Sensory Processing Disorders
... and Beyond!
A Neurological Perspective
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The Mislabeled Child
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www.mislabeledchild.com

1. To thank the OT community for identifying a critically neglected group of children who suffer from significant developmental challenges, and for developing strategies that can help those children overcome their challenges.

Goals In This Talk

RE: Why We’re So Grateful

The following is from the report on a child we saw in our clinic with SPD-type problems when evaluated by a developmental pediatrician at one of U.S. News and World Reports top 10 American medical centers.

Diagnoses were listed as:
• “Probable ADHD”
• “Possible anxiety disorder”
• “Cannot rule out Asperger’s Syndrome”
• “Motor Coordination difficulties reported with reported dysgraphia.”

Why We’re So Grateful (cont’d)

Treatment recommendations were:
• “Psychostimulant medication” to improve attention
• An addition sedative to control anxiety—which usually flared up only when he was asked to write.
• “Social skills awareness classes”
• No mention of any kind was made of any intervention for his problems with motor coordination or handwriting.

2. To discuss our view of sensory and sensorimotor processing disorders from a neurological perspective: that is, from our standpoint as physicians (and one neurologist) who are viewing these problems in the context of the complete neurological development of a child.

Goal 2

3. To review the growing scientific literature on the neurobiology, treatment, and common clinical presentations of sensory and sensorimotor disorders.

Goal 3
4. To discuss the general approach to diagnosing and treating the child with sensory and sensorimotor processing challenges, and the other challenges that accompany them.

Goal 4

In the OT literature, the classic approach to defining and treating sensory processing disorders has grown out of the work of Jean Ayres, who defined the clinical syndrome of Sensory Integration Dysfunction functionally: as an impairment in the ability to organize sensation for use.

…and Just Last Week

This functional approach continues to underlie much of the OT community’s work on sensory processing, like Dr. Lucy Jane Miller’s in Sensational Kids:

“Sensory processing is a term that refers to the way the nervous system receives sensory messages and turns them into responses.... Sensory Processing Disorder exists when sensory signals don’t get organized into appropriate responses and a child’s daily routines and activities are disrupted as a result.”

Patterns Within Patterns

Like these general descriptions of the clinical syndrome, recent categorizations of SPD clinical subtypes have also been based on patterns of behaviors or dysfunctions thought to result from difficulty processing or organizing responses to sensation.

Sensory Processing Disorder
- Sensory Modulation Disorder
  - Sensory Over-Responsivity
  - Sensory Under-Responsivity
  - Sensory Seeking / Craving
- Sensory-Based Motor Disorder
  - Dyspraxia
  - Postural Disorder
- Sensory Discrimination Disorder

How SPD Looks to You

Functional definitions like these are both useful and appropriate for a practical discipline like OT, whose primary goal is improving the functional capacity of patients.

This practical orientation is both OT’s great strength, and the reason this field was the first to recognize the severely impairing functional deficits of DS1/SPD, and the tremendous human toll they exact.

The View From Where We Stand

These same functional deficits are often responsible for some of the academic difficulties affecting the children that come to our clinic.

We, too, have a practical goal in caring for these children: to relieve their academic challenges and the problems that follow them.

But the differences in the nature of our clinical focus cause our perspective to differ from yours in two main respects:
1. Our clinical focus is not specifically on sensory or sensorimotor problems, but on all aspects of physical, cognitive, neuropsychological, and psychological function. In just a moment we’ll describe in more detail the kinds of things we look at using this “generalist” approach.

A Neurological Perspective (cont’d)

2. In addition to identifying and treating specific functional deficits, we’re also trained to reason back from observable behaviors, test results, or physical findings to see what we can discover about the nature of their origin in the nervous system. In other words, in our role as diagnosticians, we are trained whenever possible to prefer causal explanations to functional or behavioral ones, and to resort to the latter only when we fail to find the former.

'Tis a Gift to be Simple

In trying to identify these causes or sources, we’re taught to follow the basic scientific principle of parsimony. Parsimony demands that when looking for the cause of a complex phenomenon, we should always favor the simplest solution that accounts for the greatest number of observations.

So when trying to find the cause of a set of functional deficits in the nervous system, we search for some unifying factor that connects the deficits to one single neurological cause or source.

Types of Neurological Sources

Generally, there are two basic types of such sources:
1. Focal defects that can be localized to a particular neurological structure, pathway or site; or,
2. Pathological processes that are known to cause clusters of dysfunctions similar to those seen.

Let’s discuss these two in a bit more detail.

Localization (cont’d)

Take for example the following combinations of symptoms, each of which can go along with weakness on the right side:
1. R-sided Weakness and numbness, R-sided visual field cut, speech difficulty.
2. R-sided weakness without numbness: pure motor hemiparesis.
3. Proximal weakness (shoulder) greater than peripheral (hand).

Each of these three clinical scenarios suggests a different localization in the CNS:
1) Left Hemispheric Stroke.
2) Lacunar (small) stroke, often in the basal ganglia.
3) Watershed infarct, due to decreased flow in hard to perfuse areas of the brain.
Pathological/Causal Processes

- Importantly, causation can often be inferred from the localization of nervous system injury or damage (e.g., hemispheric strokes are often due to atherosclerosis or embolisms; lacunar infarcts to hypertension; and watershed infarcts to episodes of shock or circulatory collapse, or vascular disease).
- Causation can also be inferred from the particular combination of the deficits and symptoms, as being due, for example, to various genetic, developmental, or traumatic disorders.

Looking for Direction

- So, where do these approaches of localization and causation (in addition to function) get us when looking at children with disorders of sensory and sensorimotor processing?

Our Examination

To answer, let’s look at what we see when we perform a complete assessment on children with sensory and sensorimotor problems.

- History
- Behaviors
- Neurology
- Neuropsychology

Medical History

Historical factors often observed in children with sensory or sensorimotor problems:

- Premature birth or labor, or other gestational problems (e.g., maternal bleeding)
- Birth injury or difficult birth (e.g., prolonged labor, induction, fetal distress)
- Neonatal stroke, infection, or shock, or NICU hospitalization
- Prolonged sensory deprivation (due to prolonged hospital or institutional stay)
- Head trauma
- Significant auditory or visual processing deficits (including complete blindness or deafness)
- Recurrent or prolonged seizures
- A diagnosis of autism or autism spectrum disorders
- Familial dyslexia
- Certain genetic conditions (like fragile X)
- Possibly more common among highly or profoundly gifted
- Familial history
- Familial neuropathy

Note: most processes in this list do not cause deficits that are restricted to the sensory system.

Behavioral Observations

- In addition to the common sensory behaviors that relate to the categories of sensory modulation, sensory discrimination, and motor dyspraxia or postural weakness, we also commonly find many additional behaviors at a significant frequency that are not specifically sensory or sensorimotor in nature. These include:
- Difficulties with mental focus, task switching/transitions, multi-tasking, arousal, biological regularity, appreciation/understanding of time, time management, numeracy, and higher order language skills.

Neurological Examination

In addition to signs of impaired sensory and sensorimotor function, we also frequently find evidence of focal neurological impairments, like mild motor pareses, sensory neglect, abnormal reflexes, or focal cognitive impairments, often in a hemispheric or watershed distribution.

Fernette will cover these in more detail in her portion of the talk.
Neuropsychological Examination

Again, in addition to problems clearly related to sensory input and processing, we commonly see a higher than expected frequency of difficulties in tasks involving:

- complex organization and sequencing of linguistic information (independent of route of input or output);
- word finding or generation;
- the concept of time (whether months, days of the week, hours, or minutes); and,
- mathematical concepts, especially those involving quantity, estimation, and approximation.

Our Conclusions from these Exams

What can we conclude from these findings with reference to three categories of thinking about nervous system problems that we mentioned before:

1. Localization
2. Pathological processes
3. Functional categories

Localization

When thinking about children with SPD-type symptoms (and the others we’ve spoken of) from the standpoint of localization, we find that many of their difficulties can be produced or contributed to by abnormalities in one CNS structure in particular: the cerebellum.

Many children with SPD-type symptoms also show signs of focal CNS injury in a patchy or watershed fashion suggestive of low flow episodes, others in a diffuse fashion, and a few of narrower focal deficits suggestive of an undiagnosed bleed or developmental problem.

Pathological Processes

When thinking of these same children from the standpoint of causation or underlying pathological process, two primary types of processes are often implicated:

1. Conditions that directly alter or injure brain structure, organization, or functional connections (e.g., low flow, jaundice, familial/developmental dyslexia).
2. Conditions that impair the proper developmental organization and integration of the nervous system by significantly impairing sensory input and processing either within a particular functional domain (e.g., significant visual or hearing impairment), or in general (e.g., institutionalization or neglect).

Localization and Causation: Intersections and Implications

Importantly, causes of the first kind have been shown preferentially to impair function in a number of important brain structures, including the cerebellum. It is also important to realize that the effects of these causal mechanisms would not be expected to be isolated to purely sensory processing.

The intersection of the messages conveyed by looking from both the perspectives of localization and pathological process has increased our interest in the cerebellum. We’ll describe the important implications of this finding in more detail a little bit later in our talk.

Functional Categories

Because many of the injury patterns or disease mechanisms that we can identify result in diffuse nervous system dysfunction, and because in many cases the underlying causal processes are either not definitively identifiable, or are not directly subject to therapy at the level of causation (but rather of function), the continued use of functional categories is important.

In addition to categories typically thought of as being part of the syndrome of SPD, we also commonly see certain patterns of non-sensory or sensorimotor problems occurring in these children.

In summary, then, what we see in these children looks like…
Common Patterns of Dysfunction
In Children With Sensory Processing Disorders

The Perspective of Localization
- Cerebellar Symptoms

The Perspective of Causation
- Primarily early life injury, or genetic
  (No obvious opportunity for direct intervention
  based on underlying mechanism, but rather on
  impaired function.)

The Perspective of Function
- Visual Symptoms
- Auditory Symptoms
- Body Imagery
- Emotional Regulation
- Social Function
- Higher Cognitive Functions

Starting in the Cerebellum

“The Hub” - Where Everything Meets
Neurons & Processes Particularly Vulnerable to Injury

Cerebellar Function

“The Hub”
Sensory – Motor – Emotional Coordination

Senses
Motor
Spatial/Position
Interoceptive (Organs)
Limbic/Emotional
Automaticity

“The Primitive Brain”
The Automatic Brain

Cerebellar Anatomy

Midline: Trunk, Oral-Motor, Mood, Appetite
Lateral: Arms, Hands, Fingers

Cerebellar Function

The Work of the Cerebellum

- Skilled Motor Movements - Automaticity
- Visual-Motor Integration
- Learning By Imitation
- Postural Adjustments
- Protective Reflexes, Response to Danger
- Planning, Organization
- Fine Tuning & Adjustments
Cerebellum as Orchestra Conductor

If the Sensory, Motor, Emotional, and Cognitive Systems are the Players, Then the Cerebellum Helps Them Make Music Together

• Constant Adjusting and Matching of Input Signals
• Balancing Responses to Environment
• Adjusting Performance to Feedback
• Organizing Patterns

Automaticity

• When the Cerebellum’s Working Hard, You Don’t Have To...
• Automatic Integration of Sensory and Motor functions
• Frees Up Space in Conscious Awareness, Working Memory
• More Rapid Processing — i.e. Real Time
• Cerebellum Also Helps Regulate Sensorimotor Aspects of Eating

Automaticity and Skilled Motor Expertise

More Cerebellar Gray Matter in Professional Musicians

Hand-Eye Coordination

• Cerebellum Coordinates Position, Movement, Timing of Self and Objects
• Makes Adjustments After Errors

Cerebellum Coordinates Body Position Sense

Seeing, Hearing, and Sensory Position

Where the Body Is in Space

Vision Retina-Centered
Auditory Head-Centered
Touch Body-Centered

Eyes, hands, arms, and head all move independently, Cerebellum must constantly realign changes in posture
Cerebellar Function

Protective Reflexes & the Cerebellum

- Quick Response System
- Tight Postural Muscles of the Trunk, Extend Arms
- Perceive Threat, Direct Attention
- Sequence of Protective or Escape Pathways

Planning and Organization

- Based on Prior and Ongoing Sensory Experience
- Sequencing and Prioritizing Events
- Organization of Parts to Whole

Cerebellar Dysfunction

Past Pointing

Hypotonia: Weakness and Poor Posture
Coordination Balance Writing Emotional Outbursts

Postural Instability

Kneels Wider Base More Stability Scapular Winging Lordosis ‘S’

Cerebellar Dysfunction

Dynamic Sensory Feedback from the Environment

Cerebellar Dysfunction

Dysgraphia - Writing Problems

Control Cerebellar Degeneration Child with Cerebellar Findings

Irregular Sizes Separate Marks for Letters Large Letters, Trouble with Curves

May Avoid Fingers

Child with Cerebellar Findings

Large Letters, Trouble with Curves

May Avoid Fingers
Cerebellar Dysfunction

Emotional Outbursts
“Explosive Temper”

- Cerebellum connects senses to emotion centers
- Fear, anger, and autonomic pathways
- Arousal and Alertness
- Cerebellar lesions associated with irritability, impulsivity, expressive language problems, and emotional liability
- Cerebellar abnormalities are seen in pediatric bipolar patients, autism, ADHD...

The Cerebellum & “Appetites”
Taste, Smell, and Interoception

- Decrease Drive to Eat or “Picky”
- Sensitive to Taste, Smell, Texture
- Preference for Bland Foods – Pasta, Potatoes, Hot Dogs
- Decreased Sensitivity to Visceral Cues – Hunger, Thirst, Fatigue, Sometimes Pain

Cerebellar Dysfunction

The Cerebellum & Cognition

Disorders of the Cerebellum
Ataxia, Dysmetria of Thought, and the Cerebellar Cognitive-Affective Syndrome

- Planning
- Set-Shifting, Distractibility
- Verbal Fluency
- Visual-Spatial Organization & Memory
- Mood Fluctuations, Blunted Affect, “Bipolar”

The Cerebellum & Cognition

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Cerebellar Risks

Children At Risk for Cerebellar Deficits
(Note the similarity to SPD risks in general)

- Preterm birth/labor
- Birth injury, including prolonged labor, induction, fetal distress.
- Down Syndrome, Fetal Alcohol Syndrome
- Dyslexia
- Post-Trauma, Child Abuse
- ADHD “the most consistent brain abnormality”
- Autism / Aspergers “the most brain consistent abnormality…”
- Pediatric Bipolar

Cerebellar Risks

Massive Growth Cerebellum Last Trimester

Premature Birth Interrupts Growth
Critical Time for Cerebellar Neuron Division & Migration
1 in 10 Children Born Premature
Cerebellar Neurons Show Selective Vulnerability (Easily Injured)

Cerebellar Risk

Long Window for Cerebellar Therapy

Cerebellar Treatment
Cerebellar Treatment

Principles of Cerebellar Training or Therapy

- Integrative Activities
- May Focus Initial Activities – Balance, Protective Reflexes, Hand – Eye Targeting, Stationary or Moving
- If Vision & Position Don’t Agree, Vision Tends to be Wrong – Increasing Proprioceptive Input Improves Localization and Targeting
- Cognitive Training to Improve Awareness of Bodily Signals, Self-Calming

Cerebellar Anatomy

Midline: Trunk, Oral-Motor, Mood
Lateral: Arms, Hands, Fingers

Trunk & Oral Motor

Input Dynamic, Regular Input
Sensory-Motor Activation
Pattern Response to Perturbations
Processing Linear & Non-Linear Movement
Output Resistance Strengthening

Arms, Hands, & Fingers

Input Dynamic, Regular Input
Sensory-Motor Activation
Squeeze Balls, Weights
Pattern Motor Planning - Targeting
Processing Adjusting Movements
& Output Motor Inhibition
Sensory Feedback

Cerebellar Kids & Fish Oil?

- Evidence of Sustained Benefit on ADHD Behaviors
- Better than Methylphenidate

The Oxford-Durham study: a randomized controlled trial of dietary supplementation with fatty acids in children with developmental coordination disorder

Published in 2010, MD Thesis 2010

Cerebellum More Efficient After Practice

Draw a Maze

Left hand Right hand
New New Left hand Right hand
Functional Clusters

Vision
Hearing
Emotional Regulation
Body Imagery
Social Learning & Interaction
Higher Cognition

Visual Behaviors

**Visual Input Problems**
- Difficulty with Movement, Playing
- Reading, Writing Problems
- Missed Social Cues
- Poor Eye Contact, Visual Overload
- ADD Look-Alike

Withdrawn, Avoidant, Impulsive, Moody, Oppositional, Underachieving, Inattentive

**Lumped Behaviors**
- Aspergers, ADD, Autism Spectrum

Visual Behaviors

**How Visual Problems Present**

**Input:**
- Reading, Writing Problems
- ADD Look-Alike: Inattention and Distractions
- Problems with Movement, Playing
- Missed Social Cues

Pattern Processing
- Spatial Errors, Mirror Reversals
- Problems with Recognition
- Visual Interactivity

**Output**
- Hand-Eye Coordination

"All during my life I knew I had a problem; I just didn’t know what the problem was. At the age of twenty-nine, I discovered it was connected with my eyes...How is it I never suspected, never complained, never spoke of it before? The answer, I guess is that we tended to feel that all people see and feel things the way we do. At least, having nothing to compare it with, I assumed my vision was normal."

- Jess Oppenheimer, TV Writer *I Love Lucy*

Visual Behaviors

**Visual Input Problems: Reading**

- We saw a bear at our camp!
- We saw a bear at our camp!
- We saw a bear at our camp!
- We saw a bear at our camp!
- We saw a bear at our camp!

- Double Vision
- Blurring
- Reversals, Flips
- Word Substitutions

Visual Behaviors

**Visual Input Problems: Movement or Playing**

- Visual Coordination
  - Right - Left, Up - Back
- Visual Scanning
- Unrecognized “Blindspots”
- Visual Timing

Problems when I’m moving
Problems when others are moving

Decisions about edges, textures, glare, distance, speed, direction, recognition, self movement
Visual Behaviors

Visual Perceptual Errors
Mirror Reversals

Visual Behaviors

Visual Pattern Processing: Overload & Distraction

How Do You Organize What You See?

Visual Behaviors

Visual Pattern Processing: Center or Peripheral Focus?

Individual Differences in Focus & Distraction
Influenced by Practice and Training

Visual Behaviors

Therapy Interventions for Problems of Visual Input

Input: Glasses
Change Environment, Font, Color
Cognitive Teaching about Environment
Pattern: Depth Perception – Reaching, Stepping
Movement Perception, Timing
Output: Fine Eye-Hand Coordination
Gross Visual-Motor Planning
Stationary and with Movement

Developmental Optometrist

Visual Behaviors

Therapy Interventions to Reduce Distraction

Input: Study Carrel
Cover Paper, Less Page
Pattern: Cognitive Strategies-
Processing Color to Organize
Graphic Organizer
Graph Paper
Practice – Resist Distraction
Certain Video Games Help
Certain Video Games Hurt

Visual Behaviors

Therapy Interventions for Visual Overload / Memory Problems

• Use Tape Loop More
• Words to Describe & Organize Visual Information
• Practice Resisting Visual Distraction
• Use More Sensory-Motor Associations or Gestures
• Visual Imagery Strategies
**Visual Behaviors**

**Clinical Pearls – Visual Detective**

- have a high index of suspicion
- if peripheral motor is impaired, think oculomotor
- avoiding art projects, word searches
- avoiding ball sports, busy playgrounds
- poor eye contact
- meltdowns with crowded worksheets
- may be doing all right in school (if good auditory)
- may be talking all the time

**Auditory Symptoms**

**The Balancing Act of Sound**

**Auditory Symptoms**

**Acoustic Environments of Childhood**

- Home
- Class
- Lunch Room
- Gym
- Outdoors

**Auditory Symptoms**

**Risk Factors For Auditory Processing Deficits**

- Mild Hearing Frequency Loss
- Ear Infections (active or past)
- Central (Brain-Based) Auditory Processing Problems
  - Premature birth or hyperbilirubinemia
  - Mild injury
  - Chronic ear infections
  - Dyslexia
  - Autism spectrum

**Auditory Symptoms**

**Acoustical Society of America**

**Auditory Symptoms**

- Hearing is Dynamic (Always Changing)
- Different Environmental Demands

**Auditory Symptoms**

- Background Noise
- Discrimination
- Perceptual
- Localization
- Memory
- Attention
- Emotionality

**Auditory Symptoms**

- Student
- Teacher
- Parent
- School
- Community
- Environment

**Auditory Symptoms**

- Auditory Sensory Process
- Sensory Overload
- Sensory Underload
- Sensory Processing Disorders
- Sensory Sensitivity
- Sensory Sensitivity Disorders

**Auditory Symptoms**

- Sensory Processing Disorders
- Sensory Sensitivity
- Sensory Sensitivity Disorders
- Sensory Overload
- Sensory Underload
Auditory Symptoms
Background Noise Impairment

What Do They Hear?
- Sound Distortion, Reverberation
- Exaggeration of Some Sounds
- Dropped Out Sounds, Words Run Together
- Localization Problems

Auditory Symptoms
Background Noise Impairment

“I just hear everyone talking at once…”
“When I’m in a group, it just sounds like static…”
“I can’t hear anything when the teacher writes on the board…”

Auditory Symptoms
Sound Discrimination Problems in Phonological Dyslexia
Many Have Other Significant Sensory Behaviors

fMRI Changes
Dyslexics Better Suited to Processing Slow Sounds
May hear ‘blush’ and ‘brush’ as the same word

Auditory Symptoms
Auditory Hypersensitivity: Fear and Flight
Increased Brain Activation with Sound

Auditory Hypersensitivity

Fear, Anxiety
Variations in Auditory Processing

- There are Normal Variations in Auditory Processing
- Auditory Abilities Affected by Age, Gender, Ear Infections, Other Individual Factors
- At Present, Diagnosis More Specific Than Treatment

Formal CAPD Testing
When It’s Worth It, And When It’s Not

- Medical Causes Ruled Out
- If Despite Educational Interventions, Persistent Problems with Learning, Reading, Social Skills
- Can Be Unreliable Before Age 8
- Tough for Kids with Significant Attention, Emotional Regulation, or Auditory Hypersensitivity Problems

Therapy Interventions for Auditory Problems

- FM Amplification in Groups
- Cognitive training – Active Listening
- Cognitive training – Environments
- Other Sensory Corrections Help
- Spatial Localization -Vision, Balance, Rhythmicity, Timing

Pattern Processing
Background Noise Training
Auditory Closure
Closed Captioning

Interventions for Auditory Hypersensitivity/Fear

- Environmental Changes
- Cognitive Preparation
- Controlled Sound Exposure
- Reduce Hypervigilance / Arousal
- Emotional Calming
- Deep Pressure Activities

Practice at Emotional Calming
Reduces Acoustic Startle

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<th>Conditioned</th>
<th>Suppression</th>
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<td>4.0 (1.0)</td>
<td>2.0 (0.0)</td>
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Note: No statistically significant difference between conditions.

Looked at Heart Rate, Sweat Conductance, Finger Temperature...

Vision ↔ Hearing
Visual-Auditory Mismatches

McGurk Illusion

Look & Listen: Da – Da – Da – Da
Sound Off: Ga – Ga – Ga – Ga
Eyes Closed: Ba – Ba – Ba – Ba

Reading Problems, Listening & Learning Problems

Senses Compensate for Deficiencies...

The Infrastructure for Hypersensitivity

More Sensitivity with Deafness—Deaf ‘See’ with Auditory Cortex as well as Visual Cortex

In other studies, Blind Hear with Visual Cortex

Body Imagery: “Why does the grass feel like knives?”
Sensory Mismatch & Hypersensitivity

Normal Body Imagery Requires Constant Sensory Input

Body Imagery

Sensory-Motor Mismatches Impair Body Imagery & Elicit Pain in Normal Subjects

In 66% of health volunteers, abnormal sensations of pain (“numbness, pins and needles, moderate aching and/or a definite pain”) or other sensations (“perceived changes in temperature, limb weight, altered body image, disorientation”) were reported following artificially-induced sensory-motor incongruence

Body Imagery

Anesthetize Thumb \(\rightarrow\) Change Body Imagery
Thumb and Lips (Brain Map)
Bizarre Sensations, Pain

Body Imagery

Visual Feedback Training Improves Some Complex Regional Pain Syndrome

<table>
<thead>
<tr>
<th>Patient (affected limb)</th>
<th>Pain VAS Week</th>
<th>Pain VAS 4</th>
<th>Rx duration (weeks)</th>
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<tr>
<td>Case 8 (L leg)</td>
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Phegan, U NSW

McCabe, U of Bath
Body Imagery

Therapeutic Interventions to Improve Body Imagery

- Mirroring or Imitation Practice
- Increasing Proprioceptive Feedback (Weights, Heavy)
- Imagining Movement Alternated with Movement (Successful in Improving Rehabilitation of Hemiparesis)

Emotional Regulation:
System Server Crash

- Fight-or-Flight
- Fear, Threat
- Anxiety
- High Stress

Emotional Regulation

Brain Reorganization May Exaggerate Emotional Cues
Eye Contact Triggers More Threat in Autism

Emotional Regulation

The Chemistry of Stress

- More Threat Perceived with Elevated Cortisol
- Elevated Cortisol with Panic Attacks, Tantrums
- Healthy Volunteers Injected with Cortisol ➔ Perceive More Threat & Pain

Emotional Regulation

Chronic Stress & Sensory Overload
Hypervigilance, Increased Emotional Arousal
**Emotional Regulation**

**Input**
- Reduce Sensory Overload
- Predictable, ‘Safe’ Environment

**Pattern**
- Cognitive Training – Esteem, Control

**Processing & Output**
- Teach Child, Parents, Teacher
- Pressure, Massage (Reduce Cortisol)
- Activities to Encourage Impulse Inhibition
- Controlled Incremental Challenge

**Better Effects of Cognitive Behavioral Therapy**
If Include Families in Therapy Sessions
- Cognitive Behavioral Interventions – More Effective for Children with Stress Disorders
- If Child & Parent Teaching Occur
- Signs & Symptoms in the Environment & Child
- Cognitive & Physical Regulation Strategies

**Social Function**

**Imitation & the Roots of Empathy**

**Trainable Mirror Networks in the Brain**

Dancers’ Brains Respond More to Dance Movements They Know

Glaser, University College London

**Social Function**

**Imagining Yourself in a Picture**
Requires Sensory-Motor Cortex

First Person Perspective

**Social Function**

**When a Child’s Sensory Systems Are Dysfunctional, Empathy is Less Automatic**
Sensory Processing – Social Connection

- Normal Developmental Differences in Perspective-Taking (ages 3-6, confuse points of view – me vs. you)
- Cognitive Empathy May Precede Emotional Empathy
- Training Improves Mirroring and Empathy

Pinella, U San Diego

Selman
Social Function

Poor Eye Contact
Many Different Reasons

Social Function

Direct Eye Gaze Specifically Activates Brain

There is something special about direct eye contact…

Frith, U College London

Social Function

Direct Eye Contact Hard for Some People

Social Function

Shyness

Those with “Social Phobia” Avoid Angry Faces More

Gordon, U of Sydney

Social Function

Normal Development & Memory Overload

“If I have to look at the teacher, I forget what I’m going to say…” – 8 year old boy

Social Function

Looking at Faces
Overloads Visual Memory of Children

Cognitive Demands of Face Monitoring:
Evidence for Visuospatial Overload.

Normal 6-10 year old children
gaze aversion improved recall

Doherty-Sneddon, University of Stirling
Social Function

Words & Pictures

Social Function

Social Interactions are Hard with Sensory or Sensory Overload Problems

- Visual Movement
- Visual Memory
- Visual-Spatial Relationships
- Visual Recognition
- Visual Overload
- Language Comprehension – Tone of Voice, Context, Organization, Inference

Chuang, Stanford

Social Function

Working Memory
Our Cognitive Desk Space

Social Function

The Struggle for Eye Contact

- Young Children
- Some Dyslexics
- Mild Brain Injury
- Shy or Socially Anxious
- Sensory Processing Disorders
- Autism Spectrum Disorders

Social Function

Improving Eye Contact

- Gets better with practice
- Easier with family members, familiar faces
- Easier when one knows what one’s going to say
- Start with good & smile, then look away
- May be easier when moving / swinging
- Easier when you know it’s hard for other people too
- Improves with reduced anxiety, better emotional regulation

Social Function

Higher Cognitive Difficulties & Sensory Dysfunction

Particularly Tasks That Require Complex Coordination

- Seeing, Hearing, Doing
- Complex Language: Input + Output
- Problem Solving, Social Pragmatics
Patient Cases

Case 1

11 year old boy
Attention Problems
Anger and Frustration

Case 1

Sensory Integration Inventory - Revised

Tactile: Pushes up pants legs and sleeves, avoids or is irritated by clothing texture, resists grooming, wants to touch everything & everyone, sometimes hits or slaps self
Vestibular: loses balance, falls or trips, poor protective response, bumps into objects, self-stimulatory like running
Proprioception: clumsy or awkward getting on or off equipment, bites nails, history of banging head, slaps self
General: Unpredictable outbursts, slow to recover, hard to calm, short attention span

+ Seeks gross motor movements (crashing, bumping), distracted by movement, trouble filtering out noises

Case 1

Clinical and Medical History

• Uncomplicated pregnancy except mom with asthma on steroids, normal delivery and early development
• Hyperactivity noted as a toddler
• “Always been clumsy” – trips, bumps into things, flipped over handlebars of bike
• Chronic Ear Infections, no PE tubes – but considered
• Tinnitus at times, sometimes too loud in gymnasium
• Carsickness, bad foot odor
• Family History – father was adopted, one cousin with hearing loss

Case 1

Neurological Exam

“Sure I see double – like I can see two of my hand, right now!”
MSE: Not Hyperactive
CNs: Intermittent Lazy Eye
Hearing asymmetric. Softer on R to 128 & 256 Hz
Cannot distinguish any whispers bilaterally.
Sensory: Prominent Chorea. Mild distal neuropathy. Tuning fork “warm” on toes. 1+ reflexes at ankles.

Case 1

Neuropsychological Assessment

General: Not Hyperactive in General
Fidgety and Sensory Seeking (Swivel Chair) with Difficult Tasks
And...

Case 1

Visual & Visual-Motor Tasks

Trouble with Mazes
Intact Visual Vigilance but Increased Time (not Attention)
Good Ball Catch – More Problems Near-Point
Poor Motor Sequence Imitation
Poor Visual Copying
Impaired Picture Naming, But Excellent Category Naming
Sloppy Handwriting
Hates to Write
Case 1

Auditory Tasks
Good Verbal Instructions
Good Sound Cueing
Excellent Complex Sentences
Good Sentence Formulation
Good Read Aloud Paragraph & Comprehension
Impaired Summarization of a Listened Paragraph,
But Good Comprehension (Working Memory Overload)

Not An Attention Problem

Case 1

Decision-Making

Untreated Visual Problem
Background of Other Milder Sensory Issues – Hearing, Neuropathy
Emotional Frustration from Increasing Near Visual Work
Increasing Motor Demands & Poor Visual Motor Control

Case 1

Glasses & Six Months of OT

<table>
<thead>
<tr>
<th></th>
<th>Before OT Percentile</th>
<th>After OT Percentile</th>
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<tbody>
<tr>
<td>Vis Mot Int</td>
<td>6%</td>
<td>61%</td>
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<td>Vis Percep</td>
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<td>Fine Motor Speed</td>
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<td>12</td>
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<tr>
<td>Upper Limb Speed</td>
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<tr>
<td>Grip</td>
<td>35#, 30#</td>
<td>45#, 45#</td>
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</table>

Attention, Emotions Improved – Returned to School & Sports

Case 1

Other Specialists
Developmental Optometrist
Convergence Insufficiency
Divergent Strabismus
Audiologist
Mild Bilateral Hearing Loss
30-35 dB 250-1000 Hz

Case 1

The Plan
Correct Vision & Visual –Motor
Glasses & Eye Exercises for Near Work
OT for Visual – Motor & Sensory Regulation
Conservative Management of Hearing

Case 2

8 Year Old Boy
Meltdowns at School
Refusing to Write or Draw
Social Skills Problems
Sensory Overloads
Case 2

Sensory Integration Inventory - Revised

Tactile: sensitive to clothing, removes shoes, spits out food, clingy behavior, tries to touch everyone, rubs against objects
Vestibular: loses balance, falls or trips, poor protective response, bumps into objects
Proprioceptive: doesn’t shape hands to hold object, looks at hand to reach, holds items lightly, clumsy
General: Sensitive to sound, problems task switching self-stimulatory behaviors have subsided, but jumps and bounces

Clinical and Medical History

- Crash C-section, Meconium Passed
- Never Crawled, Mild Speech Delay
- Content as Toddler, But Underactive
- Sensory Overloads in Busy Environment
  Covers Ears, Withdraws, Misbehaves

Neurological Exam

- Decreased Eye Contact
- Speech Hesitant, Abnormal Prosody
- Impaired Visual Tracking
- Sound Sensitive, Reports Louder on R
- Hypotonic, Tailor Sits
- Postural, Prominent Fine & Gross Motor Weakness
- Impaired Motor Sequencing
- Ataxic Finger-to-Nose
- Impaired Reaching Under Visual Guidance (Cerebellum)
- Unsteady Tandem Gait and Balance
- Sensory Exam to Primary Modalities Normal
- Prominent Chorea
  More than Sensory

Neuropsychological Findings

- Fists Pen, Severe Dysgraphia (Writing Over Letters, Shaky Lines)
- Poor Motor Sequencing, Weak Fine, Gross, Postural
- Postural Weakness Affects Writing, Prefers to Stand
- Generally Good Task Persistence
- Sensory Seeking with Seat Work
  Not ADD

Auditory Tasks

- Strong Auditory Attention with Little Background Noise
- Good Complex Sentence and Listening Comprehension
- Good Phonology
- Impaired Multi-Tasking... Listening, Seeing, Writing

Visual Tasks

- Intact Visual Vigilance, But Increased Time
- Impaired Direct Copying, Better with Air Writing

Copy Diamond

First Try
Second Try
Better with Air Writing
Proprio > Visuomotor Cerebellar
**Case 2**

**Visual Tasks**

- Impaired Visual Planning Gestalt Weakness

Make a Floor Plan for a Pizza Parlor

**Other Specialists**

Audiologist:
- Figure: Ground – 2 %tile
- Filtered Words – 25 %
- Competing Words – 50 %
- Masking 0 dB (normal > 5.5 dB)

Sustained Auditory Attention Quiet: 100%
Sustained Auditory Attention Background Noise: 45%

**Case 2**

**Decision-Making**

Cerebellar Injury at Birth

- Poor Coordination & Decreased Motor Exploration
- Strengthen to Improve Protective Reflexes, Trunk Stability, Writing
- Cerebellar Regulation of Emotions
- Poor Eye-Hand Control & Visual Planning
- Auditory Issues – Only Certain Environments

**The Plan**

- Postural, Gross, Fine Motor Strengthening
- Visual-Motor Coordination
- Visual Organization
- Sensory & Emotional Regulation
- Environmental Teaching & Modifications
- FM Headset as Needed
- Auditory & Language Practice
- Verbal Organization Strategies

**Occupational Therapy Assessment**

<table>
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<tr>
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<td><strong>Grip:</strong> 6#, 5.5#</td>
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<tr>
<td>Three-Jaw Chuck 4#, 3#</td>
<td>(5-13)</td>
</tr>
<tr>
<td>Key Pinch 3#, 2#</td>
<td>(7-16, 4-15)</td>
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**Writing**

Before OT

After OT

Improved Exploratory & Social Motor Play, Climbing
Encourage More Hands-on Work and Building
Use Verbal & Spatial Strategies to Improve Visual Organization

Conclusions

• Very Exciting Time for OT & Neuro Rehab
• Therapy Has Powerful Effects on Reshaping Brain Pathways
• More Than Ever, Physicians & OTs Should Be Sharing Information and Observations

Common Codes:
- Encephalopathy 348.30
- Incoordination 781.3
- Apraxia 784.60
- Hemiparesis 342.90
- Speech Disturbance 784.5
- Ataxic Gait 784.2
- Visual Problems 368.6
- Anxiety due to Medical Auditory Discrimination 388.43 293.84

Conclusions

• Sensory Processing Behaviors are the Tip of an Iceberg
• Tremendous Opportunities to help Children “Rewire”
• OTs Profoundly Affect the Course of Children’s Lives