Sensory Response Pattern & Social-Communication in Children with ASD

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  - Autism Speaks (Baranek, PI)

- **Team members**
  - Drs. Grace Baranek, Elena Patten, Brian Boyd, Jane Roberts, PhD, Michele Poe, PhD, Karla Ausderau, Elizabeth Crais, Lauren Turner-Brown and other investigators
  - Staff and students

- **Children and their families**

- **Disclosures:** none
Objectives

- Describe three prevalent patterns of sensory responsiveness in children with ASD (hyporesponsiveness, hyperresponsiveness, and sensory seeking)
- Explain why these patterns may co-occur within individual children with autism
- Identify the associations between sensory responsiveness patterns and various aspects of development and adaptation among children with ASD
- Apply information on sensory responsiveness patterns to intervention decision-making
Sensory Response Patterns

- Hyporesponsiveness is characterized by an absence of the expected response to a stimulus.
- Hyperresponsiveness: exaggerated behavioral reaction, aversive response, or effort to avoid a sensory stimulus.
- Sensory seeking behaviors: actions that perpetuate or intensify a sensory experience.
- Enhanced sensory perception: detection or discrimination of sensory stimuli that is more acute than typical.
Sensory Experiences Project

- Funded by NICHD since 2003 (Baranek, PI)
- Initially recruited a cross-sectional sample of children with ASD, other DD, and typical development
- 2 to 7 year olds with autism; other two groups MA-matched to children with autism
- Now bringing back children for longitudinal follow-up between ages 7 and 12
- Multiple studies within larger project to understand the nature of these sensory feature and their relation to core symptoms, development, and adaptive functioning
- Also, a large N study of individuals with ASD via internet responses by parents (ARRA supplement grant)
Assessments and Variables

- Sensory measures
  - Sensory Experiences Questionnaire (SEQ; Baranek, 1999a)
  - Sensory Profile (SP; Dunn, 1999)
  - Sensory Processing Assessment (SPA; Baranek, 1999b)
  - Tactile Defensiveness and Discrimination Test-Revised (TDDT-R; Baranek, 1998)

  Measurement model → Factor Scores for HYPER, HYPO, & SEEK

- Autism symptoms in social-communication domain
  - ADOS (Lord et al., 1999)
  - Revised social-communicative algorithm scores (Modules 2 & 3 scaled to Module 1)

- Nonverbal mental age
  - Visual Reception Age equivalent score (or Leiter for oldest children)
Assessments & Variables

- **Language**
  - Mullen Scales of Early Learning: Receptive Language and Expressive Language Scales
  - Preschool Language Scale-4th edition
  
  Aggregated into “language quotient” score

- **Joint Attention Protocol**
  - Scores for Responding to JA and for Initiating JA

- **Social and Communication Adaptive Behavior**
  - Vineland Adaptive Behavior Scales: Communication Scale and Social Scale: standard scores
Study 1: Sensory Experiences Questionnaire

(Baranek et al, 2006, *J. Child Psychology & Psychiatry*)

Autism group

- Overall Sensory Symptoms: 39% within 1SD of typical mean, 69% between 1 and 2SD, 56% above 2SD
- Hyper responsive: 36% within 1SD, 20% between 1 and 2SD, 23% above 2SD
- Hypo responsive: 40% within 1SD, 44% between 1 and 2SD, 37% above 2SD
- Both Hyper + Hypo responsive: 21% within 1SD, 17% between 1 and 2SD, 63% above 2SD

DD group

- Overall Symptoms: 62% within 1SD, 60% between 1 and 2SD, 80% above 2SD
- Hyper responsive: 22% within 1SD, 40% above 2SD
- Hypo responsive: 21% within 1SD, 30% above 2SD
- Both Hyper + Hypo responsive: 21% within 1SD, 1% above 2SD
Take-Home Messages from Study 1

- Children with autism have more sensory symptoms related to HYPER and HYPO than children with other DD.
- Children with autism are particularly distinguished from children with other DD by HYPO responses.
- A combination of high HYPO and high HYPER responses occur in more than 1/3 of children with autism, but rarely in children with other DD.

ALSO:

- Sensory symptoms are inversely related to MA for both groups.
- Children with autism are more HYPO in responding to both nonsocial and social stimuli than children with other DD, with an elevated effect for social stimuli.
Study 2: HYPO, Joint Attention & Language

(Baranek et al, in press, Development & Psychopathology)

- Sensory Processing Assessment Orienting Items
  - Air Puff: nonsocial, tactile
  - Shoulder Tap: social, tactile
  - Penlight: nonsocial, visual
  - Hand wave: social, visual
  - Sound Stick: nonsocial, auditory
  - Name Call: social, auditory

- Up to three trials presented of each stimulus

- Scores based on # of trials presented before an orienting response occurred: 1, 2, 3 (or score of 4 for no response)
Orienting to Nonsocial Stimuli

Baranek et al., in press
Orienting to Social Stimuli

Baranek et al., in press
Relation of HYPO to Joint Attention & Language

- Higher HYPO scores (longer to orient) on SPA was negatively correlated with Responding to JA on the JA Protocol
  - No difference based on group or context (social/nonsocial)
  - Significant interaction with MA, such that at higher MAs there was no significant correlation

- Higher HYPO on SPA was negatively correlated with Initiating JA
  - No difference based on group or context
  - Nonsignificant trend to IJA x MA interaction ($p = .063$)

- For Autism group only, HYPO was negatively correlated with language ratio scores; no interaction with MA
Take-Home Messages from Study 2

- Children with ASD are more hypo-responsive (less likely to orient) to social and nonsocial stimuli than children with DD or typical development at low MAs.
- At low MAs, children who orient less to varied stimuli are less likely to respond to joint attention bids, and also to initiative joint attention bids.
- For children with autism, children who are more hypo-responsive show lower language abilities relative to their chronological ages (across the MA range in this study).
### Study 3: Relation to Social-Communication

*(Watson et al., 2011, *J. Speech, Lang. & Hearing Research*)

<table>
<thead>
<tr>
<th></th>
<th>Autism ( n=72 )</th>
<th>DD ( n=44 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA (SD)</td>
<td>52.3 (16.5)</td>
<td>48.1 (22.0)</td>
</tr>
<tr>
<td>MA (SD)</td>
<td>32.0 (20.6)</td>
<td>33.4 (17.2)</td>
</tr>
<tr>
<td>Gender (male)</td>
<td>61 (85)</td>
<td>25 (57)</td>
</tr>
</tbody>
</table>
**Study 3:**
Sensory Features in Two Groups

Watson et al., 2011

<table>
<thead>
<tr>
<th></th>
<th>AD</th>
<th></th>
<th>DD</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>HYPER</td>
<td>0.23</td>
<td>0.12</td>
<td>-0.38</td>
<td>0.15</td>
</tr>
<tr>
<td>HYPO</td>
<td>0.22</td>
<td>0.11</td>
<td>-0.35</td>
<td>0.14</td>
</tr>
<tr>
<td>SEEK</td>
<td>0.27</td>
<td>0.10</td>
<td>-0.43</td>
<td>0.13</td>
</tr>
</tbody>
</table>

AD: n = 72  
DD: n = 44
### Study 3: Sensory Features in Two Groups

Watson et al., 2011

<table>
<thead>
<tr>
<th></th>
<th>AD ( n = 72 )</th>
<th>DD ( n = 44 )</th>
<th>Group Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPER</td>
<td>Mean ( 0.23 )</td>
<td>Mean ( -0.38 )</td>
<td>Diff ( 0.59 )</td>
</tr>
<tr>
<td></td>
<td>SE ( 0.12 )</td>
<td>SE ( 0.15 )</td>
<td>SE ( 0.19 )</td>
</tr>
<tr>
<td>HYPO</td>
<td>Mean ( 0.22 )</td>
<td>Mean ( -0.35 )</td>
<td>Diff ( 0.57 )</td>
</tr>
<tr>
<td></td>
<td>SE ( 0.11 )</td>
<td>SE ( 0.14 )</td>
<td>SE ( 0.18 )</td>
</tr>
<tr>
<td>SEEK</td>
<td>Mean ( 0.27 )</td>
<td>Mean ( -0.43 )</td>
<td>Diff ( 0.70 )</td>
</tr>
<tr>
<td></td>
<td>SE ( 0.10 )</td>
<td>SE ( 0.13 )</td>
<td>SE ( 0.17 )</td>
</tr>
</tbody>
</table>

\( p < .001 \) for SEEK.
Associations between Sensory Patterns & Social-Communication Algorithm Scores on ADOS

Watson et al., 2011

- **HYPER**: no significant association, tend to be negatively associated
  - $\beta = -0.043; SE = 0.025; p = 0.082$

- **HYPO**: significant positive association
  - $\beta = 0.048; SE = 0.023; p = 0.04$, correlation not different by group

- **SEEK**: significant positive association for autism group only
  - $\beta = 0.078; SE = 0.025; p = 0.002$
Associations between Sensory Patterns and Language Quotient Aggregate Scores

Watson et al., 2011

- HYPER: no significant association
- HYPO: significant negative association
  - $\beta = -.01; SE = .004; p = .018$
- SEEK: significant negative association
  - $\beta = -.011; SE = .004; p = .005$
Associations between Sensory Patterns and VABS Social & Communication Scores

Watson et al., 2011

- HYPER: no significant association with either
- HYPO: significant negative association with social
  - $\beta = -.017; \ SE = .007; \ p = .011$
- HYPO: Trend for communication
  - $\beta = -.012; \ SE = .006; \ p = .052$
- SEEK: no significant association with either
  - Negative trend for communication $\beta = -.010; \ SE = .006; \ p = .090$
Take-Home Messages from Study 3

- Hyper-responsiveness has no consistent association with either severity of ASD social-communication symptoms or with language, communication, or social skills.
- Both hypo-responsiveness and sensory seeking are associated with more severe ASD social-communication symptoms and with less optimal language, communication and/or social skills.
- Both hypo-responsiveness and sensory seeking may limit social learning opportunities.
Study 4: Sensory Patterns in Verbal versus Nonverbal Children with ASD
(Patten et al, 2011 International Meeting for Autism Research)

- Verbal vs. nonverbal status based on ADOS definition
  - Fewer than 5 non-imitated words or word approximations heard during ADOS

- First analysis is cross-sectional: 79 children with ASD
  - Mean CA = 53 months, SD = 16.6, range from 25-86 months
  - Verbal vs. nonverbal groups were significantly different on demographics of:
    - CA
    - IQ proxy
    - Race
    - Maternal Education
    - Household income
  But not on gender or ethnicity
Cross-sectional Analysis of Nonverbal vs. Verbal Children with ASD

Patten et al., 2011

<table>
<thead>
<tr>
<th>Source</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPO</td>
<td>Nonverbal</td>
<td>.63</td>
</tr>
<tr>
<td></td>
<td>Verbal</td>
<td>-.03</td>
</tr>
<tr>
<td>SEEK</td>
<td>Nonverbal</td>
<td>.90</td>
</tr>
<tr>
<td></td>
<td>Verbal</td>
<td>-.03</td>
</tr>
<tr>
<td>HYPER</td>
<td>Nonverbal</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>Verbal</td>
<td>.24</td>
</tr>
</tbody>
</table>

Source   | df | F    | p   |
----------|----|------|-----|
HYPO      | 1  | 7.46 | .008*|
SEEK      | 1  | 19.72| .000*|
HYPER     | 1  | .259 | .612 |
Study 4: Sensory Patterns in Verbal versus Nonverbal Children with ASD

Patten et al., 2011

- Second analysis is from small longitudinal study
  - 14 children with autistic disorder
  - Mean CA = 36 months, SD = 4.3, range from 28-42 months at Time 1
  - Nonverbal or single words only at Time 1
  - Seen one year later for Time 2 assessments
  - Looked at Time 1 sensory factor scores based on Time 2 classification as “Nonverbal” or “Verbal” (from ADOS)
Relation of Early Sensory Patterns to Later Verbal Status in Children with Autism

Patten et al., 2011

Sensory Factor scores at T1

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPO</td>
<td>1.41</td>
<td>1.25</td>
</tr>
<tr>
<td>SEEK</td>
<td>1.14</td>
<td>.77</td>
</tr>
<tr>
<td>HYPER</td>
<td>.34</td>
<td>.85</td>
</tr>
</tbody>
</table>

Table: Sensory Factor scores at T1

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYPO</td>
<td>12</td>
<td>2.19</td>
<td>.05</td>
</tr>
<tr>
<td>SEEK</td>
<td>12</td>
<td>2.62</td>
<td>.02</td>
</tr>
<tr>
<td>HYPER</td>
<td>12</td>
<td>.27</td>
<td>.84</td>
</tr>
</tbody>
</table>
Take-Home Messages from Study 4

- Provides confirmatory evidence for the associations between hypo-responsiveness and sensory seeking on the one hand and language outcomes on the other hand.

- Suggests that these sensory patterns may be a factor operating longitudinally to decrease the likelihood a child will become verbal.

- (But we are still just looking at associations, so are not certain about the role of sensory response patterns in social-communicative development.)
A Pilot Early Intervention Study with One-Year-Olds at-Risk for ASD
Baranek et al., 2012, International Meeting for Autism Research

- Children identified as at-risk for ASD based on First Year Inventory at 12 months
- Assigned to “Adapted Responsive Teaching” or Community Services only
- 2:1 randomization
  - 11 children assigned to Adapted Responsive Teaching
  - 5 children assigned to Community Services
- Adapted Responsive Teaching is a parent-mediated intervention in which parents are coached to use responsive strategies to promote “pivotal” social-communication and sensory-regulatory behaviors in their children
Early Development Project-1
Child Sensory Outcome

HLGM for SEQ Hyporesponsive

Eff. size = -.87

Baranek et al., 2012
Early Development Project-1

Child Sensory Outcome

HGLM for SEQ Hyper-responsive (p<.05) Eff. size = 1.37

Baranek et al., 2012
Trying to Make Sense of It All
(Baranek, personal communication)

Hyper-arousal → Seeking as Modulator?

Hypo-arousal → Seeking as Modulator?

Typical ASD

Optimal

Typical

ASD

UNC School of Medicine
Implications for Intervention

- Disclaimer: I’m not a specialist on sensory-based interventions!
- Recent meta-analyses on sensory-based intervention research continue to report
  - Lack of empirical support
  - Methodological weaknesses in studies
- Yet, we know that extreme sensory response patterns are prevalent in children with autism
- Hypo-responsiveness & sensory seeking may interfere with the acquisition of social-communicative skills
- So what’s the interventionist to do?
Suggestions for Intervention

- EBP in this case will rely heavily on the “local evidence”: parents’ wisdom, professional expertise, being accountable for systematically evaluating strategies used with the individual child.
- Think of the sensory responses you see in a child with autism as an indicator of current arousal or processing readiness.
- Focus on managing arousal so that child can engage in meaningful activities.
- The measured outcome will not be the child’s sensory responses, but rather something pertaining to his/her ability to engage in those meaningful activities.
Ideas on Management

- **Hypo-responsive:**
  - Observe what the child DOES respond to, & embed those stimuli in social routines
  - Heighten salience of stimuli: position in child’s space, increase intensity &/or use multi-sensory stimuli

- **Seeking:**
  - Use sensory interests to motivate child; embed in social routines
  - Expand opportunities & supports for increased exploration & variety in play activities
  - Spend time on face-to-face engagement without objects

- **Hyper-responsive:**
  - Pair desensitization strategies with specific functional activity
  - Give child opportunity to control stimuli
  - Teach coping strategies: asking for break or alternative activity
Summary

- Hyper-responsiveness, hypo-responsiveness, & sensory seeking are all prevalent in children with ASD.
- Many children with ASD show more than one pattern of extreme sensory response—perhaps due to smaller zones of optimal arousal.
- Hypo-responsiveness & sensory seeking may have important implications for social-communicative development.
- In the absence of evidence for the effectiveness of treating sensory responses as primary goals, a focus on management of sensory responses to achieve functional outcomes is suggested.