

**ACT's Focus on Research Conference 2023****Sensory Features and Anxiety in Autism: Implications for Families and Practitioners**

A two-day in-person and virtual conference hosted by ACT

Thursday, April 27, 2023

Friday, April 28, 2023

**Biobehavioral Approaches to Translational Research in Neurodevelopmental  
Conditions: A Spotlight on Sensory Differences in Autism**

*Presented by Tiffany Woynaroski, PhD, CCC-SLP*

**Territorial Acknowledgement**

As visitors on this land, ACT - Autism Community Training is grateful for the opportunity to work and learn on the ancestral and unceded territory of the Skwxwú7mesh (Squamish), xʷməθkʷəy̓əm (Musqueam) and səliłwətaʔt (Tsleil-Waututh) people who have lived in this area since before recorded time. These nations are hə́nqəmiṇəm and Skwxwú7mesh speaking peoples. The hə́nqəmiṇəm (Halkomelem) and Skwxwú7mesh (Squamish) languages are part of the Salish Language family, which dates back many millennia. We pay our respects to elders past, and to those present and emerging. As settlers to this land, we are committed to working towards reconciliation.

Simon Fraser University respectfully acknowledges the xʷməθkʷəy̓əm (Musqueam), Skwxwú7mesh Úxwumixw (Squamish), səliłwətaʔt (Tsleil-Waututh), q̓ícəy̓ (Katzie), kʷikʷəłəm (Kwikwetlem), Qayqayt, Kwantlen, Semiahmoo and Tsawwassen peoples on whose unceded traditional territories their three campuses reside.

**Event Schedule**

*All times are Pacific Daylight Time (PDT)*

Day 1 – Thursday, April 27, 2023

<b>8:15 am</b>	<b>–</b>	<b>9:00 am</b>	Registration / Log on with Zoom Link
<b>9:00 am</b>	<b>–</b>	<b>9:15 am</b>	Introduction by Michelle Schmidt
<b>9:15 am</b>	<b>–</b>	<b>10:15 am</b>	Keynote Presentation by Connor Kerns, PhD
<b>10:15 am</b>	<b>–</b>	<b>10:45 am</b>	Break
<b>10:45 am</b>	<b>–</b>	<b>12:00 pm</b>	Panel: Experiences with Anxiety
<b>12:00 pm</b>	<b>–</b>	<b>1:00 pm</b>	Lunch

<b>1:00 pm</b>	<b>–</b>	<b>3:10 pm</b>	Research Presentations
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Day 2 – Friday, April 28, 2023

<b>8:15 am</b>	<b>–</b>	<b>9:00 am</b>	Registration / Log on with Zoom Link
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<b>9:00 am</b>	<b>–</b>	<b>10:00 am</b>	Keynote Presentation: Tiffany Woynarski, PhD
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<b>10:00 am</b>	<b>–</b>	<b>10:30 am</b>	Break
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<b>10:30 am</b>	<b>–</b>	<b>11:45 am</b>	Panel: Early Development & Sensory
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<b>11:45 am</b>	<b>–</b>	<b>12:45 pm</b>	Lunch
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<b>12:45 pm</b>	<b>–</b>	<b>1:45 pm</b>	Future in Research
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### **Accessibility**

ACT is committed to preventing, as well as identifying and removing barriers facing people interacting with our organization. Moving forward, ACT will make every effort to provide real time captioning as well as American Sign Language (ASL) interpreters for all our events.

### **Acknowledgements**

We are grateful to Tiffany, who will be sharing research findings on the “cascading effects” framework – the theory that alterations in sensory responsiveness arise early in life and produce cascading effects on the development of higher-order skills conventionally associated with autism, such as language and communication ability. ACT offers a warm welcome to Tiffany for presenting her research program and recent findings.

Over the years, those who have attended ACT events know that as we are a small not-for-profit organization, we depend on community collaboration and support to sustain our work. We deeply appreciate the many autistic individuals, parents and caregivers, professionals, and organizations across British Columbia who volunteer their time, donate funds, provide sponsorship, and help spread the word – especially during these challenging times.

Thank you also, to Still Interpreting Inc. for providing ASL Interpretation and Accurate Realtime Inc. for providing communication access realtime translation (CART) services.

**ACT – Autism Community Training**

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[ACT's Autism & Intellectual Disability \(AID\) Search](#) – Keyword search over 2,000 records containing evidence-based, practical information resources in 36 languages sourced internationally, including B.C.-based community resources useful to families and community professionals.

[ACT in Chinese](#) and [ACT in Punjabi](#) – ACT has been able to both create and identify valuable resources for the Chinese-speaking and Punjabi-speaking communities in British Columbia.

[ACT's Autism Manual for B.C.](#) – A manual for parents and community professionals with 13 chapters, including New Diagnosis Process, Contracting with Professionals, B.C. Education System, Building a Community Group, and more!

[ACT's Event & Training Alerts](#) – Sign-up to keep in touch with our upcoming events and training opportunities.

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A series of black silhouettes on a light gray background showing the progression of human development. From left to right, it includes a fetus in a womb, a crawling baby, a toddler, a young child, a teenager, and two adult figures. Each silhouette is reflected on the surface below it.

# Biobehavioral Approaches to Translational Research in Neurodevelopmental Conditions

Tiffany Woynaroski, PhD, CCC-SLP  
Presented at ACT's Focus on Research Conference 2023  
April 28, 2023

## Outline

1

- My Background

2

- Overview of Research Program

3

- Spotlight on Recent Results

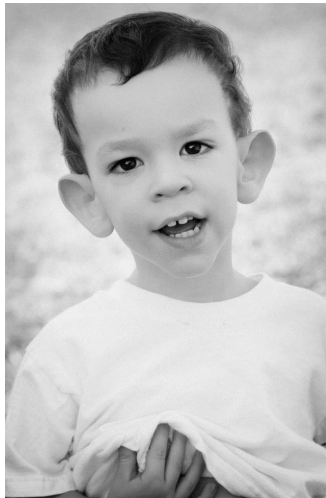
4

- Some Future Directions

5

- Questions





## Clinical Background

- My research is rooted in my clinical experiences with children with neurodevelopmental conditions and their families.



## Personal Experience

I am also the parent of a handsome and brilliant young man on the autism spectrum.



## Anecdotally...

- Children with neurodevelopmental conditions are highly heterogeneous, especially in social, communication, and language skill, and they respond quite differently to various supports and services.



## Empirically...

- Research suggests that supporting social, communication, and language development will optimize participation in daily life and long-term outcomes.



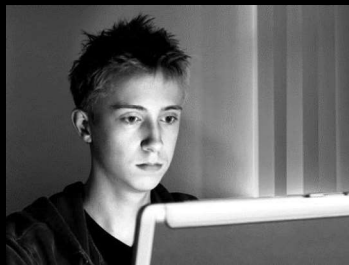
# My Present Position

- I now direct the Biobehavioral Approaches in NeuroDevelopment (BAND) laboratory at Vanderbilt University Medical Center.



## Our Approaches

- We employ biobehavioral approaches to (a) identify brain and behavioral factors that explain heterogeneity in profiles, (b) predict growth or response to intervention, and (c) identify mechanisms by which treatments work.

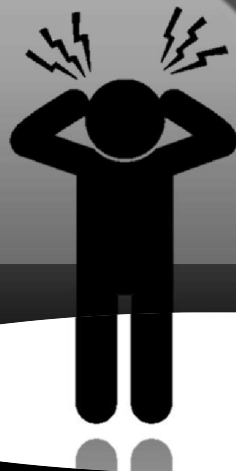


## Two Lines of Research



- One line of research is exploring novel ways of measuring “old” factors.
- The second is exploring relatively “new” biobehavioral factors.

## Differences in Sensory Responsiveness in Autism



# Acknowledgments



- This work has been carried out in collaboration with others at Vanderbilt, the University of North Carolina, Duke University, and University of Washington.

# Acknowledgments

This line of research has been supported by CTSA award No. KL2TR000446 (Woynaroski), the Vanderbilt Institute for Clinical and Translational Research Pilot Award from the National Center for Advancing Translational Sciences (PI: Hartmann), as well as NIH U54 HD083211 (Neul), NICHD R01 HD057284 (Stone), the Marino Autism Research Institute, the Wallace Foundation, the Simons Foundation Autism Research Initiative, Autism Science Foundation, NIDCD 1R01DC01376 (Yoder), NIDCD 1R21DC016144-01 and 1R01DC020186-01A1 (Woynaroski), and an IDRC Exchange Award to T. Woynaroski.

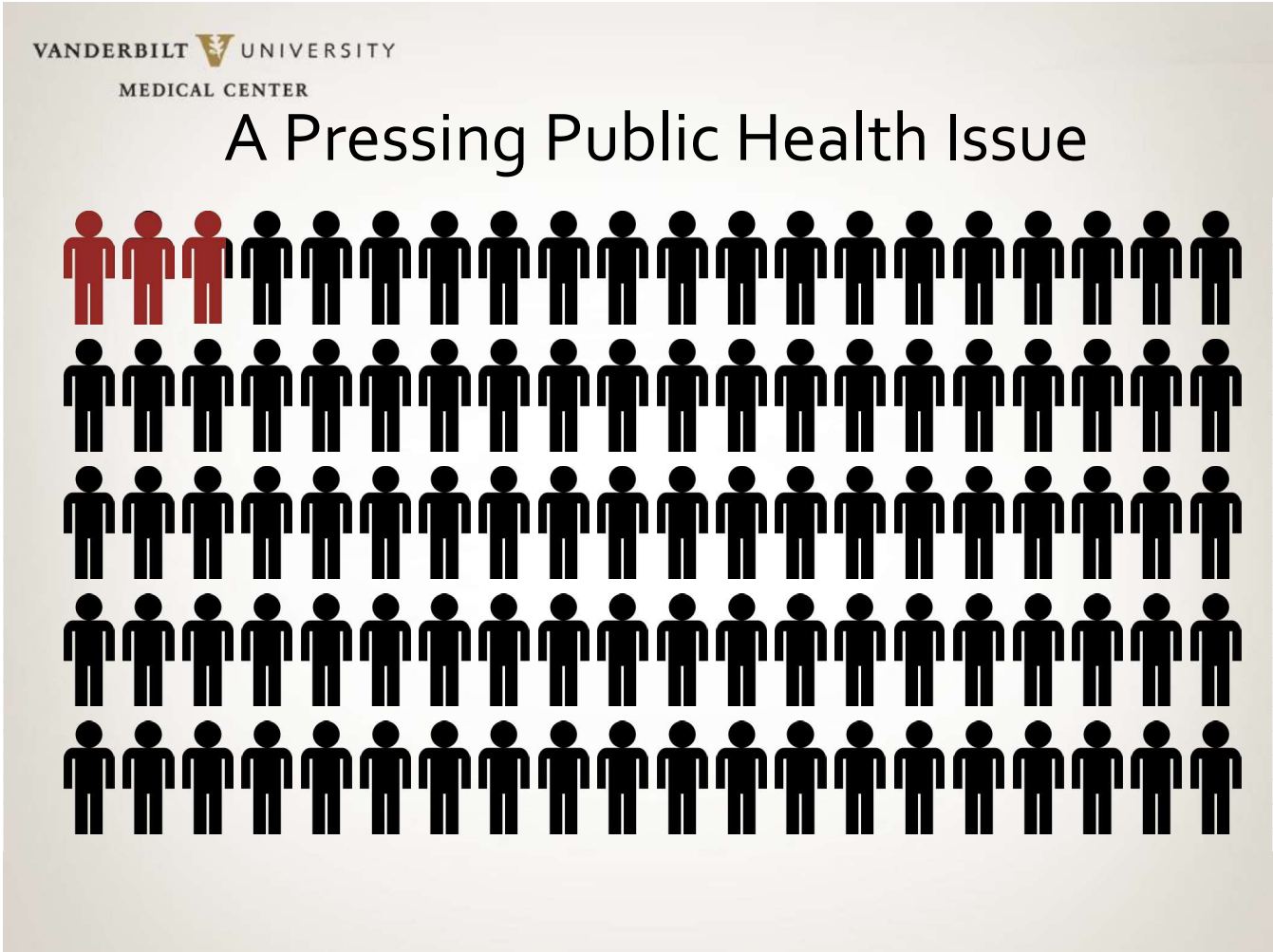
The contents of this talk are solely the responsibility of the author and do not necessarily represent the official views of the National Center for Advancing Translational Sciences, the National Institutes of Health, or any other funding agencies. The author declares no conflicting interests.

Caregivers provided consent to share photographic and electronic media for educational and/or training purposes.



- This research focuses on children with or at high likelihood for autism— a neurodevelopmental condition.

# Autism





## Core and Related Features

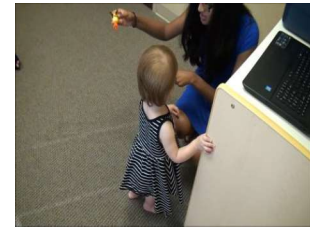


- Social communication differences have conventionally been considered the core characteristics of autism.
- Many autistic children also present with co-occurring language learning challenges.

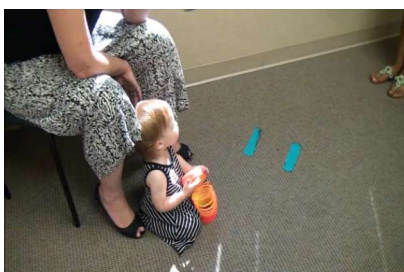
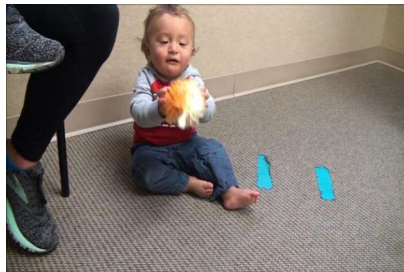


## Sensory Differences

- Autistic children also display differences in “sensory responsiveness” or behavioral patterns of responding to sensory stimuli.



“Typical” Sensory Responsiveness



“Typical” Sensory Responsiveness



# Hyperresponsiveness



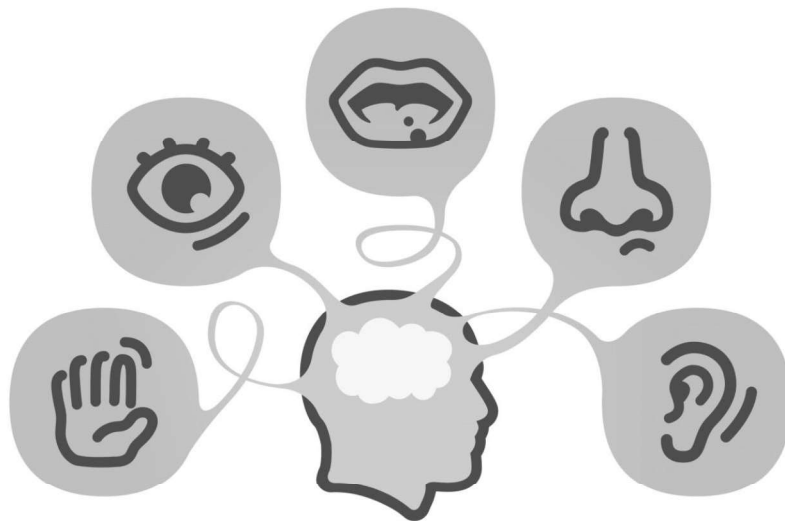
# Sensory Seeking



# Hyporesponsiveness



## Theory of Cascading Effects



- It has been proposed that early differences in sensory responsiveness arise from altered brain states and produce cascading effects on higher order skills.

# Empirical Support

# Empirical Support

As children age, development of adaptive skills is needed to perform daily life activities that become increasingly complex and demanding. Research indicates that children who exhibit unusual sensory responses to their environment (i.e., hypersensitiveness)



## Sensory Responsiveness in Older Children

- We examined differences in sensory responsiveness, and links with broader features, in school-age children and adolescents with autism.

Table 1. *Means and Standard Deviations of Selected Variables by Group*

	<b>AUT</b> <i>M (SD)</i>	<b>NON</b> <i>M (SD)</i>
Age (Years; Months)	12;8 (3;1)	12;8 (2;9)
Sex	37 male; 13 female	37 male; 13 female
Nonverbal IQ*	109 (16.91)	118.08 (12.62)

*Note.* Nonverbal IQ = Nonverbal intelligence as measured by the Leiter International Performance Scale-3 or the Test of Nonverbal Intelligence-4.

\*Denotes groups significantly differed,  $p < 0.01$ .

## Participants

- Participants were 50 school-age children and adolescents with autism and 50 typically developing (TD) controls matched on age and biological sex.



## Measures of Sensory Responsiveness

- Patterns of sensory responsiveness were measured via the Sensory Experiences Questionnaire (SEQ) and Sensory Profile (SP).

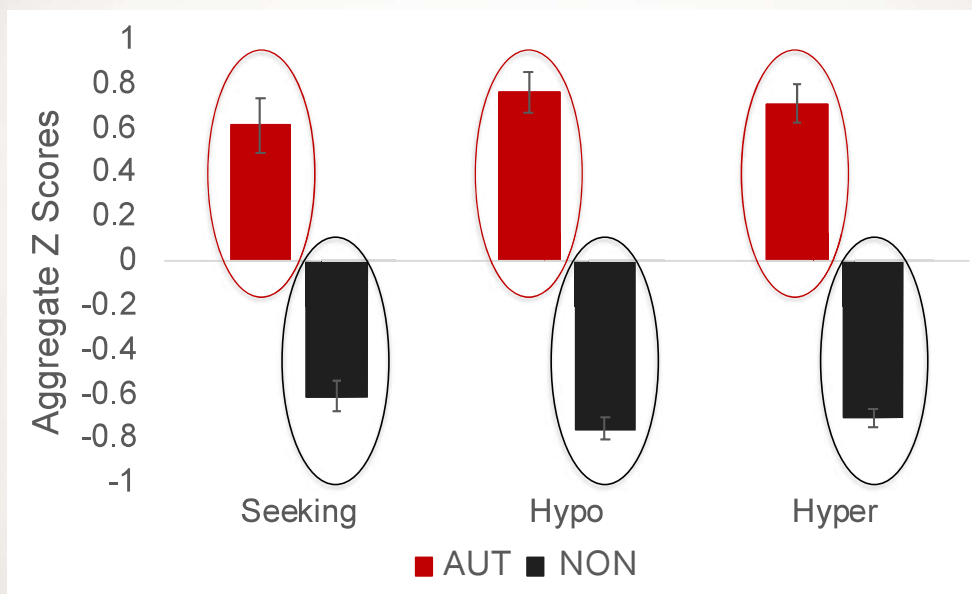


## Measures of Core and Related Symptoms

- Autism Diagnostic Observation Schedule-2
- Social Responsiveness Scale [SRS]
- Vineland Adaptive Behavior Scales [VABS]
- Behavior Assessment System for Children [BASC]
- Clinical Evaluation of Language Fundamentals [CELF]



## Between-Group Differences



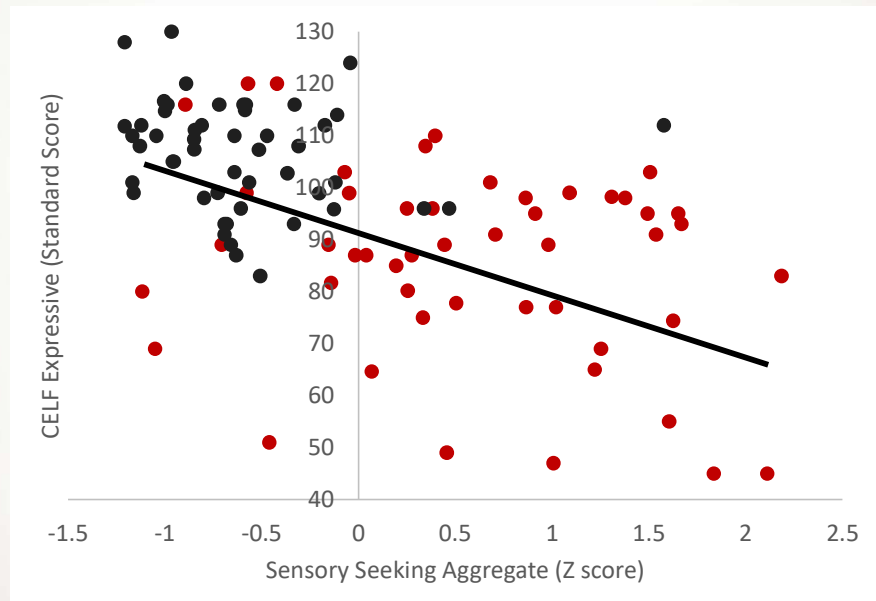
- Groups significantly differed in each pattern of sensory responsiveness, with large effect sizes ( $p$  values all  $< .001$ ;  $d$ s = 2.9, 2.9, and 1.7 for hyporesponsiveness, hyperresponsiveness, and sensory seeking).

## Correlations with Clinical Features

	Seeking	Hypo	Hyper
Age	-0.27*	-0.06	-0.03
NVIQ	-0.31*	-0.22	-0.25
CEL F Core Language SS	-0.49*** <sup>†</sup>	-0.49***	-0.39***
CEL F Receptive Language SS	-0.45***	-0.45***	-0.40***
CEL F Expressive Language SS	-0.46***	-0.48***	-0.43***
SRS RRB T score	0.74***	0.82***	0.82***
SRS SCI T score	0.69***	0.89***	0.87***
VABS Communication SS	-0.61***	-0.77***	-0.70***
VABS Activities of Daily Living SS	-0.48***	-0.68***	-0.64***
VABS Socialization SS	-0.64***	-0.85***	-0.81***
BASC Anxiety T score	0.38***	0.48***	0.58***
BASC Depression T score	0.56***	0.66***	0.63***
BASC Internalizing T score	0.47***	0.61***	0.65***
Seeking	1	0.68***	0.62***
Hypo	0.68***	1	0.82***
Hyper	0.62***	0.82***	1

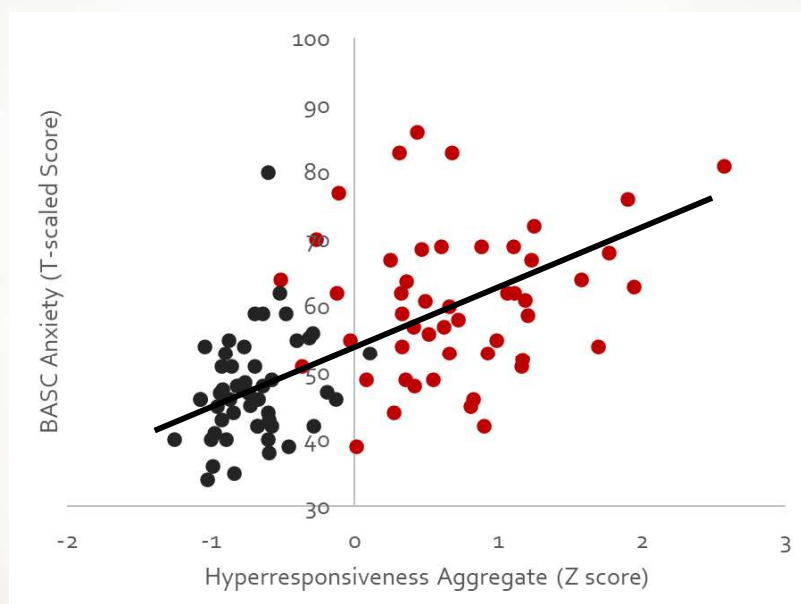
Note. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ . <sup>†</sup>Indicates moderation by group. Seeking = Sensory seeking, Hypo = Hyporesponsiveness, Hyper = Hyperresponsiveness, SS = Standard/scaled score, T score = T scaled score, SCI = Social communication index, RRB = Restricted repetitive interests and behaviors.

## Links with Language



- Sensory seeking was negatively associated with expressive language across diagnostic groups (zero-order correlation =  $-.46$ ).

## Associations with Anxiety



- Hyperresponsiveness was strongly associated with anxiety across diagnostic groups (zero-order correlation =  $.58$ ).

# Conclusions

- Findings show that differences in sensory responsiveness that are linked with broader features persist beyond early childhood.



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## Our Prospective Studies



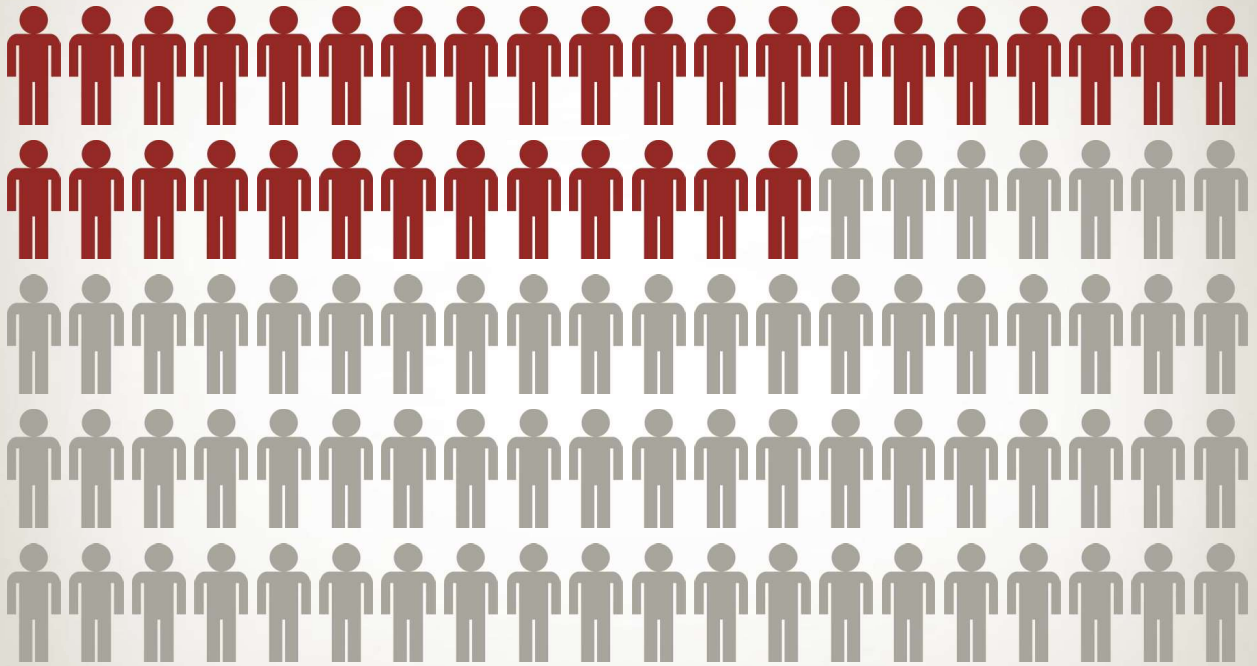
Early Sensory Responsiveness  
Early Brain States

Future Social, Communication,  
and Language Skill & Symptoms

- We have subsequently explored the extent to which early sensory responsiveness predicts future features in infant siblings of children with autism.

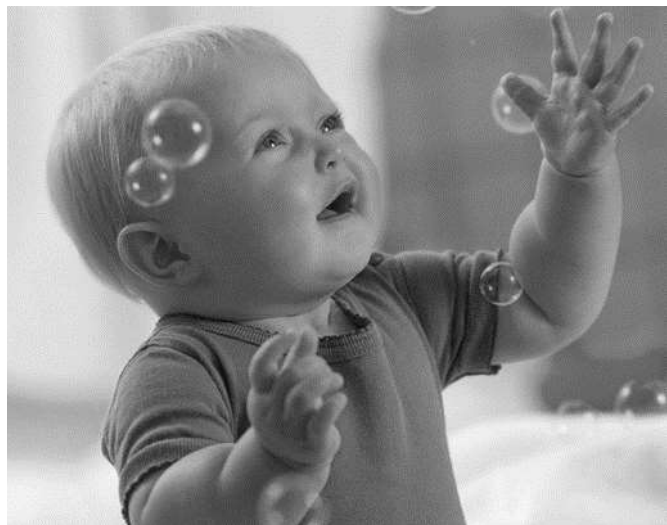


# A “High Likelihood” Population



## Early Sensory Seeking

- The results I will share today are from a study that explored the developmental sequelae and neurophysiological substrates of sensory seeking.





## Measure of Sensory Seeking

- At 18 months of age, we measured infants' sensory responsiveness using a standardized behavior sample called the Sensory Processing Assessment (SPA).



## Measure of Brain States

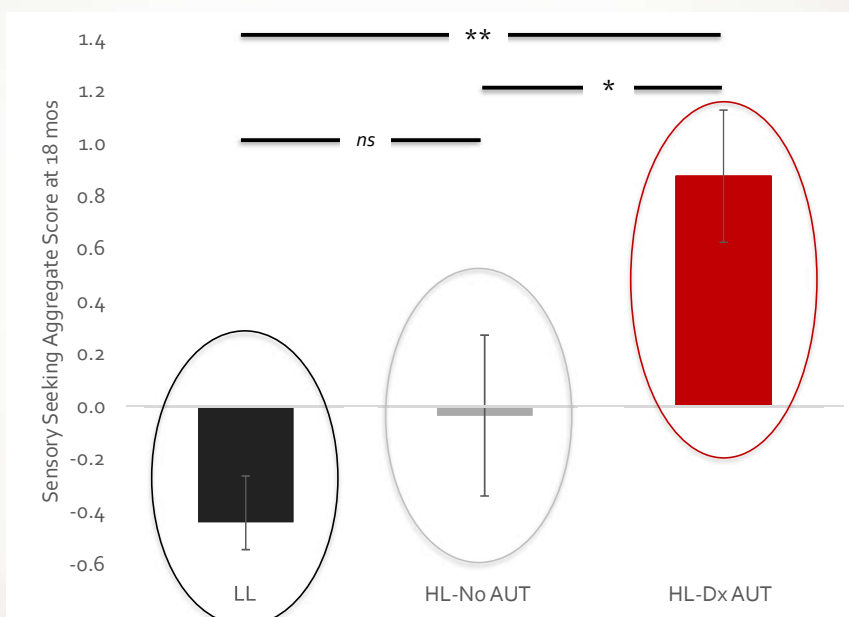
- At this same time point, we measured infants' brain states using "resting state" electroencephalography (EEG).

# Measure of Social Features



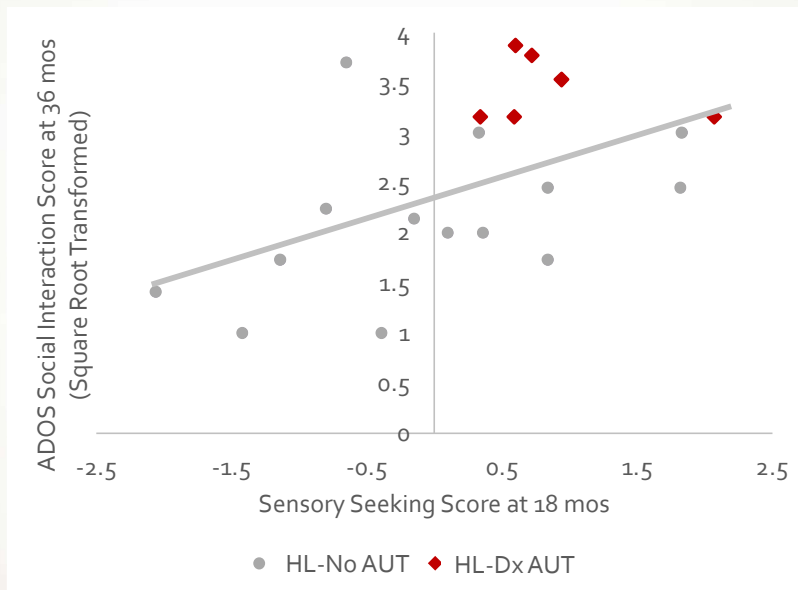
- We measured social features in the context of a comprehensive diagnostic evaluation when infants were 36 months old.

## Early Emergence



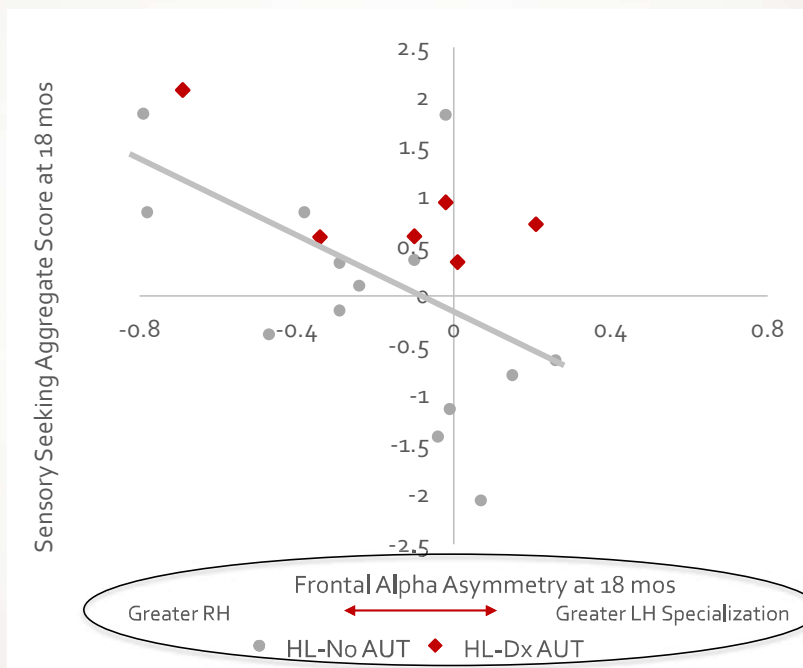
- Results suggest that differences in sensory responsiveness are early-emerging.

# Cascading Effects



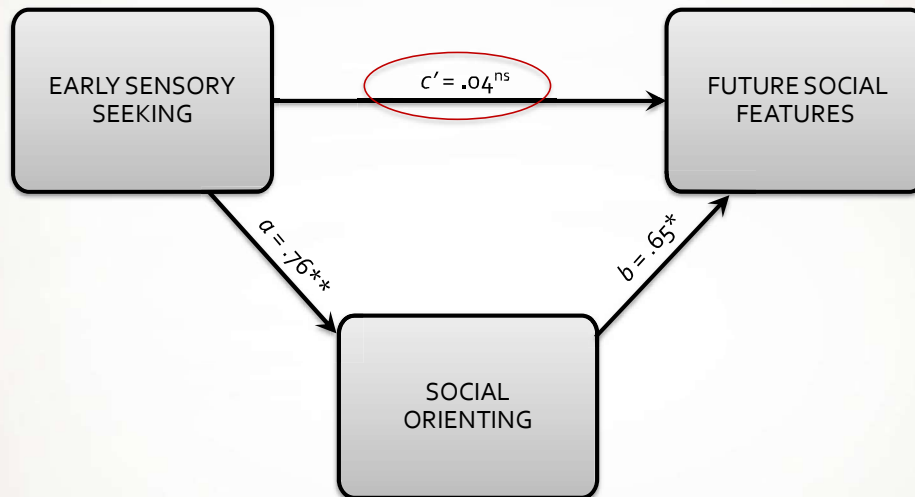
- Early differences in sensory responsiveness also appear useful for explaining individual differences or predicting features, at least in high likelihood infants.

# Neural Bases



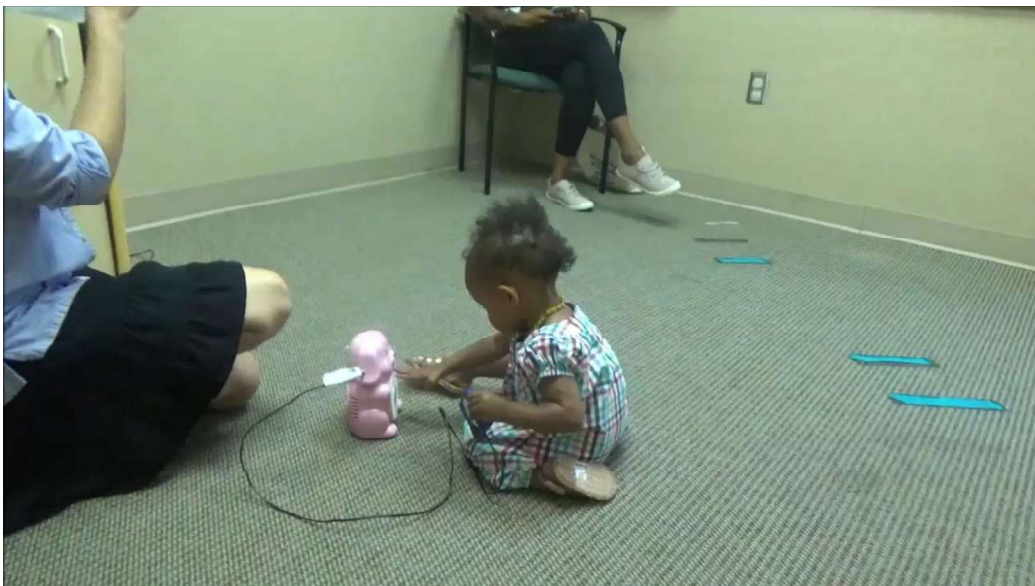
- Many differences in brain states covary with sensory responsiveness, at least in infants at high likelihood for autism.

# Mechanisms



- We are also now beginning to elucidate the mechanisms by which sensory differences are producing cascading effects in high risk populations.

## Seeking and Social Hyporesponsiveness







## Increasing Support

- Results provide added empirical support for the cascading effects theory in infants at elevated likelihood for autism.



## Potential for Translation

- These findings may facilitate early identification and guide us in the development of novel approaches to early intervention.



## Consideration of Interventions

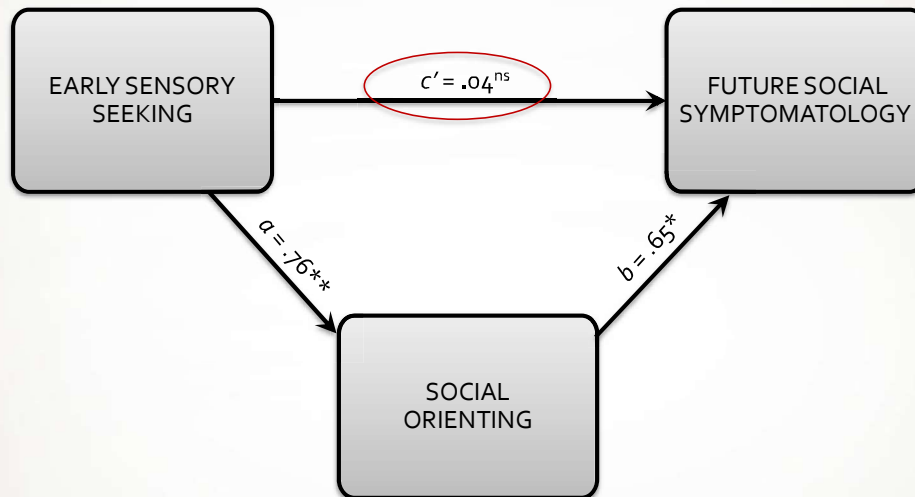
- With increasing empirical support for the theory of cascading effects, we began to ponder how to best intervene on early sensory differences in infants at high likelihood for a future diagnosis of autism.

## A Focus on Social Hyporesponsiveness



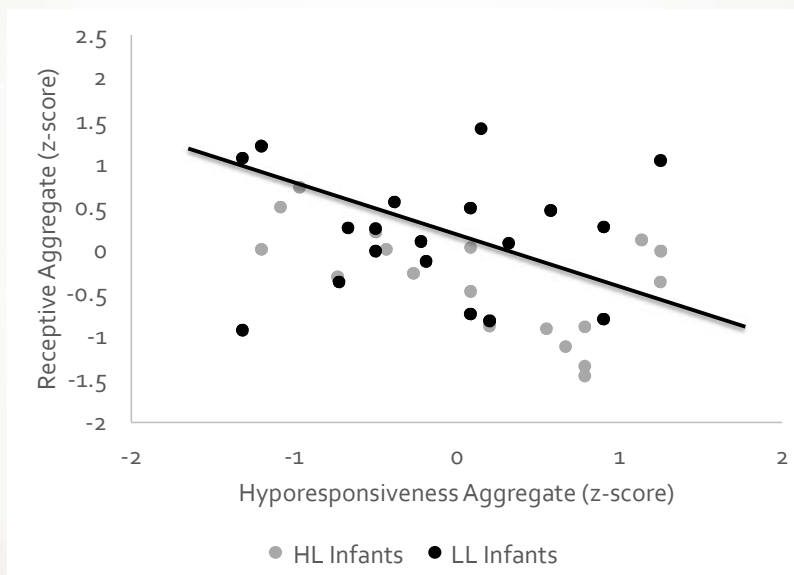
- We were focused, as a first step, on early social hyporesponsiveness, which refers to reduced responding to social bids.

# A Focus on Social Hyporesponsiveness



- Reduced/absent orienting to social stimuli in particular seemed to explain how or why other sensory features, like seeking, were producing cascading effects.

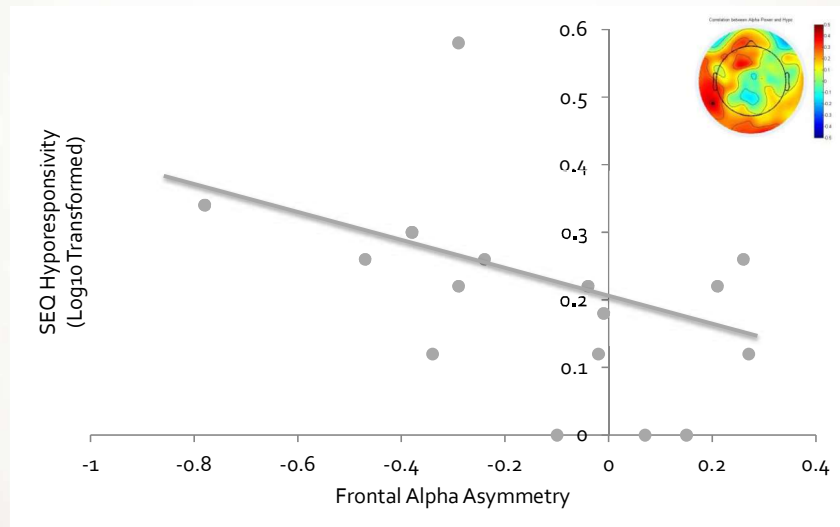
# Links with Communication



- In an independent sample of infants, we are seeing hyporesponsiveness predicts future social, communication, and spoken language skill.

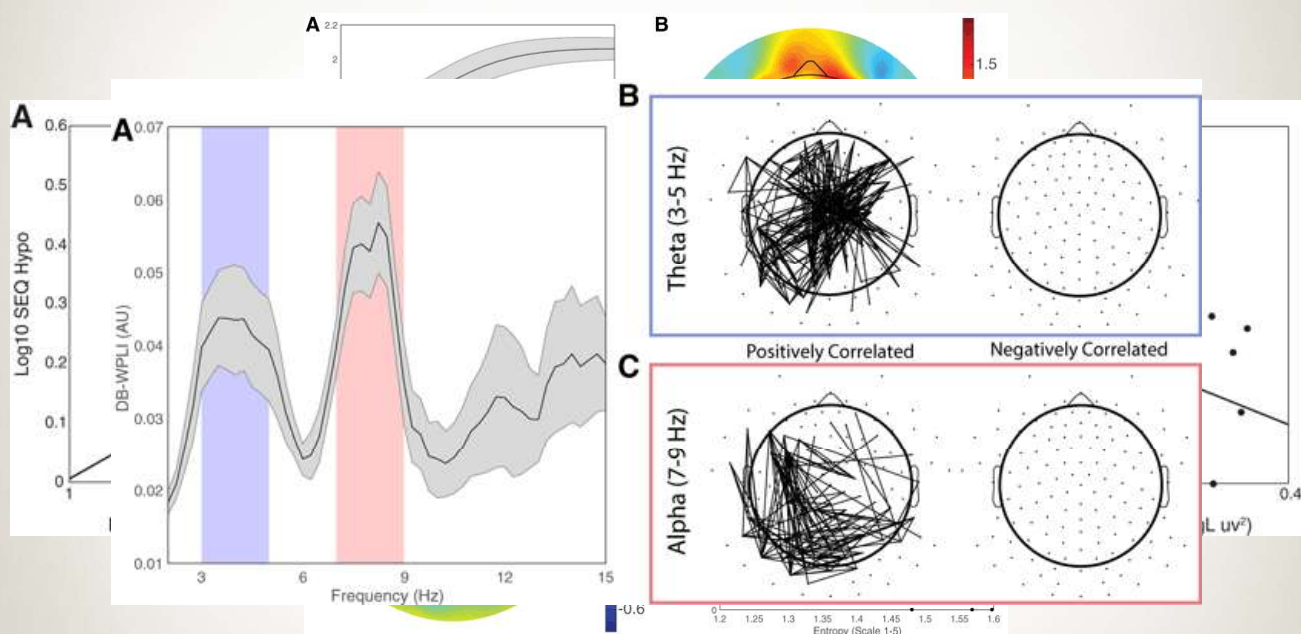


# Associations with Brain States



- In high likelihood infants, hyporesponsiveness is predicted by indices of resting brain state, such as hemispheric specialization indexed by frontal alpha asymmetry.

# Associations with Resting Brain States



- Hyporesponsiveness is also associated with broader differences in resting state oscillatory power, complexity, and connectivity in high likelihood infants.

"Practitioners and agencies serving children with ASD that endeavor, or are mandated, to use research-based, or scientifically-based, interventions should not use SIT outside of carefully controlled research."  
-Lang et al., 2012

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Sensory diet

#### ABSTRACT

Intervention studies involving the use of sensory integration therapy (SIT) have been identified and analyzed. Twenty-five studies were described in terms of (a) participant characteristics, (b) interventions used, (c) sensory, behavioral, and cognitive outcomes, (d) dependent variables, (e) intervention procedures, (f) study outcomes, and (g) certainty of evidence. Details of 3 of the reviewed studies that SIT was effective, 8 studies found mixed results, and 14 studies reported no effect on SIT. Many of the reviewed studies, including the 3 studies reporting positive results, had serious methodological flaws. Therefore, the current evidence does not support the use of SIT in the education and treatment of children with autism spectrum disorders (ASD). Practitioners and agencies serving children with ASD that endeavor to use research-based, or scientifically-based, interventions should be outside of carefully controlled research.

"There is inconclusive evidence supporting the efficacy of sensory-based treatments for children with disabilities...for a majority of [these children], sensory-based treatments are more likely to be ineffective than effective."  
-Barton et al., 2015

Children with autism spectrum disorders often exhibit co-occurring sensory processing problems and receive interventions that target self-regulation. In current practice, sensory interventions apply different theoretical constructs, focus on different goals, use a variety of sensory modalities, and involve markedly disparate procedures. Previous reviews examined the effects of sensory interventions without acknowledging these inconsistencies. This systematic review examined the research evidence (2000-2012) of two forms of sensory interventions, sensory integration therapy and sensory-based intervention for children with autism spectrum disorders and concurrent sensory processing problems.

Article  
A systematic review of sensory-based treatments for children with disabilities

Barton <sup>1,2</sup>, Brian Reichow <sup>3,4</sup>, Alana Schmitz <sup>5</sup>,  
Smith <sup>6,7</sup>, Daniel Sherlock <sup>8</sup>

<sup>1</sup>University of North Carolina, United States  
<sup>2</sup>University of North Carolina, United States  
<sup>3</sup>Yale Child Study Center, United States  
<sup>4</sup>University of Colorado Health Science Center, United States

## Limited Support for Existing Treatments



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### Project AIM: Autism Intervention Meta-Analysis for Studies of Young Children

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Boston College

Margaret Cassidy, Kacie Dunham,  
and Jacob I. Feldman  
Vanderbilt University

Jenna Crank and Susanne A. Albarran  
The University of Texas at Austin

Sweeya Raj  
Vanderbilt University

Prachy Mahbub  
Mount Holyoke College

Tiffany G. Woynaroski  
Vanderbilt University Medical Center

In this comprehensive systematic review and meta-analysis of group design studies of nonpharmacological early interventions designed for young children with autism spectrum disorder (ASD), we report summary effects across 7 early intervention types (behavioral, developmental, naturalistic developmental behavioral intervention [NDBI], TEACCH, sensory-based, animal-assisted, and technology-based), and 15 outcome categories indexing core and related ASD symptoms. A total of 1,615 effect sizes were gathered from 130

"Across all included studies, we found no evidence that *any* intervention type had the potential to influence sensory outcomes..."

meeting prespecified quality indicators. Finally, we conducted moderator analyses to evaluate whether summary effects across intervention types were larger for proximal as compared with distal effects, and for context-bound as compared with generalized effects. We found that when study quality indicators were not taken into account, significant positive effects were found for behavioral, developmental, and NDBI intervention



## Consideration of an NDBI

- We hypothesized that an NDBI called Improving Parents as Communication Teachers (ImPACT) may reduce social hyporesponsiveness and translate to more optimal social communication and language outcomes in high likelihood infants.

An  
Ongoing  
RCT



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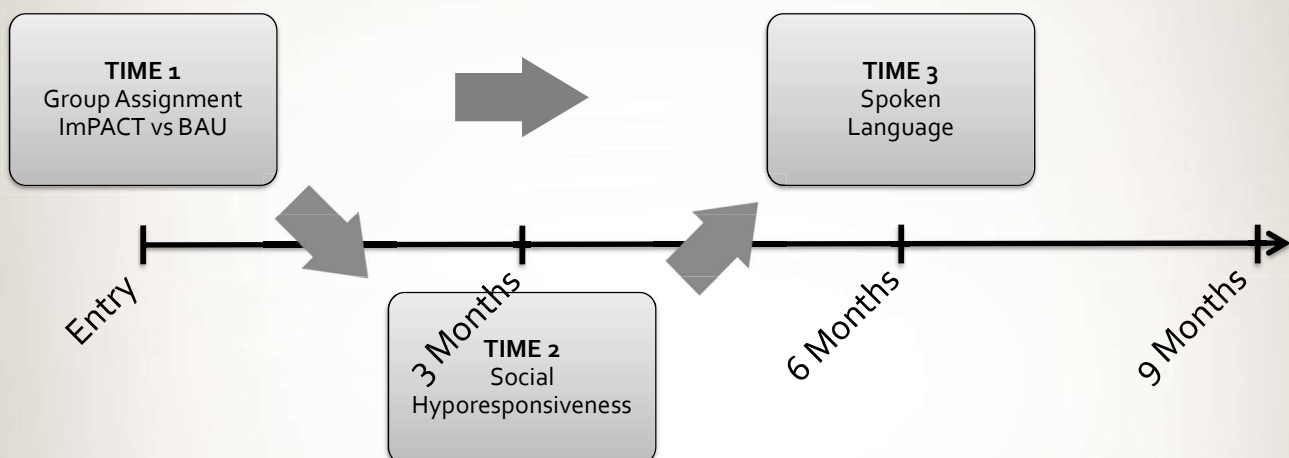
- We tested this hypothesis via a supplement to an RCT testing the efficacy of ImPACT for use with high likelihood infants at Vanderbilt.

## The Parent Project

- In the parent project, high likelihood infants were randomly assigned to receive ImPACT versus a business-as-usual control condition.
  - ImPACT delivery: 24 sessions over 3 months in the home setting



## Study Design



Infants were followed over a total of 9 months, with study visits occurring at study entry and subsequently at 3-month intervals.

	ImPACT Mean (SD)	BAU Mean (SD)
Chronological Age In Months	13.5 (1.8)	14.5 (2.1)
MSEL Early Learning Composite (IQ)	87.2 (17.5)	85.9 (16.7)
MSEL Visual Reception Age Equivalency	12.3 (2.3)	13.8 (2.7)
MSEL Expressive Age Equivalency	10.9 (3.2)	11.6 (3.5)
MSEL Receptive Age Equivalency	10.1 (3.0)	9.8 (2.7)
MSEL Mental Age <sup>†</sup>	11.6 (2.2)	12.7 (2.6)

*Note.* \*  $p < .05$ . <sup>†</sup> Score reflects average of visual reception, fine motor, expressive, and receptive age equivalency scores. MSEL = Mullen Scales of Early Learning. Age equivalency scores are reported in months.

## Participants

- Participants in this supplement were 39 12-18 month old high likelihood infants (17 m, 22 f) assigned to receive ImPACT versus the BAU control at Vanderbilt.

## Measure of Social Hyporesponsiveness

- Infants' social hyporesponsiveness was measured at Time 2 with a previously developed and validated parent report—the Sensory Experiences Questionnaire.







## Measures of Spoken Language

- Time 3 spoken language was measured via the Communication and Symbolic Behavior Scales (CSBS), the Brief Observation of Social Communication Change (BOSCC), and the MacArthur-Bates Communicative Development Inventories (MCDI).

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## Effect on Social Hyporesponsiveness

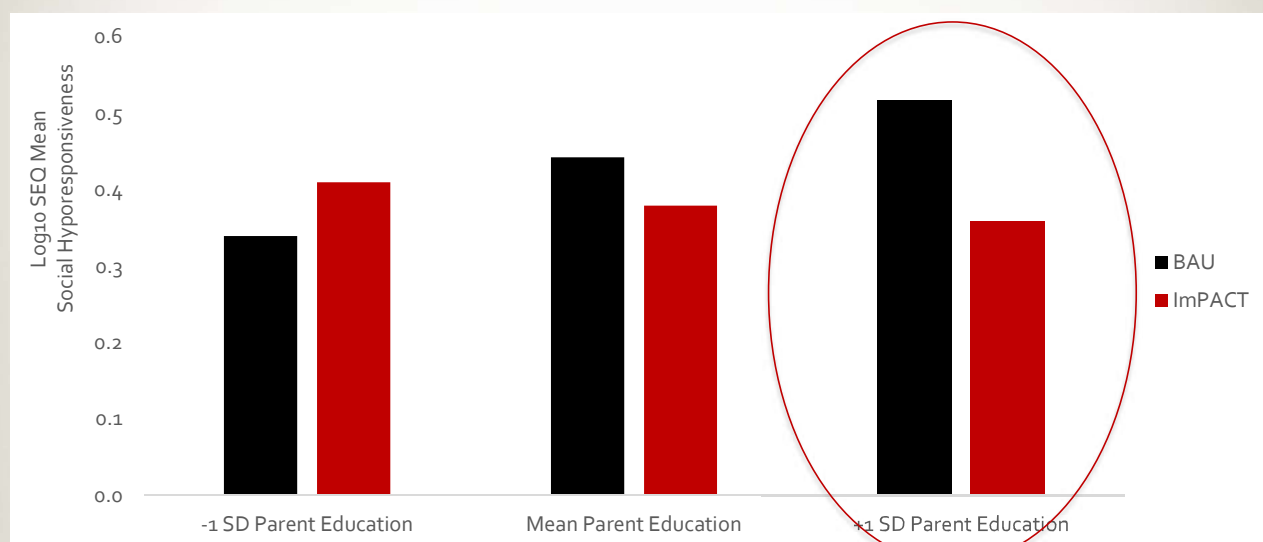
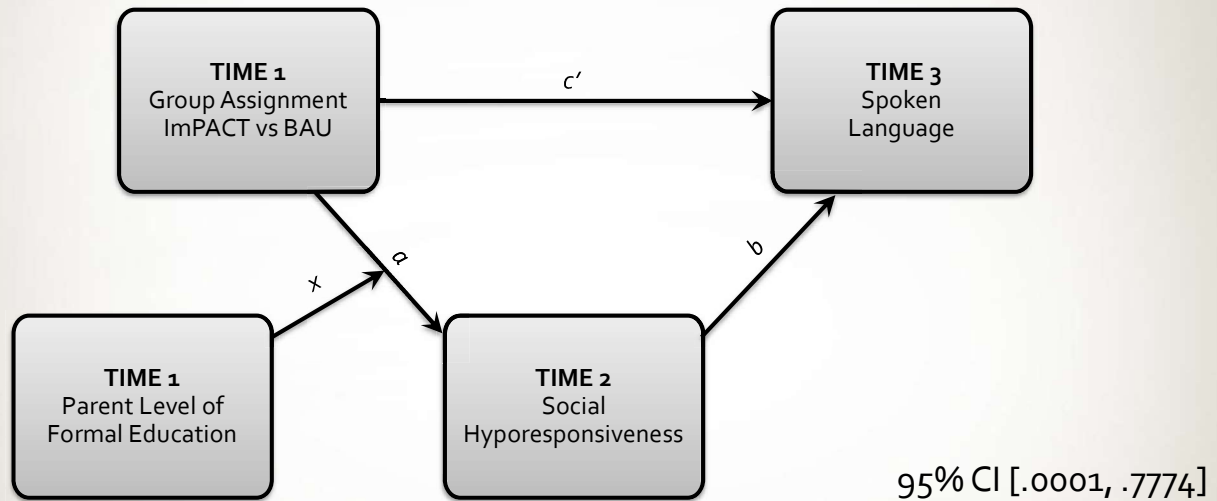


Figure 1. Effect of treatment group on social hyporesponsiveness according to parent level of formal education, using +/- 1 SD and mean on parent level of formal education (relative to study sample) to illustrate this conditional relation.

- ImPACT was superior to BAU for effects on Time 2 social hyporesponsiveness for infants with parents with more formal education ( $p$  value for parent education \* treatment group parameter in model testing moderated effect = .0015).

# Effects on Distal Language Skills



- The effect of ImPACT on Time 2 social hyporesponsiveness translated to more optimal Time 3 language outcomes for this subgroup of high likelihood infants.

## Business as Usual



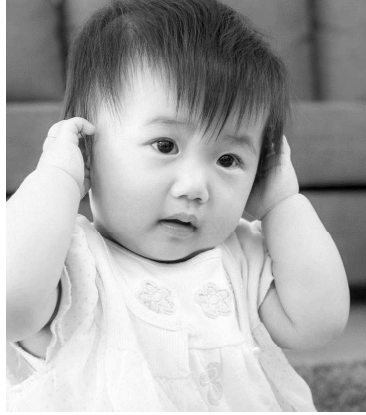
# ImPACT



## Preliminary Support for ImPACT

- This study suggests early intervention may impact sensory function and translate to more optimal spoken language outcomes in infants at high likelihood for autism.



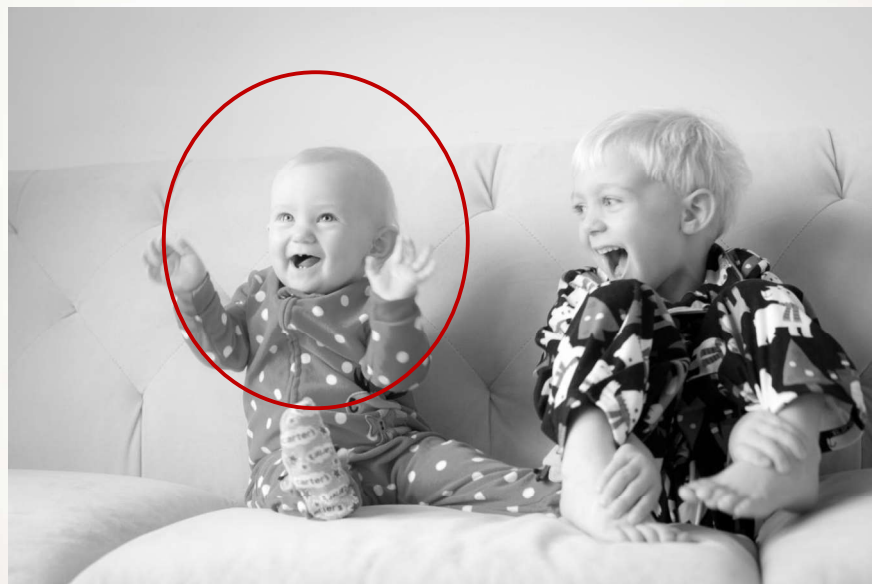


## Future Directions

- Systematic replication and extension is needed to determine whether the present results reproduce and extend to broader patterns of sensory responsiveness.

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## Future Directions



- Future studies should further evaluate whether the effects that we have observed here generalize beyond the group of infants at high *familial* likelihood for autism.



- I will be testing whether cascading effects are “autism specific” or reflect a more generalized mechanism impacting neurodevelopment.

## Future Directions



## Future Directions

- We are partnering with our local science center to collect normative data on sensory responsiveness via the Living Laboratory program.

# Future Directions

- We will continue characterizing sensory (and multisensory!) function in autistic persons and those at high likelihood for autism across the lifespan.



# Future Directions

- I also aim to elucidate the broader biological bases of sensory differences across autistic individuals.

**SPARK**   
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## Future Directions

- We will continue to work to ascertain how we might best intervene upon or accommodate (multi) sensory differences in persons on the spectrum.

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## Thanks!!

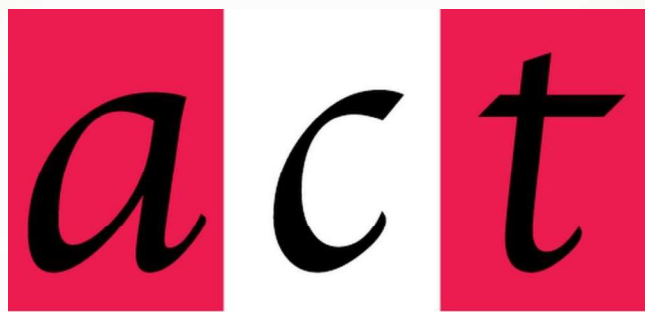




# Thanks!!

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# Thanks!!



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