Enabling Sensory Stimulation for the Promotion of Normal Development in a Child with Visual Impairment: A Case Report

Sarah Agustin PT/s, Shirah Burgey PT/s, Molly Cornelissen PT/s, Lindsey Duquette PT/s, Liz Flood PT/s, Jess Foley PT/s, Austin Goldenberg PT/s, Kayla Hazel PT/s, Trevor Larsen PT/s, Sneha Mehta PT/s, Christina Policastro PT/s, Manisha Sanghvi PT/s, Justine Steinberger PT/s, Lindsey Woolson PT/s, Lorna Hayward, PT, EdD, MPH

Abstract
The implementation of a novel Sensory Substitution Device (SSD) in the form of cubed was intended to stimulate other senses to facilitate function for a child with visual deficits.

Background
Individuals with severe visual deficits have greater difficulty with everyday motor function. Children with visual deficits need alternative sensory input and training to improve their motor function, and subsequently their activities of daily living (ADL) skills. Research supports improvement in sensory integration and motor functioning after the implementation of a Sensory Substitution Device (SSD), which is designed to stimulate other senses in the absence of vision. Two SSDs were designed for an 8 year old child, R, with visual impairments along with cognitive and developmental delays. A group of 14 physical therapy (PT) students traveled to Latacunga, Ecuador for one week to implement these sensory devices and provide PT interventions to enhance motor development.

Aims and Purpose
The purpose of this project was to create two sensory substitution devices to enhance motor control and functional mobility in a child with visual impairments. Construction of the device was a collaborative, interdisciplinary effort between NU PT students and Enabling Engineering to create an innovative sensory device that is functional and sustainable for the staff in Ecuador. The SSDs were designed to engage the child’s other sensory systems - vestibular, auditory, and tactile. One SSD contains features that create a calming environment while the other SSD was intended to be more stimulating. The SSDs were used to motivate the child to perform reaching and balance related tasks. The caretakers, or Tias, and the PT in Ecuador were instructed on how to use the device to ensure sustainability of the intervention.

Methods
The SSDs were introduced to the Tias and the PT during a one-hour training session. During this session, the staff were educated about the purpose of the SSDs and the appropriate use of them. The PTs worked with R for a two hour physical therapy session, using the SSDs for one hour during the session. PT was performed in a quiet, private room. R was seated and the SSD was placed at her eye level. R was allowed to freely explore the SSD for the first ten minutes and then the PTs began purposeful, guided interventions that involved overhead reaching, bimanual tasks and postural strengthening.

Stimulating Cube Design- painted in bright colors: red, orange, yellow
• Turning gears to simulate cause and effect as well as target the vestibular system through the use of head movements
• Musical instruments involving exciting noises such as drums, xylophone, tambourine (all non-electric for sustainability)
• Texture maze with sharp turns to encourage movement and outcomes of play
• Bead roller coaster to help with fine motor control
• Doors that open up to a mirror, different textures to further upright other sensory systems

Calming Cube Design- painted in relaxing colors: blue, green, purple
• Functional textures such as zippers and buttons to encourage fine motor control
• Assortment of soft, soothing textures and calming music to soothe the patient and strengthen their tactile system
• Soft maze where the child can push a marble through to encourage problem solving
• Rainstick attached to a wheel to encourage cause and effect
• Sock puppet feature with swinging door to encourage calming textures, communication skills

Results

<table>
<thead>
<tr>
<th>Pre SSD</th>
<th>Post SSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commands: Followed 0/10 simple one-step commands</td>
<td>Commands: Followed 10/10 one- and two-step commands</td>
</tr>
<tr>
<td>Posture: Moderate cervical and thoracic kyphosis and lumbar lordosis</td>
<td>Posture: Minimal cervical kyphosis, neutral spine position</td>
</tr>
<tr>
<td>Sitting balance: Reached within base of support (BOS) with assist</td>
<td>Sitting balance: Reached within and outside base of support without assist</td>
</tr>
<tr>
<td>Bimanual Tasks: Performed bimanual activities 25% of the time</td>
<td>Bimanual Tasks: Performed bimanual activities 85% of the time</td>
</tr>
<tr>
<td>Shoulder Active ROM: 90 degrees shoulder flexion</td>
<td>Shoulder Active ROM: 120 degrees shoulder flexion</td>
</tr>
<tr>
<td>Attention span: Tolerated therapeutic intervention for 5 minutes</td>
<td>Attention span: Actively played with each side of the SSD for 10 minutes</td>
</tr>
</tbody>
</table>

Discussion
After implementing the SSDs, R exhibited better posture, increased shoulder range of motion (ROM), increased bimanual task completion reaching out of base of support (BOS), and increased attention. Following therapy sessions with the cube, R demonstrated functional changes in motor development and increased spatial awareness. Maintaining R’s attention proved difficult at times due to behavior challenges. However, the cubes provided a calming outlet for the child to self soothe. While in Ecuador, we also found that other student PTs were able to use the SSDs during therapy sessions for other children with sensory processing disorders. In addition, a majority of the children benefitted from the SSDs due to the calming features that worked to reduce overstimulation. This novel device provided opportunities for many other children to enhance their sensory systems.

Acknowledgements
Special thanks to the Enabling Engineering Team- Tessa Fielding, Andrew Horowitz, Erik Ryde, Madison Shultz, and Mara Wallisch and Waleed Meleis, PhD, MS, BSE
Special thanks to Brooke Schober-Service Learning Teaching Assistant

References