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Sensory Regulation Across the Lifespan

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Introduction

Sensory-based interventions are a common modality in pediatric occupational therapy. This is mostly because of how often sensory concerns co-occur with developmental delays and neurodevelopmental conditions such as Autism Spectrum Disorder, Attention-Deficit / Hyperactivity Disorder, and intellectual disabilities. As a result, much of the evidence surrounding sensory integration is focused on children and adolescents. However, therapists know that sensory factors can impact well-being in patients of any age and with any condition.

It is expected the coming years will bring about a growing base of literature on sensory integration as it pertains to other age groups and populations. As this and any other research emerges, it is best practice for therapists to use it as a guide for the work they do. This will allow OT providers to offer more holistic interventions for individuals across the lifespan. This course will offer an overview of what sensory integration looks like from an occupational therapy lens when provided to various age groups and in various contexts.

Section 1: Sensory Terminology & Goal Setting

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In order to offer sensory-based interventions and understand the etiology of sensory concerns across the lifespan, therapists must know the difference between various sensory processes. Sensory integration is perhaps the most predominantly used term in this realm. Sensory integration (also known as sensory processing) is defined as the neurological act of taking in, interpreting, and using information from their environment. Sensory integration allows someone to determine what tactile, olfactory, auditory, visual, gustatory, proprioceptive, and vestibular input is important and what is not important. If the

brain deems the information important, it will create an adaptive response that may vary from one situation to another. However, sometimes the brain takes unimportant information and triggers an adaptive response, which is what happens when someone is hypersensitive or over-reactive to certain sensory input. A good example of sensory integration is the relationship between taste and smell as they pertain to food. When a baby is presented with a new food, they will smell it (and likely touch it or play with it) before they eat it. As most individuals learn at some point, the aroma and texture of food is equally as important as the taste of that food. These tendencies are not exclusive to babies, as most individuals take other food qualities into account before eating something. These past experiences are what lead a person to develop preferences for certain foods and avoid other foods. If someone's sense of smell is temporarily or permanently impacted, this will have an effect on how their food tastes regardless of how the taste receptors on the tongue work. Each sensory system is intertwined with one another, which allows us to experience various facets of the world around us.

Another term therapists should be familiar with is sensory regulation, which refers to the act of regulating one's responses to various stimuli in the environment. Someone with intact sensory regulation skills will be able to process a range of stimuli around them without any impact on their function. Another way to describe sensory regulation is having a good balance between what input someone responds to and what input someone doesn't respond to. If someone moves to an empty room before they start studying or doing homework, this is their attempt at assisting with sensory regulation. This move is intended to help direct the person's brain to focus on processing their coursework rather than processing the input around them. An empty room has less external sensory input (e.g. fewer people, decorations, devices, etc.), which can all negatively impact a person's ability to concentrate. The person studying will likely still be aware of the

distractions in other rooms and may be able to hear low talking, the hum of a fan, or the TV on. But that input is not the focal point of what their brain is processing, so they will most likely be able to take them in without it having an impact on their work. If someone is aware they have trouble focusing with visual or auditory input in the room, this will be an effective strategy for sensory regulation. Some people may be able to filter out the distractions and get their work done despite distractions in their environment. In this instance, moving to an empty room is not a necessary strategy for sensory regulation. Sensory regulation, in this example, is also known as self-regulation since someone is managing it on their own.

Sensory modulation, on the other hand, moreso involves a person's level of arousal. Sensory modulation involves maintaining a standard level of alertness for various activities based on the sensory information they take in and how their body learns from it. Because this process involves learning and developing habits, patterns, and routines as a result of that knowledge, modulation is more focused on a person's actions than sensory regulation and integration are. Sensory modulation is responsible for the behavioral and motor responses that result from the sensory input a person processes. Sensory modulation has some overlap with sensory regulation in that the same strategies can be used for both purposes, as the difference lies in the timing. For example, if someone tries to study in a loud room with a lot of visual input but cannot focus on the content, they may become anxious, frustrated, and irritable. If they get up and move to an empty room to finish their work, this is a modulation strategy aimed at bringing their level of arousal back down to baseline so they can focus. Another example of a modulation strategy in this circumstance might be putting on headphones and listening to calming instrumental music.

Sensory discrimination is another major term therapists should be aware of. While modulation uses sensory information to inform a person's level of alertness at any given time, discrimination allows someone to attribute meaning to the sensory

information they take in. Instead of storing the sensory information, sensory discrimination allows someone to understand what all of it means for their lives and how to use that information in a functional manner. If someone has intact sensory discrimination, they should be able to differentiate between very different items and items that are somewhat similar. For example, let's say a therapist shows a child a puzzle piece that contains the left half of a heart and asks the child to find the right half among a pile of unmatched pieces. A child who has difficulty with sensory discrimination may locate a piece with the right side of a heart and think they have completed the task. However, the heart they found is larger and has more jagged edges, therefore, it does not match the heart half they already have. Another example of poor sensory discrimination might be related to anticipating force. Let's say a therapist asks an older adult to open the top of a glass jewelry box to place some items inside. If the older adult very gently touches the top with their fingertips but does not grasp or manipulate it in a way that helps open it, this might be due to poor sensory discrimination. They are being gentle due to fear of breaking the box, but are not using enough force to effectively open and use the object in its intended way.

Sensory Goal Setting

Therapists should readily recognize the difference between each of these processes and understand the impact each of them has on sensory-specific treatment. These processes should be assessed during the evaluation process to better guide OT treatment in a functional and holistic manner. Therefore, therapists should also be able to write effective sensory goals to structure the plan of care for patients with sensory concerns. Due to OT's distinct emphasis on function, sensory goals will look quite different across the lifespan due to the occupations individuals participate in during various phases of life.

Therapists should use the SMART format to create all therapy goals. SMART stands for specific, measurable, achievable, relevant (or realistic), and time-bound, which are all important aspects of effective therapy goals. The only aspect of the SMART acronym that is slightly different for sensory goals is the instruction that they be specific. When writing sensory goals, therapists should be sure to mention the sensory system that interventions will target. For example, if a child demonstrates tactile defensiveness, the goal should clearly mention that. In addition, goals must focus on function, so they should discuss more than simply overcoming sensory deficits. Goal verbiage should discuss the impact overcoming those deficits will have on the individual's function. When discussing tactile defensiveness exhibited by a 6-year-old child, a comprehensive goal might read: "Stephan will tolerate tactile input for 4 minutes to improve independence in mealtime with or without the use of [insert specific adaptive strategy]." The goal of sensory-focused treatment is for individuals to develop acceptable and effective adaptive responses to stimuli they encounter on a regular basis. For this reason, the mention of 'an adaptive strategy' in goals is rather redundant unless the goal cites a specific technique, such as deep breathing or getting deep pressure from a weighted blanket.

As mentioned earlier, sensory goals will look different depending on the individual's age and desired occupations. Here, we outline some goal examples for each age group:

Sensory Goals for Infants/Toddlers

These goal examples are meant to follow the typical developmental progression. Therefore, many of the first goals are intended for newborns and infants (from birth up to 1 year) while the goals toward the end of this section are more appropriate for 2-3-year-old children who are between the toddler and preschool-aged phase.

Many of these goals cover sensory integration with a heavy emphasis on play, as that is the primary occupation for infants and toddlers. Since so many skills are developing during this age range and those areas are often intertwined, many goals for this age range may also address bilateral integration and motor skills.

- The parent/caregiver will provide 6 hours of skin-to-skin contact across multiple sessions for their child each day to assist with tactile defensiveness and level of arousal during play activities.
- The child will tolerate light touch to the hands, feet, forehead, chest, and stomach for 2-4 consecutive minutes each day to assist with tactile defensiveness during diaper changes, grooming, and bathtime.
- The child will tolerate 30 minutes of gentle massage at least 3 times per week to assist tactile defensiveness during dressing and oral hygiene.
- The child will tolerate being held in sidelying, prone, supine, and cradled positions for 2-3 consecutive minutes to assist with regulation of the vestibular and proprioceptive systems during play activities.
- The child will observe the environment while being held in sidelying, prone, supine, and cradled positions for 2-3 consecutive minutes to assist with visual development.
- The child will make eye contact with people 70% of the time during face-to-face play time in preparation for greater attention to a range of visual stimuli during play.
- The parent/caregiver will rock their child for 30 minutes each day or provide opportunities to incorporate rocking and swinging into play for 30 minutes each day to assist with vestibular development in play.

- The child will use both hands to participate in gentle tug-of-war and other bilateral integration activities for 3-5 minutes at a time to offer proprioceptive input and improve motor skills in preparation for play.
- The child will spontaneously crawl through, over, and under various household objects 60% of the time without assistance during active play.
- The child will tolerate 2 new pureed foods for 1 consecutive week without demonstrating aversion to improve diet range and engagement during mealtime.
- The child will appropriately engage with push/pull toys for 30 seconds at a time to provide proprioceptive input and improve play participation.
- The child will engage with toys that have lights and patterns for 1-2 minutes at a time to improve visual processing during play.
- The child will begin self-feeding with finger foods during 5 consecutive meals to improve tolerance of tactile input and participation in mealtime.
- The child will visually attend to 80% of stimuli as evidenced by pointing at, reaching for, and interacting with visual input presented during play.
- The child will sing along and dance to a 4-minute song with a visual and auditory demonstration from an adult to improve auditory processing during play.
- The child will take turns talking with a peer or adult for 3-5 minutes with no more than 1 break to improve auditory processing during play.
- The child will engage with various textures for 5-7 minutes during age-appropriate games (bubbles, water table, soap) without demonstrating signs of aversion.

- The child will independently ascend/descend 5 stairs with or without help (e.g. using a hand rail or holding an adult's hand) without demonstrating signs of sensory distress to improve motor coordination and vestibular development.
- The child will improve their ability to self-soothe (get a hug, rock in a chair, sit with their blanket) 80% of the time they verbalize distress without demonstrating any aggression.

Sensory Goals for Children/Adolescents

Once entering childhood and even adolescence, the focus on sensory goals shifts quite a bit. For school-based OTs addressing sensory concerns, the main focus of goals should be academic participation, learning, and behavior management. This is because services provided under an IEP should have academic performance in mind. Therapists who work in school settings can also write objectives related to ADLs, but these typically focus on ADLs that apply to the school environment (i.e. managing a backpack, coat, rain or snow boots at the start and end of the school day; and managing lower body clothing during toileting). OT goals in a school setting also involve collaboration with the student's teacher for optimal success. Therapists who treat children on an outpatient basis typically focus on emotion regulation, ADL participation, social skills, and play. These goals should include parent training and collaboration to enhance carryover.

- The student/child will independently request a sensory break 80% of the time when they experience overstimulation during [insert classroom activity here] (e.g. circle time, seated reading, interactive lab assignment, recess, lunch).
- The student/child will maintain attention for 8-10 minutes during classroom tasks.

- The student/child will work with their therapist to identify and engage in 5 activities that can assist with overstimulation.
- With assistance from their teacher, the student/child will request noise-canceling headphones as needed when working on independent assignments during class time.
- The student/child will use a healthy strategy for expressing strong emotions (e.g. verbalize how they feel, point to images on a mood board, use AAC to identify feelings) to avoid episodes of behavioral aggression resulting from sensory concerns 50% of the time.
- The student/child will use a healthy strategy for expressing strong emotions (e.g. verbalize how they feel, point to images on a mood board, use AAC to identify feelings) to avoid self-harm behaviors resulting from sensory concerns 50% of the time.
- The student/child will take advantage of bean bag chairs and other alternative seating in the classroom 80% of the time they are experiencing sensory distress.
- The student/child will increase prosocial behaviors with peers by 30% following implementation of outlined sensory diet to improve function within the classroom.
- The student/child will improve body awareness and pacing of movement by 40% following implementation of outlined sensory diet to improve personal safety during recess and when moving within the hallways.
- The parent/caregiver will comply 100% with brushing protocol (provided every 90 minutes during the child's waking hours) for 1 or more weeks to improve sleep routines and minimize sensory distress.

- After implementing the outlined sensory diet, the student/child will engage in age-appropriate self-care and fine motor tasks with proper posture for 15 minutes using no more than minimal assistance 80% of the time.
- After implementing sensory strategies, the student/child will use a modified tripod grasp on their writing utensil while coloring for 5-7 minutes.
- After implementing sensory strategies, the student/child will maintain upright sitting posture for 10 minutes while completing a writing assignment, eating lunch, or engaging in a fine motor activity.
- After implementing sensory strategies, the student/child will use their dominant hand to safely grasp scissors and cut a sheet of paper in half with assistance from their helper hand 80% of the time.
- The student/child will utilize pen-and-paper based stress management tools (e.g. journaling, drawing, coloring) at least 1 time per day when they are experiencing sensory distress.
- After implementing a sensory strategy of their choice, the student/child will participate in a group activity for 5-7 minutes without inappropriately or unsafely touching peers with less than 3 verbal prompts.
- The student/child will use a sensory strategy to transition between activities without outbursts during the school day 50% of the time.
- The student/child will improve tactile sensitivity to better interact with fine motor strengthening materials (play-doh, kinetic sand, slime) with no more than 5 verbal cues.
- The student/child will appropriately grade force with their writing utensil when coloring, writing, erasing, and drawing with no more than 5 verbal cues.

- The student/child will improve tolerance for noisy environments in order to walk between classes without signs of distress 2 out of 5 times each day.
- After using sensory strategies, the student/child will follow verbal directions without needing them repeated 40% of the time.
- The student/child will use organizational strategies to complete assignments by the expected deadline 60% of the time.
- The student/child will tolerate hair washing for 60% of the task without demonstrating aversion or aggression to improve hygiene and ADL independence.
- The student/child will tolerate hand washing for 50% of the task without aversion or splashing water unnecessarily to improve hygiene and ADL independence.
- The student/child will tolerate teeth brushing for 40% of the task without gagging or fleeing the room to improve oral hygiene and ADL independence.
- The student/child will fall asleep within 45 minutes of bedtime routine without tantrums or aggressive behavior 5 out of 7 days of the week to improve sleep hygiene and ability to better self-regulate during the day.
- The student/child will sit an appropriate distance from peers during circle time and other classroom activities without striking another student 3 out of 5 days of the week.
- The student/child will verbalize understanding of their sensory diet and how to do each activity in the diet with 80% accuracy.

Sensory Goals for Adults

Due to the practice settings where adults are treated and the contexts they usually frequent, sensory goals for adults can vary widely. Many adults with sensory concerns may be seen in work hardening programs or vocational training centers. As such, goals for those patients would likely pertain to integrating or reintegrating into a work setting as well as being able to function in their chosen job role.

Adults may find sensory concerns co-occur with mental health concerns and, therefore, may be treated for sensory processing deficits in long-term psychiatric hospitals, outpatient behavioral health clinics, and possibly even through home health services. Since there is such a large difference between these levels of care, goals in these settings will also vary. OTs addressing sensory processing deficits with adults in long-term psychiatric hospitals may focus more on emotion regulation, behavior management, personal safety, emergency management skills, ADL participation, and forming routines. On the other hand, providers offering outpatient treatment focused on helping adults manage sensory deficits may discuss community integration, work function, household management, and social participation.

Some sensory goals for adults may include:

- The patient will improve visual-motor integration to more easily attend to and process visual input during digital presentations at work 3 out of 5 days each week.
- The patient will improve visual-motor integration to efficiently and comfortably read text (from a computer screen or in a book) for 5-7 minutes without signs and symptoms of visual fatigue or distress.

- The patient will use visual aids (paper calendar, digital reminders, phone alarms, and to-do lists) to improve management of work deadlines with 80% accuracy.
- The patient will pre-schedule emails at the end of the work day 80% of the time to improve ease of morning routine the next day.
- The patient will use assistive devices (headphones, earbuds, music) and/or initiate environmental modifications (e.g. changing rooms, closing shades, using room dividers) to improve attention to work by 50% in the presence of auditory and visual distractions.
- The patient will use touch typing along with spell check for 5 minutes at a time to reduce visual strain and visual processing difficulties.
- The patient will move from one household task to another after a 5-minute rest break or preparatory session 80% of the time to improve IADL function.
- The patient will practice deep breathing before each new activity they engage in at work 80% of the time.
- The patient will identify and use three preferred self-soothing techniques (chewing gum, spinning in chair, clicking pen) to improve attention and regulation while performing seated tasks at work 70% of the time.
- The patient will perform windmill arms, chest stretches to improve posture and enhance attention during seated work 70% of the time.
- The patient will take a brisk walk on their morning coffee break 4 out of 5 days out of the work week to improve alertness and regulate mood in preparation for scheduling and organizing their week.

- The patient will listen to music and perform therapy putty exercises at their desk during the first 10 minutes of the work day 4 out of 5 days of the work week to assist with improving alertness related to work tasks.
- The patient will recognize when they are visually overstimulated and properly use an eye mask for 10 minutes each day to improve visual function and overall regulation.
- The patient will identify input they find calming, alerting, and grounding/ centering with or without help from their therapist.
- The patient will use the teach back method to confirm understanding of when to use various sensory strategies when distressed.
- The patient will record the impact their arousal has on their ability to sleep, relax, interact socially, learn/perform at work, and perform at home 6 out of 7 days each week.
- The patient will work with their therapist to form a sensory diet based on a modified daily routine (one for weekdays and one for weekends) that is conducive to sensory regulation.
- The patient will engage in self-rating and self-reflection activities to manage their sensory regulation 80% of the time they are in distress.
- The patient will verbalize their emergency plan for use when they are feeling unable to achieve a regulated state.
- The patient will adjust the frequency and intensity of each activity in their sensory diet for maximum efficacy at least twice per month and on an as-needed basis.

- The patient will manage sensory distress in public to better integrate into social settings and engage in socially acceptable behaviors such as taking turns and listening to others when they talk in 8 out of 10 trials.
- The patient will outline a specified transition routine to assist with bridging the gap between one task and the next in 8 out of 10 trials to improve productivity.
- When attending to large tasks at home, the patient will use proper time management to break their work into smaller parts 70% of the time.
- The patient will improve sequencing and organization during ADL and leisure tasks in times of sensory overload by 80%.
- The patient will enhance self-monitoring skills by 60% to identify errors in their coursework and skills they could further work on.
- The patient will comprehend and apply safety skills to their daily life when out in the community 60% of the time.
- The patient will develop self-advocacy skills as evidenced by communicating their needs to supervisors when they arise 60% of the time.
- The patient will utilize seating modifications and tangible sensory tools at least once per week in the workplace to optimize their access to support.
- The patient will shift focus between two tasks such as actively listening to a coworker's conversation while organizing their desk 100% of the time.
- The patient will actively participate in group discussions in the workplace by contributing relevant ideas or sharing insights in 8 out of 10 trials.
- The patient will selectively filter out distractions in order to maintain focus on a work task without stopping what they are doing 60% of the time.

- The patient will complete 2 consecutive household chores until they are finished without taking a break.

Sensory Goals for Older Adults

Sensory regulation and sensory-based treatments evolve even more when they are targeted to an older adult population. For example, while the focus of sensory treatment for young adults and adults may be geared toward improved work and home function, sensory integration for older adults is typically used to improve orientation, cognitive function, and management of behaviors. Therefore, a range of practical activities (with thoughtful additions) can be used to address the sensory needs of older adults.

- The patient will demonstrate improved tolerance of tactile input by kneading dough while baking without aversion for 3 minutes.
- The patient will exhibit improved engagement in mealtime by feeding themselves at least 2 bites of each food they help make, with or without utensils.
- The patient will notice the smell of cookies baking and appropriately engage in joint conversation with their therapist or peer for 4 minutes about what the smell reminds them of and how it makes them feel.
- The patient will discuss their favorite homemade meals, recipes they used to use, and other food related content with their therapist to prepare for cooking in future sessions.
- The patient will verbally recite or explain 70% of a recipe's ingredients and/or steps in preparation for cooking in future sessions.
- Once regulated and ready, the patient will demonstrate appropriate safety awareness when operating the stovetop 100% of the time.

- The patient will help the therapist fold towels 3 out of 7 days of the week, and identify the scent on the clean towels with 50% accuracy.
- The patient will follow 1-step verbal and visual directions to fold laundry for 8-10 minutes at a time.
- The patient will participate in folding laundry with a peer while tolerating the smell of clean laundry for 5 minutes without signs or symptoms of aversion.
- The patient will demonstrate a 30% improvement in alertness while participating in a puzzle with bright colors and patterns to prepare for feeding and socialization.
- The patient will complete a 6-piece puzzle made from one of their childhood pictures with 80% accuracy and no outside assistance without losing focus.
- The patient will match 4/4 brightly-colored shapes together with min A without rubbing eyes, losing focus, or leaving the table.
- The patient will participate in arm knitting with neon yarn for 5 minutes and mod A without squinting excessively, losing focus, or falling asleep.
- The patient will sort 30 small beads according to color with assistance only in the form of verbal cues.
- The patient will properly use large gauge needles to complete 5 stitches while crocheting while seated upright and maintaining proper visual attention.
- The patient will locate 3 specific items in a large box of miscellaneous objects, then verbalize the name and purpose of those items with 80% accuracy.

- The patient will sort 15 items in a large box of miscellaneous objects according to their purpose with 50% accuracy.
- The patient will participate in making a sensory fidget box or squish bag by making 10 selections of various textures, photos, patterns, colors, and objects to include.
- The patient will independently initiate use of a sensory fidget box or squish bag while sitting when they are feeling restless 80% of the time.
- The patient will engage in painting with a brush for 6 minutes with a therapist providing a consistent visual demo.
- The patient will locate and properly use handheld fidget 80% of the time they are feeling restless or agitated during the day.
- The patient will go to the sensory room 4 out of 5 times they are feeling overwhelmed and sit in their special chair to improve orientation as well as feelings of safety and relaxation.
- The patient will use at least 1 essential oil functionally before completing 4 out of 5 seated tasks.
- The patient will remain seated watching a movie of their choice for 8-10 minutes without agitation or other aversion.
- The patient will sit with their family for 10 minutes during mealtime and eat at least half of their meal with utensils.
- After using essential oils, the patient will appropriately make eye contact with someone who talks to them 80% of the time.
- After tolerating gentle hand massage, the patient will engage in beading activity to make a bracelet or necklace for their grandchild with minimum A.

- After walking outdoors safely with a caregiver, the patient will improve pro-social behaviors by 60% when interacting with peers during mealtime.
- The patient will remain in the room (with or without the use of fidgets) and listen to a poem or book being read aloud for 4-5 minutes.
- The patient will demonstrate good body awareness and personal safety while interacting with a small dog during pet therapy 4 out of 5 days of the week.
- The patient will guess the smell of 5 spices with 50% accuracy while engaging in a cooking activity with minimum A.

Section 1 Personal Reflection

In addition to using the SMART goal format, what specific aspects should a therapist include in a sensory goal to make it person-centered?

Section 1 Key Words

Adaptive strategy - The ability to adjust one's plans in response to difficulties that arise; in a therapeutic sense, adaptive strategies can be taught and are intended to be spontaneous and ongoing as challenges present themselves

Section 2: Sensory Regulation in Infancy

References: 6 - 31

Babies experience a great deal of development in the first year of their life, also known as infancy. During this time, parents and doctors may monitor milestones in several categories, including social/emotional, language/communication,

cognition, and motor development. However, within each of these categories are milestones that also point toward the growth of a baby's sensory systems. Between the time they are born and the time they turn 1, typically developing babies are expected to meet the following sensorimotor milestones:

- Demonstrating the ability to calm down when they are picked up or spoken to
- Reacting to loud noises, usually by turning their visual attention toward the noise
- Babbling, cooing, squealing, and making a range of sounds other than crying
- Looking at people as they move
- Watching toys and other inanimate objects for several seconds at a time
- Turning their head toward the sound of a familiar person's voice
- Finding enjoyment from looking at oneself in the mirror
- Laughing, either spontaneously or in response to engagement with a familiar figure
- Sticking their tongue out and blowing or making other loud noises
- Taking turns making non-crying sounds with a peer or a familiar figure
- Putting inanimate objects in their mouth to explore them
- Showing a wider variety of facial expressions, including angry, sad, happy, and surprised
- Moving their head toward you when their name is called

- Stringing several sounds together such as “mamamama” and “dadadada” (this happens later in infancy)
- Banging two items together to listen to the sounds they make
- Playing games that involve making noise, such as pat-a-cake
- Searching for items they see their parents hide, such as toys in a container or placed under a blanket

Children in this phase of life may be treated by OT in the Neonatal Intensive Care Unit (NICU) or through Early Intervention (EI) within the home. Understandably, much intervention provided during this time is focused on parent education with a strong emphasis on preparing the child for future milestones. Research suggests that early intervention programs are most effective when they focus on sensorimotor development, attention/regulation, relationships, and therapists supporting the family. Programs with these components are associated with positive outcomes for infants at risk of atypical neurodevelopmental function. Motor activities have the most sensory benefits when they are self-initiated and developmentally appropriate. Supporting self-regulation is best when it helps parents and infants bond. Therapists should support families using principles of responsive parenting and the coaching model to assist with parental mental health. Studies that looked at the interventions offered in NICUs and their effect on infants mostly looked at the types of sensory input offered.

An OT working in early intervention may offer education on positioning an infant properly within the home, either with or without equipment. This is not only intended to prepare the child for building more fine and gross motor skills, but proper posture also allows for better head positioning to encourage more sensory exploration using the eyes and hands. On the other hand, an OT caring for an

infant in the NICU may directly provide calming and regulating sensory input on a consistent basis.

In a general sense, OTs may educate parents on any of the following interventions based on their baby's needs:

- Multisensory intervention
    - A RCT looked at the efficacy of multisensory interventions for preterm infants in the NICU. One group received standard care while the other group received standard care plus multisensory interventions. Standard care consisted of recordings of each infant's parent's voice as well as skin-to-skin contact from their parents. Multisensory interventions included holding the infant while also providing light pressure, playing a recording of their parent's voice, offering a pacifier for sucking, exposure to a parent-scented cloth, and regulated, mindful breathing from the therapist holding them. As measured at 1 year old and 2 years old, the multisensory group experienced enhanced tactile processing and sensory adaptation with some impact on speech sound differentiation and motor function. These interventions can easily be implemented in any NICU to maximize neurodevelopmental outcomes for premature infants. This is especially important for infants in the NICU, but also important for children receiving early intervention services within the home.
    - A randomized controlled trial compared the impact of standard care vs. a multisensory program on the social-emotional development of preterm infants. Results saw little to no short-term outcomes (between months 1 and 3), but infants demonstrated improvements in social-emotional function, distress tolerance, and sadness 6 months after the program concluded.

    - A randomized controlled trial looked at the impact of an early intervention program focused on visual processing in very preterm infants without major medical concerns. One group received standard care, including protocols such as minimal handling and Kangaroo Mother Care. The other group received early intervention focused on routine care along with parent training and multisensory stimulation (infant massage plus visual interaction) implemented by parents. Results showed 59% of infants in the early intervention group demonstrated improvements in ocular motility, tracking arcs, discrimination, and visual attention compared to just 17% in the standard care group. Visual development is very important in infancy, so these results reinforce the need for multisensory stimulation as well as education to further enhance visual development.

- Skin-to-skin contact
    - This involves laying a baby directly on their mother's chest and covering them in a warm blanket
    - Many people believe this is only necessary right after birth, but it should be practiced beyond the hospitalization for several months
    - Studies show that skin-to-skin contact encourages the infant to go through 9 stages: a birth cry, relaxation, awakening, activity, rest, crawling, familiarization, suckling, and sleeping
    - The baby's head should be turned to one side with their nose and mouth visible to help with breathing; their legs should be tucked in and their hands should be near their face
    - This position can be held for as long as mother and baby can tolerate it, as it encourages feeding and bonding

    - Benefits include regulated breathing, heart rate, body temperature along with stimulated digestion and relaxation for both mother and baby
    - Therapists should also educate parents as to the ideal frequency and duration along with outward signs the baby is benefiting from this interaction
- Bonding
    - Tending to infants' needs during this period is important, as is taking the time to form a bond with them that promotes feelings of calm and safety
    - Research shows that sensory hyperreactivity is associated with caregiver responsiveness in parents of infants who are at risk for ASD, and these signs may be visible as early as 7 months; in particular, caregivers of infants with moderately high hyporeactive and hyperreactive sensory responses demonstrated higher caregiver responsiveness than parents of infants with less sensory reactivity
- Infant massage
    - Gentle massage is most often indicated to help with sleep, but this can also assist with bonding, improve digestion, and enhance body awareness
    - Massaging should be focused on the stomach (specifically just under the rib cage on both sides), legs (using a cupping motion from the thigh down to the heel and back up), face (from the middle of the forehead outward and down the sides of the face)

    - Massage can focus more on the entire stomach after the baby's umbilical cord has fallen off
    - A randomized controlled study assessed the effects of infant massage on children with developmental delays. One group received OT intervention as usual while another group received OT treatment along with 20 minutes of massage twice per week for 12 weeks total. The intervention group not only demonstrated greater improvements in general motor function and gross motor function, but they also exhibited improvements in sensory sensitivity behavior.
- Positioning
    - Studies show that prone positioning leads to the highest activation of erector spinae muscles as well as development of upper arm strength, functional reach skills, and sensory exploration while car seats lead to the lowest activation of spinal muscles
    - Carrying babies in-arm or placing them in baby carriers can benefit development of neck muscles and allow for sensory exploration
    - Prolonged time in car seats or other containment devices can stunt growth of spinal muscles
    - Supine is the ideal position for sleeping with support at the head, shoulders, and hips
    - Sidelying is recommended for babies who need to be consistently tube fed, diapered, or accessed easily for other medical care; this allows the baby to adjust their head on their own and use one upper extremity more readily

    - Prone positioning is helpful for infants who have unstable oxygen levels, as babies lose less heat and energy in this position; however, babies must be consistently monitored in this position and should not sleep in prone due to risk of suffocation

- Rocking and swinging
    - Slow, linear vestibular stimulation is known to be calming and helps organize the nervous system
    - Whether in a rocking chair while being held in mom's arms or in a stationary glider, rocking and swinging can be very beneficial in soothing an infant
    - During infancy, it makes sense for parents to direct this sort of input and offer rocking and/or swinging when their child is distressed; however, therapists should emphasize the importance of teaching older children to engage in this type of activity so they can seek such input out safely and autonomously when they are distressed
- Self-feeding
    - Babies need to eat soft, nutrient-dense food in multiple sessions over the course of the day since their stomach is small and they can't tolerate large feedings
    - Babies should transition from formula or breastmilk to primarily pureed food between 4 and 6 months of age, but breastmilk or formula will remain an important source of nutrients in addition to pureed food for a few more months

    - Babies can eat food with a thicker consistency between 6 and 9 months old; they can move to chunks of soft, chewable food between the ages of 10 and 12 months
    - OT instruction toward the end of infancy should involve encouraging babies to self-feed with fingers and even experiment with children's eating utensils; this will not only help with the process of feeding, but can teach babies to enjoy mealtime and play a more active role in this occupation
    - In order to expand their diet and help them tolerate a range of tastes and textures, babies should be eating a wide variety of foods each day as they progress through infancy – grains, all animal products (fish, poultry, meat, dairy, and eggs), fruits, and vegetables
    - The only food that should be limited during this time is honey; this contains a strain of bacteria infants cannot process until they reach 1 year old, and this may lead to infant botulism
- Swaddling
    - Studies show that swaddling helps increase how long infants sleep as well as decreasing the amount of times infants switch between sleep states; this leads to more restful sleep, which is important for self-regulation in infants
    - Parents should swaddle infants correctly by spreading the blanket flat with one corner folded; after laying the baby face up on the blanket and placing their head above the folded corner, they should straighten the baby's left arm and wrap the left blanket corner over their body; then tuck the blanket between the baby's right arm and right torso

- Education
    - Education should focus on how parents can help their infants better reach developmental milestones during this phase
    - Research supports the use of education to help with sensory regulation for infants. This particularly pertains to tactile input – early tactile stimulation is the most direct opportunity for infants to make contact with their surroundings. Affective touch can stimulate vagal activity, which sets the tone for self-regulation skills (and even executive functioning) as time goes on.
    - One study looked at the efficacy of a structured sensory-based program titled Supporting and Enhancing NICU Sensory Experiences (SENSE) implemented with infants in the NICU. This program used the Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) framework. Results showed that earlier parent education as part of this program was correlated with higher levels of parent participation. 85% of infants who took part in the SENSE program received sensory interventions from their parents rather than rehab staff, which is believed to have had a major impact. This NICU-based program (and others) were found to be effective, low-cost, and have good fidelity.
    - Research finds that infants born prematurely demonstrate varied levels of tactile sensitivity. Almost all preterm infants could recognize and react to a light mechanical stimulus while infants born at term and healthy adults did not perceive this input or demonstrate any associated reaction. This suggests that infants born prematurely may require additional support and intervention in the realm of sensory sensitivity compared to infants born at term.

- A longitudinal study found that the frequency of fussing, crying, and other visible signs of sensory distress is directly associated with self-regulation abilities between the ages of 1 and 5. Infants that were difficult to soothe were found to have poorer self-regulation abilities once they became toddlers and preschoolers, but only if they had highly sensitive mothers. There was no connection between these two factors if the infants did not have sensitive mothers. According to the optimal arousal theory, infants with highly sensitive mothers who received moderate amounts of low intensity negative reactivity demonstrated better self-regulation once they became school-aged.
- A systematic review performed on the efficacy of sensory-based interventions in the NICU found that all studies focused on short-term effects and did not assess the long-term impact of interventions. There was a wide range of outcomes and specific modalities, but categories were overwhelmingly auditory-based, tactile-based, and multisensory in nature and deemed effective across the board. This lends support to therapists offering education focused on a variety of senses.
- One study found that increased prenatal anxiety in mothers was associated with higher unpredictability in maternal care through unpredictable maternal sensory signals. This correlation was observed more in mothers whose own self-regulation skills were low. These behaviors may exacerbate sensory regulation concerns in infants and stunt the development of their self-regulation skills. This study spanned nearly the entire infancy period, so results speak to the long-term effects these behaviors have on infant sensory processing. Studies such as this suggest that addressing sensory regulation in infants involves providing some degree of sensory

interventions to parents and caregivers. This may include offering education on self-soothing techniques and coping strategies, seeking emotional support from mental health professionals or friends, and utilizing community resources to assist with parenting duties.

- Certain parenting styles were also found to have an impact on self-regulation in infants, so this should also be part of education. Infants of parents with a permissive parenting style were nearly 3 times more likely to develop abnormal sensory thresholds compared to infants with parents who used an authoritative parenting style. Infants with parents who are more permissive were also 2.4 times more likely to demonstrate stronger internalizing behaviors as well as 3 times more likely to experience stronger externalizing behaviors, when each occurred. Preterm infants of parents with authoritative parenting styles were less likely to have behavioral problems.
- Some education will be specific to the infant's age (see below)
- Between the age of 0 and 3 months:
    - Therapists should discuss the use of tummy time (only when parents are able to supervise the child) in order to help strengthen the core muscles in preparation for further motor and sensory development; tummy time can be on a floor, play mat, or on the parent's chest
    - Toy selection will be important and should have bright colors, lights, noticeable sounds, etc. to assist with development of the eyes and ears; aim for toys that move across a baby's field of vision (e.g. mobiles) or things that can be moved in such a manner by the parent

        - Talking and singing to babies at this age offers a variety of auditory input
        - Oral motor exercises (cheek circles inward/outward, massaging the cheek over the ears and under the jaw, tracing the top lips and bottom lips with your finger, tracing down from the nose to the lips to the chin) are intended to help with motion needed for suckling and offer calming input
        - Engage children in activities that encourage them to bring their hands to midline (clapping games, stacking blocks, using musical instruments, hand-over-hand crossover exercises, pulling a car or other toy from side to side in front of your baby to encourage them to visually track from side to side)
    - Between the age of 4 and 6 months:
        - Education should focus on continuing tummy time, but also placing children in a variety of positions throughout the day to strengthen all their muscles equally; parents should avoid having kids only sit upright or lay on their back
        - Play with your child in various positions - on their side, on their back, sitting with support from parents or furniture
        - Activities that encourage rolling (placing toys in a spot where a baby must roll to get to them, use toys with sounds and lights to encourage the movement, use your hand to kickstart the roll once they are in prone and let your baby finish rolling on their own, have the baby positioned on a wedge pillow or blanket to start, rock the baby's hips while they are supine to encourage

segmental rolling, get in the habit of helping babies roll each time before you pick them up)

- Once babies start rolling, parents should aim to transition them away from swaddling to activities like rocking and swinging for relaxation; this offers more freedom of movement
- Toy selection should include an even greater variety of sounds, textures, and visuals to help with sensory development as well as improve motivation for play and interaction; some examples include crinkle fabric toys, toys with mirrors, toys with a variety of soft fabrics, board books with textures and buttons that make noise, durable bath toys, shakers and other noise makers, toys that babies can pull with them while they crawl or that parents can pull to encourage babies to crawl and access the toy; hiding toys under blankets, in boxes, at the end of tunnels, and in other areas where babies can explore also helps get them acquainted with their environment more

- Between the age of 6 and 9 months:
  - Place toys and other desired objects on vertical surfaces to encourage more visual exploration/stimulation and reaching
  - Once babies begin crawling, their environment should be clean and safe from hazards but not necessarily free of obstacles; this will not only offer them more opportunities to explore, but will also help with the development of adaptive strategies to get around things

        - Activities of interest that engage sensory development as well as bilateral integration include pop tubes, bubbles, and books with various colors/textures
        - Parents may need to assist with transitions and encourage self-soothing, as babies this age may develop preferences for certain activities or toys and may have trouble moving away from that to something less preferred; pacifiers offer oral-motor input that may help soothe, as do songs or music to help prepare them for moving on; parents can use certain comforting objects like a stuffed animal or favorite blanket to help ease transitions; lots of verbal praise and physical encouragement (hugs, kisses) also helps with transitions
    - Between the age of 9 and 12 months:
        - Activities should focus on exploring various textures even more to prepare the baby for finger feeding and eating new, potentially different foods
        - Other activities should focus on balance and vestibular input to help prepare babies this age for the various types of input they will encounter when they begin to walk
        - Games like peek-a-boo help with visual development as well as interactive songs and games like pat-a-cake, row your boat, and wheels on the bus; making music with pots, pans, and other household items also encourages exploration along with auditory stimulation; stacking, sorting, and moving household items can help with cognitive development as well as exploring various textures and patterns

A range of contextual factors have the potential to impact sensory processing and sensory development in infancy. These include physical abuse, emotional abuse, substance misuse during or after pregnancy, maternal depression, social cohesion of one's neighborhood, poverty, and connectedness in the school system as well as the community. Parent's work schedules impact their ability to be present for early intervention services; attendance and session engagement also play a part in seeing optimal outcomes. Chronic stress in the household can affect a child's sensory development. Health-related social needs such as education and health literacy, housing instability, and cultural acceptability also may impact a family's engagement in both NICU services and early intervention programs focused on sensory processing concerns.

Section 2 Personal Reflection

How can OT address the contextual factors that may impact sensory development for infants? What professionals might OT collaborate with to better balance the effect these factors have on infants?

Section 2 Key Words

Affective touch - Mechanical stimulation that is slow-moving and low-force, which is typically perceived as pleasant and non-threatening; in the therapy world, affective touch may also be referred to as light touch

Multisensory intervention - Intervention that engages more than one sense at a time; multisensory is a term that can be used to describe methods of teaching (multisensory instruction, education, or learning) as well as rehabilitation (multisensory treatment or intervention)

Section 3: Sensory Regulation in Childhood and Adolescence

References: 32 - 68

After infancy, children enter what is generally known as childhood. Early childhood lasts from 3 to 8 years old, with the first portion of that – 1 to 5 years – being the toddler phase. Middle childhood is between 9 and 11 years old. Early adolescence lasts from ages 11 to 14, or grades 6 through 9. Middle adolescence is from 15 to 17 years old, or grades 9 through 12.

Sensory-related milestones during these stages of life include:

1-2 years:

- Distinguishing between edible and inedible objects
- Looking at books while someone reads to them
- Learning from past experiences, especially those that have caused some form of injury (e.g. walking slowly on the stairs due to previously tripping on one and hurting themselves; staying away from objects on the stove after being burned from touching a hot pan)
- Tolerating messy play when it arises and enjoying it so much they seek it out at times
- Eating a wider range of food textures once they transition to solid foods
- Settling themselves in preparation for sleep during the day or night
- Imitating sounds they hear

2-3 years:

- Sitting on their own to look at a book or listen to it being read to them
- Seated activity tolerance and attention span should be 3-5 minutes by age 2 and 8-10 minutes by age 3

3-4 years:

- Choosing weather appropriate clothes each morning
- Tolerating various textures of clothing (e.g. cotton, polyester, wool, etc. but also tolerating the feel of tags inside clothing and tighter-fitting clothing)
- Coping with being in a busy and/or noisy environment

4-5 years:

- Seated activity tolerance and general attention span should be 15 minutes between ages 4 and 5
- Sitting and paying attention to peers or their teacher during circle time at school

5-6 years:

- Knowing where their body is in time and space and using this information to coordinate movements for activities like throwing and catching a ball
- Sitting at a desk while following teacher instructions to complete in-class assignments

6-7 years:

- Going to sleep at night independently and sleeping through the night
- Seated activity tolerance and general attention span should be around 25 minutes at a time

- Sitting and paying attention during class, mealtime, religious services, movies, etc. without fidgeting or having a tantrum
- Showing eagerness to learn new skills and accomplish a wider variety of tasks
- Handling group situations (e.g. standing in line or being in a crowd) without reacting aggressively to being touched accidentally
- Enjoying playground activities (e.g. not seeming fearful when their feet leave the ground)
- Transitioning between activities comfortably – on their own or when initiated by someone else
- Seeming generally organized in work and play spaces
- Being able to function in a noisy environment (e.g. able to do work in a group setting)
- Enjoying many activities and liking staying busy
- Showing interest in creative activities such as painting and drawing
- Jumping rope and riding a bike without falling

8-10 years:

- Jumping, skipping, and chasing others to play games like tag and hopscotch
- Seated activity tolerance and general attention span should be around 40 minutes by the age of 10

11-14 years:

- An increase in clumsy and awkward movements, which is common due to growth spurts and adjustment to hormones

14-18 years:

- Regular physical activity such as organized sports can lead to an increase in strength, coordination, and agility
- Sexual functions and sexual identity develop, which may lead adolescents to experience new sensations and uncomfortable emotions
- Hormonal and life changes may lead some adolescents to engage in risky behaviors (e.g. having unprotected sex, distracted driving, underage drinking, substance use, etc.) they believe will ease social pressure and alleviate uncomfortable emotions

Children of any age with sensory regulation concerns may be seen by OTs in outpatient clinics or through school-based therapy. The interventions OTs provide in each setting are typically based on the resources available. For example, many outpatient clinics have large, open spaces that are structured like gyms with mats, swings, bolsters, ball pits, and a range of other sensory activities. These resources are rarely available in traditional school settings, but may be present in schools specifically for children with Autism Spectrum Disorder or Intellectual Disabilities. Sensory-based treatment also varies between the settings due to the way goals are structured. School-based goals are part of documents called Individualized Education Plans (IEPs), so they have a strong focus on academic participation and success. Goals in outpatient settings can focus more on functional needs across the continuum, and there is typically also heavier parent involvement here.

Education remains an important piece of sensory-based OT intervention for children. However, education is especially central during early childhood and in the case of children with severe cognitive impairments such as moderate to

severe Intellectual Disabilities and those who are non-verbal. Sensory-based interventions for children include:

- Education
    - Many children become more independently active in an attempt to meet their sensory needs, so it becomes important for parents to assist with preventing sports-related injuries during this phase. Ensure that kids wear helmets, elbow pads, and knee pads while riding bikes, skateboarding, roller blading, snowboarding, skiing, and more.
    - Children of all ages and needs require certain amounts of exercise to assist with their development and the growth of strong, healthy muscles and bones. Children between the ages of 6 and 12 should get at least 1 hour of moderate to vigorous physical activity per day, with most of that being aerobic activities. Many parents need instruction on what those activities are. Aerobic activities are those that raise the heart rate and breathing rate through constant and continuous activity. Aerobic activities include: walking, swimming, jogging, biking, hiking, running, rowing, skating, skiing, dancing, organized sports, martial arts, and gymnastics.
    - Free play is equally as important as structured play, since this allows kids to better meet their sensory needs and expend more calories. Free play in nature is even better; scavenger hunts, treasure hunts, sports, and other games can all be done outside for added benefit.
    - Sleep is important for sensory regulation and development during childhood. Educate parents to get kids away from devices (phones, tablets, laptops, TVs) at least 90 minutes before bedtime so they

don’t have difficulty falling asleep. Kids who enjoy the sound of it may want a noise machine or music playing at a low volume from a radio or docking station. Kids who like having visual imagery to fall asleep to may want an artificial aquarium with lights and the soothing look of water.

- This is a great time period to have kids help with grocery shopping, cooking, grooming, skin care, yard work, and more. This gives them the chance to interact with a variety of textures, tastes, and smells. Engage them in conversation about how things smell, taste, feel, sound, and look. This not only helps with sensory exploration but also allows them to mention how they feel about each type of sensory input and work through it with someone there to help.
- Children who respond well to vestibular stimulation may like games such as Twister and Simon Says, which can each involve changing positions while offering proprioceptive input.
- Evidence shows that parent-mediated programs were the most effective for sensory concerns in children with neurodevelopmental disorders. In particular, a large systematic review found that outcomes included improved child communication, improved social skills, improved parental knowledge about parent coaching, improved motor/cognitive skills, and improved learning abilities.
- Education specifically related to resilience is also important, moreso with older children and adolescents. One study showed that a culturally-modified resilience education program was effective in increasing middle and high school students’ overall self-efficacy. In particular, highly sensitive students responded more positively to this

intervention than students who scored normally on standardized sensory assessments.

    - During adolescence, education should cover motor vehicle safety, boundaries surrounding curfew and various extracurricular activities done with greater independence, and other personal safety topics such as safe sex. Adolescents should also have their own physical space within the home to assist with regulation during especially trying times and for the sake of identity development.

- Qigong sensory treatment (QST)
    - QST is a touch-based program that parents provide to children. QST involves light touch and massage that helps parents and children bond as well as decrease touch sensitivity in children with ASD.
    - There is strong evidence to support the use of QST for children with Autism Spectrum Disorder. A systematic review on QST shows that it can improve sensory regulation as well as behavioral concerns and language development in children with ASD. QST is also connected with improved social skills, sensory awareness, self-control, and cognitive awareness with benefits extending to parents.
    - Some dated OT literature states that QST offers some of the strongest sensory improvements for children with ASD.
    - Due to the sheer amount of evidence available, studies suggest QST is used as a complementary therapy or when behavioral treatments are not available.
- The Alert Program

    - There is also strong evidence to support the Alert Program and its outcomes with children who have sensory regulation concerns. The Alert Program uses a range of analogies and educational techniques to teach kids about how their bodies operate – including how to calm themselves down during periods of stress, how to appropriately energize themselves during periods of low energy, and how to keep themselves balanced as much as possible during all areas of life.
    - A randomized controlled trial found that eight one-hour Alert Program sessions over eight weeks was associated with improvements in behavior and executive functioning from parent reports but not standardized testing.
    - The Alert Program has also proven useful in addressing sensory outcomes for kids with ADHD. One study found that an 8-week Alert Program was associated with good child participation and acceptance. Results showed that parents had increased knowledge and use of sensorimotor techniques after the program and children had less ADHD symptoms at home. This study did find that more research was needed to enhance carryover in other settings, which is something OT can address during sessions.
- Social stories
    - There is also strong evidence supporting the use of social stories for both sensory regulation and behavior management, particularly with children and adolescents who have ASD.
    - Social stories use visual modeling through characters to teach children proper behavior and a wide range of other skills including sensory regulation, ADL participation, organization, and more.

- Ayres Sensory Integration (ASI)
    - Some of the strongest evidence pertaining to sensory interventions is in support of treatment using the Ayres Sensory Integration approach.
    - One study shows ASI is effective in treating sensory-based motor disorders when provided three times per week for 10 weeks. Positive outcomes included an improvement in motor performance and attainment of child-identified goals.
- Digital interventions
    - Some studies have supported the use of digital interventions aimed at emotion regulation for children with sensory regulation concerns. Any interventions focused on promoting adaptive behaviors as a way to better manage emotions are considered effective, as they are more accessible and appealing to this population.
    - A systematic review found that digital games were the most prevalent and had the most consistent evidence, particularly for those at risk of anxiety. Others (including biofeedback, virtual or augmented reality, and program or multimedia-based interventions) had a positive effect on sensory and emotion regulation outcomes, but less significant than digital games.
    - One study tested the efficacy of a digital sensory well-being hub on children and adolescents with developmental disabilities and sensory needs in public schools. The hub is adaptable and offers a wide range of sensory experiences and interventions. After collecting data for one year, the study found the hub was used for preventive and spontaneous visits. The most sought-after interventions through the

hub were a fidget wall, a beanbag and weighted blanket, a sensory cocoon with tensile fabric, and a media wall. Users most often requested quiet space, compression, tactile feedback, and proprioceptive input.

    - Another study looked at the impact of digitally delivered dietary and sensory intervention for kindergarteners with selective eating. Results were inconclusive, which suggests digital intervention may not be effective for children this young and/or children with food-related sensory concerns.

- Sleep-based interventions

    - Therapists can educate parents on the creation of a calming bedroom environment along with a regular sleep schedule to assist with sensory regulation concerns surrounding sleep. There is strong evidence supporting the efficacy of consistent environmental and behavioral modifications for improving sleep.

    - The Sleep Toolkit (STK) is specifically tailored to children and adolescents with ASD who have insomnia. This method involves modeling positive evening behaviors through visual scheduling, a faded bedtime program to help kids learn to go to bed when they are tired, and a supplemental calming program to lower arousal levels. The calming program includes yoga, massage, mindfulness, warm baths, muscle relaxation, and breathing techniques. There is more evidence to support other techniques for children under 5, including positive routines, bedtime fading, and unmodified/graduated extinction. Evidence supports the use of cognitive behavioral therapy (CBT) as more beneficial for older children and adolescents with ASD who have insomnia.

    - Parent-based sleep education should include educating a child to sleep alone, avoiding naps, encouraging daytime activities, and creating a stable sleep environment. There is not as much evidence for this type of education, but it is most often used in combination with other techniques.

- Weighted blankets
    - Studies show weighted blankets do not have a significant effect on improving sleep for children and adolescents with ASD. However, evidence does support the use of weighted blankets for use with children who have ADHD as well as isolated sensory concerns. Studies show that weighted blankets improve childrens' ability to fall asleep, sleep through the night, feel more calm at bedtime, and report relaxation during the day. Children report feelings of safety when using the blanket as well as improvements in sleep hygiene, daily participation, and balance between activity and sleep.

- Experience-based learning
    - Any interventions that involve direct participation (e.g. practicing ADLs at home, doing an assignment within the classroom, facilitating play during recess on the playground or in the gym, etc.) are considered most beneficial for this population. A large systematic review found that experience-dependent interventions across PT, OT, psychology, and education were associated with neuroplastic changes in both children and adolescents with and without diagnoses. While more research is needed to determine what about these interventions actually triggered neuroplasticity, this is promising support for the use of OT in childrens' natural contexts.

- An OT-led study aimed to assist with the development of practice guidelines according to research on OT intervention from birth to 5 years of age. This study found that various OT interventions are considered effective in encouraging the development of socioemotional, motor, self-care, and cognitive skills in children of this age group. Results also showed that these interventions can partly be implemented by other professionals and caregivers in various settings the child is familiar with for maximum carryover.

During childhood and adolescence, sensory concerns have been connected with poor diet, obesity, and parental substance misuse or substance use disorder. Each of these factors has a strong connection to brain pathways that integrate sensorimotor behavior, reward systems, and feeding habits.

In addition, chronic pain has also been associated with sensory modulation during both childhood and adolescence. A study conducted by OTs looked at the intersection of sensory modulation, attachment, function, and chronic pain in children. Results showed that sensory sensitivities were correlated with higher levels of disability in children and adolescents. Children with attachment anxiety were more likely to have sensory concerns categorized as low registration as well as poorer school-related quality of life. This shows that children who demonstrate insecure attachment patterns were more likely to have difficulty with sensory modulation as well as functional performance. Therapists who address these concerns (and coach parents in how to do the same) can facilitate better engagement in children with chronic pain.

Therapists would be remiss in neglecting the impact major world events have had on youth. COVID-19 had a marked influence on the health and well-being of children and adolescents. Researchers have particularly tried to discover if resilience served as a protective factor for environmental sensitivity in youth.

Preliminary research showed there was a positive, but weak, correlation between environmental sensitivity and COVID-19 stress as well as a negative correlation between resilience and environmental sensitivity. This same study also found a negative correlation between resilience and COVID-19 stress. In summary, this pandemic-specific research suggests that higher environmental sensitivity does not necessarily make children and adolescents more vulnerable as long as resilience can be strengthened. This adds even more support to resilience being an integral aspect of OT treatment for children and adolescents.

Section 3 Personal Reflection

What treatment-related considerations should a therapist be mindful of when providing sensory interventions for patients in late childhood as compared to adolescent patients?

Section 4: Sensory Regulation in Adulthood

References: 69 - 76

While the same contextual factors that impact sensory regulation in children and adolescents still apply to adults, there are additional factors that may lead to sensory processing concerns. When someone enters adulthood, co-occurring mental health concerns play an even larger role in their ability to regulate sensory input. Research shows a strong link between sensory processing concerns and psychiatric conditions such as schizophrenia, anxiety, disorders, depression, posttraumatic stress disorder, and even conduct disorders. Someone with one of these conditions may experience uncomfortable emotions more often than other adults, and this can easily lead to or worsen existing sensory concerns if not managed appropriately. Research has found a link between sensory sensitivity and

insecure attachment in relationships. Additionally, having an anxious attachment style is associated with reckless use of substances – specifically misuse of prescription medications and more frequent use of tobacco products.

Since there is so much crossover between mental health concerns and sensory concerns, it is most common for therapists to treat adults with sensory regulation concerns in mental health settings. However, therapists may also encounter these concerns in other settings such as general acute care, skilled nursing facilities, and outpatient clinics.

Adults with sensory regulation concerns can benefit from some of the following interventions:

- Education
    - Studies show that adults with diagnosed and undiagnosed ASD found that stimming offered relief from sensory concerns. Stimming reportedly helped with both negative and positive emotions, but many adults with ASD feel social pressure to avoid stimming in public places. Suppressing the urge to stim is associated with negative emotions and impaired cognition. Therapists can encourage stimming as long as it does not impact function or safety, and educate adult patients about how to stim in a way that does not cause injury or other distress.
- Using a sensory journal to help create a sensory diet and implement environmental modifications
    - Therapists should teach patients to log their current sensory regulation techniques, activities that cause overstimulation or understimulation, and likes or dislikes related to sensory input. This

also helps patients identify physical symptoms such as headaches, nausea, and vertigo. Patients can then review this journal with their therapist to help in the creation of a sensory diet.

- Sensory diets may include actively seeking input (e.g. playing calming music), passively receiving input (e.g. sitting under a heavy blanket), or adjusting the environment to remove triggers (e.g. dimming the lights to help ease eye strain). Each person is different, even if they have the same sensitivities, so trying various techniques and settling on the ones that work is key.
- Additional strategies may need to be implemented for occupations such as caregiving, parenting, safe driving, and household management.
- **Tactile techniques that can be part of a sensory diet:** twirling your hair on your finger; squeezing a stress ball; running kinetic sand through your fingers; finding a small fidget like a spinner, pop-it, pop socket phone attachment, pencil topper; placing calm strips on your phone or laptop; wearing textured clothing with additions such as sequin, elbow patches, plush fabrics, etc.; applying lotion to the arms and legs; using a hand massager on the hands, arms, legs, and feet; sensory brushing protocol with traditional brush or using bean bag or similarly weighted object; taking alone time when individuals are too close to you
- **Auditory techniques that can be part of a sensory diet:** clicking your pen top; having white noise or the radio, TV, or a podcast on in the background if you need more input; using ear plugs, earbuds, or noise-canceling headphones to block out noise; instrumental music can be calming for many people, while hip-hop, rap, and rock can be

more alerting; listening to nature sounds or having a running water fountain on your desktop; running a fan, air conditioner, or other similar device in the background

- **Visual techniques that can be part of a sensory diet:** using task lighting instead of overhead lighting; changing some lights in the home to dimmer switches; clearing visual clutter in places where you need to focus (e.g. desk or cubby at work or in a home office) or want to relax (e.g. living room or bedroom at home); using color to your advantage as much as you are able (for alertness, choose colors like red and orange in clothing, wall color, and home or office decorations; for calming, choose neutral colors or shades of blue in clothing, wall color, and home or office decorations); take frequent eye rest breaks when reading or using a computer for extended periods of time; use eye masks when sleeping or relaxing; environmental modifications are especially helpful for modulating visual input – working or relaxing in an open space with windows and doors helps improve alertness while desk dividers, closed doors, curtains, and room partitions can all encourage relaxation and remove distractions; blue light glasses,adhesive glare screens, and adjusting blue light settings on devices can help reduce strain for those who use computers for extended periods of time
- **Olfactory techniques that can be part of a sensory diet:** smelling candles, lotions, essential oils, scrubs, etc. that help relax (lavender, orange, chamomile, vanilla); using the same mediums in different scents to help with alertness (peppermint, cinnamon, lemon, grapefruit); deep breathing, especially when in a preferred environment; using coffee beans or an unscented product in between other smells to balance olfactory input

- **Gustatory techniques that can be part of a sensory diet:** Chewing gum or mints to improve focus during certain tasks; eating crunchy foods is also alerting and requires oral motor strength, which some people find additionally alerting (crackers, carrots, apples, pretzels, mixed nuts, chips, rice cakes); sour, sweet, spicy, salty, cold, and chewy foods are also alerting; sucking foods and beverages (yogurt, smoothie, milkshake, applesauce) through a straw can also help with alertness; soft and warm foods are more calming
- **Proprioceptive techniques that can be part of a sensory diet:** shaking your foot while sitting down; relaxing on the couch with a heavy blanket on top of you; exercising daily (push-ups using the floor, wall, desk, or chair; resistance band exercises; graded putty exercises; heavy work, which may come in the form of household chores such as mowing the lawn and moving boxes or running and lifting weights); using a mindfulness app to improve body awareness; deep breathing exercises; arm and shoulder squeezes; using a weighted blanket or lap pad; self-massage. There is good evidence behind proprioceptive techniques such as weighted blankets, lap pads, and similar equipment for adults with sensory concerns, particularly when used during sleep, leisure, and after distressing situations.
- **Vestibular techniques that can be part of a sensory diet:** tipping a standard chair back on two legs while sitting in it; rolling side to side in a swivel chair; doing yoga poses that involve inverting the head; spinning in an office chair; using a therapy ball as a desk seat rather than a standard chair; standing to work at your desk; practicing windmill arm exercises; dancing with or without music

    - **Interoceptive techniques that can be part of a sensory diet:** heavy work, deep breathing, mindfulness, and yoga can help with various senses so these are good additions to most sensory diets; being able to control your body temperature and the temperature of the room and discussing emotions before acting on them also help with interoception

- Sensory stimulation for traumatic brain injury (TBI)
    - A systematic review found that sensory stimulation led to significantly greater improvements in Glasgow Coma Scale score when provided to adult patients in a coma following traumatic brain injury. Results showed the best outcomes when patients received multisensory stimulation; auditory stimulation along with tactile stimulation yielded similar results. This study also saw better outcomes when family provided the input rather than clinicians, which lends support to incorporating family in the intervention process. Family involvement also led to improvements in time needed to awaken, awakening rate, and satisfaction rates of loved ones.

In terms of best practices for adults, much of the literature for sensory regulation surrounds children and adolescents. This trend also extends to standardized assessments. As such, therapists should ensure that any evaluation measures are inclusive, age-appropriate, and functionally relevant to adult patients with sensory regulation concerns. An OT-led study found that individuals with psychiatric conditions had varied sensory preferences compared to the general population. This study also showed that sensory preferences tended to vary from one condition to another. Therapists should use this to inform practice moving forward to ensure all sensory-based treatments are personally tailored to their patients.

Section 4 Personal Reflection

How might an OT structure sensory-based treatment for an adult patient with a history of trauma?

Section 5: Sensory Regulation in Older Adults

References: 77 - 82

The aging process has a major impact on sensory function. Once someone reaches the age of 50, they may begin to experience age-related hearing, vision, and vestibular changes that may continue to progress as they age. For some people this may mean needing reading glasses due to having less visual acuity or getting a hearing aid to assist with hearing loss. However, sometimes these sensory changes lead to visual or hearing-related diagnoses that further complicate someone's ability to perceive the world around them. Conditions like glaucoma, cataracts, tinnitus, noise-induced hearing loss, chronic ear infections, and more can lead someone to have difficulties with sensory regulation. Furthermore, individuals who rely on medical equipment such as glasses and hearing aids may present as disoriented, confused, irritable, impatient, and otherwise distressed without them. Even with the use of these sensory aids, older adults may benefit from sensory-based interventions in areas that are particularly deficient. Studies show that sensorial frailty can raise someone's risk of cognitive impairment and dementia as they age in addition to worsening existing cognitive concerns. This offers even more support to the use of sensory-based interventions to help older adults.

Sensory interventions are commonly used with older adults who have dementia, as sensory disturbances often occur in this population. Treatment for older adults with dementia may more often be sensory-based when patients are living in

residential facilities such as long-term care or assisted living. Older adults with sensory concerns can benefit from a range of environmental modifications wherever they live – in the home, skilled nursing care, long-term facilities, or specialized dementia units. Environmental modifications such as pleasantly and familiarly decorated hallways, door disguises, and ambient lighting (not too dim as to prevent falls) can all minimize the risk of wandering, which may result from sensory concerns and emotional distress. Older adults with sensory concerns may also benefit from soothing textures to fidget with and reduce with restlessness. Additional tactile interventions may be necessary for older adults with temperature sensitivity, which can impact feeding and bathing.

There is strong evidence supporting the benefit of massage for older adults as well as multisensory activities that are occupationally and environmentally based. These may include gardening, listening to music, engaging in mealtime, animal-assisted therapy, yoga, and dance. There is also research on the use of the Montessori approach with older adults, which uses self-motivated opportunities for growth that nurture an individual's desire for understanding and respect. There is limited research on the efficacy of aromatherapy, art-based therapy, simultaneous provision of visual and auditory interventions, and Snoezelen rooms for older adults. Despite this, several pieces of literature state that Snoezelen rooms are the most widely used sensory interventions for older adults. This emphasizes the importance of therapists not only being consulted regarding sensory modifications to residential facilities but also using interventions with strong evidence.

Another scoping review identified nature-based sensory interventions emerging as a replacement for traditional Snoezelen rooms in many facilities that house older adults with dementia. In addition, multicomponent interventions have grown in popularity. These are similar to multisensory interventions in that they are multi-faceted. However, multicomponent interventions are more common in

other disciplines, as they consist of traditional cognitive training programs with various sensory components inserted into modules. While there is some evidence to support the advantage of nature interventions for those with dementia and sensory concerns, there is not much evidence on multicomponent interventions as of yet.

There is some evidence supporting the use of ambient assisted living technologies for older adults with cognitive, physical, and sensory impairments. A systematic review finds some benefit from artificial intelligence-based programs, wireless technologies such as medical alert buttons and video conferencing, and assistive robotics to help with feeding and social interaction as well as safety. However, much more research is needed in this realm to prove true efficacy for older adults with sensory concerns.

Immersive virtual reality has also been explored as a sensory intervention for older adults with cognitive impairments. One feasibility study looked at its impact on older adults with mild to severe cognitive impairments and/or physical impairments. In this instance, virtual reality offered footage of nature scenes. Participants reported no negative side effects and feelings of improved relaxation and greater sense of adventure. This evidence suggests virtual reality and nature-based sensory interventions can be combined to benefit older adults with sensory concerns.

There are a range of interventions that can be utilized for older adults who exhibit isolated sensory concerns as well as those related to cognitive impairments. Occupational therapists are well-positioned to implement sensory techniques themselves, train caregivers and family on the use of these techniques outside of treatment, and assist with environmental modifications to encourage more functional participation.

Section 5 Personal Reflection

How might sensory-based OT treatment for patients in a memory care unit differ from sensory-based OT treatment for patients being seen in their homes?

Section 5 Key Words

Snoezelen room - Customized multisensory environments that are intended to reduce agitation and difficult behaviors by allowing individuals in the room to direct their own experience

Section 6: Case Study #1

A 1-month-old infant who was born 6 weeks premature is currently in the NICU, where she has been since birth. The infant's parents meet with OT, who just began seeing the patient, and report their child is having difficulty sleeping, digestive concerns, and difficulty settling when staff try to put her to sleep. The parents want as much treatment as possible while their child is in the NICU and have some concerns over how the transition will go when she is discharged home. There is no discharge date set yet, as she is still somewhat medically unstable.

1. What is the best intervention for this infant and her family?
2. What type of recommendations will most help this infant reach her aforementioned outcomes?

Section 7: Case Study #1 Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What is the best intervention for this infant and her family?

   Education is highly important for sensory concerns during this phase of life. This education is even more essential so the parents can create and strengthen a bond with their child before she goes home, and so they can counter the negative sensory impact the NICU is likely having on the child.

2. What type of recommendations will most help this infant reach her aforementioned outcomes?

   The OT should educate the parents on using infant massage, which will help with attachment as well as sleep and digestion. In terms of difficulty settling, the OT can tell parents to bring in items that smell like them to keep with the baby, which may offer some comfort. Parents can also buy a pacifier to help the baby regulate during times of distress. The OT can tell parents they might want to bring in calming music such as nature sounds or instrumental songs to play when they take the baby to a private room during visiting hours. This can help drown out the loud and sometimes unsettling sounds in the NICU.

Section 8: Case Study #2

The family of a 4-year-old child is interested in him receiving OT for sensory and fine motor concerns. The family relays to the child's doctor that he has some issues with fasteners while dressing at home and no concerns with sensory issues.

However, they state that the child's teacher is more interested in OT than they are, as she reports the child mouths inedible objects and gets upset by both loud noises and typical classroom noises. These concerns happen the most during circle time and when he is asked to sit at his desk for work. They are beginning to impact his academic performance.

1. What recommendations might help this child the most?
2. What might this child's goals look like?
3. What setting should OT take place in for the most benefit?
4. Should the parents be involved to help with carryover at home if there are no concerns in that setting?

Section 9: Case Study #2 Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What recommendations might help this child the most?

   This child's concerns appear to be related to regulating his activity level/ movement as well as seeking oral motor input. In terms of recommendations, the child could benefit from a modified seat or seat cushion to help them sit both on the carpet and at their desk. They may also benefit from a therapy band placed around their desk chair's legs. Each of these recommendations offers proprioceptive input that can help calm the body. The OT can also request that the teacher incorporate some gross motor activities into their schedule just before children are asked to sit for

circle time. This could benefit the entire class in terms of behaviors and engagement.

Recommendations for oral motor seeking behaviors may include eating more crunchy and chewy foods during schooltime, using an electric toothbrush at home, and possibly even trialing the use of a chewy for more appropriate seeking if the other recommendations do not help.

2. What might this child's goals look like?

   Based solely on the child's concerns in the classroom, some helpful goals may include seated activity tolerance, appropriate use of inedible objects, and adherence to using adaptive equipment functionally:

   - After engaging in gross motor activities, the child will remain seated for 6-8 minutes and participate appropriately during circle time 3 out of 5 school days each week.
   - The child will seek out and use their chewy appropriately 70% of the time when they are feeling distressed to improve seated activity tolerance and direction-following.
   - Parents will incorporate at least 4 crunchy and/or chewy foods into the child's diet at home each day to improve oral motor regulation by 60%.
   - After receiving oral motor input, the child will manipulate and properly fasten buttons, snaps, and/or zippers on upper body clothing with min A.

3. What setting should OT take place in for the most benefit?

Since the sensory concerns are mostly happening at school **and** they are beginning to affect academic performance, school-based OT is most appropriate for this child.

4. Should the parents be involved to help with carryover at home if there are no concerns in that setting?

   Parents should certainly be involved in the process, as the child spends more time at home than he does at school. Even if the parents are not noticing any sensory concerns at home, it's possible they don't know what to look for. During the evaluation process, the OT should speak with parents, offer some education on what sensory concerns may look like, and get their input accordingly. This will help address the full scope of this child's concerns and write efficacious goals.

Section 10: Case Study #3

A 34-year-old male recently diagnosed with Major Depressive Disorder is having difficulty at his new job. He is having difficulty meeting deadlines and properly interacting with customers, and is particularly concerned since he is still in the probationary phase. He works in IT and finds himself agitated and somewhat lethargic about halfway through the day. He tells OT that this happens when he feels he can no longer keep his eyes open. He has begun having headaches also, which never happened before his MDD diagnosis. He reports sleeping very well (at least 8 hours each night) and has written out a sensory journal to help shed some light on his problem areas. Upon reading the journal, the OT has reason to believe these symptoms are mostly sensitivity to visual input, but that other sensory systems may also be worsening his problem.

1. What recommendations might best help this patient?

2. Does this patient need a referral elsewhere or can OT help the full scope of his concerns?

Section 11: Case Study #3 Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What recommendations might best help this patient?

   Since visual input has been identified as a concern and this patient mostly does computer work, the OT should recommend making his devices less harsh. The OT can help this patient get anti-glare screen protectors for his computer, adjust system settings so the blue light is not as strong, or look for blue light blocking glasses. While the patient reports sleep is not a concern, it may be hard for the patient to tell if their sleep is a problem if it's been the same for so long. OT can also recommend an eye mask for use at night to help sleep better and also reduce visual strain during the day when the patient wants to rest or relax. In addition, this patient would benefit from breaks from their computer, so OT should encourage him to get up and walk around the room for around 5 minutes every hour. This not only helps with circulation but reduces eye strain. If the patient is unable to get up and walk during these times, the OT can instruct him to at least look away from their computer for 1-2 minutes every 30 minutes to ease visual input.

   While walks can help with alertness, there may be some need for auditory input to assist with level of arousal. If the recommendations for visual sensitivity are not entirely effective, the OT can also recommend that the

patient plays white noise, nature sounds, binaural beats, or other instrumental music in the background at work to improve their energy levels and concentration.

2. Does this patient need a referral elsewhere or can OT help the full scope of his concerns?

   It depends on how effective these recommendations are. It's very possible that OT could have resolved each of this patient's concerns as long as he adheres to these recommendations. However, if the patient's concerns persist, in light of his MDD diagnosis, he might also benefit from vocational counseling to request job-related modifications to help him be more efficient in his role. The OT can determine the need for this after a few weeks of working with the patient.

Section 12: Case Study #4

A 74-year-old male was just diagnosed with dementia and demonstrates moderate cognitive impairments. He lives in a single-level home with his healthy wife, who has been helping with the patient's ADLs for the past few months before he was diagnosed. The patient demonstrates no safety concerns as of yet and can still navigate the home with the help of a rolling walker and his wife standing nearby. He has been referred to OT due to increasing agitation and fear surrounding ADLs. The patient will sob when his wife wets a washcloth to wipe his face and hands. The patient is also fearful of getting in the tub, so the wife has been giving him sponge baths and the patient shrieks when the disposable wipes touch his skin. The patient's baths have been taking place in the evening just after dinner and some of these behaviors are extending further into the evening. The patient will sit in the living room to watch TV for the rest of the evening and continue to cry or yell that he is scared. This persists up until bedtime.

1. What may be the cause of this patient's response?
2. What recommendations can help improve this patient's evening routine?

Section 13: Case Study #4 Review

This section will review the case studies that were previously presented. Responses will guide the clinician through a discussion of potential answers as well as encourage reflection.

1. What may be the cause of this patient's response?

   Since bathing is the start of this patient's response, it's likely that this patient's concerns are related to changes in sensory function as well as partly due to cognitive changes. This patient likely has some difficulties with temperature control and vestibular concerns that may be causing fear of getting into the tub.

2. What recommendations can help improve this patient's evening routine?

   This patient would benefit from gentler sensory input during bathtime. It's recommended that his wife either get a wipe warmer to make the disposable wipes less shocking to the skin or switch to washcloths, which offer a softer, more plush material. The patient would also benefit from adjustments to the temperature of the water. OT should educate the wife to test out warmer water on the patient. There should be less of a concern about burning the patient, since he is getting sponge baths. However, the wife should test the water before running the washcloth under it and using it to bathe the patient. The patient may also benefit from wearing soft slippers and a plush robe (ideally one that is familiar to him) after bath time to encourage relaxation. It is possible that the distress this patient is

experiencing during bath time is running into the evening partly due to sundowning. For this reason, it's recommended that his wife move bathtime to another time in the day when the patient is more alert and more calm - possibly in the early or late morning.

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