The Egyptian Journal of Medical Human Genetics (2015) 16, 375–380

HOSTED BY

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The Egyptian Journal of Medical Human Genetics

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ORIGINAL ARTICLE

Effectiveness of sensory integration program in motor skills in children with autism

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Received 24 November 2014; accepted 30 December 2014
Available online 24 February 2015

KEYWORDS

Sensory integration program;
Autism spectrum disorder;
Peabody Developmental Motor Scale;
Gross motor;
Fine motor

Abstract *Background:* Autism spectrum disorders (ASDs) represent an extensive category of conditions that had a variety of deficits. Dysfunctions of perceptual and sensory processing as well as interaction and neurological functioning result in various functional behavior limitations.

Aim: The present study aimed to determine the effectiveness of sensory integration program in children with autism.

Methods: Thirty-four children from both sexes suffering from autism spectrum disorders (ASDs) participated in this study. Their age ranged from 40 to 65 months with mean age 53.21 ± 6.87 months. The children were tested pre and post treatment using the Peabody Developmental Motor Scale (PDMS-2) to assess gross and fine motor skills and to identify the effectiveness of sensory integration on the developmental skill levels. Each child received sensory integration program. The sensory integration program was conducted three sessions per week for 6 months.

Results: Comparing the pre and post treatment mean values of the variables measured using PDMS-2, revealed significant improvement in gross and fine motor skills.

Conclusion: The sensory integration therapy was effective in the treatment of autistic children as it helps those children to become more independent and participate in everyday activities.

1. Introduction

Autism spectrum disorders (ASDs) represent an extensive category of conditions that had a variety of deficits. These deficits change considerably and vary from mild to severe. These children had problems with social communication, somatosensory, typical developmental patterns, mood and concentration [1]. Perception, communication, sensory processing and neurological dysfunctions result in various functional behavior limitations [2].

Sensory processing dysfunction is relatively familiar among children with ASD; ranging from 42% to 88% [3]. Those children often have complexity in modifiable responses to sensations and specific stimuli. They may use self-stimulation to recompense for limited sensory input or to keep away from overstimulation [4–6].

These atypical sensory reactions suggest unfortunate sensory integration in the central nervous system. This could explain

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Peer review under responsibility of Ain Shams University.

http://dx.doi.org/10.1016/j.ejmhg.2014.12.008
1110-8630

impairments in attention and arousal self-stimulatory behaviors, represented as repetitive movements that had no detectable function in the environment. Each behavior interferes with a child's capability to join in or become skilled at therapeutic activities [1].

Sensory-based therapies are progressively more used by therapists in the management of children with developmental and behavioral disorders. These therapies engage activities that are thought to manage the sensory system by providing vestibular, proprioceptive, auditory, and tactile inputs. Brushes, swings, balls, and other particularly intended therapeutic or recreational equipment are used to supply these inputs [7].

Problems with sensory organization have been established through deficits in 'sway-referenced' (balance) trials in people with autism. Difficulty with postural stability has been shown to be specifically observable when somatosensory processing was relied upon, and suggests a trouble of multisense integration [8]. Related studies have shown that the action and sensory integration troubles of autistic students are summarized in the difficulty in visual space; kinesthetic sense; and events that need multisensory integration [9].

The aim of this study was to determine the effectiveness of sensory integration program in children with autism.

2. Subjects, instrumentations and procedures

2.1. Subjects

Thirty-four children from both sexes (21 males, 13 females) suffering from autism spectrum disorders (ASDs) participated in this study. Their age ranged from 40 to 65 months with mean age 53.21 ± 6.87 months.

This study was conducted in the period from September 2012 to February 2014. They were recruited from the schools of special needs and some private clinics, according to the following criteria:

1. They were suffering from mild to moderate autistic features according to the Childhood Autism Rating Scale (CARS); [10]. All children were assessed by a psychologist to determine the degree of autism; they had a score ranging from 25 to 35 according to this scale.
2. Children were able to follow simple verbal commands and instructions included in the test. Their IQ ranged from 69 to 83 (borderline) according to Stanford Binet Test.
3. They had neither visual nor auditory defects.
4. They had no history of cerebral palsy or epilepsy.

The study was approved by an Ethics Committee of the Cairo University. Child's parents were provided with a Volunteer Information Sheet and written consent informing them about the purpose of the study, its benefits and inherent risks and their committee with regard to time and money.

2.2. Instrumentations

2.2.1. For evaluation

2.2.1.1. Peabody Developmental Motor Scale (PDMS-2). Before evaluation, the purposes and procedures were fully explained to the children's parents. The Peabody Developmental Motor Scale (PDMS-2) was used to assess gross and fine motor skills [11]. The children were tested pre and post treatment to determine the developmental skills levels and to identify the efficiency of sensory integration on the developmental skill levels. Each child was evaluated and tested individually following the standard protocol.

2.2.2. For treatment

A sensory integration program was conducted to all children who participated in this study. This program was conducted three sessions per week for 6 months. Each child's particular play was individualized and guided by the therapist; the therapy was done in a large gym with mats, swings, a ball pit, carpeted "scooter boards," and other equipment. It was designed to encourage the kids to be active and get more comfortable with the sensory information they are receiving. The activities were set up to allow each of the senses to be used frequently during the session.

2.3. Procedures

2.3.1. Testing procedures

Each child was examined individually, using the Peabody Developmental Motor Scale (PDMS-2), the examiner recorded the relevant data about the child being tested which included name, gender, and age. The child's age was determined by subtracting the birth date from the date on which he/she was tested, finally, the child's age was converted to months by multiplying the number of years by 12 and adding the number of months. Age in months was used to determine scoring information.

- The testing procedure consisted of:
  - (A) <u>Assessment of gross motor skills including the following subsets:</u>
    - (a) *Stationary:* The 30-item stationary subtests measure child's ability to maintain his or her body within its center of gravity and keep up equilibrium.
    - (b) *Locomotion:* The 89-item locomotion subtests evaluate child's ability to move from one place to another. The actions measured included crawling, walking, running, hopping, and jumping forward.
    - (c) *Object manipulation:* The 24-item object manipulation subtests assess child's ability to manipulate balls. Examples of the actions measured included catching, throwing and kicking.
  - (B) <u>Assessment of fine motor skills including the following subsets:</u>
    - (a) *Grasping*: The 26-item grasping subtests measure child's ability to use his or her hands. It began with the ability to grasp an object with one hand and progressed to actions concerning the controlled use of the fingers of both hands.
    - (b) *Visual-Motor Integration:* The 72-item Visual-Motor Integration subtests measure child's ability to use his or her visual perceptual skills to carry out complex eye-hand coordination tasks, such as reaching and grasping for an object, building with blocks and copying designs.

2.3.1.1. Scoring the PDMS-2. Each child was permitted to perform 3 trials testing before actual recording of the raw scores of each subtest. The PDMS-2 norms are based on scoring each item as 2, 1 or 0.

Record of scores:

After administration of all tests in each subtest, raw and standard scores were calculated for each one. Finally, gross and fine motor quotients were determined. These scores were recorded in the recording score sheet for each child as following:

- *Raw scores:*Raw scores were the total points accumulated by a child on each subtest (child received a 2, 1 or 0 for each item). They were recorded first before the other scores.
- *Standard scores:*Standard scores provided the clearest picture of an examinee's subtest performance. Standard scores of each subtest were converted from raw scores.
- *Fine, Gross Motor and Total motor Quotients (FMQ) (GMQ) & (TMQ):*The most reliable scores for the PDMS-2 are GMQ, FMQ and TMQ. In this study, GMQ was calculated from the standard scores of the three subtests (stationary, locomotion and object manipulation). Sum of standard scores of these subtests was converted to GMQ.FMQ was calculated from the standard scores of the two subtests (grasping and visual motor integration). Sum of standard scores of both subtests was converted to FMQ.TMQ was produced by a mixture of the results of the gross and fine motor subtests. Sum of standard scores of both subtests was converted to TMQ.
- *Age equivalents:*Age equivalent was calculated by converting the subtest raw scores into motor age equivalent.
- *Interpretation of the composite quotients in terms of diagnosing strengths and weaknesses in motor development:* The composite quotients (GMQ, FMQ and TMQ) were converted into a description according to the motor construct incorporated into the PDMS-2. That description reflected the child ability relative to motor development. The results of the subtests were used to make three global indexes of motor performance called composites which included:
  A. *Gross motor quotient:* The gross motor quotient (GMQ) is a composite of the results of the subtests (stationary, locomotion and object manipulation) that measure the use of the large muscle systems.
  B. *Fine motor quotient:* The fine motor quotient (FMQ) is a composite of the results of the two subtests (grasping and visual motor integration) that measure the use of the small muscle systems.
  C. *Total motor quotient:* The total motor quotient (TMQ) is formed by a combination of the results of the gross and fine motor subtests. It is considered the best estimate of overall motor abilities.

2.3.2. For treatment

- *Tactile*The tactile system processes information on pressure, pain and temperature through the skin. Sensory integration materials for this child involved touchable bubbles, finger painting and a mist spray fan.
- *Vestibular:* The vestibular system processes information on equilibrium and movement by sensory receptors in the upper neck, inner ear, eyes and the body. The children were rocked, spinet, bounced and tumbled. Sensory integration materials for this child were swings, balancing boards, therapy exercise balls, trampolines and see saws.
- *Proprioceptive:* The proprioceptive system processes information on body's position and movement by receptors in the joints, tendons, ligaments, connective tissue and muscles. Effective sensory integration materials involved hand weights to carry during walks, stress balls, modeling clay and weighted blankets.
- *The fine motor skills included:*
  - Tying shoes.
  - Zipping and unzipping.
  - Buckling and unbuckling.
  - Writing without significant muscle fatigue.
  - Playing games that require precise hand and finger control.
  - Drawing, painting, and coloring.
  - Manipulating a colored mud.
  - Putting small objects together.
  - Doing puzzles.
  - Using scissors.
  - Manipulating small objects such as coins with different sizes.
  - Opening and closing objects.
  - Picking up and holding onto small objects.
  - Developing and maintaining an effective and proper pencil grip.
  - Pinching objects between fingers.
  - Using locks and keys.
  - Turning things over or turning pages of a book.
  - Screwing and unscrewing.

- *Heavy work activities (i.e., proprioceptive input) included:*
  - Whole body actions involving pushing, pulling, lifting, playing, and moving.
  - Use of hands for squeezing, pinching, catching with different sizes.
  - Carrying objects, such as heavy books, chairs, baby's diaper bags.
  - Jumping and bouncing on/with items, such as on a trampoline, a mattress or soft area, a hopping ball.
  - Walking/running/playing in the sand.
  - Twister.
  - Children sitting on a spinning chair and spinning in a rotatory motion clockwise and counterclockwise direction at different speeds with blindfolded eyes.
  - Using balance board.
  - Big gem ball.
  - See saw swing.
  - Giving child heavy blankets, at bedtime.
  - Firm towel dry after baths, wrapping up tightly.
  - Rolling gym ball or big ball on top of them while they lie on the floor.

2.4. Statistical analysis

The mean value and standard deviation were calculated for each variable measured during this study. Paired *t*-test was calculated for each variable measured during this study. We used level of significance as 0.05.

3. Results

3.1. Pre and post treatment values of raw scores

Comparing the pre and post treatment mean values of all measured subtests revealed significant improvement as ($p < 0.05$), Fig. 1.

3.2. Pre and post treatment values of standard scores

Comparing the pre and post treatment mean values of all measured subtests revealed significant improvement as ($p < 0.05$), Fig. 2.

3.3. Pre and post treatment values of age equivalence in months for the sub motor tests

Comparing the pre and post treatment mean values of all measured subtests revealed significant improvement as ($p < 0.05$), Fig. 3.

3.4. Pre and post treatment values of gross, fine and total motor quotients

Comparing the pre and post treatment mean values of gross motor quotient (GMQ) fine motor quotient (FMQ) and total motor quotient (TMQ) revealed significant improvement as ($p < 0.05$), Fig. 4.

3.4. The interpretation of the composite quotients in terms of diagnosing strengths and weaknesses in motor development

Based on the gross, fine and total motor quotient classifications, the pretreatment quotient showed that there were five children with ASD who had gross motor skills in the average range; eight ASD children scored below average gross motor, thirteen children had poor gross motor skills and seven of them scored very poor gross motor on the PDMS-2. Three children with ASD had fine motor skills in the average range on the PDMS-2. Four children with ASD scored below average, ten scored poor and seventeen scored very poor fine motor skills. Four children with ASD in this study had total motor

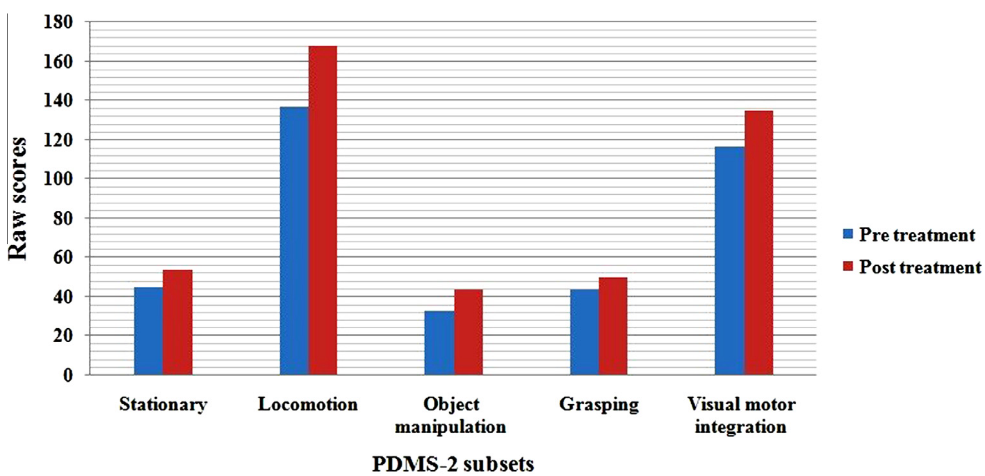

Figure 1 The pre and post treatment mean values for raw scores.

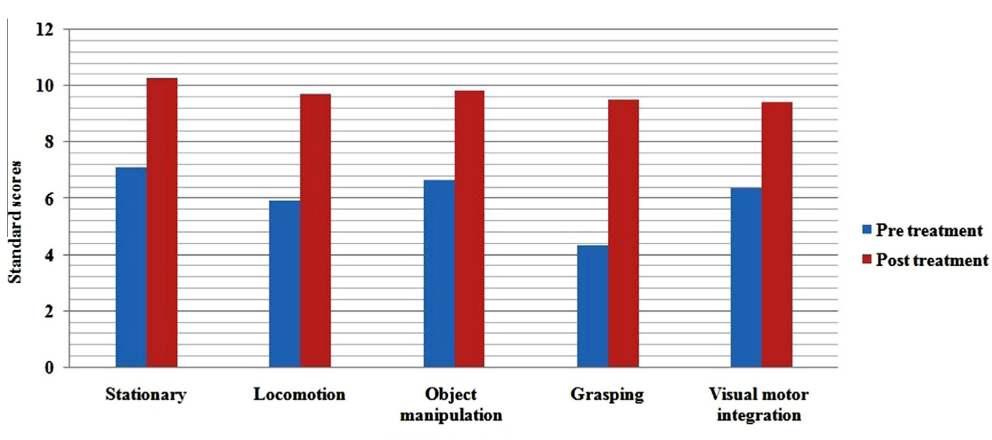

Figure 2 The pre and post treatment mean values for standard scores.

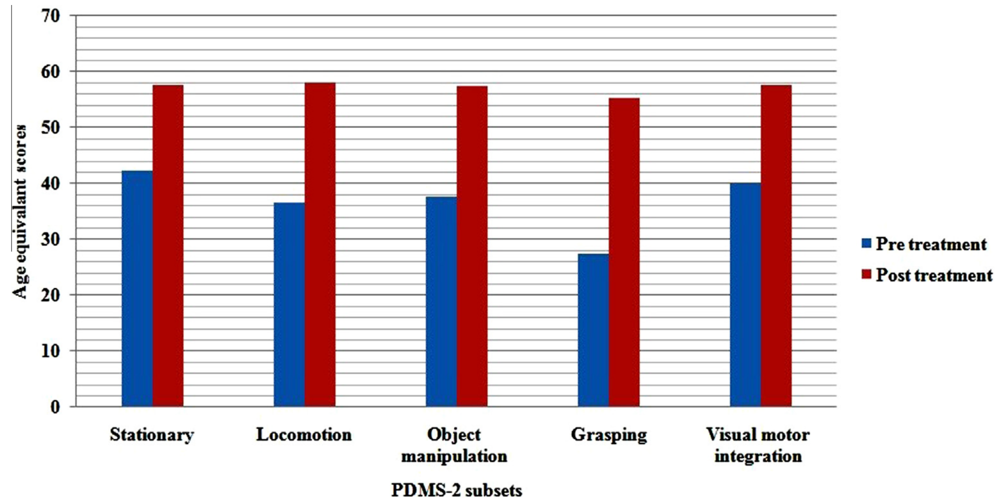

Figure 3 The pre and post treatment mean values for age equivalence in months.

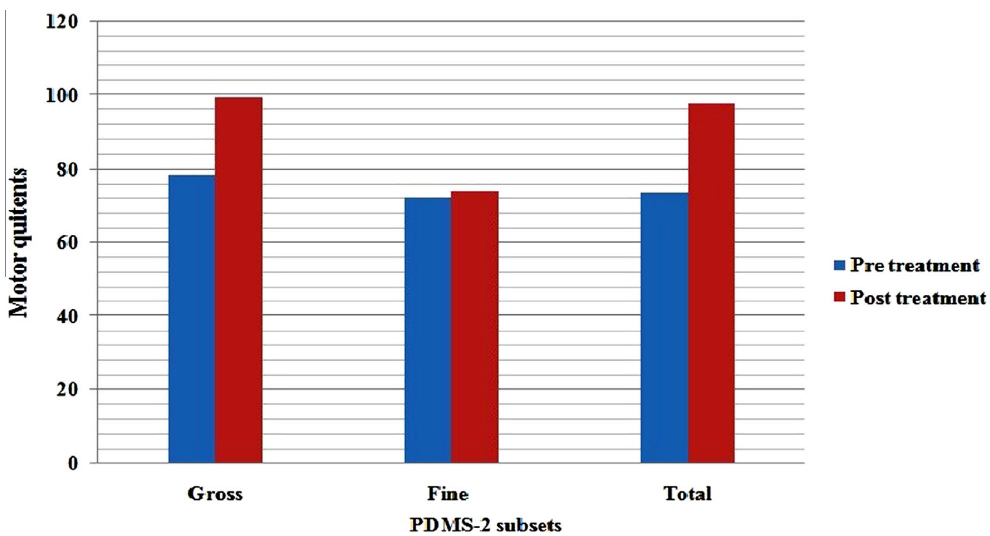

Figure 4 Pre and post treatment values of gross, fine and total motor quotients.

skills in the average range on the PDMS-2. Five children with ASD scored below average, eleven children scored poor and fourteen scored very poor total motor skills. The post treatment quotient showed that the all children had average range for gross, fine and total motor skills on the PDMS-2.

4. Discussion

This study was conducted to determine the effectiveness of sensory integration program in children with autism. The age of the children included in this study ranged from three to five and half years old because later development is more affected in autistic children. Common findings in young children with ASD include increased joint laxity, hypotonia, clumsiness, apraxia and toe walking. Difficulty may also occur with more complex motor behaviors such as stacking cubes or climbing on toddler preschool playground equipment [12].

The motor stereotypic behaviors such as hand flapping, spinning, running in circles, twirling a string, tearing paper, drumming and flapping light switches and oral stereotypic behaviors such as humming or incessant questioning were noted in autistic children. The inability to concentrate and stereotypic behaviors may prevent children from engaging in meaningful activities or social interaction [13].

In this study the Peabody Developmental Motor Scale was used as a standardized tool for measurement of gross and fine motor skills performed by preschool children with ASD [16]. The most commonly used standardized tests for assessing motor skills of young children are the PDMS-2 and the Bayley scales of infant development-second edition (BSID II) Motor Scale, which can document motor delays using age-equivalent scores and/or standard scores. He also found that pre-school aged children with ASD performed gross and fine motor skills similar to children with developmental delays on the Peabody Developmental Motor Scale when matched for chronological and mental age [14].

In this study, the treatment procedures were selected based on the sensory integration (SI) theory. This theory emphasizes that tactile, proprioceptive, and vestibular systems improve muscle tone, automatic reactions, and emotional welfare. At birth, the child's actions are often related to input from the sensory channels. As children grow up and increase their interactions with the environment, the visual and auditory systems become more essential and are included with the other sensory systems. The eye hand coordination requires the assimilation of several types of sensory input to direct the movement toward to the target. When the child's hand makes contact with the object, the child integrates tactile information about the object's texture with visual information about size, shape, and color. Further manipulation of the object provides proprioceptive/kinesthetic feedback from the child's hand movements in response to the object, which may assist to explain information about size and shape [15–18].

Heavy work activities (i.e., proprioceptive input) are used for children with sensory processing difficulties to help enlarge attention, decrease defensiveness, and alter arousal. The improvement of fine motor skills in children will permit them to do a variety of significant functional tasks [7]. The results of this study showed significant improvement in their motor skills after receiving sensory integration therapy.

The Goal Attainment Scaling scores significantly changed and a significant decrease in autistic mannerisms were noted for autistic children who received sensory integration therapy rather than autistic children receiving fine motor (FM) interventions [13]. Sensory integration therapy works directly on a child's nervous system functioning, capitalizing on plasticity within his or her nervous system, and resulting in the development of adaptive behaviors and an increased ability to learn [19].

5. Conclusion

It may be concluded that the sensory integration therapy was effective in the treatment of autistic children as it helps those children to become more independent and participate in everyday activities.

Role of funding source

No benefits or funds were received in support of this study. None of the authors has received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article.

Conflict of interest

Authors have not declared any conflict of interest.

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