insomnia (Jacobs, Benson, & Friedman, 1993), chronic pain (Caudill, Schnable, Zuttermeister, Benson, & Friedman, 1991), hypertension (Benson, Rosner, Marzetta, & Klemchuk, 1974), and cardiac diseases

(Leserman, Stuart, Mamish, & Benson, 1989). Apart from encouraging effect on mental (see review, Jacobs, 2001; Mandle, Jacobs, Arcari, & Domar, 1996) and physical health (Lai, Lan, & Wong, Teng, 1995; Lan, Chen, Lai, & Wong, 1999; Yeh et al., 2004; Young, Lawrence, Jee, & Miller, 1999), some empirical data have also suggested that mind-body exercise has a positive influence on emotional and psychological problems in normal population (Chou et al., 2004; Jin, 1989; Jin, 1992; Li, Duncan, & Duncan, 2001; Li, McAuley, Harmer, Duncan, & Chaumeton, 2001; Sandlund & Norlander, 2000; Wang, Taylor, Pearl, & Chang, 2004). For instance, Brown and his colleagues (1995) conducted several randomized controlled experiments to compare the effect of aerobic and mind-body exercises on psychological problems. The results showed that women who did mind-body exercise (i.e., Tai Chi) showed significantly reduced anger and total mood disturbance, as compared with those who did aerobic exercises. Another experiment examined the effect of mind-body exercise (i.e., Tai Chi) on depressive symptoms of older adults. The results showed that after three-month intervention, the elderly had significant reduction in several categories of depressive symptoms, including somatic and psychological ones (Chou et al., 2004). Similar effect was also observed on college students who reported higher mental health scores (Wang et al., 2004) and reduced nightmares (Slater & Hunt, 1997) after practicing Tai Chi for a short period of time. In addition to having positive effect on psychological problems, a recent study further suggested that mind-body exercise may also be beneficial to cognitive function (Chan et al., 2005) in older adults. Specifically, older adults who practiced mind-body exercise regularly demonstrated better memory performance than those who did not.

Whereas the effect of mind-body exercise has been studied for over a decade, these studies are limited to adult and elderly population. The influence of mind-body exercise, that involves two components of relaxation responses and physical exercise, on the psychological and cognitive functions of children is relatively less understood. Nevertheless, some studies have been carried out to explore the effect of relaxation training alone on the psychological and cognitive functions of children and their results are so far very positive. By engaging in relaxation training, children are found to have enhanced self-concept (Carter & Russell 1985; Omizo, 1980), reduced general anxiety and test anxiety (Little & Jackson, 1974; Rossman & Kahnweller, 1977; Thompson, Griebstein, & Kuhlenschmidt, 1980) and stabilized off-task behavior (Klein & Deffenbacher, 1977). In addition, improvement in reading, spelling and Mathematics achievement is also observed in children (Carter & Russell, 1984). In a relatively more recent study, the results have showed that a relaxation response-based curriculum has significant positive impact on the self-esteem of a group of high-school students (Benson et al., 1994). Another study has also demonstrated that relaxation training improved the grade, work habits, and co-operation of a group of middle-school students (Benson et al., 2000), and an autogenic relaxation training is found to show some positive effect in reducing the behavioral and emotional problems of children and adolescents (Goldbeck & Schmid, 2003). Therefore, it is generally agreed that relaxation training is beneficial to children and can improve psychological and cognitive functions.

Physical exercise is another important component in mind-body exercise and has shown to demonstrate similar positive effect as relaxation training on the psychological and cognitive functions. Specifically, by facilitating the release of brain-derived neurotrophic factor (BDNF) in the brain, physical exercise is known to enhance brain health and plasticity

by promoting neurogenesis, protecting the cerebral cortex from ischemic damage and enhancing long-term potentiation which in turn facilitates learning and memory (Cotman & Berchtold, 2002; Hollmann & Struder, 2000). Studies on the elderly individuals indicate that physical exercise is one of the most protective factors to preserve cognitive function or to reduce cognitive decline during aging. In addition, elderly individuals with regular engagement in physical exercise have better information processing (Clarkson-Smith & Hartley, 1989; Dik, Deeg, Visser, & Jonker, 2003; Hawkins, Kramer, & Capaldi, 1992; Etnier et al., 1999; Toole & Abourezk, 1989; Van Boxtel et al., 1997), working memory (Clarkson-Smith & Hartley, 1989; Dustman et al., 1984; James & Coyle, 1998; Kramer, Hahn, & McAuley, 2000), verbal memory (Berkman et al., 1993; Fabre, Chamari, Mucci, Masse-Biron, & Prefaut, 2002; Hill, Storandt, & Malley, 1993; Richards, Hardy, & Wadsworth, 2003; Stewart, Prince, & Mann, 2003), verbal fluency (Emery, Schein, Hauck, & MacIntyre, 1998), reasoning (Clarkson-Smith & Hartley, 1989), planning and organization (Hall, Smith, & Keele, 2001; Kramer et al., 1999) than those without. However, most of these existing findings have all along been based on studies of aerobic exercises and are limited to adult and elderly population. Some studies have been conducted to explore the positive effect of physical exercise on children, but these studies mainly focus on the psychological function of children, which includes improvement in self-esteem, self-concept (Alpert, Field, Goldstein, & Perry, 1990; MacMahon & Gross, 1987), internal locus of control (Labbe & Welsh, 1993), classroom behavior (Etscheidt & Ayllon, 1987; Evans, Evans, Schmid, & Pennypacker, 1985), creativity and divergent thinking (Tuckman & Hinkle, 1986). It is still unknown if physical exercise can facilitate cognitive function of children, as demonstrated in adult and elderly population.

At present, empirical studies have demonstrated that mind-body exercise has positive effect on the psychological and cognitive function in adults, and either relaxation training or physical exercise is beneficial to children. Having combined components of relaxation training and physical exercise, it is anticipated that mind-body exercise may show similar, if not greater, effect than relaxation training or physical exercise solely. However, up to our knowledge, no empirical study has been conducted to explore the effect of mind-body exercise on children. One of the major factors that hinders the application of mind-body exercise on children is probably due to the nature of the exercise, that is, the slow and gentle movement in the mind-body exercise is not very attractive to children. Therefore, in an attempt to introduce mind-body exercise to the young population, we have developed a 30-minute mind-body exercise program specifically suitable for children (Chan, 2005). To arouse their interest, colorful floor mattresses and cushions were used, and the mind-body exercise was performed with familiar music such as "London Bridge is falling down". The purpose of the present study was to evaluate the effectiveness of this mind-body program on a group of low-achieving (with relatively poor academic performance and some emotional and behavioral problems) primary school students. Since tutorial remediation is a common intervention to facilitate learning and to improve behaviors of the low-achieving students, the present study compared the mind-body exercise group with a tutorial group. Primary school students were randomly assigned into either the tutorial class or the mind-body training program, and their academic performance, psychological and cognitive functioning was compared. Given that previous studies have suggested encouraging effect of mind-body

exercise on mood and cognitive function in adults, it is anticipated that children in the mind-body group would show greater improvement in academic performance and cognitive function, and reduction in psychological problems, as compared with those in the tutorial group.

## Method

### Participants

Target participants were children with poor academic performance and behavioral problems. However, in order to avoid social stigma for participating in the project, participants' recruitment was open to all students in a primary school in Hong Kong. A public lecture was given to all parents to introduce the purpose and operation of the program. Parents were invited to complete and return a consent form to the research team if they agreed to have their children participating in the project. A total of 160 parents voluntarily signed up for their children. Eighty students were semi-randomly selected from this pool to participate, so as to ensure that the numbers of average achievers and low achievers were similar. Low-achieving children were those with grade point average at the lower half of the class, and/or have been identified by their class teachers as having behavioral or emotional problems. These 80 children were evenly assigned into the experimental (mind/body training) and control (tutorial class) groups.

During the entire program, a total of 8 children dropped out and 12 did not attend the class frequently (less than 50% attendance). The results of these 20 students were excluded from statistical analysis, resulting in a final total of 60 children (30 females, 30 males). They were aged between 6.83 and 10.58 years (mean = 8.82, SD = 1.21), and their level of education ranged from 2 to 5 years (mean = 3.43; SD = 1.17). Twenty-five (13 females, 12 males) of them were in the intervention program (experimental group) and the remaining 35 (17 females, 18 males) attended the tutorial class and served as the control group. As shown in Table 1, the experimental and control groups were matched in age ( $t(58) = 1.257, p > 0.05$ ), years of education ( $t(58) = 1.314, p > 0.05$ ), gender distribution ( $\chi^2(1) = 0.069, p > 0.05$ ), and estimated IQ as measured by the Test of Nonverbal Intelligence, 3<sup>rd</sup> edition (TONI-III; Brown, Sherbenou, & Johnson, 1997) ( $t(58) = 0.073, p > 0.05$ ). Among the 60 children, 28 were identified as low-achieving children as their academic performance was below the 50<sup>th</sup> percentile in their corresponding grade level and exhibited either emotional or behavioral problems at school. There were fourteen students in the experimental ( $n = 14$ ) and another fourteen in the control ( $n = 14$ ) groups.

**Table 1. Demographic Characteristics of Experimental and Control Groups**

Variables	Control Group (n = 35)	Experimental Group (n = 25)
	Mean (SD)	Mean (SD)
Age (years)	8.98 (1.24)	8.58 (1.16)
Education (years)	3.60 (1.19)	3.20 (1.12)
Gender (Male/Female)	18/17	12/13
Estimated IQ	100.11 (14.76)	100.36 (9.74)
Percentage of Attendance (%)	85.46 (11.93)	88.29 (10.89)

## Outcome Measures

### *(I) Academic Performance*

The academic performance of each child was evaluated by their grade point average (maximum: 100) at school at baseline ( $T_1$ ) and after ( $T_2$ ) the program. The grade point average was the mean final scores of various subjects including Chinese Language, English Language, Mathematics, Physical Education and Arts. Since the final scores of each subject was the average scores of different examinations over the semester, thus the grade point average could reflect the general academic performance of the children within the academic year.

### *(II) Measures of Behavioral and Emotional Problems*

The Chinese version of the Teacher's Report Form (TRF) of the Child Behavior Checklist (CBCL) (Achenbach, 1991; Leung et al., 2006) was used to assess the psychosocial functioning of the participants. The checklist consists of 113 items with three main scores, namely Total Problem, Internalizing and Externalizing scores and eight subscales, including Withdrawn, Somatic Complaints, Anxious/Depressed, Social Problems, Thought Problems, Attention Problems, Delinquent Behavior, and Aggressive Behavior. The Chinese version of CBCL-TRF has shown to be a valid and reliable test in Chinese children (Leung et al., 2006).

The class teacher of each child, who was blind to the rationale of the study and the group arrangement of children, was invited to complete the TRF at baseline ( $T_1$ ) and after the program ( $T_2$ ) voluntarily. Given that they did not know the group assignment and the rationale of the study, their evaluation was considered as reliable and less biased.

### *(III) Measures of Cognitive Functions*

#### **(i) Memory**

The Hong Kong List Learning Test (HKLLT) -- Form One (Chan, 2006; Chan & Kwok, 1999), a locally validated verbal memory test (Chan & Cheung, 2007; Chan, Ho, & Cheung, 1998; Chan, Kwok, et al., 2000; Chan et al., 2005; Cheung Chan, Chan, Lam, & Lam, 2006; Cheung, Chan, Law, Chan, & Tse, 2000; Cheung, Chan, Law, Chan, & Tse, 2003) was used to assess the verbal learning and memory of the children. It is a Chinese list-learning test that is designed to provide an individually administered assessment of the process and organization strategies involved in learning and memorizing verbal information (Chan, 2006). For the past ten years, the HKLLT has been used in several empirical studies to examine the memory performance of normal (Chan & Cheung, 2007; Chan, Ho, & Cheung, 1998; Chan, Cheung, Ho, & He, 2000; Chan et al., 2005; Ho & Chan, 2005; Ho, Cheung, & Chan, 2003) and various clinical population, including patients with temporal lobe epilepsy (Chan & Cheung, 2007; Cheung et al., 2006), schizophrenia (Chan, Kwok, et al., 2000), dementia (Au, Chan, & Chiu, 2003), frontal lobe damage (Chan, Ho, & Poon, 2002) and temporal lobe lesions (Chan, Cheung, Law, & Chan, 2004; Cheung & Chan, 2003; Cheung et al., 2000; Cheung et al., 2003). It is considered as ecologically valid memory test for Chinese population (Chan, Shum, & Cheung, 2003).

The memory test at baseline ( $T_1$ ) and after ( $T_2$ ) the program was conducted by two different research assistants blind to the group assignment. The HKLLT, which consists of a list of 16 two-character Chinese words, was presented orally to each child during three learning trials. Participants were asked to recall as many words as possible after each learning trial and a 30-minute delayed recall trial. After delayed recall, the children were then orally presented a recognition list of 16 target words and 16 distracters for discrimination. Their learning and memory function was evaluated by their total learning score with a maximum of 48 points, which is the sum of number of words recalled during three learning trials, and by their discrimination score in the recognition task using the equation  $[(\text{Correct hits} - \text{False alarms})/16] \times 100$ .

## Design and Procedures

### *Intervention Program*

The program was conducted at a local primary school in Hong Kong with a total of 40 sessions in the program. The sessions were held twice a week, and each session lasted for 30 minutes. The program was carried out in an activity room of the primary school and run by two trained assistants. Before doing the mind-body exercise, a cool-down activity to calm down their mood was performed, during which the children were reminded to keep silent before entering the room. Different kinds of mattresses and cushions with cartoons were laid on the floor, and relaxing music with some natural sounds (e.g., forest, birds and wind) were played before their entry. The children were free to choose their favorite mattresses and/or cushions to lie on or sit on. In order to help them attend to the music, they were told that they would have to draw a picture to show what they had heard from the music. After listening to

the relaxing music for about 10 minutes, the children were given colored pencils and paper to draw their pictures freely.

After the cool-down activity, the children practiced the mind-body exercise which consists of 13 movements (Chan, 2005) modified from an ancient mind-body exercise developed by Chan Hay Yee of the Song Dynasty (around 1000 A.D.). This series of movements requires the children to perform the exercise and pay attention to every movement of his/her body with a relaxed and peaceful mind. The rationale of training the children to focus with a relaxed mind was to enhance their psychological and cognitive function. It is no doubt that being attentive is important for being productive; however, humans instantly become stressful when they try to pay attention. Stress will in turn negatively affect the production. Therefore, the productivity will become higher if one can be attentive and relaxed simultaneously. Therefore, regular practice of mind-body exercise can be an effective way to train up one's concentration ability without overstressing oneself, and ultimately enhances one's learning and productivity.

While there are many mind-body exercises for adults, relatively few mind-body exercise are suitable for children. Because of the slow and complex movements, children generally lose their interest and patience in practicing this type of exercise. In order to make the mind-body exercise more interesting and easier for children to engage in, the movements were simplified in the study, and light classical music or choruses were added to each movement to make it easy to follow. Funny names, such as "Robot", "Rowing Boat", and "Crawling Bugs", were given to each movement to make them more attractive and easier to be remembered (Chan, 2005). The whole mind-body exercise was completed in 15 minutes. The mean percentage of attendance rate for the experimental group was 88.29% (SD = 10.89).

### *Control Program*

Children in the control group attended a tutorial class during the time when the experimental group attended the mind/body training program. They received tutorial remediation on their homework by two school teachers. Tutorial class was chosen as a control condition because it is the most common remediation used for children with behavioral and learning problems in Hong Kong. The duration of the tutorial class was the same as that of the mind/body training program, i.e., 30 minutes. In order to rule out the possibility of imbalanced attention paid by experimenters on the children within session, equal amount of manpower, i.e., two teachers, was allocated to the tutorial session so as to offer assistance to children in need. Similar to the experimental group, children's attendance was recorded by the teachers in the tutorial group. Their mean percentage of attendance rate was 85.46% (SD = 11.93) and the percentage of attendance rate for the experimental and control groups was comparable (Table 1).

### *Data analysis*

The mean and standard deviation for each dependent variable were computed for both the control and experimental groups at baseline ( $T_1$ ) and after the intervention ( $T_2$ ). Group

(control, experimental) x Time ( $T_1$ ,  $T_2$ ) analyses of variance with repeated measures (ANOVAs) were performed to evaluate group differences in the changes in scores before and after the intervention program. Paired  $t$ -tests were used to test the changes in scores within each group, and independent  $t$ -tests were conducted to test for group differences between the scores of the control and experimental groups at baseline as well as after the intervention. Chi-square analyses were used to examine the difference in proportions of categorical variables between the two groups. Effect sizes were also computed for the group differences in terms of partial eta squared (Tabachnick & Fidell, 2001) for repeated measures ANOVA [small ( $< 0.06$ ), medium (0.06 to 0.13) and large ( $\geq 0.14$ )]. All analyses were conducted using SPSS 11.0.1 version, and the effect sizes were all labeled according to the general guideline suggested by Cohen (1988).

## Results

### Baseline Condition

Table 2 shows the baseline ( $T_1$ ) academic performance as measured by grade point average, T-scores on the CBCL-TRF and memory performance on the HKLLT for the control and experimental groups. Independent  $t$ -tests showed that the two groups in general did not differ in their scores on the grade point average. Across the three major scales, that is Total Problem, Internalizing, Externalizing scales and the eight subscales of the CBCL-TRF, the experimental and control groups were comparable, except on the Somatic Complaints subscale in which the experimental group scored higher on this subscale than the control group at baseline ( $t(58) = 2.682$ ,  $p = 0.01$ ). Regarding memory performance, though the experimental group tended to recall and discriminate fewer words on the HKLLT, there was no significant difference on the total learning and discrimination scores between the experimental and control groups (Table 2).

**Table 2. Grade Point Average, T-scores on the Child Behavior Checklist-Teacher's Report Form of Children and Memory Performance on the HKLLT at baseline**

	Control Group (n = 35)	Experimental Group (n = 25)	$t(58)$	$P$
	(Mean±SD)	(Mean±SD)		
<i>Grade Point Average</i>	79.72±7.10	77.33±9.55	-1.114	0.270
<i>CBCL-TRF</i>				
Total Problem	47.63±8.67	49.96±10.74	0.941	0.350
Internalizing	47.14±7.83	49.12±9.71	0.872	0.387
Externalizing	47.89±9.15	49.68±9.64	0.732	0.467
<i>Subscales</i>				
Withdrawn	51.97±4.69	53.52±4.96	1.232	0.223
Somatic Complaints	51.03±3.40	55.08±8.00	2.682	0.010*

	Control Group	Experimental Group	<i>t</i> (58)	<i>P</i>
	( <i>n</i> = 35)	( <i>n</i> = 25)		
	(Mean±SD)	(Mean±SD)		
Anxious/Depressed	52.46±4.30	53.20±5.14	0.608	0.546
Social Problems	52.23±4.34	54.36±7.89	1.341	0.185
Thought Problems	51.60±4.85	52.28±5.05	0.526	0.601
Attention Problems	53.20±4.52	54.36±5.85	0.866	0.390
Delinquent Behavior	53.06±4.96	53.56±5.52	0.368	0.713
Aggressive Behavior	53.08±4.73	54.32±5.71	0.941	0.365
<i>HKLLT</i>				
Total Learning (maximum = 48)	24.94±7.30	22.84±7.51	-1.087	0.282
Discrimination Score (maximum = 100%)	89.46±13.11	81.25±18.92	-1.988	0.051

*Note.* \**p* < 0.05.

## The Effect of Mind-Body Training on Academic Performance

### *Whole Group*

The grade point averages (maximum score: 100 points) of each student at baseline and after the intervention program were compared. The baseline mean grade point average of the experimental group was 77.33 (SD = 9.55) and that of the control group was 79.72 (SD = 7.10) which were not significantly different.

Although the mean grade point average of the experimental (mean = 77.20, SD = 7.57) and control groups (mean = 77.90, SD = 8.10) was not significant ( $F(1,58) = 2.423$ ,  $p = 0.125$ ) after the intervention, there was a wide range of change in grade point average within the experimental and control (-9.45 points to 13.35 points) groups (Figure 1). The large standard deviation suggested that some children were more benefited than the others from the program. In addition, the non-significant different scores could be attributed to this relatively great standard deviation. Thus, in order to reveal the effect of mind-body exercise by taking into consideration of the great within group variation, the maximum points of improvement between groups were compared.

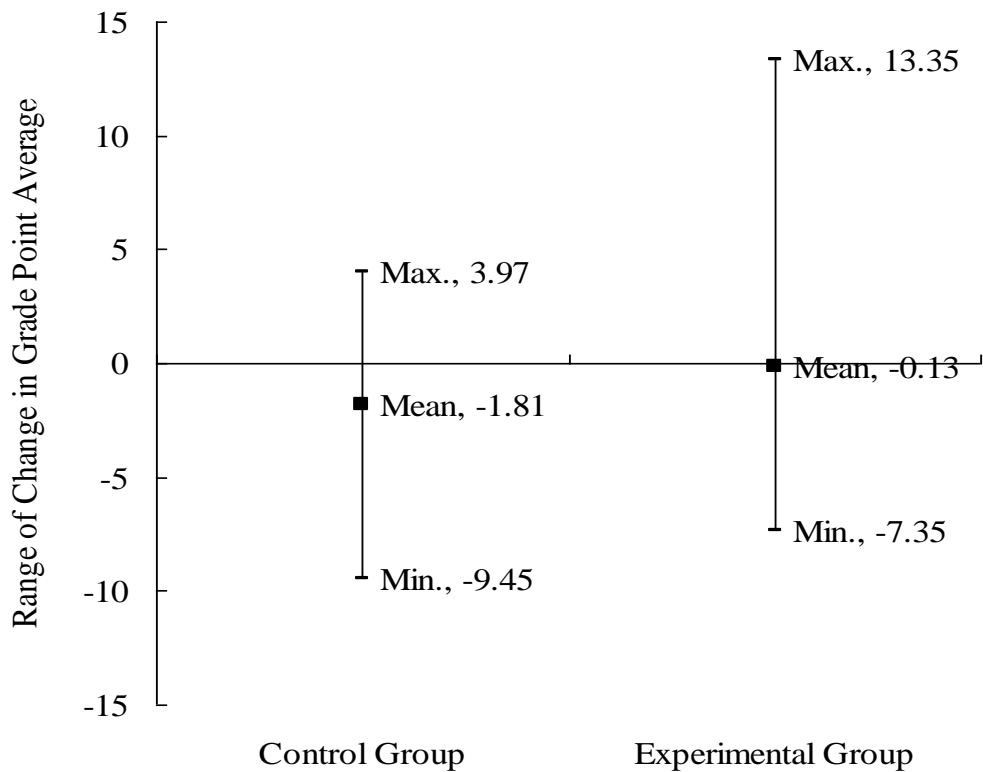


Figure 1. The range of changes in grade point average of the whole experimental and control groups after the intervention program.

As shown in Figure 1, the control group achieved a maximum improvement of 3.97 points, while the experimental group achieved a maximum increase of 13.35 points. In addition, six children (24%) in the experimental group demonstrated an improvement greater than the maximum 3.97-point increase of the control group. Chi square analysis showed that the proportion was statistically significant ( $\chi^2(1) = 9.333, p = 0.002$ ). Since 24% of the children in the experimental group demonstrated a progress in academic performance greater than the maximum improvement of the control group, these results suggested that the mind/body exercise had a positive effect on the academic performance of some but not all children. Therefore, further analysis was done to find out any factors that might cause this within-group discrepancy.

#### *Over-peak improvement group*

Analyses were conducted to examine the possible factors that might have contributed to the higher-than-maximum increase in grade point average of these six children, i.e., the “over-peak improvement” group. As compared with the other children in the experimental group ( $81.26 \pm 5.95$ ), their school performance at baseline grade point average was significantly lower ( $64.87 \pm 8.13, t(23) = 5.393, p < 0.000$ ). Their age, education levels and estimated IQ, however, were not significantly different from each other. It appears that children with poorer

school performance showed more improvement from the mind-body training program than those with average or above average performance.

### *Low-achieving group*

In view of the more noticeable effect demonstrated by children with poor academic performance, a sub-group of children whose grades were at the lower end of their respective grade level were selected for further comparison to evaluate the effect of this program on this particular population. Fourteen children (7 boys, 7 girls) in the experimental group and 14 (9 boys, 5 girls) in the control group were included in this analysis. The two groups did not differ in age ( $t(26) = -1.243, p = 0.225$ ), years of education ( $t(26) = -1.314, p = 0.200$ ), gender distribution ( $\chi^2(1) = 0.583, p = 0.445$ ), estimated IQ ( $t(26) = 0.856, p = 0.400$ ), and academic performance at baseline ( $t(26) = -0.838, p = 0.400$ ).

**Table 3. Demographic Characteristics of Low-achieving Children in the Experimental and Control Groups**

Variables	Control Group (n = 14)	Experimental Group (n = 14)
	Mean (SD)	Mean (SD)
Age (years)	8.83 (1.14)	8.29 (1.17)
Education (years)	3.50 (1.22)	2.93 (1.07)
Gender (Male/Female)	9/5	7/7
Estimated IQ	93.86 (11.32)	97.21 (9.35)
Grade Point Average at baseline	73.26 (6.17)	71.00 (7.99)
Percentage of Attendance (%)	85.33 (15.17)	93.34 (4.71)

While the maximum point of increase in the control group was 2.87, there was 42.86% (6 out of 14 children) of the low-achieving children in the experimental group demonstrated an improvement greater than the maximum point (i.e., 2.87) of the control group and the maximum point of increase in the experimental group was 13.35. Chi-square result was statistically significant ( $\chi^2(1) = 4.762, p = 0.029$ ). These results further suggested that children with poorer academic performance seemed to be demonstrated more improvement in terms of their change in academic performance from the mind-body training program than from the tutorial class.

## The Effect of the Mind-Body Training on Behavioral and Emotional Problems

### *Whole Group*

Table 4 shows the baseline ( $T_1$ ) and post-intervention ( $T_2$ ) T-scores on the Total Problem, Internalizing and Externalizing scales, as well as the eight subscales of the Chinese version of the CBCL-TRF for the control and experimental groups. Figure 2 shows the exact change in T-scores of the CBCL-TRF after the intervention program.

Results of paired-t tests showed a significant decrease in the Total Problem ( $t(24) = 2.335, p = 0.028$ ) and Internalizing scale ( $t(24) = 2.118, p = 0.045$ ) within the experimental group. That is, after the intervention program, the teachers reported reduced overall and internalizing symptoms among the experimental groups. However, within the control group, there was no significant difference between their Total problem ( $t(34) = 1.069, p > 0.05$ ), Internalizing ( $t(34) = 0.783, p > 0.05$ ), and Externalizing ( $t(34) = -0.615, p > 0.05$ ) scales on the CBCL-TRF after attending the tutorial class (Figure 2a).

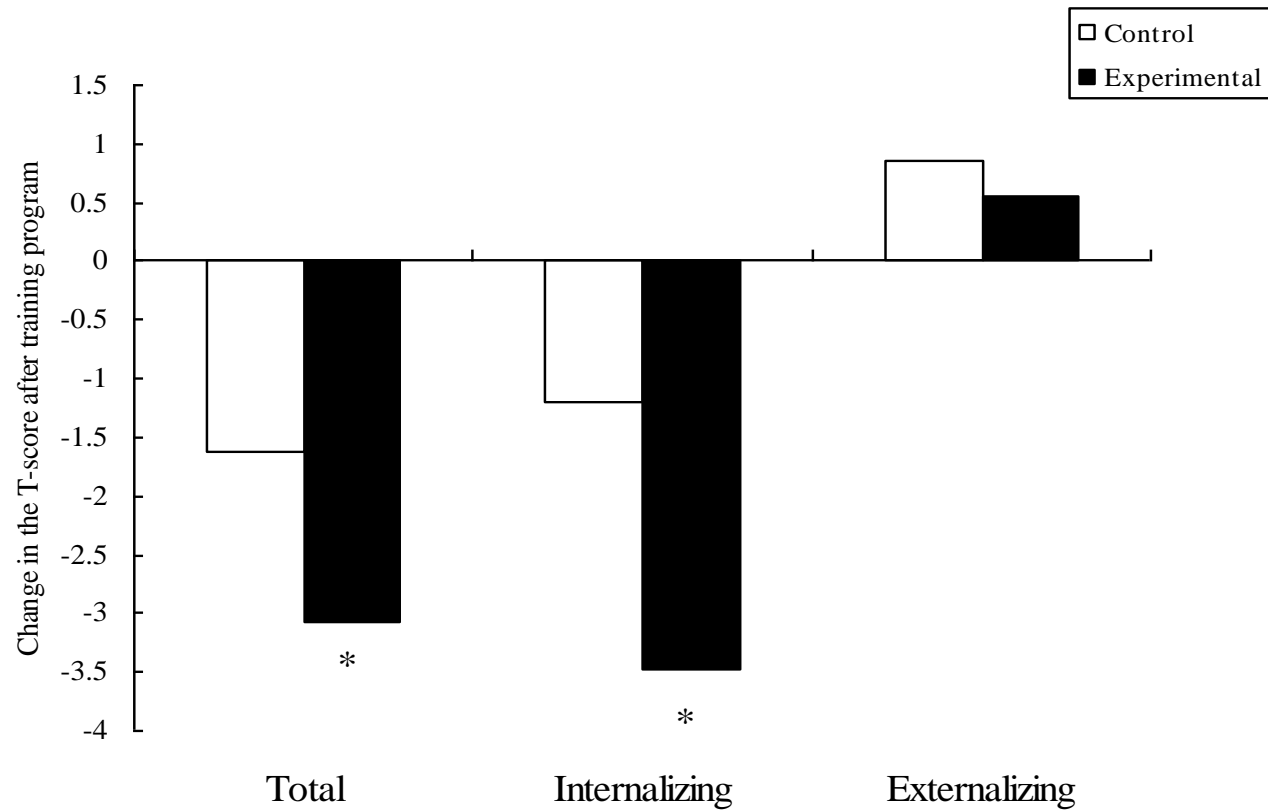
Further analysis on the eight subscales of the CBCL-TRF (Figure 2b) revealed that the experimental group in general demonstrated a trend of reduced symptoms for seven subscales of the CBCL-TRF and statistically significant decrease was found in the subscales of Withdrawn ( $t(24) = 2.689, p = 0.013$ ), Somatic Complaints ( $t(24) = 2.254, p = 0.034$ ) and Attention Problems ( $t(24) = 2.442, p = 0.022$ ). However, within the control group, no significant change was found among eight subscales after the tutorial class. These results suggested that the mind/body training program seems to be an effective intervention for behavioral and emotional problems of these children.

A repeated measures ANOVA was conducted to compare the changes in scores between the experimental and control groups (Table 4) before and after the experiment. Significant interaction effects were found for the Withdrawn ( $F(1,58) = 6.446, p = 0.014$ ) and Somatic Complaints ( $F(1,58) = 5.583, p = 0.022$ ) subscales. At baseline, the two groups did not differ on the Withdrawn subscale ( $t(58) = 1.582, p > 0.05$ ). After the program, however, the experimental group demonstrated a significant decrease in score while the control group remained unchanged, suggesting that the experimental group had fewer withdrawn problems than the control group after the program. For Somatic Complaints subscale, the experimental group scored higher on this subscale than the control group at baseline ( $t(58) = 2.682, p = 0.01$ ). After the training program, the experimental group ( $51.24 \pm 4.41$ ) had a significant decrease in this subscale which was comparable to the control group ( $51.86 \pm 5.51$ ). These results again suggested that the mind/body training program seemed to be an effective intervention for behavioral and emotional problems of these children.

**Table 4. T-scores on the Child Behavior Checklist-Teacher's Report Form of Children**

	Control Group (n = 35)				Experimental Group (n = 25)				Group x Condition Interaction		
	Pre-score (Mean±SD)	Post-score (Mean±SD)	<i>t</i> (34)	<i>p</i>	Pre-score (Mean±SD)	Post-score (Mean±SD)	<i>t</i> (24)	<i>p</i>	<i>F</i> <sub>1, 58</sub>	<i>p</i>	Partial $\eta^2$
Total Problem	47.63±8.67	46.00±11.52	1.069	0.292	49.96±10.74	46.88±9.51	2.335	0.028*	0.468	0.496	0.008 <sup>S</sup>
Internalizing	47.14±7.83	45.94±9.14	0.783	0.439	49.12±9.71	45.64±7.88	2.118	0.045*	0.996	0.322	0.017 <sup>S</sup>
Externalizing	47.89±9.15	48.74±9.56	-0.615	0.542	49.68±9.64	50.24±9.19	-0.401	0.692	0.021	0.884	0.000 <sup>S</sup>
<i>Subscales</i>											
Withdrawn	51.97±4.69	52.06±4.63	-0.162	0.872	53.52±4.96	51.12±2.64	2.689	0.013*	6.446	0.014*	0.100 <sup>M</sup>
Somatic Complaints	51.03±3.40	51.86±5.51	-0.723	0.474	55.08±8.00	51.24±4.41	2.254	0.034*	5.583	0.022*	0.088 <sup>M</sup>
Anxious/Depressed	52.46±4.30	51.74±4.73	1.005	0.322	53.20±5.14	52.12±3.88	1.282	0.212	0.110	0.741	0.002 <sup>S</sup>
Social Problems	52.23±4.34	52.57±6.11	-0.435	0.666	54.36±7.89	52.60±6.35	1.543	0.136	2.460	0.122	0.041 <sup>S</sup>
Thought Problems	51.60±4.85	53.26±7.61	-1.661	0.106	52.28±5.05	52.00±5.54	0.190	0.851	1.273	0.264	0.021 <sup>S</sup>
Attention Problems	53.20±4.52	52.69±5.00	0.571	0.572	54.36±5.85	52.04±3.90	2.442	0.022*	1.829	0.182	0.031 <sup>S</sup>
Delinquent Behavior	53.06±4.96	53.37±5.53	-0.305	0.762	53.56±5.52	53.44±6.44	0.115	0.909	0.083	0.774	0.001 <sup>S</sup>
Aggressive Behavior	53.08±4.73	53.71±5.44	-0.731	0.470	54.32±5.71	54.36±5.51	-0.040	0.968	0.199	0.657	0.003 <sup>S</sup>

Note. \**p* < 0.05; <sup>S</sup> = small, <sup>M</sup> = medium.



a)

Figure 2. The change in T-scores of a) Total Problem, Internalizing and Externalizing scales (continued on next page)

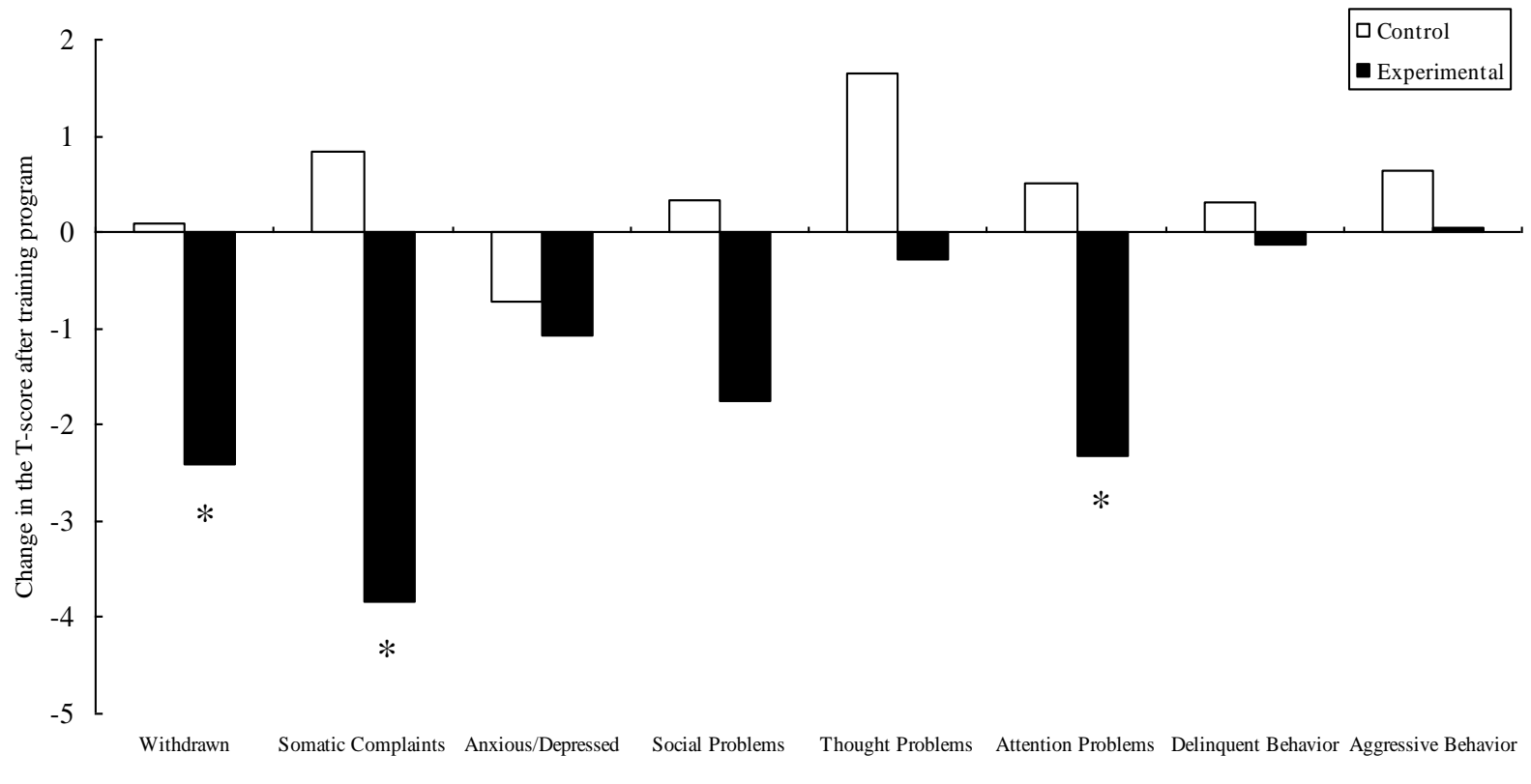


Figure 2. The change in T-scores of b) eight subscales of the Child Behavior Checklist-Teacher's Report Form for the whole experimental (n = 25) and control (n = 35) groups. Positive values mean increased symptoms and negative values mean reduced symptoms after the program. The experimental group demonstrated a significant decrease in the Total Problem, Internalizing scales, Withdrawn and Attention Problems subscales after the program (\*  $p < .05$ ).

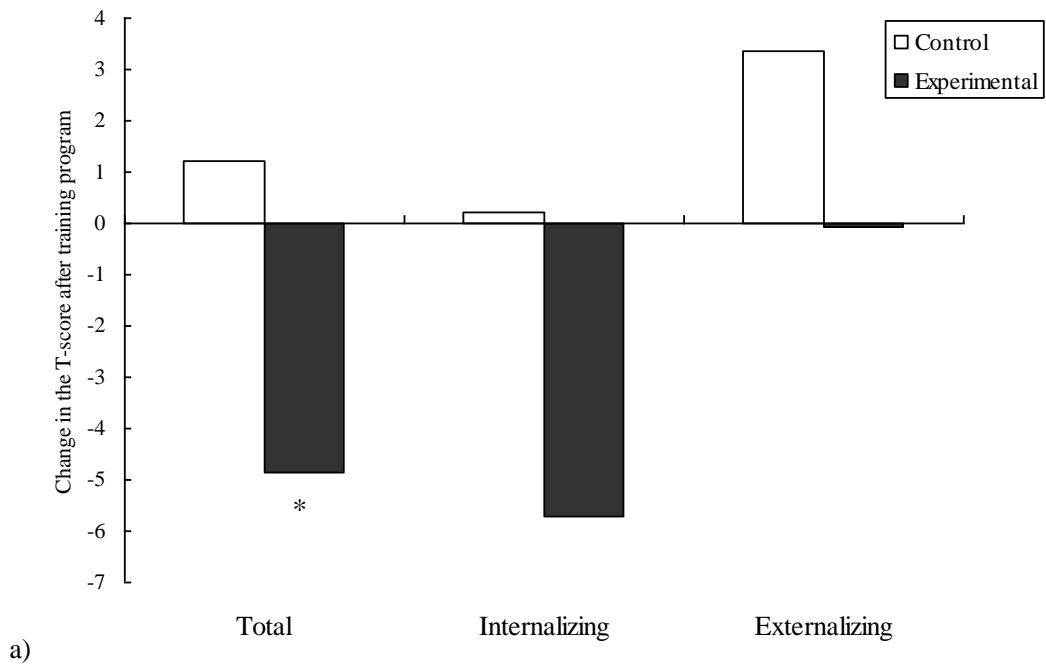
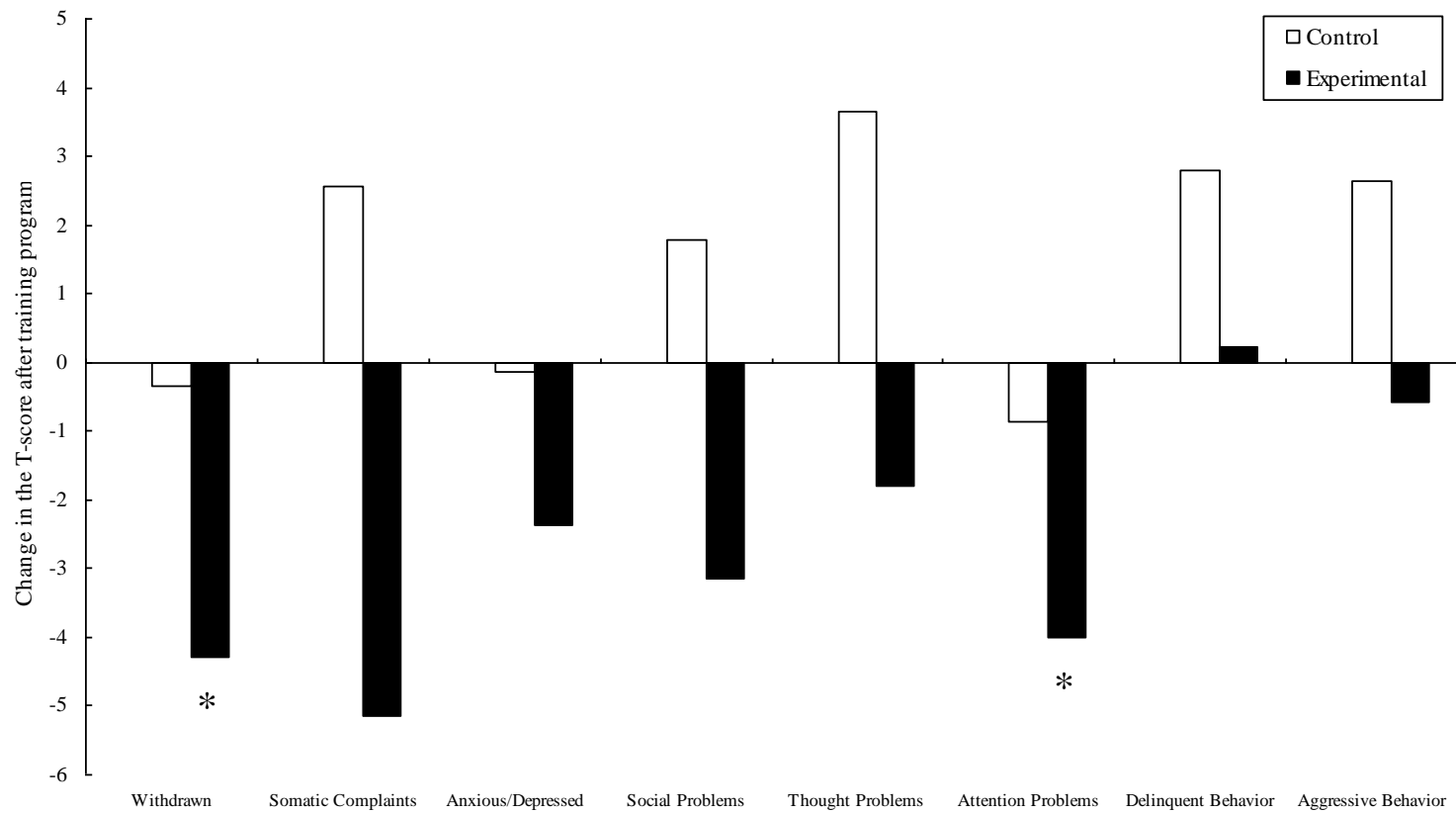


Figure 3. The change in T-scores of a) Total Problem, Internalizing and Externalizing scales (continued on next page)



b)

Figure 3. The change in T-scores of b) eight subscales of the Child Behavior Checklist-Teacher's Report Form for low-achieving children in the experimental (n = 14) and control (n = 14) groups. Positive values mean increased symptoms and negative values mean reduced symptoms after the program. The low-achieving children in experimental group demonstrated a significant decrease in the Total Problem, Withdrawn and Attention Problems subscales after the program (\*  $p < .05$ ).

### *Low-achieving group*

The results of the CBCL-TRF for the low-achieving children were consistent with those of the whole group analyses. Within the control group, no significant change was found across all scales after the tutorial class and the low-achieving children in the control group did not show significant changes in any subscales of the CBCL-TRF after the program. However, low-achieving children in the mind/body training group demonstrated significant decreases in the Total Problem scale ( $t(13) = 2.338, p = 0.036$ ) (Figure 3a), and subscales of Withdrawn ( $t(13) = 3.027, p = 0.010$ ) and Attention Problems ( $t(13) = 2.615, p = 0.021$ ) (Figure 3b). In sum, after attending the mind-body training program, low-achieving children demonstrated significantly fewer withdrawn and attention problems, as reported by their teacher, than children in the tutorial group.

## The Effect of the Mind-Body Training on Learning and Memory

### *Whole Group*

*Learning.* A Time ( $T_1, T_2$ ) x Trials (Trial 1 -3) x Group repeated measures ANOVA was performed to examine the learning ability across three learning trials on the HKLLT. The results showed a significant Time x Group interaction effect ( $F(1, 56) = 5.856, p = 0.019$ ) (Figure 4a). Further analysis showed that the main effect of time was significant ( $F(1, 56) = 56.525, p < 0.000$ ), that is, both groups recalled more words during learning trials after the program. However, further comparisons with paired t-test showed that the experimental group demonstrated greater improvement in the total score after the intervention program (mean difference:  $7.17 \pm 5.36$  words) than the control group (mean difference:  $3.68 \pm 5.44$  words).

*Memory.* Memory ability was defined as the amount of information that can be retained after 30 minutes and it was measured by the discrimination score on the recognition task. The results of repeated measure ANOVA on the score revealed significant interaction effect,  $F(1, 56) = 9.821, p = 0.003$  (Figure 4b). Further comparisons with paired t-test showed that the experimental group had better memory ability (mean difference:  $11.20\% \pm 16.38\%$ ),  $t(23) = -3.349, p = 0.003$ ) after intervention program while the control group remained unchanged (mean difference:  $-1.84\% \pm 15.04\%$ ,  $t(33) = 0.713, p > 0.05$ ). Taken together, these results suggested that the experimental group demonstrated better learning ability and memory, as compared with the control group, after attending after-school mind-body exercise program.

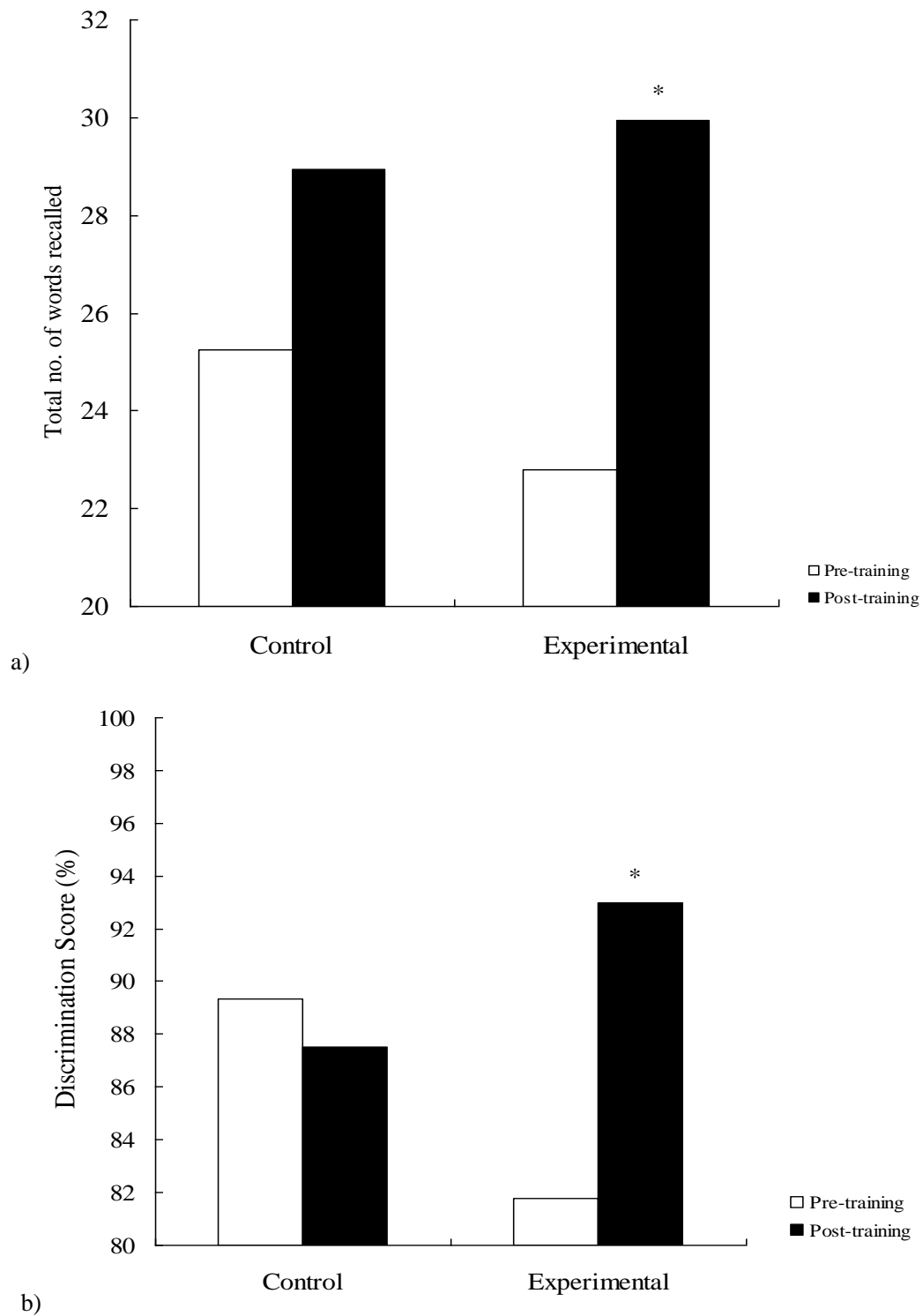


Figure 4. a) Total learning score b) discrimination score on the Hong Kong List Learning Test for the whole experimental and control groups before and after the intervention program. The experimental group demonstrated better learning and memory after the program (\*  $p < .05$ ).

### *Low-achieving group*

*Learning.* A Time ( $T_1, T_2$ ) x Trials (Trial 1 -3) x Group repeated measures ANOVA was performed to compare the learning ability across three learning trials on the HKLLT for low-achieving children in the experimental and control groups. Similar to the whole group analysis, the results showed a significant Time x Group interaction effect ( $F(1, 25) = 7.982, p = 0.009$ ). Further comparisons with paired t-test showed that the experimental group demonstrated greater improvement in the total score after the intervention program (mean difference:  $8.61 \pm 6.16$  words,  $t(12) = -5.044, p = 0.000$ ) than the control group (mean difference:  $1.92 \pm 6.13$  words,  $t(12) = -1.177, p > 0.05$ ). The maximum improvement in the experimental group was an increase of total 18 words across three trials where that in the control group was an increase of total 10 words (Figure 5a)

*Memory.* The results of repeated measure ANOVA on the score revealed significant interaction effect ( $F(1, 25) = 7.962, p = 0.009$ ). Further comparisons with paired t-test showed that the experimental group had better memory ability (mean difference:  $16.83\% \pm 18.81\%$ ,  $t(12) = -3.224, p = 0.007$ ) after intervention program while the control group remained unchanged (mean difference:  $-4.46\% \pm 20.28\%$ ,  $t(13) = -0.824, p > 0.05$ ). Taken together, these results suggested that the children in the experimental group demonstrated better learning ability and memory as compared with the control group after attending mind-body exercise program. Whereas the maximum improvement in the discrimination score for children in the control group was an increase of 31.25%, the maximum improvement in the experimental group was an increase of 62.5%, which was double of the improvement in the control group (Figure 5b).

Therefore, apart from improvement in academic performance and psychological functioning, the mind-body exercise also demonstrated positive effect on the learning and memory ability of the children, particularly for low-achieving children.

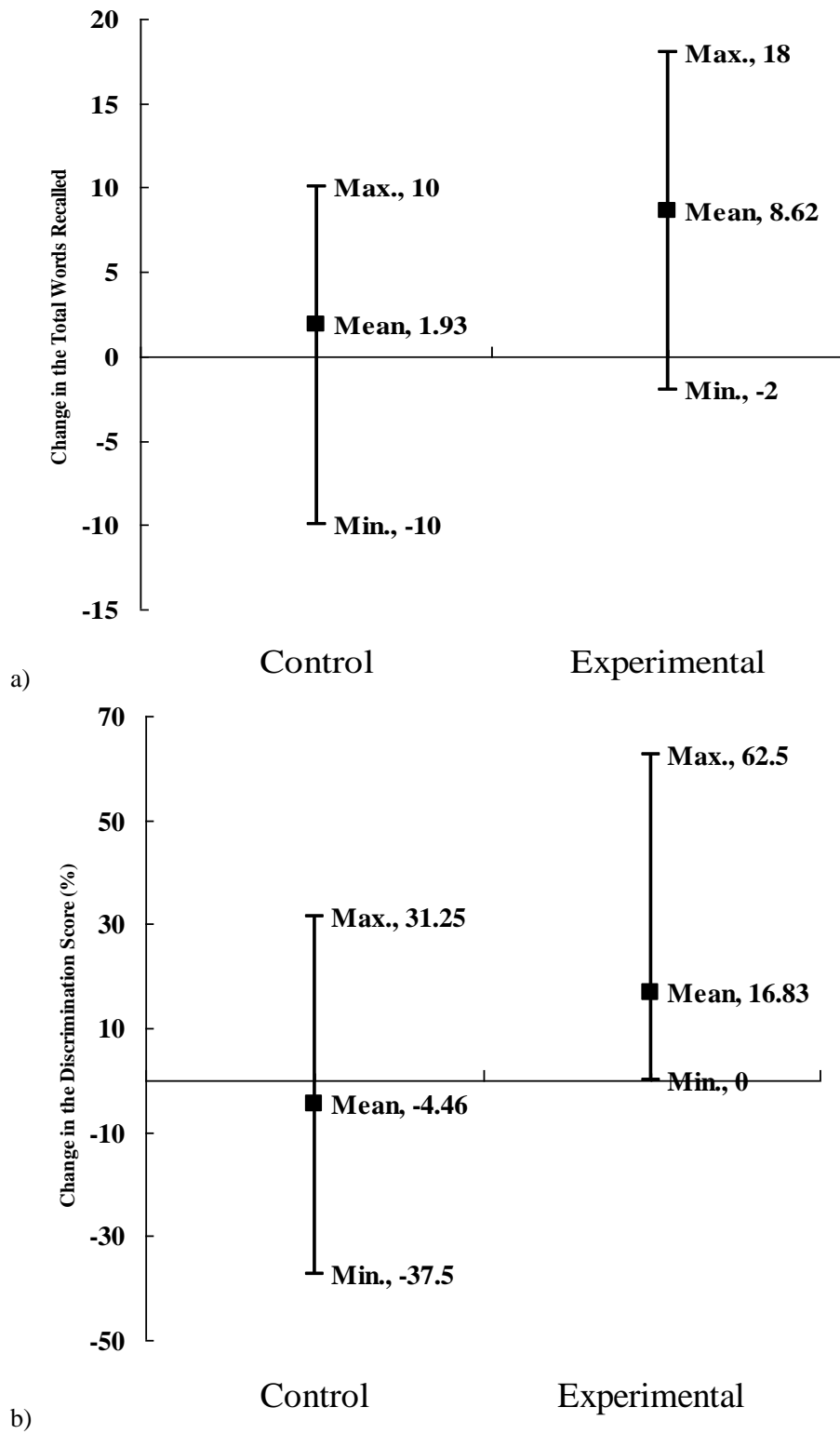


Figure 5. The range of changes in a) total learning score b) discrimination score on the Hong Kong List Learning Test for the low-achieving children in the experimental and control groups.

## Discussion

The primary purpose of the present study was to evaluate the effect of a mind/body training program on children, and the results were somewhat encouraging. Some children who attended the mind/body training program demonstrated greater improvement in school performance than those in the tutorial class, and the effect was more noticeable among low-achieving children. Specifically, while low-achieving children in the tutorial class achieved a maximum improvement in grade point average of 2.87 points, around 43% of low-achieving children in the mind/body training group showed improvement above this level, and the effect was statistically significant. In addition, the maximum improvement demonstrated by the mind/body training group was 13.35 points, which was about four times the improvement that was observed in the whole control group (3.97 points). Furthermore, the mind/body training group showed greater improvements in their learning and memory than the control group. The low-achieving children also showed a significant reduction in their behavioral and emotional symptoms after the mind/body training as shown by their reduced Total Problem and Internalizing T scores in the CBCL-TRF, while those in the control group did not show any changes. Low-achieving children in the mind/body group also had significantly fewer withdrawn and attention problems as suggested by their changes in scores on the Withdrawn and Attention Problems subscales.

The present results seem to be counter-intuitive in that children demonstrated better improvement after spending time to do mind-body exercise instead of taking remedial classes. But if we look at the behavioral and learning problems from the perspective of neuroscience, the results may not be as surprising as it seems to be. Since all human behaviors and emotions are mediated by the brain, poor learning and behavioral problems in children can be considered as a consequence of their brains which are functioning below the optimal level. Thus, activities that benefit the operation of the brain should in turn improve the individuals' behavior and emotion. Physical exercise and relaxation were found to be two positive factors affecting brain functions, and the mind-body exercise is a unique combination of these two factors.

It is well-known that physical exercise is a protective factor for preserving cognitive functions and reducing cognitive decline associated with aging (Albert et al., 1995; Dik et al., 2003). In children, physical exercise can have positive effect on psychological functioning, which includes increase in self-esteem (Alpert, et al., 1990; MacMahon & Gross, 1987), increase in internal locus of control (Labbe & Welsh, 1993), improvement in classroom behavior (Etscheidt & Ayllon, 1987; Evans et al., 1985), and enhancement of creativity (Tuckman & Hinkle, 1986). Although mind-body exercise is characterized by slow movements, it is a moderate intensity exercise with physiological benefits similar to cardiovascular exercise, such as improved pulmonary functions (Hong, Li, & Robinson, 2000; Lan, Lai, Chen, & Wong, 1998) and enhanced muscle strength (Jacobson, Chen, Cashel, & Guerrero, 1997; Lan et al., 1998). Therefore, mind-body exercise can be regarded as a type of physical exercise that has beneficial effect similar to those associated with cardiovascular exercise for enhancing brain functions.

In addition, stress is harmful to the brain and affects cognitive processing (Kirsbaum, Wolf, May, Wippich, & Helhammer, 1996; Lupien et al, 1998) and mental health (Monroe

Harkness, Simons, & Thase, 2001; Pelletier, 1977). Effective stress management can lead to a reduction of emotional and behavioral problems (Goldbeck & Schmid, 2003; Little & Jackson, 1974; Thompson et al, 1980). Mind-body exercise emphasizes the maintenance of a peaceful mind while engaging in the exercise. It can elicit a state of relaxation that can help reducing the harmful effect of stress on the brain. Thus, it is not surprising that the mind-body exercise showed positive effect on enhancing learning abilities and reducing behavioral and emotional problems in children.

It is a common belief (or a common misunderstanding) that the harder the child studies, the more he/she learns, and the smarter he/she is. Therefore, many parents often arrange tight schedules packed with different kinds of lessons and classes for their children to attend. However, an over-tight schedule may induce stress on the child, which in turn may reduce his/her rate of learning (Lupien et al., 1998; Sapolsky, 1996). The present results demonstrated that as little as one hour per week of appropriate relaxation and physical exercise was able to improve the academic performance and reduce behavioral and emotional problems of some children. This indeed serves to draw attention to the issue of stress management in children.

The positive effect demonstrated in this study should not be focused exclusively on the present mind-body program. Rather, it should be considered evidence to support the concept of mind-body training as a possible intervention for children with behavioral problems or learning difficulties. Indeed, this program may have the advantage over other training programs because it is a group program specially developed for children and particularly suitable to run in school setting or after-school centers for children. In addition, while the positive effect of mind-body interventions have been reported in studies on adolescents (Benson et al., 1994; Goldbeck & Schmid, 2003) and college students (Deckro et al., 2002; Thompson et al., 1980), the present study provided further evidence to suggest that younger children can also benefit from this type of training.

As a pilot study on the effect of mind-body exercise on children, this study has some limitations. First, the sample size was relatively small, which could have caused some non-significant results with large effect sizes. In addition, all participants in the present study were Chinese children. Whether similar effect can be obtained on other cohorts of different cultures and backgrounds remains unknown. Thus, further studies are needed to validate the present findings.

## **Acknowledgement**

We are grateful for the support of Mr. Chan Wing Kwong (the Principal), the teachers, parents, and students of Po Leung Kuk Luk Hing Too Primary School in Hong Kong. This study was supported by the Hong Kong Quality Education Fund.

## References

- Achenbach, T. M. (1991). *Manual of the teacher's report form and 1991 profile*. Burlington, VT: University of Vermont, Department of Psychiatry.
- Albert, M. S., Jones, K., Savage, C. R., Berkman, L., Seeman, T., Blazer, D., & Rowe, J. W. (1995). Predictors of cognitive change in older persons: MacArthur studies of successful aging. *Psychology and Aging, 10*, 578-589.
- Alpert, B., Field, T., Goldstein, S., & Perry, S. (1990). Aerobics enhances cardiovascular fitness and agility in preschoolers. *Health Psychology, 1*, 48-56.
- Au, A., Chan, A., & Chui, H. (2003). Verbal learning in Alzheimer's dementia. *Journal of International Neuropsychological Society, 9*, 363-375.
- Benson, H., Rosner, B. A., Marzetta, B. R., & Klemchuk, H. M. (1974). Decreased blood-pressure in pharmacologically treated hypertensive patients who regularly elicited the relaxation response. *Lancet 23*, 1(7852), 289-291.
- Benson, H., Kornhaber, A., Kornhaber, C., LeChanu, M. N., Zuttermeister, P. C., Myers, P., & Friedman, R. (1994). Increases in positive psychological characteristics with a new relaxation-response curriculum in high school students. *Journal of Research and Development in Education, 27*, 226-231.
- Benson, H., Wilcher, M., Greenberg, B., Huggins, E., Ennis, M., Zuttermeister, P. C., Myers, P., Friedman, R. (2000). Academic performance among middle-school students after exposure to a relaxation response curriculum. *Journal of Research and Development in Education, 33*, 156-165.
- Berkman, L. F., Seeman, T. E., Albert, M., Blazer, D., Kahn, R., Mohs, R., Finch, C., Schneider, E., Cotman, C., McClearn, G., Nesselroade, J., Featherman, D., Garmezny, N., McKhann, G., Brim, G., Prager, D., & Rowe, J. (1993). High, usual and impaired functioning in community-dwelling older men and women: findings from the MacArthur Foundation Research Network on successful aging. *Journal of clinical epidemiology, 46*, 1129 – 1140.
- Brown, L., Sherbenou, R. J., & Johnson, S. K. (1997). *Test of Nonverbal Intelligence (3<sup>rd</sup> ed.)*. Austin, Texas: PRO-ED.
- Brown, D. R., Wang, Y., Ward, A., Ebbeling, C. B., Fortlage, L., Puleo, E., Benson, H., Rippe, J.M. (1995). Chronic psychological effects of exercise and exercise plus cognitive strategies. *Medical & Science in Sports & Exercise, 27(5)*, 765-775.
- Carter, J., & Russell, H. (1984). *Application of biofeedback relaxation procedures to handicapped children*. Final Report, Project No. 443CH00207, U.S. Department of Education.
- Carter, J., & Russell, H. (1985). Use of EMG biofeedback procedures with learning disabled children in a clinical and an educational setting. *Journal of Learning Disabilities, 18*, 213-216.
- Caudill, M., Schnable, R., Zuttermeister, P., Benson, H., & Friedman, R. (1991). Decreased clinic utilization by chronic pain patients after behavioral medicine intervention. *Pain, 45*, 334-335.
- Chan, A. S. (2005). *Chan's mind-body exercise for children*. Hong Kong: Centre For Neurocognitive Function Enhancement, The Chinese University of Hong Kong.

- Chan, A. S. (2006). *Hong Kong List Learning Test (2<sup>nd</sup> ed)*. Hong Kong: Department of Psychology and Centre for Neurocognitive Function Enhancement, The Chinese University of Hong Kong.
- Chan, A. S., & Cheung, M. C. (2007) Pre-activating the mesial temporal lobe facilitates learning. *Neuroscience Letters*, *411*, 194-199.
- Chan, A. S., Cheung, M. C., Ho, Y. C., He, W. J. (2000). Localized brain activation by selective tasks improves specific cognitive functions in humans. *Neuroscience Letters*, *283*, 162-164.
- Chan, A., Cheung, M. C., Law, S. C., & Chan, J. H. (2004). Phase II study of Alpha-Tocopherol in improving the cognitive function of patients with temporal lobe radionecrosis. *Cancer*, *100*, 398-404.
- Chan, A. S., & Kwok, I. (1999). *Hong Kong List Learning Test: Manual and preliminary norm*. Hong Kong: The Chinese University of Hong Kong.
- Chan, A. S., Kwok, I., Chui, H., Lam, L., Pang, A., & Chow, L. Y. (2000). Memory and organizational strategies in chronic and acute schizophrenic patients. *Schizophrenia Research*, *41*, 431-445.
- Chan, A. S., Ho, Y., & Cheung, M. (1998). Music training improves verbal memory. *Nature*, *396*, 128.
- Chan, A. S., Ho, Y., Cheung, M., Albert, M. S., Chiu, H. F. K., & Lam L. C. W. (2005). Association between mind-body and cardiovascular exercises and memory in older adults. *Journal of the American Geriatrics Society*, *53*, 1754-1760.
- Chan, A., Ho, S., & Poon, W. S. (2002) Neuropsychological sequelae of patients treated with microsurgical clipping or endovascular embolization for anterior communicating artery aneurysm. *European Neurology*, *47*, 37-44.
- Chan, A., Shum, D., & Cheung, R. (2003). Recent development of cognitive and neuropsychological assessment in Asian countries. *Psychological Assessment*, *15*, 257-267.
- Cheung, M. C., & Chan, A. S. (2003). Memory impairment in humans after bilateral damage to lateral temporal neocortex. *NeuroReport*, *14*, 371-374.
- Cheung, M. C., Chan, A. S., Chan, Y. L., Lam, J. M. K. and Lam, W. (2006) Effect of illness duration on the memory processing of patients with temporal lobe epilepsy. *Epilepsia*, *47*, 1320-1328.
- Cheung, M. C., Chan, A. S., Law, S.C., Chan, J. H., & Tse, V. K. (2000). Cognitive function of nasopharyngeal carcinoma patients with and without temporal lobe radionecrosis. *Archives of Neurology*, *57*, 1347-1352.
- Cheung, M. C., Chan, A. S., Law, S. C., Chan, J. H., & Tse, V. K. (2003). Impact of radionecrosis on cognitive dysfunction in patients following radiotherapy for nasopharyngeal carcinoma. *Cancer*, *97*, 2019-2026.
- Chou, K. L., Lee, P. W. H., Yu, E. C. S., Macfarlane, D., Cheng, Y. H., Chan, S. S. C., & Chi, I. (2004). Effect of Tai Chi on depressive symptoms amongst Chinese older patients with depressive disorders: A randomized clinical trial. *International Journal of Geriatric Psychiatry*, *19*, 1105-1107.
- Clarkson-Smith, L., & Hartley, A. A. (1989). Relationships between physical exercise and cognitive abilities in older adults. *Psychology and Ageing*, *4*, 183-189.

- Cohen, J. (1988), *Statistical power analysis for the behavioral sciences (2nd ed.)*. Hillsdale, NJ: Erlbaum
- Cotman, C., & Berchtold, N. (2002). Exercise: A behavioral intervention to enhance brain health and plasticity. *Trends in neuroscience*, 6, 295- 301.
- Deckro, G. R., Ballinger, K. M., Hoyt, M., Wilcher, M., Dusek, J., Myers, P., Greenberg, B., Rosenthal, D. S., & Benson, H. (2002). The evaluation of a mind/body intervention to reduce psychological distress and perceived stress in college students. *Journal of American College Health*, 50, 281-287.
- Dik, M., Deeg, D. J., Visser, M., & Jonker, C. (2003). Early life physical activity and cognition at old age. *Journal of Clinical and Experimental Neuropsychology*, 25, 643-653.
- Dustman, R. E., Ruhling, R. O., Russell, E. M., Shearer, D. E., Bonekat, W., Shigeoka, J. W., Wood, J. S., & Bradford, D. C. (1984). Aerobic exercise training and improved neurophysiological function of older adults. *Neurobiology of Aging*, 5, 35-42.
- Emery, C. F., Schein, R. L., Hauck, E. R., & MacIntyre, N. R. (1998). Psychological and cognitive outcomes of a randomized trial of exercise among patients with chronic obstructive pulmonary disease. *Health Psychology*, 17, 232-240.
- Etnier, J., Johnston, R., Dagenbach, D., Pollard, R. J., Rejeski, W. J., & Berry, M. (1999). The relationships among pulmonary function, aerobic fitness, and cognitive functioning in older COPD patients. *Chest*, 116, 953-960.
- Etscheidt, M. A., & Ayllon, T. (1987). Contingent exercise to decrease hyperactivity. *Journal of Child and Adolescent Psychotherapy*, 4, 192-198.
- Evans, W. H., Evans, S. S., Schmid, R. E., & Pennypacker, H. S. (1985). The effects of exercise on selected classroom behaviors of behaviorally disordered adolescents. *Behavioral Disorders*, 11, 42-51.
- Fabre, C., Chamari, K., Mucci, P., Masse-Biron, J., & Prefaut, C. (2002). Improvement of cognitive function by mental and / or individualized aerobic training in healthy elderly subjects. *International journal of sports medicine*, 23, 415- 421.
- Goldbeck L., & Schmid, K. (2003). Effect of autogenic relaxation training on children and adolescents with behavioral and emotional problems. *Journal of American Academy of Child and Adolescent Psychiatry*, 42,1046-1054.
- Hall, C. D., Smith, A. L., & Keele, S. W. (2001). The impact of aerobic activity on cognitive function in older adults: A new synthesis based on the concept of executive control. *European Journal of Cognitive Psychology*, 13, 279-300.
- Hawkins, H. L., Kramer, A. F., & Capaldi, D. (1992). Aging, exercise, and attention. *Psychology and Aging*, 7, 643-653.
- Hill, R. D., Storandt, M., & Malley, M. (1993). The impact of long-term exercise training on psychological function in older adults. *Journal of Gerontology*, 48, 12-17.
- Ho, Y., & Chan, A. (2005). Comparing the effects of mahjong playing and reading on cognitive reserve of the elderly. *Journal of Psychology in Chinese Societies*, 6, 5-26.
- Ho, Y., Cheung, M. C., & Chan, A. S. (2003). Music training improves verbal but not visual memory: cross-sectional and longitudinal explorations in children. *Neuropsychology*, 17, 439-450.

- Hollmann, W., & Struder, H. K. (2000). Brain function, mind, mood, nutrition, and physical exercise. *Nutrition, 16*, 516-519.
- Hong, Y., Li, J. X., & Robinson, P. D. (2000). Effects of long-term Tai Chi exercise on balance, flexibility, and cardiovascular response in the elderly. *British Journal of Sports Medicine, 34*, 29-34.
- James, D. T. D., & Coyle, C. (1998). Aerobic Exercise, IQ and Memory in the Older Adult. *Education and Ageing, 13*, 37-48.
- Jin, P. (1989). Changes in heart rate, noradrenaline, cortisol and mood during Tai Chi. *Journal of Psychosomatic Research, 33*(2), 197-206.
- Jin, P. (1992). Efficacy of Tai Chi, brisk walking, meditation, and reading in reducing mental and emotional stress. *Journal of Psychosomatic Research, 36*(4), 361-370.
- Jacobs, G. D. (2001). Clinical applications of the relaxation response and mind/body interventions. *Journal of Alternative and Complementary Medicine, 7*, S3-S101.
- Jacobs, G. D., Benson, H., & Friedman, R. (1993). Home-based central nervous system assessment of a multifactor behavioral intervention for chronic sleep-onset insomnia. *Behavioral Therapy, 24*, 159-174.
- Jacobson, B. H., Chen, H. C., Cashel, C., & Guerrero, L. (1997). The effect of Tai Chi Chuan training on balance, kinesthetic sense, and strength. *Perceptual and Motor Skills, 84*, 27-33.
- Kirschbaum, C., Wolf, O. T., May, M., Wippich, W., & Hellhammer, D. H. (1996). Stress- and treatment-induced elevations of cortisol levels associated with impaired declarative memory in healthy adults. *Life Sciences, 58*, 1475-1483.
- Klein, P. J., & Adams, W. D. (2004). Comprehensive therapeutic benefits of Taiji: A critical review. *American Journal of Physical Medicine & Rehabilitation, 83*(9), 735-745.
- Klein, S. A., & Deffenbacher, J. L. (1977). Relaxation and exercise for hyperactive, impulsive children. *Perceptual and motor skills, 45*, 1159-1162.
- Kramer, A. F., Hahn, S., Cohen, N. J., Banich, M. T., McAuley, E., Harrison, C. R., Chason, J., Vakil, E., Bardell, L., Boileau, R. A., & Colcombe, A. (1999). Ageing, fitness and neurocognitive function. *Nature, 400*, 418-419.
- Kramer, A. F., Hahn, S., & McAuley, E. (2000). Influence of aerobic fitness on the neurocognitive function of older adults. *Journal of Aging and Physical Activity, 8*, 379-385.
- Labbe, E. E., & Welsh, C. (1993). Children and running: Changes in physical fitness, self-efficacy, and health locus of control. *Journal of Sport Behavior, 16*, 85-97.
- Lai, J. S., Lan, C., Wong, M. K., & Teng, S. H. (1995). Two-year trends in cardiorespiratory function among older Tai Chi Chuan practitioners and sedentary subjects. *Journal of the American Geriatrics Society, 43*(11), 1222-1228.
- Lan, C., Chen, S. Y., Lai, J. S., & Wong, M. K. (1999). The effect of Tai Chi on cardiorespiratory function in patients with coronary artery bypass surgery. *Medicine & Science in Sports & Exercise, 31*(5), 634-638.
- Lan, C., Lai, J. S., Chen, S. Y., & Wong, M. K. (1998). Twelve-month tai chi training in the elderly: Its effect on health fitness. *Medicine and Science in Sports and Exercise, 30*, 345-351.

- Leserman, J. Stuart, E. M., Mamish, M. E., & Benson, H. (1989). The efficacy of the relaxation response in preparing for cardiac surgery. *Behavioral Medicine, 15*, 111-117.
- Leung, P. W. L., Kwong, S. L., Tang, C. P., Ho, T. P., Hung, S. F., Lee, C. C., Hong, S. L., Chiu, C. M., & Liu, W. S. (2006). Test-retest reliability and criterion validity of the Chinese version of CBCL, TRF, and YSR. *Journal of Child Psychology and Psychiatry, 47*, 970-973
- Li, F., Duncan, T. E., & Duncan, S. C. (2001). Enhancing the psychological well-being of elderly individuals through Tai Chi exercise: A latent growth curve analysis. *Structural Equation Modeling, 8*(1), 53-83.
- Li, F., McAuley, E., Harmer, P., Duncan, T. E., & Chaumeton, N. R. (2001). Tai Chi enhances self-efficacy and exercise behavior in older adults. *Journal of Aging and Physical Activity, 9*, 161-171.
- Little, S., & Jackson, B. (1974). The treatment of test anxiety through attentional and relaxation training. *Psychotherapy: Theory, Research, Practice, Training, 11*, 175-178.
- Lupien, S. J., de Leon, M., de Santi, S., Covit, A., Tarshish, C., Nair, N. P., Thakur, M., McEwen, B. S., Hauger, R. L., & Meaney, M. J. (1998). Cortisol levels during human aging predict hippocampal atrophy and memory deficits. *Nature Neuroscience, 1*, 69-73.
- MacMahon, J. R., & Gross, R. T. (1987). Physical and psychological effects of aerobic exercise in boys with learning disabilities. *Journal of Developmental and Behavioral Pediatrics, 8*, 274-247.
- Mandle, C. L., Jacobs, S. C., Arcari, P. M., & Domar, A. D. (1996). The efficacy of relaxation response interventions with adult patients: a review of the literature. *Journal of Cardiovascular Nursing, 10*, 4-26.
- Monroe, S. M., Harkness, K., Simons, A. D., & Thase, M. E. (2001). Life stress and the symptoms of major depression. *Journal of Nervous and Mental Disease, 189*, 168-175.
- Nakao, M., Fricchione, G., Myers, P., Zuttermeister, P. C., Barsky, A. J., & Benson, H. (2001). Depression and education as predicting factors for completion of a behavioral medicine intervention in a mind/body medicine clinic. *Behavioral Medicine, 26*, 177-184.
- Omizo, M. (1980). The effects of biofeedback-induced relaxation training in hyperactive adolescent boys. *Journal of Psychology, 105*, 131-138
- Pelletier, K. R. (1977). *Mind as healer, mind as slayer. A holistic approach to preventing stress disorders*. New York: Delta.
- Richards, M., Hardy, R., & Wadsworth, M. E. J. (2003). Does active leisure protect cognition? Evidence from a national birth cohort. *Social Science and Medicine, 56*, 785-792.
- Rossmann, H., & Kahnweiler, J. (1977). Relaxation Training with Intermediate Grade Students. *Elementary School Guidance and Counseling, 11*, 259 – 265.
- Sandlund, E. S., & Norlander, T. (2000). The effects of Tai Chi Chuan relaxation and exercise on stress responses and well-being: An overview of research. *International Journal of Stress Management, 7*(2), 139-149.
- Sapolsky, R. M. (1996). Why stress is bad for your brain. *Science, 273*(5276), 749-750.
- Schwartz, J. M., & Begley, S. (2002). *The mind and the brain. Neuroplasticity and the power of mental force*. New York : Regan Books.

- Slater, J., & Hunt, H. T. (1997). Postural-vestibular integration and forms of dreaming: A preliminary report on the effects of brief Tai Chi Chuan training. *Perceptual and Motor Skills, 85*(1), 97-98.
- Stewart, R. Prince, M., & Mann, A. (2003). Age, vascular risk, and cognitive decline in an older, British, African-Caribbean population. *Journal of American Geriatric Society, 51*, 1547-1553.
- Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics (4th ed.)*. Boston: Allyn & Bacon.
- Thompson, J. G., Griebstein, M. G., & Kuhlenschmidt, S. L. (1980). Effects of EMG biofeedback and relaxation training in the prevention of academic underachievement. *Journal of Counseling Psychology, 27*, 97-106.
- Toole, T., & Abourezk, T. (1989). Aerobic function, information processing, and aging. In A. Ostrow (Ed.), *Ageing and motor behavior* (pp. 37-65). Indianapolis: Benchmark press.
- Tsang, H.W.H., Cheung, L., & Lak, D. (2002). Qigong as a psychosocial intervention for depressed elderly with chronic physical illnesses. *International Journal of Geriatric Psychiatry, 17*, 1146-1154.
- Tuckman, B. W., & Hinkle, J. S. (1986). An experimental study of the physical and psychological effects of aerobic exercise on schoolchildren. *Health Psychology, 5*, 197-207.
- Van Boxtel, M., Paas, F., Houx, P., Adam, J., Teeken, J., & Jolles, J. (1997). Aerobic capacity and cognitive performance in a cross-sectional aging study. *Medicine and Science in Sports and Exercise, 10*, 1357-1365.
- Wang, Y. T., Taylor, L., Pearl, M., & Chang, L. S. (2004). Effects of Tai Chi exercise on physical and mental health college students. *American Journal of Chinese Medicine, 32*(3), 453-459.
- Yeh, G. Y., Wood, M. J., Lorell, B. H., Stevenson, L. W., Eisenberg, D. M., Wayne, P. M., Goldberger, A. L., Davis, R. B., & Phillips, R. S. (2004). Effects of Tai Chi mind-body movement therapy on functional status and exercise capacity in patients with chronic heart failure: A randomized controlled trial. *The American Journal of Medicine, 117*, 541-548.
- Young, D. R., Lawrence, A., Jee, S. H., & Miller, E. R. III. (1999). The effects of aerobic exercise and Tai Chi on blood pressure in older people: Results of a randomized trial. *Journal of the American Geriatrics Society, 47*(3), 277-284.