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Sensory-Enhanced Pediatric Constraint Induced Movement Therapy

Mary Rebekah Trucks, MS, OTR/L
Dory Wallace, MS, OTR/L

Learning Objectives

- After this course participants will be able to identify the essential 5 elements of the ACQUIREc signature form of Pediatric Constraint Induced Movement Therapy (P-CIMT).

- After this course participants will be able to list various standardized measures useful in the assessment of a sensory-enhanced protocol for P-CIMT.

- After this course participants will be able to identify 3 -5 sensory-enhanced treatment activities for various ages of children receiving P-CIMT.
Signature P-CIMT

5 Elements
- Constraint:
  - splint or cast
- High Dose of Therapy:
  - 3-6 hours over 3-4 weeks
- Shaping and Repetitive Practice
- Natural Environments
- Transition Planning

ACQUIREC (signature P-CIMT)
- Acquisition of new motor skills
- Continuous practice with shaping to produce
- Quality movement of the Upper Extremity through Intensive therapy and Reinforcement in Everyday patterns and places 
  - Casting

Research: P-CIMT

- Current research focus of P-CIMT
  - NIH:
    - Multi-site
    - Multi-dose
    - Multi-constraint (cast or splint) and no constraint
  - Overall:
    - Dosage levels
    - Types of constraint
    - Group/camp vs. individual
    - Repeat treatments, etc.

- Sensation: secondary focus and typically not assessed

(DeLuca et al., 2005, Case-Smith et al., 2012; DeLuca et al., 2006; DeLuca et al., 2007; DeLuca et al., 2012; Kinnucan, 2000; Stagnitti, 2003)

(Auld et al., 2014)
Research: Sensory Based

- Sensory intervention research in adults post stroke
  - Positive tactile results for the following:
    - Transfer enhanced training
    - Stimulus specific training
    - Ice therapy
    - Mirror therapy
    - Functional deafferentation with anaesthetic cream
      (Auld et al., 2014)

- Assessment of sensation in children with unilateral motor impairment (UMI)

- Development of assessment tools in children with UMI
  (Auld et al., 2012a, 2012b; Kinnucan, 2010)

- Sensory intervention research in children with UMI

Purpose of Sensory-Enhanced P-CIMT Research

- Impaired Tactile Sensation:
  - Impacts 77% of children with UMI
  - 40% impaired registration and perception
  - 37% impaired perception
    (Auld et al., 2014)

- Connection of sensory ability to motor ability
  - Accounts for 30% of variance
    (Auld et al., 2012a; Eliasson et al., 1995a)

- Sensory comprised of:
  - Registration
  - Perception
    (Auld et al., 2012b)
Sensory-Enhanced P-CIMT Research Process

Overall Procedure
Assessments
Participants
Intervention

Overall Procedure

- Convenience sampling
- IRB: addendum and approval
- Ages: 6 years +
- Administration and scoring of assessments (pre/post)
- Administration of Sensory-Enhanced Protocol
Sensory Assessments

- **Assess tactile registration prior to perception** (Auld et al., 2014)

- **Registration:**
  - Semmes Weinstein 5 Monofilaments (SWM) (Schreuders, 2008)
  - Temperature (non-standardized method)
    - Heated spoon (heating pad) and Cold spoon (freezer)

- **Perception:**
  - Disc-Criminator—Static 2 point Discrimination (Klingels et al., 2010)
  - Stereognosis (Boyd et al., 2010; Klingels et al., 2010)

- **Qualitative Questionnaire** (parent and child versions)

---

**Picture Examples**

<table>
<thead>
<tr>
<th>Registration - SWM</th>
<th>Perception - Disc-Criminator</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image of SWM]</td>
<td>![Image of Disc-Criminator]</td>
</tr>
</tbody>
</table>
Motor and Functional Assessments

<table>
<thead>
<tr>
<th>Standardized</th>
<th>Non-Standardized</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Assisting Hand Assessment (AHA)</td>
<td>• Directed Play (DP)</td>
</tr>
<tr>
<td>(Krumlinde-Sundholm, 2007)</td>
<td>(DeLuca et al., 2007)</td>
</tr>
<tr>
<td>• Shriner’s Hospital Upper Extremity Evaluation (SHUEE)</td>
<td></td>
</tr>
<tr>
<td>(Davids et al., 2006)</td>
<td></td>
</tr>
</tbody>
</table>

Participants
## Case Information

<table>
<thead>
<tr>
<th>Cases</th>
<th>Case One: EJ</th>
<th>Case Two: JG</th>
<th>Case Three: KS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>7 years</td>
<td>7 years</td>
<td>8 years</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Right sided hemiparesis</td>
<td>Right sided hemiparesis</td>
<td>Left sided hemiparesis</td>
</tr>
<tr>
<td>P-CIMT Tx History</td>
<td>4 sessions</td>
<td>11 sessions</td>
<td>7 sessions</td>
</tr>
<tr>
<td>Level of Sensory Impairment</td>
<td>Moderate/Max</td>
<td>Moderate/Max</td>
<td>Minimal</td>
</tr>
</tbody>
</table>

## Clinical Observations

<table>
<thead>
<tr>
<th>Cases</th>
<th>Case One: EJ</th>
<th>Case Two: JG</th>
<th>Case Three: KS</th>
</tr>
</thead>
</table>
| Clinical Observations | • Increased flexor tone: wrist and fingers/thumb  
• Minimal spontaneous use of RUE  
• Age-appropriate bilateral skills:  
  • Completed one handed or not at all (i.e. shoe tie) | • Minimal tone overall; increased tone supination  
• Increased motor and functional ability | • Mild flexor tone: thumb and wrist  
• Increased motor and functional abilities with LUE |
**Treatment Focus**

<table>
<thead>
<tr>
<th>Cases</th>
<th>Case One: EJ</th>
<th>Case Two: JG</th>
<th>Case Three: KS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Focus</td>
<td>• Increase motor ability and strength of RUE for increased independence in age appropriate ADLs</td>
<td>• Increase fine motor strength, stability, and movement for independence in dressing (buttons, shoe tie, zippers, putting gloves on, etc.)</td>
<td>• Increase in strength and movement to support skills necessary for school-based occupations (typing) and age appropriate leisure activities (swimming, tennis)</td>
</tr>
</tbody>
</table>

**Treatment Process**

- Sensory-Enhanced Protocol
  - 20 treatment days
  - 6 hours of treatment Monday through Friday
  - 60% of each day = Sensory-enhanced activities
    - Motor and Function based
    - Stretching included as well
  - Variations in treatment
    - Amount of time constraint was worn for repeat children
### Sensory-Enhanced Treatment Examples: Older Children

<table>
<thead>
<tr>
<th>Motor</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify weight of objects with vision occluded.</td>
<td>Use of rope and micro-fleece blanket to pull objects across the room</td>
</tr>
<tr>
<td>Carrying objects in bucket with textured handle.</td>
<td>Finger paint mixed with bird seed and cake sprinkles</td>
</tr>
<tr>
<td>Grasp of objects using contrasting temperatures</td>
<td>Grasp of various textured sea shells from a sand box</td>
</tr>
<tr>
<td>Grasp of objects from various textures (beans, water beads, moon sand, gel)</td>
<td>Movement of the involved arm in water and different temps of water</td>
</tr>
<tr>
<td>Mirror Box: basic movement of the involved hand (completed a minimal amount during bilateral tx)</td>
<td>Magnets: turned around to repel as well which creates and unusual sensation</td>
</tr>
<tr>
<td>Weight bearing on a textured surface</td>
<td>Carry objects in bucket without knowing the weight prior to grasp</td>
</tr>
<tr>
<td>Identify letters drawn on arm/hand</td>
<td>Sponge paint/squeeze -grade pressure</td>
</tr>
</tbody>
</table>

### Sensory-Enhanced Treatment Activities: Older Children

<table>
<thead>
<tr>
<th>Functional</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dressing:</strong> tactile feedback to fingertips while practicing putting in earrings.</td>
<td><strong>Dressing:</strong> location of arm in shirt; fingers remain open pushing through sleeve</td>
</tr>
<tr>
<td><strong>Dressing:</strong> tactile input of various textured fabrics</td>
<td><strong>Dressing:</strong> Practice putting gloves on: fingers bent/straight and in correct slot</td>
</tr>
<tr>
<td><strong>Dressing:</strong> Shoe tie practice with eyes closed once skill was mastered</td>
<td>Searching for specific items in a purse/bag without vision</td>
</tr>
<tr>
<td><strong>Meals:</strong> use of textured utensils, tray, cups, etc.</td>
<td><strong>Meals:</strong> Holding cold juice box or cup with condensation</td>
</tr>
</tbody>
</table>
### Sensory-Enhanced Treatment Activities: Older Children

<table>
<thead>
<tr>
<th>Functional</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooking</strong>: tactile input from different food textures</td>
<td>Open various food containers to practice grading pressure</td>
</tr>
<tr>
<td>Vibrating toothbrush to palm during teeth brushing.</td>
<td>Use of hand sanitizer to wash hands due to cooling sensation</td>
</tr>
<tr>
<td>Texture of playground climbing equipment.</td>
<td>Pulling horse reins with gloves on hand to change consistency of tactile input</td>
</tr>
</tbody>
</table>

### Sensory-Enhanced Activities: Younger Children

<table>
<thead>
<tr>
<th>Activity</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger foods (pudding, cool whip, ice cream, popsicles, syrup, crackers, veggie puffs)</td>
<td>Outdoor textures: rocks, grass, sticks, leaves, water, riding toy or swing with textured handle</td>
</tr>
<tr>
<td>Textured utensil handles or cup handles</td>
<td>Animals –pet the dog, cat, rabbit, petting zoo, etc.</td>
</tr>
<tr>
<td>Blankets and stuffed animals different type of texture</td>
<td>Bath time sensory with water play, bubbles, soap, textured toys</td>
</tr>
<tr>
<td>Toothbrush, washcloth, or loofah input especially to the palm</td>
<td>Touch and feel sensory books</td>
</tr>
<tr>
<td>Toys with texture (this can be any regular toy that has an unusual texture and is applied to the hand/arm)</td>
<td>Pull toys that vibrate as they are activated; place the toy on the child’s arm/hand while it vibrates</td>
</tr>
</tbody>
</table>
Sensory Based Stretching and AROM

Texture and Stretching  Bilateral Sensory

Movement Based Sensory Examples
Flower Planting Sensory

Various textures within the activity:

- Shovel handle is textured
- Texture of dirt
- Mix of dirt with water prior to potting plant
- Fun piece of watching plant grow and watering each day

Function Based Sensory Examples
Mealtime Sensory

Textured utensils, cup, and tray  
Finger foods with opposite texture

Rice Krispy Treats

Pull Krispies from bag  
Use hand to push down
Making Dirt Cake

Crush Oreos
Mix ingredients by hand

Sensory Just for Fun

Making a pillow
Melted bar of soap
Results

Sensory
Motor
Functional

Case One
**Sensory Results: Case One**

- Sensory function: small improvements
  - Improvements: SWM and Static Two-Point
  - No change in stereognosis
  - Inconsistencies noted in sensory testing responses
  - Qualitative sensory results

- Sensory function of uninvolved upper extremity

- Sensory impairment evident during treatment process
  - Lack of awareness of food remaining on hand, lack of awareness of objects slipping from hand)

**Motor and Functional Results: Case One**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased finger extension</td>
<td>Increased bilateral hand use during ADLs</td>
</tr>
<tr>
<td>during grasp/release</td>
<td>Active use of right hand during dressing</td>
</tr>
<tr>
<td>Increased grip strength</td>
<td>Independent in adapted shoe tying with both</td>
</tr>
<tr>
<td>Increased ability to maintain</td>
<td>hands</td>
</tr>
<tr>
<td>grasp</td>
<td>The ability to tie shoes was</td>
</tr>
<tr>
<td></td>
<td>accomplished during the month of</td>
</tr>
<tr>
<td></td>
<td>therapy and improved as the motor skills of</td>
</tr>
<tr>
<td></td>
<td>the involved UE improved.</td>
</tr>
<tr>
<td>Decreased compensation</td>
<td>Brushing teeth using both hands for prep</td>
</tr>
<tr>
<td>during reaching and gross</td>
<td>Child was able to complete basic ADLs</td>
</tr>
<tr>
<td>motor arm movements</td>
<td>pre treatment, but did so one handed.</td>
</tr>
</tbody>
</table>
Motor/Functional Results: Case One

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Involved Pre</th>
<th>Involved Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHUEE SFA</td>
<td>29%</td>
<td>38%</td>
</tr>
<tr>
<td>SHUEE DPA</td>
<td>44%</td>
<td>58%</td>
</tr>
<tr>
<td>AHA</td>
<td>24%</td>
<td>64%</td>
</tr>
</tbody>
</table>

*SFA - Spontaneous Functional Analysis
*DPA - Dynamic Positional Analysis
*AHA - Assisting Hand Assessment
Sensory Results: Case Two

- Sensory function: minimal improvements
  - Improvements: Static Two-Point
  - Consistently reported difference on sensation in two hands
  - Qualitative sensory results

- Sensory function of uninvolved upper extremity

- Sensory impairment evident during treatment process
  - Lack of awareness of food on hand, lack of awareness of items slipping from grasp
  - Verbal expression that tactile sensation was impaired

Motor and Functional Results: Case Two

<table>
<thead>
<tr>
<th>Motor</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased wrist strength and stability</td>
<td>• Increased ability to spear/cut food</td>
</tr>
<tr>
<td>• Increased grip strength</td>
<td>• Increase in bilateral dressing skills:</td>
</tr>
<tr>
<td>• Increased palm to object contact during grasp</td>
<td>• Independent bilateral shoe tie</td>
</tr>
<tr>
<td>• Increased maintaining grasp with hand out of sight</td>
<td>• Independence pulling shirt over the head</td>
</tr>
<tr>
<td>• Increased dissociation of movements</td>
<td>• Independence pull pants up and down while maintaining his grasp actively in his right UE</td>
</tr>
<tr>
<td>• Increased combination of movements</td>
<td>• Independence carrying objects with varying weight</td>
</tr>
<tr>
<td></td>
<td>• Emerging skills with monkey bars</td>
</tr>
<tr>
<td></td>
<td>• Emerging ability to stand and pedal on the bike while maintaining a firm handlebar grasp</td>
</tr>
</tbody>
</table>
## Motor/Functional Results: Case Two

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Involved Pre</th>
<th>Involved Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHUEE SFA</td>
<td>62%</td>
<td>69%</td>
</tr>
<tr>
<td>SHUEE DPA</td>
<td>88%</td>
<td>89%</td>
</tr>
<tr>
<td>AHA</td>
<td>94%</td>
<td>88%</td>
</tr>
</tbody>
</table>

*SFA- Spontaneous Functional Analysis
*AHA-Assisting Hand Assessment
*Dynamic Positional Analysis

## Case Three
**Sensory Results: Case Three**

- Sensory function: registration and perception intact
  - Consistently reported difference on sensation in two hands
  - Qualitative sensory results

- Sensory function of uninvolved upper extremity

- Sensory impairment evident during treatment process
  - Increased difficulty in grading pressure during functional activities (buttons, earrings)

**Motor and Functional Results: Case Three**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased strength and stability of entire LUE</td>
<td>• Increased independence in bilateral dressing</td>
</tr>
<tr>
<td>• Wrist strength and stability</td>
<td>• Button/unbutton shirts and pants</td>
</tr>
<tr>
<td>• Thumb strength and stability</td>
<td>• Independence in zip/unzip pants and jackets</td>
</tr>
<tr>
<td>• Increased finger isolation of the PIP and DIP joints</td>
<td>• Independence putting on and taking off earrings</td>
</tr>
<tr>
<td>• Increased isolation of thumb movement</td>
<td>• Increased unilateral functional skill development for typing</td>
</tr>
</tbody>
</table>
Motor/Functional Results: Case Three

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Involved Pre</th>
<th>Involved Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHUEE SFA</td>
<td>67%</td>
<td>82%</td>
</tr>
<tr>
<td>SHUEE DPA</td>
<td>76%</td>
<td>79%</td>
</tr>
<tr>
<td>AHA</td>
<td>95%</td>
<td>98%</td>
</tr>
</tbody>
</table>

*SFA-Spontaneous Functional Analysis
*DPA-Dynamic Positional Analysis
*AHA-Assisting Hand Assessment

Conclusion

- No firm conclusion can be drawn
- Indication of overall results
  - Comparison to research by Auld
- Changes in motor and functional ability:
  - Relationship of sensory and motor in this process
- Sensory impairment
  - Upon injury or over time (Eliasson et al., 1995)
- Sensory ability
  - Possible to alter or “learn” similar to motor ability
Future Research

- Topics for future study of Sensory-Enhanced PCIMT:
  - Contribution of sensory-enhanced activities to the overall motor and functional progress of each child.
  - Use other senses as input
  - Possibility of changing or improving sensory registration and perception.
    - Is it possible to reorganize the sensory portion of the brain?
    - Possibility of sensations being “learned” just as movements?

Current Research
**CHAMP Study:**
“Children with Hemiparesis Arm and Hand Movement Project

- A multisite clinical trial funded by the National Institutes of Health
- Compares the efficacy of alternative therapies for young children with unilateral cerebral palsy
- 3 Clinical sites: Roanoke, Virginia; Charlottesville, Virginia; and Columbus, Ohio

**Cast**
- 3 hrs day / 5 days per week
- 4 weeks

**Splint**
- 3 hrs day / 5 days per week
- 4 weeks

**Usual and Customary Care / Crossover Group**

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**Baby CHAMP Study:**
“Children with Hemiparesis Arm and Hand Movement Project

- Clinical trial funded by the National Institutes of Health
- Compares 3 promising forms of therapy for infants and toddlers who have a diagnosis a cerebral palsy
- 2 clinical sites- Roanoke, Virginia and Columbus, Ohio

**Cast**
- 3 hrs day with therapist
- 1 hr day with parent providing treatment daily / 4 weeks

**Splint**
- 3 hrs day with therapist
- 1 hr day with parent providing treatment daily / 4 weeks

**No Restraint**
- 3 hrs day with therapist
- 1 hr day with parent daily / 4 weeks
Contact Information

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