

# Effect of Action Observation Training and Bimanual Arm Training on Hand Function for Children with Hemiparetic Cerebral Palsy

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## Abstract

**Background:** The background of the study focuses on addressing the challenges in hand function that these children face due to their condition. Action observation training aims to leverage the brain's mirror neuron system to improve motor skills by observing and imitating actions. Bimanual arm training involves coordinated movement of both arms to enhance functional abilities.

**Purpose:** The study compared the effects of action observation training and bimanual arm training on hand function in children with hemiparetic cerebral palsy.

**Materials and Methods:** A total of 30 children were chosen according to the inclusion and exclusion criteria. The subjects were separated into two groups: action observation training (AOT) and bimanual arm training (BAT). The Fugl Meyer assessment scale (FMA) and the Box and Block test (BBT) were used for evaluating the result.

**Results:** Both groups were homogenous at baseline, with a p value of 0.7866 in FMA and 0.6002 in BBT. The result of this study demonstrated that the action observation training group showed a better improvement than bimanual arm training with a p value of < 0.0001.

**Conclusion:** This study concluded that AOT improved hand function in cerebral palsy children.

**Key Word:** Cerebral palsy, Fugl Meyer scale, Box, and Block test.

## Introduction

Cerebral palsy (CP) is caused by abnormal brain development or damage to the developing brain. CP was defined in 1964 as "a disorder of movement and posture due to a defect or lesion of the immature brain"<sup>1</sup>. Antenatal infection, premature delivery, placental abnormalities, neonatal infection, asphyxia are the prevalent causes of CP. CP comprises not just motor impairments, but also perceptual, sensory, cognition, language, seizures, and behavioral issues

<sup>2</sup> It is the most severe physical impairment among children, affecting 1-3 people out of every thousand live births <sup>3</sup>.

Hemiparetic CP, a subtype of spastic CP that is defined as paresis or weakness on just one half of the body that encompasses the upper body, trunk, and lower body. It is one of among the most described types of cerebral palsy in the literature <sup>4</sup>. The involvement of the upper body is greater than the lower body. The damaged hand in hemiparetic CP has a problem with

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touch sensation and joint position, which impedes fine motor abilities<sup>5</sup>. Children with hemiparesis will have difficulty in carrying out fine motor skills due to weakness in the muscles. Gripping is described as a spontaneous or intentional motion of the upper part of the body (UL) to make acquaintance with an object<sup>6</sup>.

Over eighty percent of CP children have upper-extremity impairment,<sup>7</sup> which has a significant impact on their daily activities (ADLs) as well as their quality of living. Hemiparetic CP children struggle with precise holding and fine motor skills and develop an inconsistent movement pattern as a result of damage to the pyramidal tract<sup>8,9</sup>.

Bimanual arm training (BAT) is a bimanual rehabilitation method that focuses on upper extremity problems in hemiparetic CP<sup>10</sup>. Bimanual therapy is the practice of repeating repetitive actions with both hands instead of only one to complete functional tasks. Bimanual upper limb therapy is also known as bimanual training, hand arm bimanual intensive training (HABIT). The notion of HABIT combines asymmetrical actions of both hands, motor learning concepts, and neuroplasticity. The HABIT approach involves enhancing the difficulty of functional activities that demand bimanual use of both hands and repetitions to attain functional goals<sup>10</sup>.

Action observation technique is the practice of observing deliberate motions with the goal of imitating and practicing those motions. AOT is a peculiar rehabilitation strategy that involves watching and then replicating those actions<sup>11</sup>. Typically, the patient is directed to replicate, attempt, and complete the tasks seen in the video clips after observation. The top-down strategies of Action Observation Therapy (AOT) are based on basic brain science and recent breakthroughs in the mirror neuron system (MNS)<sup>12</sup>. Action observation method is a multidimensional technique that relies on basic neuroscience that encompasses rehabilitation of the somaesthesia and cognitive systems<sup>13</sup>. It executes by rousing the mirror neuron system (MNS) in the brain<sup>12,14</sup>. It might involve the influence of the MNS on upper extremity performance as a result of observing activities (learning new motor abilities) and completing identical neural structures. A mirror neuron system is composed of specialized neurons that mimic the

activities and behaviors of others. Mirror neurons are seen in the premotor cortex, supplementary motor region, primary somatosensory motor area, and parietal<sup>15</sup>. These neurons are more active when humans watch intentional movements rather than simple motions, and they are also more active when humans watch movement in a video, rather than images. Providing tools to repair damaged brain networks and seizing the opportunity to rebuild motor function despite limits are the goals of AOT in the recovery phase of patients with brain disorders as an alternative or addition to physical therapy<sup>16</sup>.

The intended objective of this study was to see how action observation therapy and bimanual arm training improved hand function in individuals with hemiparetic CP.

## AIM

To compare the effect of action observation training and bimanual arm training on hand function for children with hemiparetic CP.

## Materials and Methods

In this experimental study, the outcome of action observation therapy and bimanual arm training on hand function in hemiparetic CP children were compared. The study was conducted from the month of July 2022 to January 2023. A total of 30 samples were selected from the Saveetha Medical College and Hospital and Ambattur Rotary Hospital using a random sampling method through concealed envelope technique and informed assent were taken from their parents.

### Inclusion criteria

- Children aged 6 to 9 years old with hemiparetic CP
- Children with a Mini Mental State Score of greater than 24
- Manual ability of classification system I and II.

### Exclusion criteria

- Children who underwent orthopedic surgery or Botox injections in the upper extremity within 6 months

- Children who are prone to seizures
- Children with visual and auditory problems

### Outcome measures

#### Fugl - Meyer assessment (FMA)

In the stroke population, the Fugl Meyer evaluation scale was extensively used to measure hand function. It was recently discovered that it has been employed in the pediatric population and has been found to be very valid and dependable.

The scale consists of five domains and 155 elements, with only the hand (7 components) with a total score of 14<sup>17</sup>.

#### Box and block test (BBT)

The Box and Block tests were used for assessing unilateral fine motor skills. The score was determined by how many cubes were moved between compartments in a period of 60 seconds. Higher scores indicate more manual dexterity. It takes between 2 to 5 minutes to administer.

#### Procedure

An aggregate of 30 children were chosen based on the criteria, and informed assent was obtained from the parents. Children were randomly allocated to either: Action observation therapy or Bimanual arm training based on concealed envelope method; they were explained about the study and their intervention.

All the children were undergoing pre-test and post-test measurement with Fugl Meyer assessment (FMA) and Box and Block test (BBT). Both the group underwent a treatment session of about one hour each day, six days a week, for twelve weeks.

### 1. Action observation training

Children were instructed to sit in front of the computer screen with their backs supported. During each therapy session, children are encouraged to see a video clip of a certain object-directed every day action and then to perform what they have seen. The action is fragmented into four motor acts. For instance, adding juice into a cup, adding sugar, turning the handle of the spoon and taking the drink towards the mouth. Each motor act usually lasts for

three minutes; therefore, the overall time of a video portraying a particular motor act is twelve minutes. Each therapy session includes two tasks.

After watching an action for 3 minutes (the observing phase), children are given instructions to perform the motor act for 2 minutes (the execution phase).

The following are some of the acts depicted in the video: they are opening and closing a pencil box, folding a towel, drinking juice, eating chocolate, throwing a ball, tying shoelaces, constructing a toy out of clay, and buttoning and unbuttoning a shirt.

### 2. Bimanual arm training

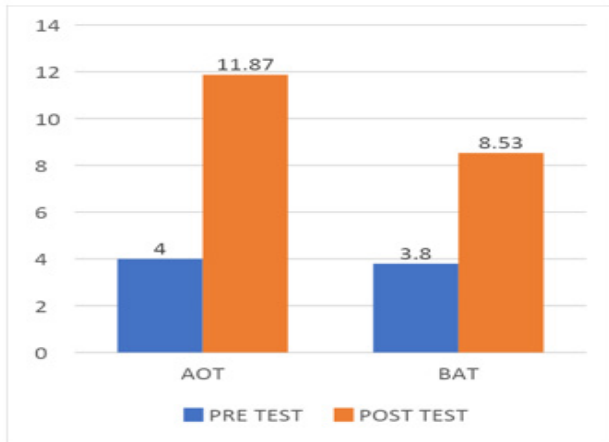
Whereas children in the bimanual training group were directed to sit in front of the computer screen with their backs supported. Children were engaged in whole-task and part-task practice. The actions are done constantly for at least 25-30 minutes while performing whole task practice. For example, while painting, the purpose is to finish a drawing with various colored paints. Holding the brush, aligning and balancing the sheet of paper with the impaired hand, and painting on the sheet with the non-impaired hand are all motor components. Part-task practice was utilized to break down motor abilities into smaller components while improving repetitions and skill (e.g., twisting puzzle pieces to increase forearm supination). In a card game, for example, we could instruct the participant to flip over as many cards as possible in 15-20 minutes.

Supination, which is limited in many hemiparetic CP, would be the focal point of the activity in the game of cards.

### DATA ANALYSIS

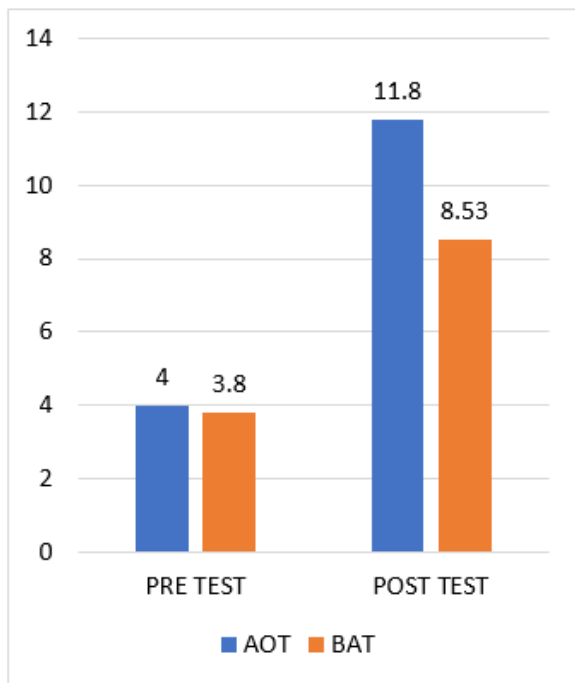
All parameters were subjected to the mean and standard deviation (SD). For analyzing pre and post-test measurements within the group, a paired t-test was performed.

The unpaired t test was used to compare the group's pre and post-test measurements between the group. The P value of <0.0001 was deemed statistically significant.



**Graph 1**

**Pretest and post-test values of action observation training and bimanual arm training within the group using Fugl Meyer Assessment.**



**Graph 2**

**Pretest and post-test values of action observation training and bimanual arm training between the group using Fugl Meyer Assessment.**

**Results**

**Graph 1** shows the pretest and post-test values of action observation training and bimanual arm training within the group obtained by FMA which was analyzed using paired tests.

**Graph 2** shows the pretest and post test values of action observation training and bimanual arm training between the group obtained by FMA which was analyzed using unpaired tests.

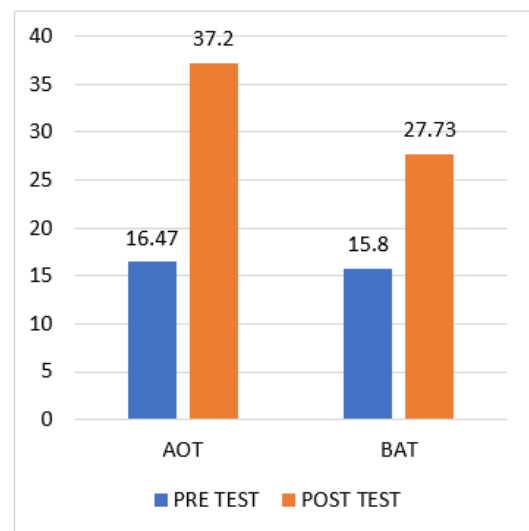
**Graph 3** shows the pretest and post test values of action observation training and bimanual arm training within the group obtained using BBT which was analyzed using paired tests.

**Graph 4** shows the pretest and post-test values of action observation training and bimanual arm training between the group obtained by FMA which was analyzed using unpaired tests.

The result showed that AOT pre-test and post-test mean and standard deviation values using FMA are  $(4.00 \pm 2.14$  vs  $11.87 \pm 1.85)$  and BAT pre-test and post-test mean and standard deviation values using FMA are  $(3.80 \pm 1.86$  vs  $8.53 \pm 1.81)$  with a p value < 0.0001.

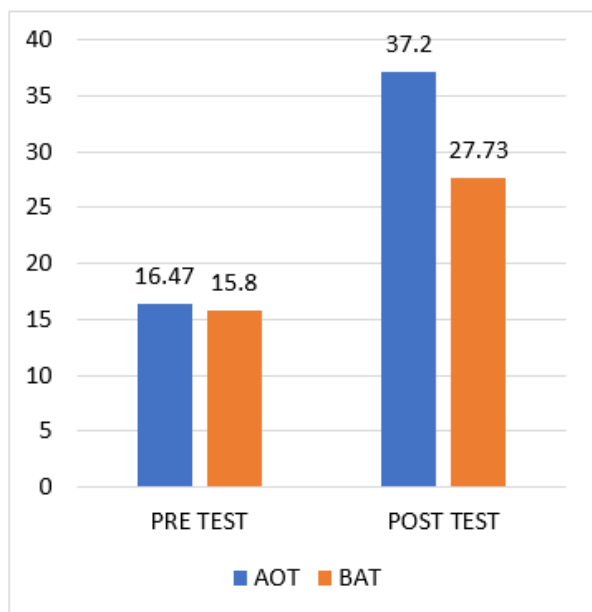
AOT pre-test and post-test mean and standard deviation values using BBT are  $(16.47 \pm 3.60$  vs  $37.20 \pm 6.06)$  and BAT pre-test and post-test mean and standard deviation values using BBT are  $(15.80 \pm 3.28$  vs  $27.73 \pm 4.99)$  with a p value < 0.0001.

This comparative study showed a substantial improvement in the action observation training group than the bimanual arm training group.



**Graph 3**

**Pretest and post-test values of action observation training and bimanual arm training within the group using Box and Block test.**



**Graph 4**

**Pretest and post-test values of action observation training and bimanual arm training between the group using Box and block test.**

### Discussion

This comparative study was the first to investigate the outcome of action observation training and bimanual arm training on hand function in hemiparetic CP children. Buccino evaluated whether action-observation physical training could assist CP children to improve upper extremity function.

This study included 15 individuals who were separated into two groups: case and conventional groups. The children in the case group were given instructions to watch videos of hand and upper limb movements required for daily life, while the control group watched only a motionless screen and performed the same movements as the case group.

The Melbourne scale was used to analyze upper limb function. When compared to the conventional group, upper limb function improved in the case group. As a result, it has been demonstrated that physical training combined with action observation improves performance of everyday activities and function of the upper limb not only in adults but also in pediatric rehabilitation<sup>18</sup>.

Like this, Sgandurra investigated whether

performance plus AOT was better to performance alone in children with CP. While those in the action group played computer games alone, children in the AOT with performance group were told to watch one or two goal-directed action video sequences. The findings of this study revealed that AOT improved upper extremity function in unilateral CP<sup>19</sup>.

According to Kim et al., action observation therapy (AOPT) was shown to enhance upper extremity function in CP children<sup>20</sup>.

The AOPT group in the current investigation often practiced the upper extremity movements seen in video clips of normal children performing them.

After seeing landscape photographs, the Physical Training group did the identical tasks as the AOPT group. Upper extremity motor function was also assessed with the MAS, BBT, and ABILHAND - (Kids) tests. CP children had a significant gain in upper extremity motor function.

Said to have seen this is likely because AOT may have a positive impact on neurorehabilitation associated with a wide range of neural networks, given the motor-mimicking properties of the MNS<sup>21</sup>. Additionally, research by Buccino et al. evaluated the impact of action observation therapy (AOT) in the treatment of upper limb function for individuals with CP. In this study, it was discovered that giving children with CP either AOT and performance together was more beneficial than giving them only performance.

On both scales-the Melbourne assessment scale and assisting hand assessment-they discovered that upper extremity motor function significantly improved compared to controls<sup>22</sup>.

The comparison of baseline and post-treatment data demonstrated a considerable improvement in action observation therapy compared to the bimanual training group, with favorable effects observed on the Fugl Meyer evaluation scale and the Box and Block test. As a result, the study's findings indicated that action observation training enhanced hand function in hemiparetic CP children. The action observation training group experienced positive changes in all outcomes after twelve weeks.

## Conclusion

In accordance with the study, action observation training, as opposed to bimanual arm training, has a larger favorable impact on hand function in children with hemiparetic cerebral palsy. Although the results of the Box and Block test and the Fugl Meyer assessment for both groups showed a significant improvement after treatment, the action observation training group had a greater increase in hand function than the bimanual arm training group.

## ISRB APPROVAL

This study was performed in line with the principles of Helsinki. Approval was granted by the ethical committee of Saveetha College of Physiotherapy, Tamil Nadu, India.

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**Conflict of interest:** Nil

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