Developing a Training Intervention to Improve Performance of Neuropsychological Skills in ADHD Children

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ABSTRACT

Cognitive neuroscience and attention are closely related to each other. By looking at the neurocognitive problems of hyperactivity and the benefits of cognitive function, the purpose of this study was to evaluate the effectiveness of a training intervention to improve the performance of neuropsychological skills of ADHD children. Twenty nine students 9–12 years old who had been exposed to high levels of hyperactivity were selected from prior studies. The outcomes measures before and after the intervention were collected during a 13-week study. Post training performance of participants in the EPCP group was significantly higher. ADHD children in the control group had significantly lower performance. The training program that we set up in this study was effective for improving the performance of neuropsychological skills in ADHD children. The findings of this study conclude that an Educational Package of Cognitive Plays (EPCP) program can protect ADHD students from a reduction in neuropsychological skills at the processing and organizing of the information.

Key Words: Neuropsychological Skills, ADHD Children, Students, Intervention

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Introduction

According to the Diagnostic and Statistical Manual of Mental Disorders-5th Edition (DSM-IV), Attention deficit hyperactivity disorder (ADHD) is a category of neurodevelopmental disorders. This disorder in childhood often overlaps with "extrapolated" disorders such as coping disobedience and behavioral disorder (American Psychiatric Association, 2013). On the other hand, as a disorder in childhood with obvious symptoms of neglect and impulsivity, it has attracted the attention of many researchers (Charach *et al.*, 2013; Wang, 2017; Xiaoxu *et al.*, 2017); as long as one of the neuropsychiatric hypotheses of this disorder is based on a malfunction of the cerebrospinal region of the cornea with a sluggishness of metabolism and less blood flow, as well as damage to the cortical structures and under the cortex of the brain (McLachlan *et al.*, 2017). Also, the studies of nerve psychiatric and histology and nerve chemistry emphasize the role of different mechanisms of the right hemisphere, especially for controlling behaviors, and in general, the multiple manifestations of ADHD overlap with disorders in the neurological regions. Particularly, frontal cortex and right hemisphere parietal are associated with under-cortical structures.

In recent years, early diagnosis and intervention of young children with neuropsychological disabilities has attracted the attention of some researchers. The psychological nerve's explanations are very important in this regard, which is to examine the relationship between mental processes and brain

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(brain cortex) (Semrud-Clikeman and Teeter Ellison, 2009). Under the influence of these findings, the psychological nerve patterns associated with ADHD have been proposed by neuropsychologists in recent decades (Musser *et al*., 2011).

Issues such as cognitive impairments, specific damage in attention and executive functions are the main hypotheses raised in this disorder. Children with ADHD have a low score and show a poor performance in many assignments, such as waiting, keeping attention, motor inhibition, executive functions, and verbal learning and memory (Cantwell, 1996). They also need to receive mental health services along with other common treatments for this disorder.

The National Institute of Clinical Evolution concluded that a comprehensive health plan should be involved with the views and support of teachers and parents and both are important in the treatment. It is also necessary to improve communication with schools in order to make feedback from assessments, along with reviewing the effectiveness of drugs (Clinical Governance, 2004). Drug therapy for this disorder involves central nervous system stimulants, but taking medicine alone can rarely meet the therapeutic needs of ADHD children and requires psychological interventions (Michael and Wendt, 2001; Dogra and Veeraraghavan, 1994). Regarding this issue, it is necessary to use intervention programs to resolve or improve the neuropsychological problems in these children.

The present study developed a training intervention program to effectively improve the performance of neuropsychological skills in ADHD children. Our experimental study used the variables attention, memory, sensory-motor activities and visual-spatial processing as indicators of neuropsychological skills (Sidemen, 2006). Furthermore, we included stimulated somatosensory cortex as an important motor and sensory-related outcome variable (Jorquera-Cabrera *et al*., 2017; Sanz-Cervera *et al*., 2017). We hypothesized that the intervention program we designed would effectively improve in the variables stimulated somatosensory cortex (hypothesize 1), attention, memory, sensory-motor activities and visual-spatial processing (hypothesize 2).

Methods

Participants

This experimental study was done during the spring of 2016. Children with ADHD were recruited through four elementary schools in Shijiazhuang (China). We invited students to participate and provided with information about our study. This study was approved by the ADHD Pediatric Behavioral Therapy Center in Shijiazhuang. We invited 29 elementary students 9-12 years old (mediation: 10.2 years) who had higher total scores in ADHD. Only three female students agreed to participate, so we excluded them from our study to allow this report to focus only on male students with ADHD. The inclusion criteria were: a confirmed diagnosis of ADHD, age 9-12 years, male student, IQ 90-120 according to the fourth Wechsler IQ test, and not having other disorders that limits this study. Participants were randomly assigned to an EPCP group (n = 15) and a control group (n = 14).

The EPCP program

The Educational Package of Cognitive Plays (EPCP) program was performed 13 weekly hour-long sessions (two sessions a week and last week one session) based on scientific background and acknowledgment by the experts of learning disabilities in 11 sets of collections during three months (spring 2016). The content of the EPCP program sessions is presented in Table 1.

Procedure

At the subject recruitment stage, the researcher collects a pretest IQ and neuropsychological skills during the first week. He gave a detailed instruction list to the children with ADHD. Also, he collects the posttest neuropsychological skills and intervention implementation record after the 25 sessions (13 weeks) (Fig. 1).

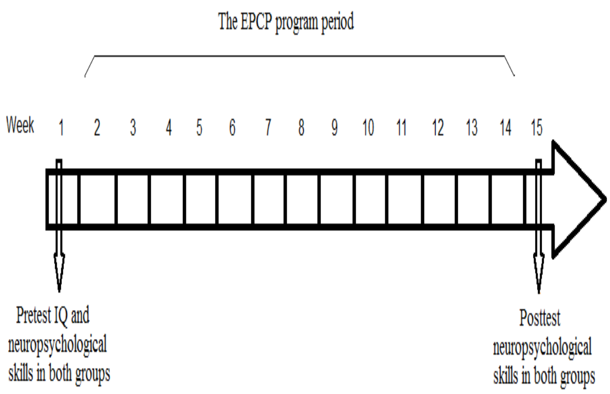

Figure 1. Procedure design and timing of sample collection in the present study

Table 1. Content of the EPCP program sessions during 25 sessions

Row	Play name	Play nature	Play method	Play goal
1	Point to point	Pencil and paper	Points are connected to each other by pencil in numerical order	Strengthening visual sequence, increasing selective attention
2	Look carefully	Pencil and paper	Child looks at shapes and marks a different shape by a pencil	Increasing visit accuracy and visual memory, increasing the thresholds of focus and attention, enhancing visual perception
3	Hidden image reminder	Pencil and paper	We first show two images to child, then we hide the images and we ask him to name those images.	Enhancing visual memory and active memory
4	Remember	Pencil and paper	We show an image to child and ask him to remember the whole and the details, and then we ask for the details by asking questions.	Enhancing visual accuracy and attention, enhancing visual memory, understanding the details of an image, enhancing active memory
5	Remembering pictures	Pencil and paper	We show an image to the student and ask him to remember the shapes and components. After a precision at a desired time, we'll show him the next page's image and ask him to identify the shapes that were removed or added in the image.	Enhancing visual accuracy and attention, enhancing visual memory, understanding the details of an image, enhancing active memory
6	Regulating pictures	Pencil and paper	We show unusual images to the student and ask him to number the images based on the story.	Understanding relationship between whole and component, the coherence of detail, the creativity of mind, ability to attach images
7	Matching symptoms	Pencil and paper	We show some shapes to the student that each of them has different symptoms, and we ask him to complete other shapes by related symptoms according to the sample.	Enhancing visual memory, coordinating eye and hand, boosting speed
8	Search for hidden image	Pencil and paper	We show images to the student and ask him to find the image by the number of titles	Understanding text and context, increasing accuracy and attention, visual distinction
9	Visual contradictions	Pencil and paper	We show the wrong images to the student and want to specify these images	Increasing accuracy and focus, strengthening the threshold of focus
10	Counting shapes	Pencil and paper	We show images to the student and want to count those images	Increasing selective attention and recognizing memory.
11	Dash line	Pencil and paper	We ask student to complete the desired dash line to reach his goal.	Increasing visual sequence and selective attention, divided attention, coordinating eye and hand
12	Continue shape	Pencil and paper	In this game, the student is asked to complete the shape according to the sequence of desired shapes.	Increasing precision and focus, visual memory, and visual sequence
13	Cluttered yarns	Pencil and paper	We ask the student to follow painted yarns to reach desired goal.	Increasing visual sequence, selective attention, coordinating eye and hand
14	Visual completion	Pencil and paper	In this game, we show a target shape to the student and want him to complete the incomplete forms according to the goal shape.	Increasing precision and focus, increasing spatial memory.
15	Recognition memory	Pencil and paper	We first show different shapes on a page to the student. After a few seconds, he goes to next page and identifies the shapes seen on the previous page.	Increasing recognition memory, visual perception and active memory
16	Play with names of colors	Pencil and paper	At the first, the student is asked to read the names of colors that their shape and color are the same. Then we want to name a strip of different colors. In the final step, we want to state the printed names of colors regardless of the observed color.	Increasing selective and visual attention, visual perception, the speed of naming and central cohesion
17	Call speed	Pencil and paper	Showing the number of words, letters, numbers and pictures in sequence and separately, and naming them	Increasing name speed and selective attention
18	Ambiguous frame	Pencil and paper	We show a frame of obscure images to the student, and then we ask him to identify the obscure images.	Increasing recognition of spatial relationships, accuracy and concentration, and increasing focus divided
19	Frosty game	Pencil and paper	In this game, the student draws similar designs by connecting a series of points to each other.	Increasing visual perception and spatial memory, strengthening central coherence
20	Incomplete images	Pencil and paper	We ask the student to complete incomplete drawings according to the purpose.	Increasing accuracy and attention, recognition of spatial relationships and visual fulfillment, central cohesion
21	Shape stability	Pencil and	We ask the student to recognize desired shape, regardless of size and how it is placed on a page that consists of a variety	Increasing executive function and visual accuracy, strengthening

		paper	of geometric shapes.	coordination and visual-motor speed
22	Sudoku chart	Pencil and paper	The student should not repeat image, number or letters on horizontal and vertical tables.	Enhancing mental and learning abilities, increasing accuracy and focus
23	Lost piece	Pencil and paper	We show interesting pictures with a missing piece to the student and ask him to find a lost image mentally, which some of the pieces are outside frame.	Increasing visual attention and perception, increasing spatial memory
24	Maze	Pencil and paper	We ask the student to find requested path.	Increasing executive function (planning and forecasting) and visual accuracy, strengthening coordination and visual-motor speed
25	Listen to words	Pencil and paper	We read some words or numbers for the child within a second, and he should tell the words in the same order as he heard. After the success, we increase the number of words or numbers.	Enhancing auditory memory, auditory sequence, verbal acoustic memory and auditory-visual memory

Measures

Stimulated somatosensory cortex

Stimulated somatosensory cortex was measured of the Sensory Processing Characteristics (SPM) scale (Jorquera-Cabrera *et al.*, 2017; Sanz-Cervera *et al.*, 2017), which consists of sixty two items in the original version. The content of the scale covers behaviors and characteristics related to sensory processing, social participation and praxis. The scale ranged from 1 (never) to 4 (always). We obtained an alpha coefficient of 0.88 at before and 0.86 after the EPCP program.

Neuropsychological skills

We used the scales attention, memory, sensory-motor activities and visual-spatial processing of the Conners' Neuropsychological Test as indicator of neuropsychological skills (Sidemen, 2006). This test was made by Conners in 2004 in order to assess the neuropsychological skills in four Likert levels (not observed so extreme) for children aged 5 to 12 years. We obtained an alpha coefficient of 0.73 at before and 0.79 after the EPCP program.

Statistical analysis

A 2 × 2 MANOVA was used to compare the two related pretest and posttest outcome measures and assess the differences in stimulated somatosensory cortex and neuropsychological skills levels between the EPCP group that used the EPCP program and the control group. The critical value was 0.05.

Results

Twenty nine students with ADHD were enrolled in our experimental study and three IQ samples were collected from each participant before the EPCP program. According to Table 2, the median age of the students was 10.2 years. Most the male students were studying in third grade (n = 12, 41.4%) and had an IQ level of 100-110 (n = 19, 65.5%) and a Caucasian/white race (n = 22, 75.9%).

Given the participants' Stimulated somatosensory cortex in Table 3, we observed no significant differences between the EPCP group (M = 3.12, SD = 0.59) and the control group (M = 3.19, SD = 0.43). Also, we observed no significant differences for the variables attention (in the EPCP group: M = 2.24, SD = 0.45; in the control group: M = 2.26, SD = 0.73), memory (in the EPCP group: M = 2.67, SD = 0.48; in the control group: M = 2.59, SD = 0.34), sensory-motor activities (in the EPCP group: M = 3.01, SD = 0.38; in the control group: M = 2.94, SD = 0.55), and visual-spatial processing (in the EPCP group: M = 3.14, SD = 0.72; in the control group: M = 3.17, SD = 0.18). These results show that there is not significant difference between both groups with respect to the variables Stimulated somatosensory cortex, attention, memory, sensory-motor activities, and visual-spatial processing.

The first hypothesis stated that the EPCP program has a positive effect on stimulated somatosensory cortex. As expected, the students with ADHD reported an increase of stimulated somatosensory cortex during the processing and organizing of the information in the EPCP group (M = 3.12, SD = 0.59 at time 1, and M = 3.34, SD = 0.64 at time 2). The second hypothesis was that the EPCP program has a positive effect on attention, memory, sensory-motor activities and visual-spatial processing. After the program, participants in the EPCP group reported an increase of attention (M = 2.24, SD = 0.45 at time 1, and M = 2.41, SD = 0.52 at time 2), memory (M = 2.67, SD = 0.48 at time 1, and M = 2.92, SD = 0.53 at time 2), sensory-motor activities (M = 3.01, SD = 0.38 at time 1, and M = 3.19, SD = 0.42 at time 2), and visual-spatial processing (M = 3.14, SD = 0.72 at time 1, and M = 3.32, SD = 0.66 at time 2) whereas participants in the control group reported a decrease of the variables. Thus, hypothesis (2) could be partially supported.

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Table 2. Characteristics of participants (age, IQ, race, and elementary grade)

Variables		All participants (n = 29)		EPCP group (n = 15)		Control group (n = 14)	
		n	%	n	%	n	%
Age, mean (SD)		10.2	1.14	10.7	1.11	10.5	1.08
IQ	90-100	7	24.1	5	33.3	3	21.4
	100-110	19	65.5	8	53.4	9	64.3
	110-120	3	10.4	2	13.3	2	14.3
Race	African American	4	13.8	4	26.7	4	28.6
	Caucasian/white	22	75.9	9	60	8	57.1
	Multiracial	2	6.9	1	6.6	2	14.3
	Other/not reported	1	3.4	1	6.7	0	00.0
Elementary grade	Third	12	41.4	5	33.3	6	42.9
	Fourth	11	37.9	5	33.3	3	21.4
	Fifth	4	13.8	3	20	2	14.3
	Sixth	2	6.9	2	13.4	3	21.4

Table 3. Results for stimulated somatosensory cortex and neuropsychological skills

Measure		EPCP group (M/SD)	Control group (M/SD)
Stimulated somatosensory cortex	Before the program	3.12 (0.59)	3.16 (0.43)
	After the program	3.34* (0.64)	2.73* (0.55)
Attention	Before the program	2.24 (0.45)	2.26 (0.73)
	After the program	2.41* (0.52)	2.02* (0.81)
Memory	Before the program	2.67 (0.48)	2.59 (0.34)
	After the program	2.92** (0.53)	2.28** (0.46)
Sensory-motor activities	Before the program	3.01 (0.38)	2.94 (0.55)
	After the program	3.19* (0.42)	2.74* (0.57)
Visual-spatial processing	Before the program	3.14 (0.72)	3.17 (0.18)
	After the program	3.32* (0.66)	3.02* (0.24)

*$\rho < 0.05$, **$\rho < 0.01$

Discussion

This is the few studies that have used cognitive plays to try to improve performance of ADHD children. We found that an Educational Package of Cognitive Plays (EPCP) program was helpful for improving the performance of neuropsychological skills. Stimulating the somatosensory cortex increased attention, memory, sensory-motor activities, and visual-spatial processing. The huge increases in the neuropsychological skills of these ADHD students implied that our EPCP program efficaciously improved the students' level of performance.

In explaining the above results, it can be inferred that children with learning disabilities are born with neurological limitations that limit their initial interactions with the world. Early and continuous interventions can largely overcome these limitations. Given the flexibility of brain and the benefits of psychological nerve and the positive effect of learning in game, training the cognitive and psychological components expressed in the form of a game as restoration training not only improves the level of academic performance during the treatment, but can also be effective in early cognitive and neuropsychological interventions in pre-primary education. One of the basic and underlying problems of children with ADHD is the defect in neuropsychological skills. Therefore, methods should be designed to improve these skills. One of these methods is sensory integrity Educational Package of Cognitive Plays (EPCP) that can directly improve the psychology skills and indirectly reduce the ADHD symptoms. The neuropsychological skills (attention, memory, sensory-motor activities and visual-spatial processing) are the foundation of learning in children especially ADHD children. Therefore, by developing and improving these basic skills, learning can be improved. Also, attention deficit disorder is the most prominent and biggest problem for these children, which makes them difficult to control the various stimuli and can not do it well (Ayres, 1989). EPCP strategy can be effective on the performance of the upper levels of brain that is responsible for performing excellent processes including attention.

Attention deficit disorder includes a wide range of students' educational problems.

When children's attention deficit and ADHD problems remain unknown, these will be exposed to emotional and social problems. Therefore, the use of appropriate interventions can be effective in improving this childhood disorder. It can be said that hyperactivity is the most obvious problem of ADHD children, in which brain function has problems in several areas including hyperactivity, and disturbances in the right hemisphere and damage to it, the basal ganglia (because of the relationship between control of muscle movements and voluntary movements) and as well as the frontal and prefrontal lobe of the brain lead to decreased person's intentional-motor activities and hyperactivity (Ayres, 1989). Most parents have weakness in some cases, such as playing and creating neuropsychological stimulation situations and providing a dynamic cognitive and emotional environment for children's play, therefore training to the parents of children with neuropsychological problems and learning disorder, especially ADHD children, can play an important role in this regard. Abdollahian et al. (2013) reported a relationship between reducing the symptoms of ADHD and play therapy in a clinical trial intervention with a children aged 7-9 years sample and concluded that play therapy could be used as an effective treatment method for children with ADHD. Wilkes-Gillan et al. (2016) showed the strong relationships between a play-based intervention and social play skills of children with ADHD in peer-to-peer interactions. Our study could partially support these results.

The major limitation of this study is that we did not use the follow-up test, while follow-up tests are essential to assess the long-term effects of interventions because follow-up courses provide more accurate indicators of people's recovery in order to stabilize and sustain the improvement. Further, our study focused only on male students, and the future researchers can add female students to their sample.

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