

Effect of sensory integration on attention span among children with infantile hemiplegia

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ABSTRACT

Objective: Normal sensory perception and environmental stimuli play an important role in learning and development of basic milestones among children. The current research aimed to explore the effects of sensory integration on attention span among children with infantile hemiplegia (IH).

Methods: Quasi-experimental research design with a control group. 17 children who had left-sided IH visiting the Rehabilitation Centre were recruited for the study (sample of convenience) after their parental consent. The 12–15-year-old children were randomly assigned to the experimental group ($n = 9$) and control group ($n = 8$). A 10-treatment session of sensory integration training was provided to the children in the experimental group whereas the control group received conventional physical therapy. The conventional therapy which consisted of gait training, exercise sessions on Swiss Ball, stretching, and Mat exercises. The Stroop color-word test was used to assess attention span among the children. The data obtained from the assessment were analyzed by multivariate analysis of covariance.

Results: The statistical test showed a significant difference in attention span ($P > 0.0001$) between the experimental group and the control group. Highlights: Sensory integration showed a positive effect on attention among children with left IH. There was a significant difference between the experimental and control group on attention span. Change in the scores is improved and retained after 4 months follow-up.

Conclusion: Sensory integration practice among children with left-sided IH lead to improvement in their attention span.

Keywords: Adolescent, attention, hemiplegia, pilot projects, sensory integration therapy

Introduction

Sensory integration therapy (SIT) is the therapeutic management of children through sensory augmentation.^[1] SIT involves a child in enriched playful activities, facilitating a meaningful motor response. The sensory integration theories assume that an impaired sensory reception would result in a delay in developmental milestones among children with developmental disorders. These sensory systems include proprioception from muscles and joints, balance and hearing from the vestibule-auditory system, visual stimuli from eyes, and tactile sensory stimuli from the skin and body awareness.

There are a limited number of studies published on the prevalence of infantile hemiplegia (IH) among Saudi population and globally. A most recent study on children suffering from stroke was published on 2006 by Salih *et al.*^[2] reported around 27.1/100,000 cases annually and most common was ischemic

(76%) of stroke and the average age of onset at 6 months (median). Hemiplegia is a neurological condition affecting either side of the body and if it happens at an early age, its known as IH.^[3] IH is one of the common types of cerebral palsy and second in frequency to spastic diplegia born preterm. Infants with spastic hemiplegia show unilateral sensory deficit and motor dysfunction due to the lesion at the somatosensory cortex of the cerebral cortex. Children with IH commonly experience more functional difficulty in upper limb than in the lower limb. Affected children also experience an unprovoked seizure. Literature has shown the difference between left- and right-side hemiplegic children; left side hemiplegic children had better linguistic ability than the right-sided hemiplegic children. On the contrary left-sided hemiplegic children had more motor, attention, and perceptual problems than right-sided hemiplegic children.^[4] When compared for syntactical awareness left hemiplegic, children performed better than the right hemiplegic children. Impaired attention and motor skills

are seen in children with IH. Researches have reported that left-sided IH exhibit more attention deficit right-sided IH.^[5,6] The attention span is a mandatory requirement to gathered relevant and sufficient information for the environment. Left-sided hemiplegic children also exhibit motor deficit, but it is more apparent in right-sided hemiplegic children. Motor skills which include gross and fine motor skills and bilateral coordination are most affected in right-sided hemiplegic children.^[7] Furthermore, clinicians have reported that sensory integration and some cognitive abilities are more affected among children with limited social participation and interaction with the peer group.^[8]

A number of researches have shown a positive effect of sensory integration training on attention span among autism spectrum disorders, Down syndrome, and learning disabilities among children except for IH.^[9] Therefore, the aim of this pilot study is to investigate the effect of sensory integration training on the attention span of children with left-sided IH.

Methods

This was a quasi-experimental design with pre-test and post-test and a control group. Participants were male and female children recruited from the Rehabilitation Centre. The sample of 17 was randomly divided into a control group ($n = 8$) and experimental group ($n = 9$); the number of participants assigned to each group was calculated from the formula

$$n = \frac{\sigma^2 (z_{1-\alpha/2})^2}{d^2}$$

Children included in this study were diagnosed with left-sided IH, being 10–15 years old and visiting our Rehabilitation Centre for regular treatment. Children having other developmental disorders and significant health issues were excluded from the study. Parents of the children were contacted to attend a seminar on sensory integration and the importance of this study. Parents of the children provided written consent. The study commences in August 2017 after the ethical approval from the ethical and research regulator authority at the Hospital Rehabilitation Centre with an approval letter no. (MU-EC-102-21-07-2017). Children were randomly assigned to the experimental and control group. The experimental group received 10 sessions of sensory integration training, and routine treatment and the control group received only routine treatment. The treatment protocol for sensory integration was obtained from research on downs syndrome^[10] (Table 1). Physiotherapists trained in sensory integration were blinded about the assignment of children in either group. The second physiotherapist who assessed the subjects on the Arabic version of the computerized Stroop color-word test^[11] was also blinded about the allotment of subjects.

The Arabic version of the computerized Stroop color-word test consists of two phases. The first phase is the preparation

phase, and the children are asked to choose any color of the circle on the monitor (red, blue, green, and yellow) and press the corresponding key on the keyboard. The scores obtained at this stage were not included in the final results. The actual test consists of 96 colorful words, divided into 48 correctly matched colorful words and 48 incorrectly matched colorful words. The sequence of each word was randomized and appeared on the computer screen for 2000 ms with 800 ms interval between two words. The children were asked to identify the word color regardless of their meanings.

All the responses were calculated by the computer such as correct answer, incorrect answer, reaction time for correctly matched colorful words as well as incorrectly matched colorful words, no answer. The Arabic version of the Stroop test has been tested on equivalence with the English version of the test. The test seems to have acceptable test-retest reliability and validity.

The experimental group participated in 10 treatment sessions (thrice a week, each session lasted for about 60 min) which included the conservative treatment and sensory integration while as the control only received the conservative treatment. The Arabic version of the Stroop color-word test was used to assess attention span in the 1st week and at the end of the 4th week. Multivariate analysis of covariance (MANCOVA) was used to analyze the data.

Results

The mean age of control and experimental groups was 12.8 and 13.7 years, respectively.

Mean and standard deviation of all the responses from the children is tabulated in Table 2.

Sample characteristics

Data obtained from the subjects are distributed normally as tested on the normality test. Two statistical tests namely Box's test and Leven test analyzed the equality of variance and covariance matrices ($P < 0.05$).

MANCOVA test was used to analyze the difference in attention span among the control and experimental group in Table 3.

There is a significant difference between the test scores obtained from the control group and the experimental group on attention span ($P > 0.0001$). The results obtained from MANCOVA showed a significant effect on the correct answer ($F = 30.54$, $P > 0.001$), incorrect answer ($F = 39.47$, $P > 0.0001$), no answer ($F = 28.64$, $P > 0.0001$), reaction time of matched words ($F = 29.87$, $P > 0.001$), and reaction time of unmatched words ($F = 27.96$, $P > 0.0001$).

According to Eta-squared (h^2), 54%, 57%, 61%, and 56% of the variation in the variables of the correct answer, incorrect

Table 1: Sensory integration training included the following items

Session	System	Details of training	Common practice included with all the sessions
1 and 2	Visual system	Choosing a different colored ball and placing them on the same colored basket. Identifying the missing parts of a picture and competing with others. Identifying various shapes of objects.	Group Stretching session for 10 min before any activity. Stretching Activities in the spider cage with a Swiss ball. Gait training on the sand, in water, backward walking.
3 and 4	Vestibular system	Balancing on a beam, riding, and riding on a toy horse. Jumping on a trampoline. Balancing on one leg.	
5 and 6	Tactile and proprioceptive	Identifying friends with eyes blindfolded. Identifying various textures, shapes, size, and weight of familiar objects. Painting with fingers.	
7 and 8	Olfactory system	Identify familiar smells such as lemon, coffee, and fruit fragrances.	
9 and 10	Gustatory system	Tasting various dishes and naming them blindfolded. Like chocolates and fruit-flavored chocolates.	

Table 2: Pre- and post-test results of attention span

Variable	Items	Condition	Groups	
			Experimental	Control
			Mean±SD	Mean±SD
Attention span	Correct answer	Pre-test	29.91±1.71	30.54±1.61
		Post-test	33.81±1.37	30.31±1.59
	Incorrect answer	Pre-test	42.93±1.52	39.47±1.91
		Post-test	36.41±1.31	38.97±2.01
	No response	Pre-test	27.91±1.93	28.64±2.31
		Post-test	23.14±2.34	28.41±1.84
	The reaction time of matched words	Pre-test	1291.51±7.81	1321.87±6.87
		Post-test	1201.94±12.76	1299.39±13.96
	The reaction time of unmatched words	Pre-test	1532.73±7.81	1423.96±4.79
		Post-test	1143.98±4.21	1411.65±7.63

SD: Standard deviation

Table 3: MANCOVA

Group	Dependent variables	SS	Df	MS	F	Sig	η^2
Attention span	Correct answer	122.83	1	122.83	30.54	0.0001	0.51
	Incorrect answer	23.07	1	23.07	39.47	0.0001	0.54
	No response	20.01	1	20.01	28.64	0.0001	0.60
	Reaction time of matched words	1073.81	1	1073.81	29.87	0.0001	0.56
	Reaction time of unmatched words	1771.28	1	1771.28	27.96	0.0001	0.59

MANCOVA: Multivariate analysis of covariance

answer, the reaction time of matched words, and the reaction time of unmatched words, respectively. Such variation could be due to the effect of sensory integration in the experimental group.

Discussion

The aim of the current study was to investigate the effect of sensory integration training on the attention span of children with left-sided IH. The results of this pilot study have shown

to affect the attention span significantly among children with left-sided IH. Similar results were also seen in children with autism^[12] and Downs syndrome.^[13] Children with left-sided IH have shown to significant involvement of attention span as compared to right-sided IH.^[14] Learning is a complex process of analyzing information gained from interaction with the surroundings. Attention is the fundamental step in the learning process which is involved in gathering and processing all the required information of a situation to create a meaningful experience and memory. Such meaningful experiences

and memories are essential elements to progress from one developmental milestone to the next.^[15] Attention span and movement of children are interdependent. Attention span in growing children helps children understand and interact with the environment. Attention span plays an important role in interpreting the continuous visual and auditory system inputs along with other sensory systems among children for learning.

Sensory integration is the process by which a child learns about the environment through various sensory organs. The sensory integration training program involves different activities which reinforces improvement in attention span and selective sensory perception, eye and hand coordination, body image, and awareness. The sensory integration training involves facilitation of sensory reception by providing an enriched environmental stimulus, thereby compensating a deficit sensory stimulus and encouraging the natural developmental gains among children.^[16-23]

SIT improved attention span in our study significantly among children with left-sided IH. Other studies on SIT on children have also shown to improve higher mental function as well as motor function. A study by Karim and Mohammed,^[24] who explored the effect of SIT on motor skills of children with autism, reported statistically significant results. A study by Kuo^[25] also reported an improvement in balance. A study investigated the effect of swimming exercise program^[26] on the motor development levels in teenagers with intellectual disability. They reported statistically significant improvement in variables such as fine motor integration, fine motor precision, and bilateral coordination. A number of researches investigating the effect of sensory integration on fine motor skills, intellectual difficulty, and learning disability have shown to cause a significant effect.^[27-33]

Constraint-induced movement therapy (CIMT) has also been effectively used to reduce upper limb disability in children with IH. Few types of research investigating the effect of 4-week CIMT in children with IH showed statistically significant results in terms of functional use of the upper limb.^[34]

Sensory integration training allows a child to compare various shape, size, and color of objects through tactile sensation and reduced external distractions. During SIT help children reduce defensiveness, change in arousal and alertness. The data obtained from the study supports the use of SIT even after the child has passed a certain age. As our sample included age group of children from 10 to 15 years old, attention span plays an important role in education and defines a successful carrier in the future. Therefore, special schools must identify children with attention span deficit especially in children with left-sided IH, autism, and down's syndrome and provide them with necessary training.

Sensory integration training in our study has shown to cause a positive effect on attention span among children with left-sided

hemiplegia. Sensory integration training has shown to cause changes in the neural circuitry of the brain or neural plasticity leading to enhanced attention as well as motor skills.

Limitations

There are several limitations of this study; they are:

1. Small sample size which largely affects its generalizability.
2. Amount of motor deficit on the affected side varies considerably among children.
3. Socioeconomic status of each child was not considered.
4. The intelligence coefficient intelligence quotient was not determined before the study.

Conclusion

Our study concludes that SIT improves attention among left-sided hemiplegic children.

Conflicts of Interest

There are no conflicts of interest.

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