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Original Article

Physiotherapy Section

Comparative Efficacy of Structured Games and Behavioural Parent Training on Working Memory in Children with Attention Deficit Hyperactivity Disorder: A Pilot Study

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ABSTRACT

Introduction: Attention Deficit Hyperactivity Disorder (ADHD) may develop during the preschool years of the child and extend into adulthood. ADHD also leads to impaired Working Memory (WM) creating problems in various functions.

Aim: To compare the effectiveness of behavioural parent training and structured games on WM of children with ADHD.

Materials and Methods: This prospective interventional study was conducted in 18 schools of Ghaziabad City, Uttar Pradesh, India. Seventy subjects were selected based on Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) criteria. Group A (n=35) received structured games and Group B (n=35) received Behavioural Parent Training (BPT). Seguin Form Board Test Time (SFBTT) was recorded as outcome on baseline and 5th week. Student's paired and unpaired t-test was done. SPSS 22.0 version was the software used and $p<0.05$ was considered as level of significance.

Results: Analysed data showed significant results within structured games group with $t=2.355$, $p<0.05$, and no significant result within BPT group with $t=-0.776$, $p>0.05$. Between group comparison showed significant difference with $t=-2.804$, $p<0.05$.

Conclusion: Training of WM in form of structured games can be an effective method when compared to BPT in children with ADHD.

Keywords: Parent child interaction, Phonological loop, Visuospatial sketchpad

INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) effects about 11% of children and 5% of adults [1]. It is characterised by symptoms of inattention, impulsivity and hyperactivity. Children with ADHD may have problems with education, social lives or may have mental illness during adolescence [2].

The prevalence of ADHD has been estimated at 5-7.1% in children and adolescents worldwide [3]. Diagnosis in childhood is associated with poor educational, occupational, economic, and social outcomes. Prevalence rate may be 4% in girls and 8% in boys in the preschool age group [4].

Inattention, hyperactivity, and impulsivity are the core symptoms of ADHD. Hyperactive-Impulsive symptoms in children includes fidgets with hands or feet or squirms in chair, has difficulty remaining seated, runs about or climbs excessively. In ADHD combined presentation, the individual meets the criteria for both inattention and hyperactivity-impulsivity [3]. The symptoms/behaviour of a child with ADHD evolve with age. A young preschool going child may show motor overactivity in the form of constant running or frequently shift from one activity to another. While, an older child may show restlessness [5]. In spite of various studies on ADHD, exact cause of the disorder is still unknown. Multiple genetic studies have determined a strong evidence of inheritance with multiple interacting genes [6].

ADHD children generally show profound impairments in WM reflected as difficulty in planning, attention and response inhibition. Attentional control and WM relay on a common set of neural structures, many of which are implicated as dysfunctional in ADHD [7,8]. WM requires storage and processing of information concurrently and is divided into 3 sub-components: Central executive, Visuospatial sketchpad and the phonological loop [9]. Central executive system controls co-ordinates the operation of two subsystems- the visuospatial sketch pad and phonological loop. It also deals with cognitive tasks such as mental arithmetic and problem solving e.g., learning. Visuo-spatial sketchpad (inner eye) stores and process information in a visual or spatial form. It is used for navigation. The ability to develop, inspect, and navigate through a mental image is thought to be a cardinal function of visuospatial sketchpad e.g., while driving a car, visualising driving directions to turn left at the next block, and right at the spotlight. The phonological loop is a section of WM which deals with spoken and written material [9]. It consists of two parts:

Phonological store (inner ear): It is linked to perception of speech, i.e., information of what we hear,

Articulatory control process (inner voice): It is related to production of speech, it rehearses words to keep them in WM for verbal information e.g., memorising a phone number [9].

BPT provides parents with behaviour modification techniques that are based on social learning principles. BPT teaches parents the skills and strategies to create a structure and reinforce good behaviour. In this strategy, parents are trained to use specialised contingency techniques to manage child behaviour in the form of positive reinforcement through praise or a reward for a pro-social behaviour and non-physical disciplinary techniques like timeout, reasoning with child, to control unwanted or negative behaviour [10,11]. BPT helps in creating a better fit between a child and parent in social settings (school, park etc) [12].

These methods are helpful when other clinical or medical interventions alone are unable to extract normal behaviour. BPT help parents to be equipped with means to regulate and manage the behaviour of their child. These strategies provide opportunities and encourage self-control of normal behaviour patterns [13,14].

In this study, WM training in the form of structured games in ADHD children were designed, in which the participants practiced structured games for five weeks. It aimed to execute the functions as well as create a therapist-subject relationship so that the child was encouraged to finish the task at hand.

This study compared the effects of structured games which utilises

visuospatial sketchpad and phonological loop in WM model of Baddeley A [15] and BPT on WM in ADHD.

MATERIALS AND METHODS

This was a multicentric prospective experimental pilot study, conducted in 18 pre-primary schools (Play school, Kindergarten level) who consented to take part in study over a period of one year (September 2018 to August 2019) in Ghaziabad city, Uttar Pradesh, India. This study was approved by the Institutional Ethics Committee of the University (REF-SBS/SOP/2018/09). Approval was also taken from the principals of the respective schools and the parents of the children for conducting the study.

Inclusion criteria: All of the children who were between 3-6 years and met DSM-IV [16] (APA, 1994) criteria for the diagnosis of ADHD based on clinical interview, who displayed at least 6 of 9 inattentive and/or hyperactive impulsive symptoms.

Exclusion criteria: Children with learning disability, autism or spectrum disorders, musculoskeletal impairments, developmental delay, subnormal IQ, visual and hearing impairments, on medication, uncooperative child and children of parents who did not give consent to study.

Sample size calculations was done using G-Power software, version 3.1.9.4. Effect size was calculated as 0.8 and power was 0.95. Seventy subjects were the sample sizes who were randomly divided into two groups using chit method. Each group had 35 children.

The variables used were independent variable and dependent variable. Independent variable were structure game and BPT. Dependent variable was SFBTT.

The material used in the present study were Seguin Form Board kit (Board, Blocks and Record sheet). Alphabetical blocks, ABC puzzle, Animal puzzle, Fruit cards, Stopwatch, Pencil, Notebook [17].

Independent variable:

- Structured games
- BPT

Dependent variables:

- SFBTT

Materials used

DSM-IV criteria

Seguin Form Board kit:

- Board
- Blocks
- Record sheet

Procedure

The subject were devided in to two groups, Group A (35) was structure game group which served as experimental group and Group B (35) included BPT group which served as control group.

Group A: The procedure of training included:

1. A B C blocks:

Position of the subject: Sitting

Instructions:

a. Subject was asked to watch the blocks carefully.
b. The board was covered with blocks.
c. When the subject was ready blocks were removed.
d. Then the subject was asked to place the blocks again at their places.

2. Animal puzzle:

Position of the subject: Sitting

Instructions:

a. Subject was asked to see the picture of the puzzle carefully for e.g., a puzzle resembling goat or cat.
b. The puzzle was divided into pieces.
c. Subject was asked to rearrange the pieces of puzzle to make a complete picture of animal as shown before.
d. A time period of 10 minutes was given to each subject to complete the puzzle.

3. Card placement:

For visuospatial memory:

Position of the subject: Sitting

Instructions:

a. The therapist put two cards on the table and asked the subject to name them for e.g., a card with a picture of sun or ball on it, the child was asked to name the card as sun or ball.
b. Then therapist flips the cards and asked the child to name them again.
c. Two more cards of different pictures are added and asked to name them and flipped again.
d. The therapist gradually increased the number of cards to 10 and followed the same rule for each series of the card.
e. In first step the cards were arranged vertically.
f. In second step the cards were arranged horizontally (for changing the method of brain processing).

4. Fruits classification:

Position of the subject: Sitting

Instructions:

a. The fruit cards were placed randomly on the table.
b. The subject was asked to divide the fruit cards on the basis of their colour and put on the table in a arranged manner for e.g., mango for yellow colour, guava for green colour.
c. Subject was asked to name the fruit and colour of the fruit and memorise it.
d. The therapist now turned the cards backwards. The subject was asked to pick a card, identify the fruit and put the card in the previously arranged place.

5. Capital letters puzzle [Table/Fig-1]

[Table/Fig-1]: Shows child performing capital letter puzzle.

Position of the subject: Sitting

Instructions:

a. The alphabets and their associated pictures were placed randomly on the table.
b. The subject was asked to match the alphabets with their associated pictures for e.g., in front of alphabet A the subject was supposed to attach the picture of apple.

The procedure was done four times a week for five weeks. A total of 20 sessions were given.

Group B: The procedure included:

Instructions:

a. The therapist conducted a parent meeting at school and explained about ADHD and the study.

b. Both the parents were trained about hyperactive behaviour of the child and were made to practice the behaviour control strategies and were also given a list of Do's and Don'ts. The list included the following components:

Praising: When the child begins and completes any given activity, the child should be praised for the desired behaviour. Simple phrases such as "good job" encourage the child to act appropriately.

Vary the statements given as praise: The phrases used by parents to encourage the child should vary; when the child hears same phrase, statement repeated over and over, it may lose its value or may be ineffective.

Ignore inappropriate behaviour: The parent should ignore or punish negative or inappropriate behaviour by non-physical discipline techniques such as time out.

Token economy system: On completing any task like homework, child can be encouraged by token system in the form of any eatable or reward.

Organisation: Organising everyday items. Have a place for everything and keep everything in its place. This includes clothing, backpacks and toys.

Routine: Keeping a routine and a schedule. Keep the same routine every day, from wake-up time to bed time. It includes times for homework, outdoor play, and indoor activities.

c. The parents were supervised for the first day and trained how to handle behaviour. They were asked to report twice a week about the changes in child's behaviour.

d. Treatment of five days per week for five weeks was given. A total of 25 sessions were given.

SFBTT was recorded on the baseline and on the last day of fifth week, post-training in both the groups. Stop watch was used to record the time taken to finish the SFBT. The subject repeated the test three times and shortest time to complete the test was included for comparison [Table/Fig-2].

[Table/Fig-2]: Shows child performing SFBT.

STATISTICAL ANALYSIS

SPSS version 22.0 was used for analysis. Data was tested for Normality using Shapiro-Wilk test, paired and un-paired t-tests were used to compare with-in and between groups. The $p<0.05$ was considered significant.

RESULTS

SFBTT was recorded on the baseline and on the first day of sixth week after five weeks of training. Mean and standard deviation scores of the groups were used for comparisons.

Mean and SD values of the age of ADHD children participating in the study were similar [Table/Fig-3].

	No of subjects	Mean±SD (years)
Structured games group (A)	35	4.58±1.03
BPT group (B)	35	4.52±1.08

[Table/Fig-3]: Mean and SD of age of children participated in the study.

The Mean and SD values of SFBTT showed reductions in SFBT time in structured games group but increased time for completion was noted in BPT group [Table/Fig-4].

Groups	Mean (Sec)	SD
Group A pre	41.3143	14.26178
Group A post	37.2286	8.90831
Group B pre	43.0286	10.50626
Group B post	44.2857	11.93012

[Table/Fig-4]: Pre and post values of SFBT time in both groups.

Data was tested for normality to apply statistical test. It was observed that data was normally distributed and parametric test was used for comparisons [Table/Fig-5].

	Shapiro-Wilk	
Groups	Statistic	p-value
Group A pre	0.904	0.005
Group A post	0.969	0.416
Group B pre	0.946	0.086
Group B post	0.950	0.115

[Table/Fig-5]: Shapiro-wilk test for normal distribution of data in both groups.

Comparisons within Group A shows significant differences with $p<0.05$. Comparison within Group B shows non-significant differences with $p>0.05$ [Table/Fig-6].

	t-value	p-value
Group A pre-Group A post	2.355	0.024
Group B pre-Group B post	-0.776	0.443

[Table/Fig-6]: Shows comparison of pre vs post data of SFBT time with in both groups.

Comparison between the groups showed significant differences with $p<0.05$ [Table/Fig-7].

	t-value	p-value
Group A post Group B post	-2.804	0.007

[Table/Fig-7]: Comparison of post vs post data of SFBT time between both groups.

DISCUSSION

The study found significant differences within the structured games group with t-value 2.355 and $p<0.05$. Comparison with in BPT group elicited non-significant differences with t-value -0.776 and $p>0.05$. Between group comparison also showed significant differences.

The significance of structured games on SFBT can be attributed to the games which contribute to the cognitive, physical, social and emotional well-being of the child and helps to increase attention and improves non-verbal skills which the child utilised in trials. When a child participates in play, it helps in improving cognitive skills required to perform with peer group, encourages reasoning and logical thinking required to solve complex problems, and creates opportunities to show intelligence there by enhancing Intelligence Quotient. It was observed that there were improvements between 33% to 67% in IQ by promoting

qualities like patience, adjustment, language correspondence, social bonding and showing emotions [18]. This is also supported by Bradley RH, Elardo R et al., whose works have shown a positive correlation between availability of toys at infant stage to increments in IQ at 3 years of age and stated that early play enhances intelligence development of child [19,20]. Jaak P found that play stimulates production of a protein, 'brain-derived neurotrophic factor', in the amygdala and the prefrontal cortex, which are responsible for organising, monitoring, and planning for the future [21].

Structured games like, alphabetical blocks, puzzle, card placement, fruits classification were used in this study. While playing games, the location of the cards or pieces of puzzle were responsible for the short-term storage of visual and spatial information, generation and manipulation of mental images.

Revising the fruits name in fruits classification will involve the phonological aspects of WM. In puzzle game the visuospatial sketchpad will be responsible for short term storage and manipulation of mental images and its transference is achieved in SFBTT task.

Behaviour management treatments are the most commonly used non-pharmacological approaches for treating ADHD and associated impairments [22]. BPT is used as a treatment approach either alone or in combination with other intervention strategies (e.g., Stimulant medication), is often employed in the clinical management of children with ADHD [23]. It is an intervention to help parents stop stressful patterns of parent-child interaction. BPT primarily emphasises social contingencies in which parents provides positive reinforcement for the child's prosocial behaviour and ignores or punishes negative behaviour by non-physical discipline techniques such as removal of privileges or time out [12].

In present study, the authors tried to find out the effects of BPT training on WM of ADHD children. It can be hypothesised that parents and therapists in the BPT groups have focused primarily on reducing the behavioural problems rather than the ADHD symptoms. So there were no significant effects of BPT on WM of ADHD children. This is in conjunction with Van den hoofdakker BJ et al., who studied about the effectiveness of BPT as adjunct to routine clinical care and found that adjunctive BPT enhances the effectiveness of routine treatment of children with ADHD, particularly in decreasing behavioural and internalising problems, but not in reducing ADHD symptoms [24].

So, structured games which emphasise on cognitive and physical level of the child affects the physical task performance more effectively than BPT to improve WM in children with ADHD. Thus, null hypothesis was accepted as alternate hypothesis partially. The alternate hypothesis is valid in terms of significant improvement within Structured Games group and significant effect of structured games over Behavioural Parent Training on WM of ADHD children.

Limitation(s)

Inability to create a special controlled environment for administrating the regime. Lack of awareness about ADHD in parents. General lack of awareness about ADHD in parents and difference in application of instructions, understanding of training among parents might have affected the outcomes.

CONCLUSION(S)

Training of WM in form of structured games can be an effective method when compared to BPT in children with ADHD.

REFERENCES

[1] Visser SN, Wolraich ML, McKeown RE. The prevalence of ADHD: Its diagnosis and treatment in four school districts across two states. Journal of Attention Disorders. 2014;18(7):563-75.
[2] Klein RG, Mannuzza S, Olazagasti MA, Roizen E, Hutchison JA, Lashua EC, et al. Clinical and functional outcome of childhood attention-deficit/hyperactivity disorder 33 years later. Arch Gen Psychiatry. 2012;69(12):1295-303.
[3] National Resource Centre on ADHD. "About ADHD", A Program on Children and Adults with Attention Deficit Hyperactivity Disorder. Available from: https://chadd.org/wp content/uploads/2018/03/about ADHD.pdf [Accessed Sept 17, 2019].
[4] Singh A, Yeh CJ, Verma N, Das A K. Overview of attention deficit hyperactivity disorder in young children. Health Psychology Research. 2015;3:2115.
[5] US Department of Education. Teaching children with attention deficit and hyperactivity disorder: Instructional strategies and practices. 2006. Retrieved from www.ed.gov/about/offices/list/osers/osep.
[6] Cortese S. The neurobiology and genetics of attention deficit hyperactivity disorder. Eur J Paediatr Neurol. 2012;16(5):422-33.
[7] Rapport MD, Chung KM, Shore G, Isaacs P. A conceptual model of child psychopathology: Implications for understanding attention deficit hyperactivity disorder and treatment efficacy. Jou Clin Child Psychol. 2001;30:48-58.
[8] Fassbender C, Schweitzer JB, Cortes CR. Working memory in attention deficit/hyperactivity disorder is characterised by a lack of specialization of brain function. Joupone. 2011;2011:0027240.
[9] Baddely A. Working memory. Sci. 1992;255:556-59.
[10] Anastopoulos AD, Shelton TL, DuPaul GJ. Parent training for attention-deficit hyperactivity disorder: Its impact on parent functioning. Journal of Abnormal Child Psychology. 1993;21:581-96.
[11] Lee PC, Niew W, Yang H, Chen VC, Lin K. A meta-analysis of behavioural parent training for children with attention deficit hyperactivity disorder. Research in Developmental Disabilities. 2012;33:2040-49.
[12] Antshel KM, Barkley R. Psychosocial intervention in ADHD. Child Adolescent Psychiatric Clinics N Amer. 2008;17(2):421-37.
[13] Barkley RA, Robin AL, Benton CM. Your defiant teen: 10 Steps to restore conflict and rebuild your relationship. JCFS. 2009;18(1):123-24.
[14] Barkley RA. ADHD: A handbook for diagnosis and treatment. Guilford Press, American Psychological Association. 1990.
[15] Baddeley A. Working memory: Theories, models, and controversies. Annu Rev Psychol. 2012;63:1-29.
[16] Diagnostic and Statistical manual of mental disorders. 4th Edition. American Psychiatric Association. 1994. American Psychiatric Publishing, Inc.
[17] Fatemeh KK, Mohammadi MR, Yadegari F. Working Memory Training in the form of structured games in children with ADHD. Iran J Psychiatry. 2016;11(4):224-33.
[18] Fisher EP. The impact of play on development: A meta-analysis. Play & Culture. 1992;5:159.
[19] Bradley RH. Social-cognitive dvevlopment and toys. Topics in Early Childhood Specil Education. 1985;5(3):11-29.
[20] Elardo R, Bradley RH, Caldwell BM. A longitudinal study of the relation of infants' home environments to language development at age three. Child Development. 1997;48(2):595-603.
[21] Jaak P. Can play diminish ADHD and facilitate the construction of the social brain? Journal of the Canadian Academy of Child and Adolescent Psychiatry. 2007;16:57-66.
[22] Pfiffner LJ, Haack LM. Behaviour management for school aged children with ADHD. Child Adolesc Psychiatry Clin N Am. 2014;23(4):731-46.
[23] Arthur DA, Terri LS, George JD, David CG. Parent training for attention-deficit hyperactivity disorder: Its impact on parent functioning. Journal of Abnormal Child Psychology. 1993;21:581-96.
[24] Van den hoofdakker BJ, van der veen-mulders L, Sjoerdsytema, Paul MGE, Ruud BM, Maaike HN. Effectiveness of behavioural parent training for children with ADHD in routine clinical practice: A randomized controlled study. J Am Acad Child Adolesc Psychiatry. 2007;46(10):1263-71.

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