Sensory Processing and Autism

Evidence, Research, Future Directions

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PLEASE DO NOT REPRODUCE ANY MATERIALS
What we Know

- Autism is prevalent – one in 88 (CDC 2012)
- Found throughout the world in all racial, ethnic and social backgrounds
- 4 times more common in males
- Individual’s with autism have **participation** challenges (self care, transitions, learning, social interactions): **Occupational Therapy facilitates participation in daily activities.**
- Individuals with autism have difficulty processing and integrating sensory information
Sensory Symptoms in ASD


N = 60
Schaaf & Benevides, 2012
Information (Sensory) Processing Difficulty

- People with autism process and respond to sensory stimuli in a much different way
- “There is an obstruction between the senses and the mind, or put somewhat differently, the door to the outside (sensory) world is blocked…incoming information may be incomplete or distorted” (Bryson, SE, 2005 in the Neurobiology of Autism, 2nd ed, p 35)
Sensory Symptoms are More Prominent in Autism

• Review of 48 empirical papers and 27 theoretical or concept papers suggests that sensory symptoms are more prominent in children with autism BUT there is not good evidence to suggest that they differentiate children with autism from other clinical groups (fXs, DD).

Exact Nature of the problem is Unclear

- While there seems to be an abundance of literature supporting the existence of sensory processing abnormalities in children with autism, it is difficult to pinpoint the exact areas of difficulty because of significant individual variability and lack of objective measures.
Generate Evidence
Use Evidence
Publish Evidence
Evidence Based Interventions

- Must be clearly described
- Have evidence about outcomes
- Have adequate power
- Be replicable
- Measure Fidelity


**Development of a fidelity measure for research on the effectiveness of the Ayres Sensory Integration intervention.**


**OBJECTIVE:** We developed a reliable and valid fidelity measure for use in research on Ayres Sensory Integration (ASI) intervention.

**METHOD:** We designed a fidelity instrument to measure structural and process aspects of ASI intervention. Because scoring of process involves subjectivity, we conducted a series of reliability and validity studies on the process section. Raters were trained to score therapist strategies observed in video recordings of adult-child dyads. We examined content validity through expert ratings.

**RESULTS:** Reliability of the process section was strong for total fidelity score (ICC = .99, Cronbach's alpha = .99) and acceptable for most items. Total score significantly differentiated ASI from four alternative interventions. Expert ratings indicated strong agreement that items in the structural and process sections represent ASI intervention. **CONCLUSION:** The Ayres Sensory Integration Fidelity Measure has strong content validity. The process section is reliable and valid when scored by trained raters with expertise in ASI.
OT/SI: Seven studies

- **Three are group comparison designs** (Pffiefer, 2011; Fazlioglu & Baran, 2008; Ayres & Tickle, 1980)

- **Three are single subject designs** (Case-Smith & Bryan, 1999; Linderman & Steward, 1999; Watling & Dietz, 2007)

- One is a **case study** (Schaaf & Nightlinger, 2007).

- Collectively, they report that individuals with ASD who receive OT/SI demonstrated gains in play, individualized goals, and social interaction; and a decrease in sensory symptoms.

- **Caution**: small sample sizes, failure to adequately characterize the sample, lack of a detailed, replicable intervention protocol with a fidelity measure, and other methodological and design flaws.

Schaaf, 2010 in Reichow, B., ….Volkmar, F – Evidence Based Practices in ASD
Small trial to examine sensitive outcome measures for larger RCT

• Children in both group made gains in individual goal attainment scales
  – Tx > Control.

• N= 37; 20 Tx, 17 control

• Fidelity measured

• significant decrease in autistic mannerisms in TX group.
Sensory-Based Interventions

• Distinguished from OT/SI
• They utilize specific sensory stimulation of one sensory system rather than the integrated approach that is consistent with OT/SI
• 4 categories:
  – Interventions that utilize touch (i.e., massage or touch therapy): promising
  – Therapy balls as seating devices: promising
  – Interventions that utilize weighted vests: unconvincing
  – Auditory interventions: unconvincing
  – Sensory diet: unconvincing
  – Brushing Protocol: unconvincing
We Need to Generate Evidence!

• Progress made
  – Studies of OT/SI and sensory-based interventions
  – ASI Fidelity Measure (Parham, et al 2001; 2011)
  – Evidence Reviews (AJOT; Reichow….Volkmar Book 2011)
  – Subtype studies: Miller, et al; Davies, 2010)
  – Physiological studies

• Each of you can participate – we need more
  – 1. Be systematic in your approach
  – 2. Use systematic clinical reasoning based on theory
  – 3. Articulate hypothesis
    • Identify participation limitations
    • Obtain a history to guide systematic assessment
    • Assess, assess, assess
    • Use theory to generate hypothesis and underlying mechanisms
    • Identify outcomes
  – 4. Test Hypotheses by charting outcomes
  – 5. Publish, publish, publish
Be Systematic!

- Devlin, et al 2010 – JADD
- Comparison of the effects of sensory integration and behavioral intervention for addressing problem behaviors
- N = 4 boys with challenging behaviors
- Conclusion: behavioral interventions effective in reducing problem behaviors but SI was not.
  - SI: 15 minute access to equipment provided during school day for approx. 6 times/day
Analysis (Schaaf & Blanche)

• “Sensory Integration Therapy”
  – not an accurate representation of the sensory integrative approach (OT/SI)
  – Did not use ASI Fidelity Measure

• Failure to conduct a systematic assessment to guide intervention

• Inaccurate use of literature
  – Does not include contemporary or classic literature

• Brings up important limitations of OT/SI
Systematic Data Driven Intervention

• Guides practitioners reasoning
• Create seamless links from:
  • Assessment to hypothesis generation
  • From Hypothesis to Intervention
  • From Intervention to outcome measures

(Sugari, Lewis-Palmer, Hagan-Burke, 2001; Blanche, 2006; Frolek-Clark, 2010; Benevides, personal conversation)
Data Driven Intervention Process (Schaaf, 2011)

Schaaf, RC & Blanche, EI. (2012). Emerging as Leaders in Autism through Data Driven Intervention. AJOT
Based on work by Sugari, McEwen, Blanche (2006) and conversation with Benevides (2010)
Generate Hypothesis
(Sugari, Lewis-Palmer & Hagan-Burke, 2001; Blanche, 2006)

A summary statement that links assessment findings to participation restrictions:

1. Identify participation challenge
2. Define factors contributing

Child is not able to sleep for more than 90 minutes at a time. Gets up and wanders around house. Based on assessment findings, poor arousal regulation related to hyper-sensitivity to stimuli are impacting ability to sleep.
Utilize Systematic Intervention

• Theory driven
• Evidence based
• Manuals or protocol that can be replicated
• Describe your intervention so it can be replicated
Measure Outcomes

• Proximal: close to the proposed factors contributing to partic challenge
• Distal: Measures of participation or goal attainment
• Examples
  • **Proximal**: Decrease in hyper-responsivity (SEQ)
  • Improved Arousal Regulation (PDDBI)
  • **Distal**: Improved ability to sleep through the night (GAS; PDDBI; chart # of hours slept)
Chart your Outcomes

- Create graphs and charts to display your outcome data
- Use Goal Attainment Scaling
- Pre-Post Assessments (SIPT, PDDBI, PEDI, Vineland)

Case Report: Improving Handwriting with Social Stories for Student with ASD
(Perhac, J., Just, C., & Schaaf, R.C)
PDDBI-PX Approach/Withdrawal Problems
Lower Scores = Better Performance

![Graph showing scores for various domains over pretest and post-test periods.](image-url)
Autism Speaks
(Schaaf, Benevides, Kelly, Freeman, Hunt, VanHooydonk, Faller, Neuwirth, Mailloux, )

• Does a manualized protocol of occupational therapy using sensory integration principles improve adaptive behaviors; participation in activities for children with Autism Spectrum Disorders?
Example of Data Driven Intervention

The Efficacy of Occupational Therapy using Sensory Integration Principles for Children with Autism

Roseann Schaaf, PhD, OTR/L, FAOTA
Teal Benevides, MS, OTR/L
Thomas Jefferson University, Phila, PA
Patricia Faller, MS, OTR/L, Joanne Hunt, OTR/L, Elke van Hooydonk, OTR/L – Children’s Rehabilitation Hospital, Tom’s River NJ
Zoe Mailloux, OTD
One of first RCT of OT/SI

- Funded by the Autism Speaks Foundation
- Inclusion Criteria
  - 4-8 years of age
  - Diagnosed with ASD using ADOS and ADI-R
  - Non-Verbal IQ >70
  - No other co-morbid genetic or developmental conditions (i.e. Fragile X, CP)
  - Demonstrate difficulty processing and integrating sensory information as measured by the SP or the SIPT
Design & Methods

**Referral & Screening**
- Children who do not meet inclusion criteria excluded

**Phenotypic Evaluation for Eligibility**
- ADOS, ADIR, IQ, SSP, SIPT

**Informed Consent**

**Pre-Test Assessments**

**Analysis of Assessment Data**
- Goal writing with Parent: GAS

**Randomization**
- Experimental Group OT/SI: 3 - 1 hr. sessions/week for 10 weeks = 30 sessions
- Control Group: Usual Care, 10 weeks

**Post Test**
- SIPT, SEQ, Vineland, PEDI, QOL, PDDBI
- Post GAScale Interview

**Vineland- II**
- PEDI, PDDBI
- WHO-QOL
- SEQ

**Data Driven Intervention Table**
- Hypothesis generation

**Phase 1 n = 10**

**Phase 2 n = 30**

**Total n = 40**
Assessment Data

• History and occupational profile
• Evaluations and Assessments
  • Sensory processing and praxis
    Sensory Integration and Praxis Test (SIPT): PRAXIS
    Sensory Profile
    Sensory Experiences Questionnaire (SEQ)
  • Adaptive behavior and participation
    Vineland Adaptive Behavior Scales (Vineland-II)
    Pediatric Evaluation of Disability Inventory (PEDI)
    Pervasive Developmental Disorder Behavior Inventory (PDDBI)
Intervention Delivery

• Active, individually-tailored sensory motor activities designed to address underlying factors affecting participation.
• 10 weeks 3X/weeks
• Follows manualized protocol
• Fidelity is tested with validated measure (Parham, et al 2010)
Intervention Manual Authors
Draft 3 - November, 2010

- Roseann C. Schaaf, PhD., OTR/L, FAOTA
- Erna Blanche, PhD., OTR/L, FAOTA
- Zoe Mailloux, MS, OTR/L, FAOTA
And the Sensory Integration Research Collaborative
- Janice P. Burke, PhD., OTR/L, FAOTA
- Ellen Cohn, PhD., OTR/L, FAOTA
- Shelly Lane, PhD., OTR/L, FAOTA
- Jane Koomar, PhD., OTR/L, FAOTA
- Teresa May-Benson, ScD, OTR/L, FAOTA
- Lucy Jane Miller, PhD., OTR/L, FAOTA
- Diane Parham, PhD., OTR/L, FAOTA
- Stacey Reynolds, PhD., OTR/L
- Sarah Shoen, PhD., OTR/L
- Teal Benevides, MS, OTR/L
- Susanne Smith Roley, MS, OTR/L, FAOTA
Intervention – Based on Core Elements of Sensory Integration Intervention (Ayres, 1972, 1979; 1989; Parham and Mailloux, 2001; Schaaf, Schoen, Lane, et al, 2010).

– Ensure physical safety
– Present sensory opportunities
– Facilitate child’s self-regulation of arousal level, attention and emotion
– Challenge postural, ocular and bilateral motor development
– Promote praxis and organization of behavior
– Tailor activities to provide the just-right-challenge
– Collaborate with the child on activity choices
– Ensure success
– Create a context of play
– Foster a therapeutic alliance with the child
<table>
<thead>
<tr>
<th>MODULE 1: Developing the therapeutic Alliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODULE 2: Addressing Sensory Responsivity to Decrease Problem Behaviors</td>
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<tr>
<td>MODULE 3: Developing Sensory Perception and Discrimination</td>
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<td>MODULE 4: Developing Praxis: The Somatomotor Adaptive Response</td>
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<tr>
<td>MODULE 5: Developing Self Initiation &amp; Purposeful Play</td>
</tr>
<tr>
<td>MODULE 6: Educating the Family</td>
</tr>
</tbody>
</table>
Sample Concept Map
(Adapted from Blanche, 2009)

Adequate sensory modulation?

No

Are there identifiable sensory triggers?

Level of arousal is high

Provide inhibitory, or modulatory sensory motor activities (see Table 1)

Level of arousal is low

Provide facilitatory sensory motor activities (see Table 1)

Yes

See other modules in manual

Monitor changes in behavior/outcomes

Provide inhibitory, or modulatory sensory motor activities (see Table 1)
Findings

Phase 1 Feasibility
Phase 2 - RCT
Feasibility Study
Schaaf, Benevides, Kelly, Mailloux - submitted

• Treatment is Safe
  – No reported injuries
• Treatment is Acceptable
  – Parents and Therapist rate positively
• Treatment is Feasible
  – Feasible for parents to attend 3X/week
  – Feasible for therapists to provide tx and obtain fidelity
• Fidelity
  – Therapists deliver intervention with good fidelity (M = 81).
RCT: Preliminary Results

- GAScale
- N = 20 (11 treatment; 9 control)
- T = -3.343; p = .045*
N = 15 (10 treatment; 6 control)
(lower score indicates better functioning).
SIPT scores Pre/Post

SIPT Scores

Subtest

Z score

-4 -3 -2 -1 0 1 2

Pre Post

Subtest
Case Report - DY

- 5 year 5 month old male with Dx of ASD
- Autism diagnosis ADOS 3 Module 3 Severity score of 7 out of possible 10
- Full Scale IQ of 106 on the Stanford Binet-5.
Physiological Evidence

Characterizing Sensory Behavior

Biomarker of Response to Intervention
“Spaceship Lab” Sensory Challenge Protocol

- Designed to be **fun** and non-threatening
- **Short**- child in “spaceship chair” for ~30 minutes
- **Non-invasive**: Measure influence of vagus nerve on heart rate and sweat responses
The Sensory Challenge Protocol

- Obtain Baseline data before and after (sitting in chair for 2 minutes)
- Eight contiguous trials in each of six sensory systems
  - olfactory (wintergreen oil)
  - auditory (siren and tones, prolonged tone)
  - visual (strobe light)
  - tactile (feather on face)
  - vestibular (chair tilted backwards)
Mindware

The maximum recording time is 600 seconds. Have the subject remain relaxed and answer a series of 'Yes', 'No', questions. After you have finished the above, click on 'Suspend'.
Sympathetic Measures: Electrodermal Activity (EDA) and Pre-ejection Period

- EDA - measures responsiveness to stimuli by changes in the skin.

**PEP**: time from depolarization of the heart to the time when blood enters the aorta. Greater sympathetic activation is indexed by shorter PEP (i.e. faster time to contraction) (Newlin & Levenson, 1979). PEP is measured using impedance cardiography, a non-invasive method of calculating blood flow resistance at the sino-atrial node over time.
Parasympathetic Measure: High Frequency Heart Rate Variability

Vagus nerve influence on heart rate variability
EDA in Children with Autism

(Miller, et al, 2001)

- Patterns

- Problems in Adaptive Behavior also noted

![Typical Reaction to Sensation](image1)

![Hyperreactivity to Sensation](image2)

![Under Reactive to Sensation](image3)
Children with Autistic Spectrum Disorder Compared to Children with Fragile X Syndrome

Miller et al., 2001
Children w/ AUT had Lower Parasympathetic Activity/HRV (Schaaf & Benevides, unpublished)

Difference in VT during SCP

Tones, $p = .023$

Tactile, $p = .029$
Differences between TYP and AUT on SSP (p<.001 for all domains; Schaaf & Benevides, unpublished)
Significant Differences between AUT vs. TYP groups on Adaptive Behavior

\[ p < .001 \text{ for all domains and ABC} \]
Higher SSP scores are significantly related to better Adaptive Behavior

Miller, et al; and Schaaf & Benevides, unpublished

n=19 (AUT=10, TYP= 9)  
($r=.571, p = .011$)
### Differences in Sensory Behaviors

<table>
<thead>
<tr>
<th></th>
<th>ASD</th>
<th></th>
<th>Typical</th>
<th></th>
<th>age-adj dif</th>
<th>p-value</th>
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<td></td>
<td>n</td>
<td>mean</td>
<td>sd</td>
<td>n</td>
<td>mean</td>
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<tr>
<td>Auditory Filtering</td>
<td>60</td>
<td>-2.9</td>
<td>1.5</td>
<td>28</td>
<td>0.4</td>
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<td>Low Energy</td>
<td>60</td>
<td>-2.4</td>
<td>2.4</td>
<td>28</td>
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<td>Movement Sensitivity</td>
<td>60</td>
<td>-1.5</td>
<td>6.5</td>
<td>28</td>
<td>0.3</td>
<td>0.4</td>
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<td>Tactile Sensitivity</td>
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<td>0.5</td>
<td>0.6</td>
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<td>Taste/Smell Sensitivity</td>
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<td>2.7</td>
<td>28</td>
<td>1.1</td>
<td>1.8</td>
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<tr>
<td>Underresponsive/Seeking</td>
<td>60</td>
<td>-3.0</td>
<td>2.0</td>
<td>28</td>
<td>0.9</td>
<td>1.3</td>
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<tr>
<td>Visual/Auditory Sensitivity</td>
<td>60</td>
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<td>1.5</td>
<td>28</td>
<td>1.0</td>
<td>0.7</td>
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<tr>
<td>Total Score</td>
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<td>1.4</td>
<td>28</td>
<td>0.8</td>
<td>0.8</td>
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</table>
HRV: ASD (n = 59) vs TYP (n = 20)

Typical vs. ASD
Differences in Severe Sensory Dysfunction Group vs TYP

Summary

- Children with autism have a different physiological response to sensory stimuli than typically developing children (tone and tactile are significantly different (lower).

- Suggests that children with ASD have poor regulation of reactivity that is related to autonomic nervous system dysregulation.
Autism: The Possibilities
Autism: The Possibilities
Autism: The Possibilities
To Emerge as Leaders we must train Advanced Practitioners who:

- Articulate our unique expertise
- Understand best practice in Autism
- Use a systematic, data-driven approach
- Publish
Thank You

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http://www.jefferson.edu/health_professions/occupational_therapy/programs/certificate_Autism.cfm
Advanced Practice Certificate in Autism at Thomas Jefferson University

- 12 credits/4 courses
- Can be applied toward OTD
- On-Line learning
- Contemporary issues in autism
- Course 1: Autism: The state of the Field
- Course 2: Best Practice Assessment
- Course 3: Evidence Based Intervention
- Course 4: Data Driven Intervention

http://www.jefferson.edu/health_professions/occupational_therapy/programs/certificate_Autism.cfm

http://www.jefferson.edu/jchp/jshp/ot/AutismCertificate.cfm
# Evidence for Sensory Based Interventions with ASD

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Key Authors</th>
<th>Limitations</th>
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<tbody>
<tr>
<td>Massage Touch Therapy</td>
<td>T. Field Silva</td>
<td>Emerging Variable intervention; no control group; no fidelity</td>
</tr>
<tr>
<td>WT Vests</td>
<td>Reichow, B Fertel-Daly, D Kane, A</td>
<td>Inconclusive No strong evidence</td>
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<tr>
<td>Auditory</td>
<td>Corbett Bettison</td>
<td>Inconclusive No strong evidence</td>
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## Evidence for Sensory Based Interventions

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<tr>
<th>Intervention</th>
<th>Authors</th>
<th>Evidence Grade</th>
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<tbody>
<tr>
<td>Brushing Therapy</td>
<td>Kimball, J</td>
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<td></td>
<td>Wilbarger, P</td>
<td>No subject descriptions</td>
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<td></td>
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<td>No report of statistical significance</td>
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<td>Therapy Balls</td>
<td>Deitz, J</td>
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