



# Sensory Features in Autism Spectrum Disorders

Lauren Little, Ph.D., OTR/L

Frontiers: The Heartland Institute for Clinical and Translational  
Research for the Clinical and Translational Research Seminars

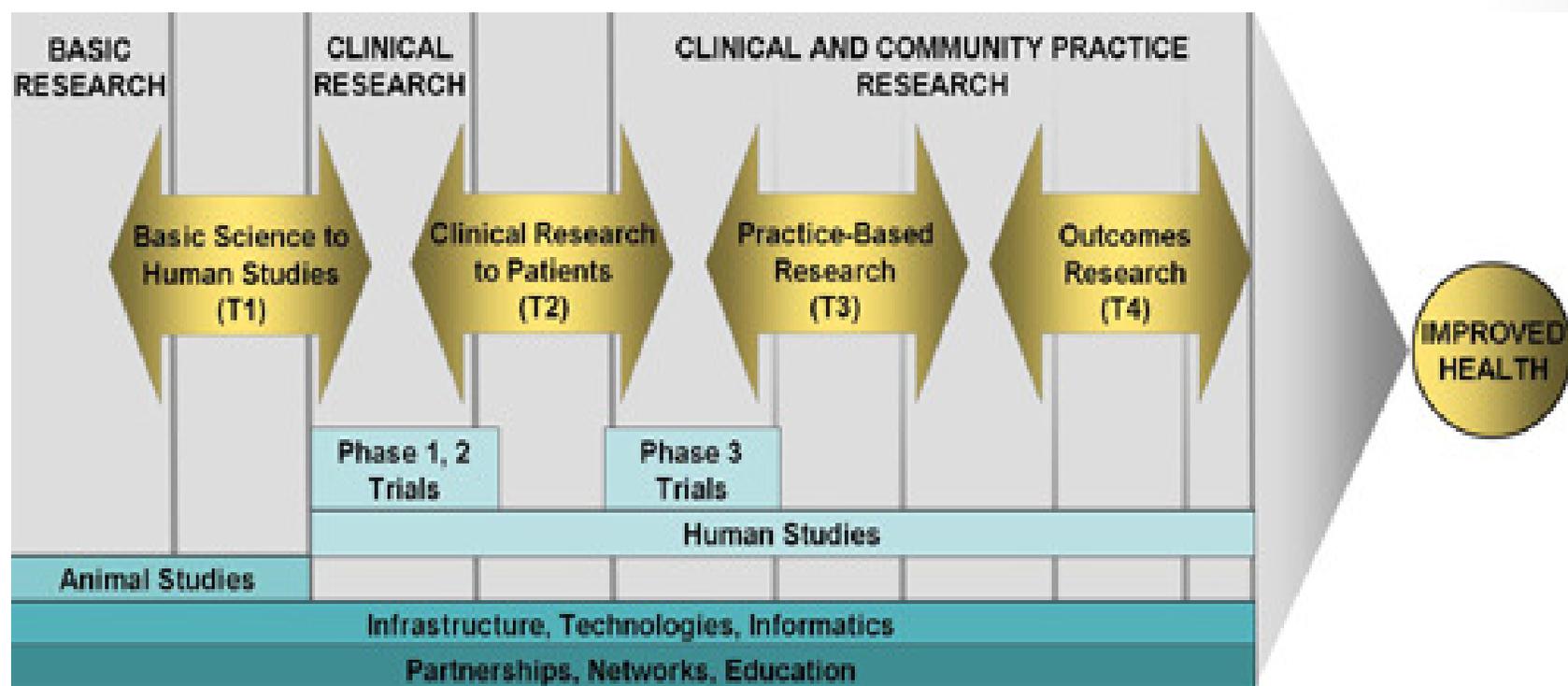
# Autism Spectrum Disorder: A Brief Overview

- 1 in 68 children (CDC, 2014)
- Two areas of impairment
  - Social Interaction & Communication
  - Restricted Interests & Repetitive Behaviors
- DSM-5 recently included sensory symptoms (i.e., hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of environment) as diagnostic features of ASD.



# Translational Research

## Bench to Bedside...to Community



Am J Bioethics. 2008;8(3): 58-60.

# Sensory Features

- Prevalence ~40% to >90% (Baranek et al., 2006; Kientz & Dunn, 1997; Kern et al., 2006; Le Couteur et al., 1989; Leekam et al., 2007; O'Donnell et al., 2012; Ornitz, Guthrie, & Farley, 1977; Tomchek & Dunn, 2007; Volkmar et al., 1986; Watling et al., 2001)
- Constellate into 4 Patterns of Response:
  - Hyperresponsiveness
  - Hyporesponsiveness
  - Sensory Interests, Repetitions, and Seeking
  - Enhanced Perception
- Individualized, varied, within and across individuals with ASD

Ausderau, K., Sideris, J., Furlong, M., Little, L. M., Bulluck, J., & Baranek, G. T. (2013). National Survey of Sensory Features in Children with ASD: Factor Structure of the Sensory Experience Questionnaire (3.0). *Journal of autism and developmental disorders*, 1-11.



## Family Perspectives: How are the things that you do as a family affected by your child's sensory experiences?

"If it's not a good experience for her, it becomes a bad experience for everyone."

"When he was younger, there was probably a year and a half when we didn't do anything, we didn't go anywhere."

"He really dislikes being in loud environments. That's, um, it's hard for him because he wants to participate and be a part, but he can't because he's always plugging his ears."

# Impact on Child & Family Function

- Activity participation (i.e., learning opportunities) (Little et al., under review; Reynolds et al., 2009)
  - Social communication (Baranek et al., 2012; Leekam et al., 2007; Rogers et al., 2003)
  - Adaptive skills (Ausderau et al., 2014; Lane et al., 2010, 2014)
  - Cognition (Baranek et al., 2006; 2007)
  - Parent stress (Ausderau et al., under review; Davis et al., 2008)
- 
- Recent research suggests utility of sensory patterns for characterizing subtypes of children with ASD –potentially stable over time (Ausderau et al., 2014; Lane et al., 2014)



# Impact on Child & Family Function

- Given vast variability within and across children with ASD, challenge of investigating both the impact & underlying mechanisms of children's sensory features in systematic manner
- What about modalities?
  - Auditory
  - Visual
  - Somatosensory
  - Gustatory
  - Olfactory
- In gustatory/olfactory modality, there is little systematic research
- Mealtimes?



# Gustatory processing in ASD

- Unusual eating behavior (e.g., aversion to food, food selectivity) presents in up to 90% of individuals with ASD
- Behavioral research consistently reports association between aversion to food & sensory sensitivity (i.e., hyperresponsiveness) (for review, see Marí-Bauset et al. 2013)
- Mixed Methods analysis suggests caregiver strategies in response to specific sensory patterns in children with ASD (N=72) v. DD (N=40)
  - ‘How often does your child refuse new foods?’ (Almost Never = 1 to Almost Always = 5)
    - ASD Mean= 3.96 (SD=1.11); DD Mean 2.76 (SD=1.14)
  - ‘Do you try to change this behavior?’
    - 87% ASD versus 59.5% DD report ‘YES’

# Caregiver Strategies

“I offer new foods weekly, but I don't force him to eat unfamiliar foods- so he rarely does.”

“He is very firm in his food choices; I can try to change appearance; rinse off sauce; hide it in something.”

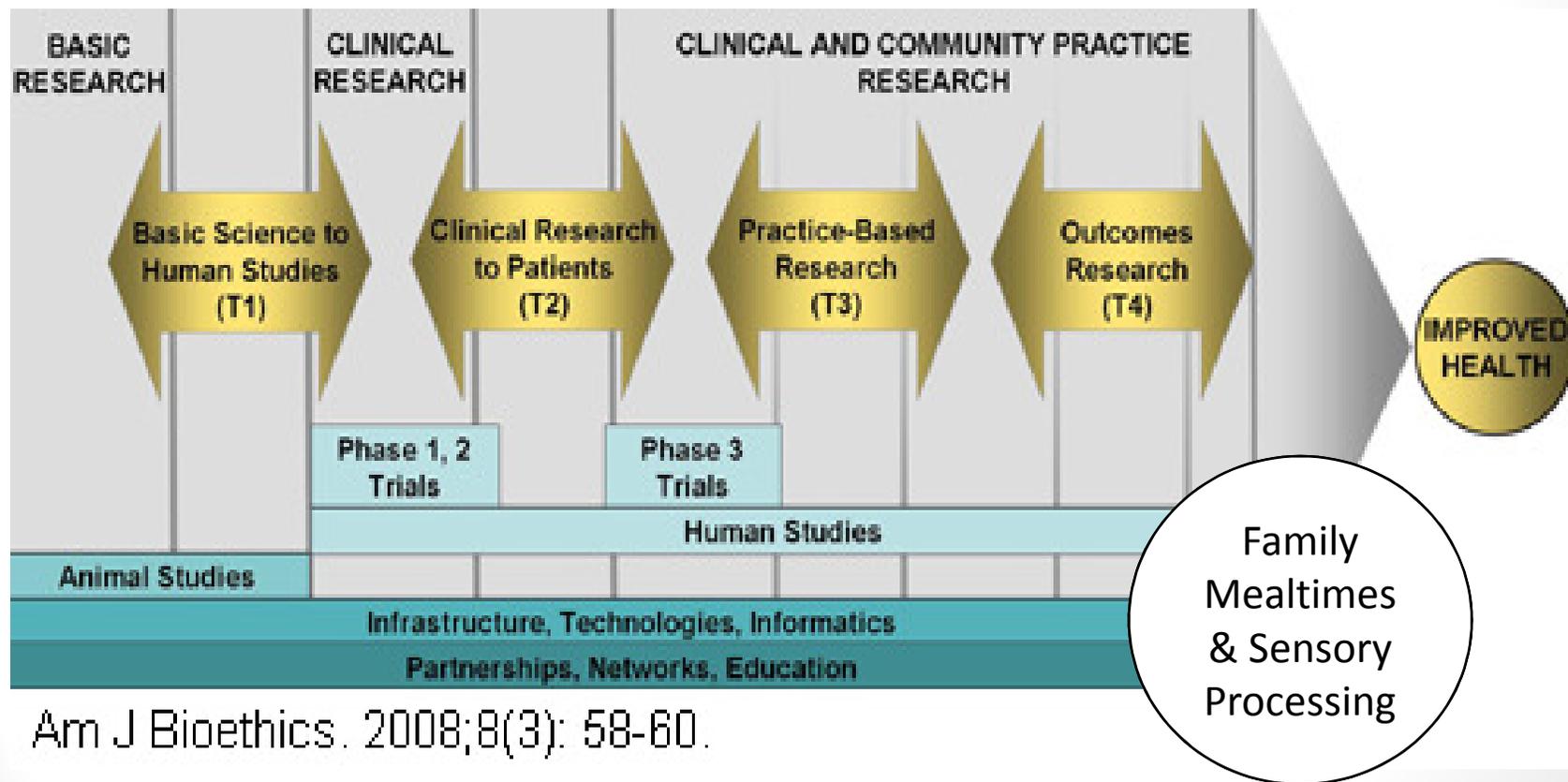
“Repeated exposures, actively working on it in OT. Specific sequence of events set by OT when introducing new foods”

“I make him try everything I can. Sometimes he gags, sometimes he shivers.”

# Family Mealtimes & Sensory Processing

- To what extent do children's sensory response patterns (HYPER, HYPO, SIRS, EP) impact food selectivity in children with ASD as compared to those with developmental disabilities (DD)?
- To what extent are caregiver-child interactions during mealtimes associated with children's sensory response patterns in ASD versus DD?
- Participants: Children with ASD ages 18 months – 6 years and their caregivers
- Measures: Behavioral Questionnaires & Observational Coding from video

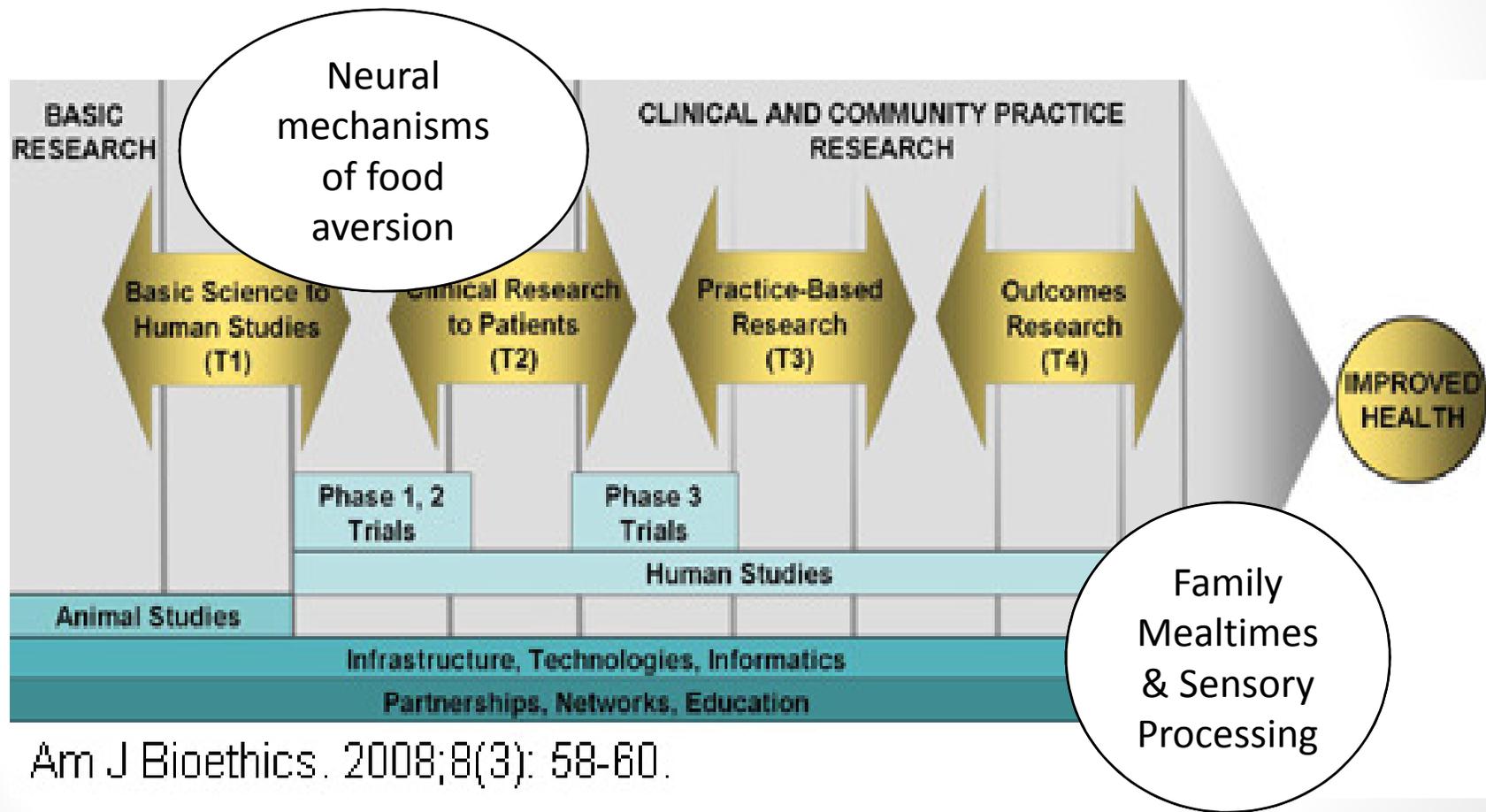
# Bench to Bedside...to Community



Am J Bioethics. 2008;8(3): 58-60.

- Video here

# Bench to Bedside...to Community



# Underlying mechanisms?

- **Sensory discrimination studies** - person's ability to differentiate between distinct sensory stimuli with respect to stimulus characteristics (e.g., frequency, duration, location, intensity).
- Heightened sensory discrimination abilities for
  - auditory (Bonnell et al., 2003; Heaton, Davis & Happe, 2008 Mottron et al., 1999)
  - visual (e.g., Ashwin et al., 2009)
  - tactile (e.g., Blakemore et al., 2006; Cascio et al., 2008)
- Children with ASD **less accurate** than controls in olfactory discrimination tasks (Suzuki et al., 2003) and taste discrimination tasks for sour and bitter (but not sweet and salty) (Bennetto et al., 2007).
- But increased emotional response / aversion
- Behavioral similarities in ASD with anorexia (e.g., Oldershaw et al., 2011; Bolte et al., 2002; Zucker et al., 2007)
- But also high prevalence of obesity (19.3% - 30.4%) (Chen et al., 2009; Curtin et al., 2010)

# Underlying neural mechanisms?

- Increasing number of studies suggest that dysfunctional insula connectivity is highly related to behavioral symptoms in ASD (Gotts et al., 2012; Uddin & Menon, 2009), including RRB (Cascio et al., 2013) and social interaction deficits (Ebisch et al., 2010)
- Studies have shown atypical insula activation in obese v. healthy weight controls as well as those with anorexia and bulimia (Obernodfer et al., 2013; Schienle et al., 2009).
- One study to date has demonstrated increased posterior insula activation in ASD versus controls during a food motivation paradigm using fMRI (Cascio et al., 2012)
- Developmental trajectories in ASD:
  - Food selectivity – increased intake of similar foods – obesity?
  - Food selectivity – overall decreased food intake – underweight?

# Neural Mechanisms of Gustatory Processing in ASD

Aim 1) Investigate insula activation during a food motivation task, using functional magnetic resonance imaging (fMRI), in individuals with ASD versus typical development (TD) ages 11-17 years

Aim 2) Examine the extent to which unusual eating behavior and hyper-reactivity is associated with insula activation in individuals with ASD ages 11-17 years

Research supported by the a Trail Blazer award through Frontiers: The Heartland Institute for Clinical and Translational Research & Hoglund Brain Imaging Center with Dr. Cary Savage & Dr. Winifred Dunn

# Participants

- We will recruit individuals with ASD (n=7) and TD (n=7) matched on chronological age and body mass index.
- Exclusionary criteria for both groups includes: co-morbid conditions of autism, such as Fragile X Syndrome; significant visual or hearing impairments; physical impairments; psychiatric conditions such as schizophrenia; or seizure activity within the last 12 months.

# Measures

- Adolescent/Adult Sensory Profile (Brown & Dunn, 2002)
- Social Responsiveness Scale (Constantino & Gruber, 2012)
- Food Preference Inventory (Sharp et al., 2013)
- Kaufman Brief Intelligence Test (Kaufman, 1990)
- Pubertal Developmental Scale (Petersen et al., 1988)



# Procedures

- A food image paradigm previously used by the research team with adolescents (e.g., Bruce et al., 2010; Holsen et al., 2005) will be used.
- Participants will passively view pictures of food, animals, and blurred images during a scanning session post mild fasting (post 4-h eating).
- Stimulus presentation time is 2.5 s, with an interstimulus interval (ISI) of 0.5 s.
- Scanning will be performed at KUMC's Hoglund Brain Imaging Center.



# Expected Results

- ASD group will show enhanced neural response to food images versus controls
  - Atypical reward and sensory response associated with food selectivity in the ASD group?
- ASD group's enhanced neural responses associated with behavioral measures of hyperresponsiveness

# Implications & Future Directions

- While neuroimaging approaches have previously been used to study auditory and tactile hyper-reactivity, gustatory processing in ASD remains largely unexamined.
- If we can elucidate the neural pathways of gustatory hyper-reactivity and associated unusual eating behaviors, we can begin to design intervention approaches that target these symptoms in ASD.
  - Reward processing?
  - Sensory processing?
  - Anxiety?
- Transactional processes throughout development

# Questions & Discussion

