Effect of tactile stimulation on dexterity and manual ability of hand in hemiplegic cerebral palsy children

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COVER LETTER TO IJTRR JOURNAL

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11th June 2016

Dear Dr.Jasobanta Sethi, MPT.,PhD.,FIAP

I/We wish to submit a manuscript entitled “Effect of tactile stimulation on dexterity and manual ability of hand in hemiplegic cerebral palsy children” for consideration by the journal International journal of therapies and rehabilitation research.

I/We confirm that this work is original and has not been published elsewhere nor it is currently under consideration for publication elsewhere.

In this paper, I/we are reporting on treatment of tactile stimulation which increases manual ability and dexterity of hand in hemiplegic cerebral palsy children. The paper should be of interest to readers in the areas of tactile stimulation, dexterity, manual ability, hemiplegic cerebral palsy.

Significance of report - Hemiplegic cerebral palsy affects activities of bimanual coordination, decreasing manual ability and thus, decreasing daily self care activities and school activities. Impaired sensations negatively impact on acquisition of skilled movement. Recent advances in computational study of motor control have also emphasized the importance of sensory feedback for movement. Tactile inputs given in the study significantly increased speed of the movement and spontaneous use of the hand in bimanual activities which suggest that tactile stimulation training, given regarding the object properties should be emphasized in routine rehabilitation for improvement in dexterity and manual ability also provides a basis for early sensory intervention.

Thanking you for your kind consideration.

Sincerely,

Dr Pratibha S. Salkar
Dr Shamla Pazare
**Author disclosure**

**Manuscript title:** Effect of tactile stimulation on dexterity and manual ability of hand in hemiplegic cerebral palsy children

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ABSTRACT
**Background:** Hemiplegic cerebral palsy results of damage to the cortico spinal tract and other developing pathways resulting into impaired hand dexterity, leading to developmental non use affecting activities of bimanual coordination, decreasing manual ability and thus, decreasing daily self care activities and school activities. According to motor control, sensations modulate the movement. Impaired sensations negatively impact on acquisition of skilled movement. Gorden et al also stated that impairments in children with hemiplegia are largely on sensory mechanism. So the aim of the study is to find the effect of tactile stimulation on dexterity and manual ability of hand in hemiplegic cerebral palsy children.

**Methodology:** Study design was Experimental study. 22 participants were divided by randomization into an experimental and control group. 11 participants in Group A (conventional rehabilitation program of strengthening and active movements) and 11 in Group B (conventional rehabilitation program and tactile stimulation exercises like texture, shape, size, common object identification with eyes open and close). 3 sessions per week for 6 weeks. Parametric data was analyzed by using paired t test and unpaired t test. Non parametric data was analyzed by Wilcoxon test and Man Whitney test.

**Result:** Data analysis reveals significant improvement in group A and group B on dexterity. But, more significant in group B (experimental group) than group A with p value (<0.05). There was significant difference in experimental group on manual ability measure.

**Conclusion:** The present study concluded that there is effect of tactile stimulation on dexterity and manual ability of hand in hemiplegic cerebral palsy children.

**Keywords:** Tactile stimulation, dexterity, manual ability, hemiplegic cerebral palsy.
Cerebral palsy is an umbrella term covering a group of non-progressive, sensorimotor impairment. Peter Rosenbaum proposed a definition of cerebral palsy with as a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non progressive disturbances that occurred in the developing fetal or infant brain.

The motor disorder of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication and by secondary musculoskeletal problem. In India, the incidence of cerebral palsy is 3 per thousand live births. Amongst spastic (70-80%) subgroup, spastic diplegia is commonest of all followed by spastic hemiplegia and quadriplegia.

Dexterity is defined as “the manual skill that requires rapid coordination of fine and gross voluntary movements based on a certain number of capacities developed through learning, training, and experience”. Dexterity implies use of variety of manipulative movements for object handling. Manipulation includes co-ordination of different body segments that allow the hand for adapting to grasp different objects. These manipulation skills develop through 10 to 12 years.

Manual ability is defined as “the capacity to manage daily activities requiring the use of upper limbs whatever the strategies involve”. It describes child’s self initiated ability to use both hands while handling objects in daily activities. Marijan et al also found manual ability being limited in adolescents with cerebral palsy including hemiplegics and conclude that limitation in manual ability are strongly correlated with limitations in daily self care abilities and school activities.

Children with hemiplegic cerebral palsy commonly exhibit sensory deficiencies in their hands in addition to motor problems. According to the motor control theory sensations can modulate the movement. Studies state that sensations impact negatively on reacquisition of skilled movements of the hand. They exhibit various types of sensory processing deficits from which mostly identified sensory deficits include astereognosis, impaired two point discrimination and difficulty with position sense which majorly relate to tactile processing. Tactile processing disorders are tactile
modulation deficits; hypo responsiveness to tactile input or registration deficits, and tactile discrimination deficits; inability to identify the temporal and spatial qualities of tactile stimuli.

Studies report that deficits with tactile perception, registration, poor tactile discrimination and astereognosis are correlated to difficulties in manipulative skills leading to poor motor hand function. Decreased or absent afferent tactile input to the brain appears to further compromise motor learning. McLaughlin et al. and Eliasson et al. have emphasized that manipulation tasks are organized as a sequence of discrete action phases, the sensory predictions generated in one action phase are used in the next. In the absence of such anticipatory control, the brain would have to rely on peripheral afferent signals to obtain this information. Such a process would be time consuming due to time-delays in sensorimotor control loops associated with receptor transduction and encoding, neural conduction, central processing and muscle activation.

Studies also state that development of hand functions in hemiplegic cerebral palsy and spontaneous use of hand takes longer time. Sensory retraining approaches are often used successfully in adults following stroke. Nicola assessed the effectiveness of sensory rehabilitative training program for deficits in somatic sensation and motor control of the hand in patients with stroke showing significant recovery in motor impairments in hand and dexterity. Gorden et al. stated that impairments in children with hemiplegic cerebral palsy are largely but not exclusively due to sensory mechanisms which may have direct implication for therapeutic intervention.

Tactile dysfunction of hand can be treated with various tactile inputs training in discrimination of size, shape, and weight of objects and texture. It involves active and passive stimulation. Purpose of this is to place demands on receptors of skin to enhance normal sensitivity. Recent advances in computational study of motor control have also emphasized the importance of sensory feedback for movement.

Improving hand functions becomes a high priority in the recovery of cerebral palsy children which can lead to improvement in activities of daily living, enhancing their quality of life. Thus, the purpose of the study was to find out effect of tactile stimulation on dexterity and manual ability of hand which may provide a basis for early sensory intervention and enhanced recovery of hand function.
Aim
To find the effect of tactile stimulation on dexterity and manual ability of hand in hemiplegic cerebral palsy children.

Objectives
1. To study the effect of conventional exercises on gross and fine motor dexterity and manual ability of hand in hemiplegic cerebral palsy children
2. To study the effect of tactile stimulation on gross and fine motor dexterity and manual ability of hand in hemiplegic cerebral palsy children
3. To compare the effects of conventional exercises and tactile stimulation on dexterity and manual ability of hand in hemiplegic cerebral palsy children

Methodology
This experimental study was conducted on 24 hemiplegic cerebral palsy patients.

INCLUSION CRITERIA
- Diagnosed cases of hemiplegic Cerebral palsy.
- Age - 8 to 12 years.
- Both males and females.

EXCLUSION CRITERIA
- Children having cognitive deficit (Health utility index- 3 Level 4 or >4).
- Children having poor sitting balance.
- Neurological or orthopedic surgery of upper extremity or hand.
- Children treated with botulium toxin injection in hand or upper extremity in past six months.

Procedure – Before collecting the data ethical approval was obtained and written consent from both parents and children were taken. All 24 subjects underwent a physical examination and assessment on outcome measures before and after treatment on Box and block test, Nine hole.
peg test, Jebsen taylor hand function test subtests, ABILHAND kids questionnaire. There was 1 drop out from each group due to health issues so, 22 subjects underwent the intervention 11 in each group. Group A received conventional exercises and group B conventional exercises along with tactile stimulation. Interventions were given for 3 sessions per week for six weeks.

**GROUP A - CONVENTIONAL EXERCISES**

The exercises were initiated with 1 set of 10 repetitions for strengthening of individual muscles. The exercises were performed with adequate rest periods in between.

- Sustained manual stretching for long finger flexors, forearm supinators and wrist flexors was given for 30 seconds hold for each.
- Active exercises for eliciting muscle activity were given where patient was asked to move the part towards the object but not touch it. All the upper extremity joint movements were performed.
- Strength training was given for shoulder flexors, extensors, abductors, external rotators, elbow flexors, extensors, supinators, wrist flexors and extensors in supine and sitting position with yellow theraband and individual finger flexors, extensors, abductors strengthening with different sizes of rubber bands and hand gripper. The intensity of these exercises was increased by increasing the hold time and increasing the leverage.

**GROUP B – CONVENTIONAL EXERCISES AND TACTILE STIMULATION**

The exercises consisting of tactile stimulation exercises were given along with conventional exercises.

**TACTILE STIMULATION**

Principles used during exercises are as follows:-

1. The exercises were done in quite environment to maximise the concentration and Attention
2. Motivation, given by meaningful task
3. Stimulation is graded from gross to fine, rough to smooth, easy to difficult i.e. identification to discrimination
4. Repetition
5. Feedback on performance
6. The exercises were started first with eyes open then with eyes closed, if incorrect then again with eyes open. Then ask to concentrate on matching what he or she feels with what he or she has seen with eyes open.

7. Levels in tactile stimulation exercise are represented by the sequencing as follows:
   
i. Identification training of the touch
   
   ii. Identification training of various texture / shapes / Objects
   
   iii. Discrimination training with first with same then with different texture / shapes / Objects (Matching tasks).

8. Each exercise was performed for 10 minutes

**Tactile stimulation:**

Touch – Improvement in touch sensations is firstly important. Touching the hand at hypothenar and thenar eminences of palm, fingers, thumb. Blunt side of pencil is used, touch should be firm and maintained given from proximal to distal direction starting near the wrist and going down. Ask the patient how many times did you touched and where. (fig1)

- Localisation of touch by using eraser end of pencil stimulating the specific areas of hand, fingers, finger tips, thumb and palm. (fig2)

For proper object discrimination, tactile discrimination with texture, shape, sizes are required.
Texture stimulation:

- Different textures were selected ranging from Rough to Smooth. Rough Textures included, rough brush, rough stone, rough plastic, corrugated cardboard, course sandpaper, sack cloth whereas smooth textures included soft cloth, fine sand paper, smooth stone, smooth chocolate rapper, silk, metal, glass. Individual textures first with rough and then moving on to smooth textures from proximal to distal direction. Then indentifying these different textures with each other (fig3,4,5)

Identification and discrimination of Texture with cloth and metal (eyes open and closed)

- Tactile discriminative training involving Identification of geometric shapes, letters, numbers by tracing them on finger tips and other areas of hand.

- Tactile inputs include knowing of shape and size which will help for tactile discrimination it focuses on tactics of perception that is interpreting the diagnostic clues from sensory information. Shape discrimination is most diagnostic attribute to the object recognition. It is a special ability to deal with spatial relationships.

- Basic different shapes were selected i.e. square, circle, rectangle, cylindrical which helps us to define the edges of objects effectively and are coincides with common objects of daily living(fig 6,7,8,9)

- Orientation of object with eyes open and then close, exploring the object for its shape by touching the edges and shape discrimination is done with identical pair of it with eyes closed.
Different sizes of above shapes were given to patient e.g. different size of circle were given (caps of bottles) also different size of squares, rectangle and cylindrical shapes were given ask them to differentiate to learn to the different size by telling the patient to look for spreading of the fingers are they large or small.

Identification and discrimination of the objects with eyes open and eyes closed

Tactile inputs for object weight identification

Weight identification Identification and discrimination of objects of daily living with eyes open and eyes close
- Actual Common objects are selected like Chocolate Big Bar, Bottle, Toothpaste, Coins, Buttons, Jam bottle, Pencil, Eraser, Bread box, Spoon, Keys this objects were made to explore for their shape, size and identification of them (fig11).

- Discrimination and identification of objects was done by putting the small objects above into the bowls of rice, beans, sand ask them to remove them without looking. (fig12)

Identification of objects in bowl of rice, beans and sand
STATISTICAL ANALYSIS

Statistical analysis was performed by using Graph pad instat and micro soft excel. Paired and unpaired t test were used to find out difference within and inbetween the groups.

For Abil Kids questionnaire – Manual ability - Rash analysis was used to calculate the manual ability. The ordinal score of questionnaire were transformed into linear interval measurements. The Wilcoxon test was used to find out the difference between the within the groups and Mann Whitney U test was used to find the difference between the groups.
Table 1: Comparison of mean values of Box and Block Test, Nine Peg Hole Test and Abil Hand Kids Questionnaire in Group A and Group B

<table>
<thead>
<tr>
<th>TEST</th>
<th>Groups</th>
<th>Pre treatment</th>
<th>Post treatment</th>
<th>p value within the groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box and Block test</td>
<td>Group A</td>
<td>27 ± 4.2</td>
<td>35.2 ± 5.6</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>26.36 ± 6.0</td>
<td>45.6 ± 8.6</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.3897</td>
<td>0.0014</td>
<td></td>
</tr>
<tr>
<td></td>
<td>between the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nine Peg Hole test</td>
<td>Group A</td>
<td>58±8.4</td>
<td>53.4 ± 8.5</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>56.81 ±11.9</td>
<td>37.36 ±12.4</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.3959</td>
<td>0.0010</td>
<td></td>
</tr>
<tr>
<td></td>
<td>between the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABIL HAND Kids Questionnaire</td>
<td>Group A</td>
<td>15.72 ± 5.00</td>
<td>15 ± 5.029</td>
<td>0.2891</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>19.18 ± 7.2</td>
<td>26.54 ± 7.4</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.0782</td>
<td>0.0011</td>
<td></td>
</tr>
<tr>
<td></td>
<td>between the</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>groups</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post treatment values between the groups shows statistically significant difference in Group B with p value (<0.05)
Table 2: Comparison of mean values of Jebsen Taylor Hand Function Test subtest in Group A and Group B

<table>
<thead>
<tr>
<th>JEBSEN TAYLOR HAND FUNCTION SUBTEST</th>
<th>Groups</th>
<th>Pre treatment</th>
<th>Post treatment</th>
<th>p value within the groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picking up objects</td>
<td>Group A</td>
<td>51.09 ± 7.3</td>
<td>46.36 ± 7.9</td>
<td>0.0009</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>49 ± 8.3</td>
<td>28.1 ± 9.1</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.2698</td>
<td>0.0001</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>between the groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simulated feeding</td>
<td>Group A</td>
<td>51.18 ± 8.1</td>
<td>46.27 ± 7.7</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>50.09 ± 10.28</td>
<td>36.27 ± 10.66</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.3926</td>
<td>0.0104</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>between the groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moving light objects</td>
<td>Group A</td>
<td>19.54 ± 4.1</td>
<td>17.27 ± 4.5</td>
<td>0.0002</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>19.81 ± 5.30</td>
<td>11.36 ± 3.20</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.4473</td>
<td>0.0010</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>between the groups</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moving heavy objects</td>
<td>Group A</td>
<td>23.54 ± 4.08</td>
<td>19.81 ± 4.2</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>Group B</td>
<td>26 ± 6.11</td>
<td>14.81 ± 4.75</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>p value</td>
<td>0.1407</td>
<td>0.0087</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>between the groups</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post treatment values between the groups shows statistically significant difference in Group B with p value (<0.05)
DISCUSSION

The results of the present study showed that conventional exercises consisting of stretching, active range of motion exercise and strengthening improved gross motor dexterity and fine motor dexterity. Indicating increased in performance of hand on dexterity measures. In terms of stretching, muscle tension is usually inversely related to length, so decreased muscle tension is related to increase muscle length and increasing the range of motion\textsuperscript{23}. Evidence suggest that training upper limb and hand movement control in cases of congenital paresis in which there is an inability to recruit motor neurons can be enhanced with therapeutic strategies used to facilitate active motion by the patient\textsuperscript{24}. Hemiplegic cerebral palsy children exhibit imbalance and weakness in upper extremity and hand. Weakness in muscle activity is due to decreased voluntary motor unit recruitment reflecting an inability or difficulty in recruitment of skeletal motor units to generate torque or movement. This weakness can be modified via activation of motor units. Strengthening exercises could promote improvements in strength through muscle tissue remodeling and neural adaptation, Evidence suggests that in CP there may be a reduction in motor-unit firing rates, presumably as a result of interrupted descending signals. Failure to increase firing rates sufficiently during contraction could cause weakness and loss of dexterity as is typically seen in both agonist and antagonist muscles\textsuperscript{25}. Taylor et. al., stated the most used methods to increase the capacity to generate strength in the patients of CP are the progressive resistance exercises, whose effects are noticeable improvement of the muscular performance and also on motor dexterity and conditioning\textsuperscript{26}. Significant improvement in gross and fine motor dexterity was seen with strengthening as observed by decrease in time to complete box and block test, nine peg hole test and also in Jebsen Taylor hand function sub tests. Strengthening increases the motor co-ordination and performance in daily activities\textsuperscript{27}. Upper extremity reach and manipulation patterns are thought to be controlled by proximal movements of the shoulder which directly impacts the distal movements. In the present study exercises were given to upper limb as well as to scapular muscles, so it would have improved shoulder stability improving accuracy and control of reaching patterns\textsuperscript{28}. There was no significant improvement in manual ability in Group A suggesting that there was no carryover of conventional exercise in spontaneous use of hand in activities in Abil hand
kids questionnaire of manual ability in hemiplegic cerebral palsy children. Carlyn Arnold et al\textsuperscript{29} states that intervention should always endeavor to improve manual ability by training the child to perform the daily activities that are optimized to use his or her hand in meaningful activities and to find self initiated solutions with different challenging activity.

Group B receiving tactile stimulation and conventional exercises showed a significant improvement in dexterity and manual ability of hand. This suggests that with tactile inputs there is a significant improvement in dexterity and manual ability.

Reaching to grasp object and taking it to desired location consist of, transportation component in which hand moves quickly to the vicinity of the target, grasp aperture the distance between the thumb and the index finger increased, the size of maximal opening is equal to size of the object when reaching for an object as, the fingers begin to stretch and grip size increases rapidly to maximum. The transport movement decelerates and final adjustments in the grasp apertures are made and grasp size decreases as hand reaches nearer the object known as pre shaping or anticipatory control of the hand\textsuperscript{30}. For successful grasping an object, the finger movements also should be timed appropriately. If they close too early or too late the grasp will be inappropriate. The ability to grasp it precisely between the thumb and index finger requires close interplay between the sensory inputs from the fingers and mechanisms controlling the motor output of hand and finger muscles. This precision grasp and manipulation depends on sensory tactile information which conveys information regarding object texture, shape, size in the development of internal representation about an objects characteristic. During lifts, internal representations of the object are used to pre program grip lift task forces .Thus scaling of forces is performed prior to the lift and it is dependent on both sensory motor memory representation and current tactile information. Impaired sensibility would probably not provide enough sensory information to form vivid internal representation of objects physical properties\textsuperscript{31}.

Elliasson et al \textsuperscript{32} also found impaired tactile regulation of isometric finger tip forces during grasping in hemiplegic children. He suggested that children with cerebral palsy who have sensory impairments may not be able to extract enough information during initial manipulatory experiences to form internal representations of the object properties. As in the present study tactile stimulation were made to orient to the object with proper shape, size and texture and discriminating them with other objects, this would have helped to improve anticipatory control and improving hand functions. This finding is with agreement with the
study done by Gorden and Duff et al\textsuperscript{33} showed that learning to use anticipatory control of load forces was based on texture, weight of an object.

A significant improvement is found in gross manual dexterity on tests of box and block test, moving light objects and moving heavy objects. Signals from tactile afferents rapidly encode features of the contacts between digits and objects and helps the object in hand to be undisplaced. Thus, this would have helped for improving speed of moving light objects.\textsuperscript{34} Johansson and Westling et al, stated that tactile information is used to monitor the weight of an object (vertical lifting force) and the frictional characteristics of the object in relation to slip enabling the motor output.\textsuperscript{35}

A significant improvement was found in fine finger dexterity test of nine hole peg test and picking up objects and simulated feeding. Study done by Megan et al, stated that somatosensory function is crucial for anticipatory control and appropriately calibrating grip force for fine hand movements. Texture perception which combines fine spatial and temporal qualities of the stimulus,\textsuperscript{36} may also have a significant role in calibrating fine precision grip. It is also suggested that tactile sensation accounts for 30 \% of variance in motor performance. The findings in the study coincides with results found by Alexandra Borstad et al\textsuperscript{37} stating that with upper extremity sensory training program significant difference was seen in both box and block test and nine peg hole test. The principles used during tactile stimulation majorly targets improvement by perceptual learning, as improving perception skills reflects capabilities of sensory system to detect, analyses and estimate physical stimuli. Perceptual learning improves neural plasticity so these principles would also have affected the significant results.

Motivation is important in learning and recovery after brain injury\textsuperscript{38}, and the brain responds to meaningful goals. Therefore, as training given was goal directed, interesting, and demanding, it has the potential of the brain for functional reorganization\textsuperscript{39}.

Furthermore, training was done with eyes closed and eyes open would help to improve motor functions in hand. As vision may dominate tactile senses in some instances, exploration of stimuli with vision occluded was included to allow participants to focus specifically on the somatic sensations.\textsuperscript{40} Also use of vision to facilitate cross-modal calibration, consistent with activity in visual cortical regions during tactile perception. Computational neural models indicate that when two modalities are trained at the same time and provide feedback for each
other, a higher level of performance is possible. So, the use of vision during exercise would have increase the response on tactile stimulation.

Augmented feedback by method of exploration on accuracy of response outcome and on performance enhance perceptual learning. Practice and summary feedback with correction can enhance learning. Finer perceptual differences are able to be distinguished through exposure to a series of graded stimuli. Graded progression facilitates perceptual differentiation. Thus, training was progressed from easy to more difficult discriminations.

Manual ability was significantly increased in Group B. Sensory impairment has correlation with decreased spontaneous use of hand. With added tactile stimulation, manual ability is increasing which indicates that tactile inputs are helpful for increasing spontaneous use of hand.

Comparison between two groups showed that there was significant improvement in Group B by conventional exercises and tactile stimulation which states that with addition of tactile stimulation there is further more improvement in motor performance in dexterity. The findings are in agreement with Byl et. al., described a program aimed to improve accuracy and speed in sensory discrimination and sensorimotor feedback. Improvements in sensory discrimination, fine motor function, and musculoskeletal measurements of the upper limb were reported following sensorimotor training; however, he also suggested that it was not possible to determine the effectiveness of sensory training alone.

In comparison to Group A the speed of dexterity test are significantly improved in Group B, Johansson & Birznieks, et al. states during manipulation brain quickly extracts information from discrete tactile events and expresses this information in fingertip actions faster.

In the present study, manual ability activities on Abil Hand questionnaire which were coinciding with the training had more improvement. Perceptual learning is usually highly specific to the task, Similarly, we found highly specific training effects in tasks employing the same sensory dimension (eg textures, shapes, sizes).
Group B showed significant improvement with additional tactile stimulation on manual ability but no significant improvement was seen in Group A which states transfer of training effects is more effective when variation in stimuli is employed. Proprioception could not be excluded from sensory deficits from the subjects but studies state that proprioception signals related to muscle length, joint angle and muscle force do not directly code the contact state between the hands and objects and the sensitivity of non-digital mechanoreceptive afferents (e.g. Musculotendinous afferents) to fingertip events is very low in comparison to that of tactile sensors.  

**CONCLUSION** - The present study concludes that tactile stimulation is effective on dexterity and manual ability of hand in hemiplegic cerebral palsy children

**LIMITATIONS**

1. Involvement of proprioception could be ruled out.
2. Muscle strength of upper limb and hand grip strength was not taken
3. Sensory testing with standardized measures like sensory integration praxis test was not taken

**SCOPE OF THE STUDY**

1. Effect of kinesthesia sensations can be studied for improvement of hand
2. Effect of retention of learning can be seen

**CLINICAL IMPLICATIONS** - Tactile inputs significantly increased speed of the movement and spontaneous use of the hand in bimanual activities which suggest that tactile stimulation training, given regarding the object properties should be emphasized in routine rehabilitation for improvement in dexterity and manual ability.

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