Sensory Features in Autism Spectrum Disorders

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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

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

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.”

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

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

• Video here
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Neural mechanisms of food aversion

Family Mealtimes & Sensory Processing

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** (Bonnel 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

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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