

Quantitative Analysis of Auditory Processing in Children with Autism Spectrum Disorder



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Background

- Atypical sensory behaviors have recently been added as symptoms of DSM-5 Autism Spectrum Disorder (ASD)
- Atypicalities have been well documented in literature related to children diagnosed with attention deficit hyperactivity disorder (ADHD) (Reynolds, 2007)
- Little is known about the profiles of auditory sensory response in ASD
- Extant literature suggests that auditory sensory atypicalities can be described as over-response, seeking, or under-responsiveness to auditory stimuli.
- Over-responsive individuals respond to stimuli in a way that is faster, longer and more intense than is expected
- Under responsive individuals are unaware or slow to respond to auditory input
- Seeking individuals crave or display interest in sensory experiences (Ghanisadeh, 2011)
- Since atypical sensory behaviors are relatively new to the diagnosis of ASD, the current study aims to fill a gap in the literature by describing profiles of auditory response behaviors in youth with ASD

Objective

- Examine patterns of behavioral response to auditory stimuli among children diagnosed with ASD and/or a likely gene disrupting mutation (LGDM) associated with ASD
- Determine if sensitive vs. hyper-responsive behaviors reflect separate factors or a continuum of auditory response behaviors
- Determine if there is a difference in the auditory response profiles associated with LGDMs within particular affected gene groups

Methods and Procedure

Participants:

135 children with ASD (n=56), LGDM (n=13) or ASD+LGDM (n=66)

Measures:

- Sensory Profile Caregiver Report, auditory scale (items 1-8)
- Items scored on 0-4 (Never to Frequently) scale
- Child Behavior Checklist (CBCL) 1.5-5 or 6-18 Attention Scale
- Child and Adolescent Symptom Inventory, 5th Ed. (CASI-5) Inattention Severity Scale

Analyses:

- Auditory response factors derived using confirmatory factor analysis in SPSS 19 sensory factor severity scores
- Group differences quantified with one-way ANOVAs
- Pearson correlations used to estimate linear association between auditory response severity and behavioral measures (seen in the Sensory Profile Questionnaire below)

Sensory Profile Questionnaire

Sensory Processing		A. Auditory Processing		ALWAYS	FREQUENTLY	OCCASIONALLY	SELDOM	NEVER
1	L	1	Responds negatively to unexpected or loud noises (for example, cries or hides at noise from vacuum cleaner, dog barking, hair dryer)					
2	L	2	Holds hands over ears to protect ears from sound					
3	L	3	Has trouble completing tasks when the radio is on					
4	L	4	Is distracted or has trouble functioning if there is a lot of noise around					
5	L	5	Can't work with background noise (for example, fan, refrigerator)					
6	H	6	Appears to not hear what you say (for example, does not "tune-in" to what you say, appears to ignore you)					
7	H	7	Doesn't respond when name is called but you know the child's hearing is OK					
8	H	8	Enjoys strange noises/looks to make noise for noise's sake					

Handwritten notes on the table:
 Item 1: Sensitive to Auditory
 Item 3: Distracted by Auditory
 Item 6: Under-responsive to Auditory
 Item 8: did not use

Results

Objective 1:

Confirmatory factor analysis derived 3 factors:

- Sensitive to Auditory
- Distracted by Auditory
- Under-responsive to Auditory

Youth with ASD (with or without LGDM) have higher scores on all three factors than youth with only LGDM, but not significant ($p > .05$)

Variable	ASD No Event	ASD+LGDM	LGDM Only	Total
Female (%)	12 (21%)	12 (18%)	7 (54%)	31 (23%)
Household Income > \$75K	31 (58%)	49 (80%)	8 (61%)	90 (70%)
Mother education > H.S. equivalent	51 (93%)	53 (80%)	11 (85%)	118 (87%)
Age in months (SD)	147 (29)	144 (51)	83 (34)	139 (45)
Inattention Severity T-score (SD)	67 (9)	70 (12)	70 (9)	69 (11)
Mean Sensitivity Item Score	1.69 (0.98)	1.74 (1.10)	1.34 (1.05)	1.69 (1.04)
Mean Under-responsive item score	2.04 (0.94)	1.95 (1.03)	1.84 (1.01)	1.97 (0.99)
Mean Distractible item score	1.63 (0.87)	1.50 (0.99)	1.26 (1.14)	1.51 (0.96)

Individual Differences :

- Inattention severity significantly correlated with all 3 sensory factors
- No association between sensory factors, severity, sex, age or IQ

Correlation of Sensory Profile and Demographics

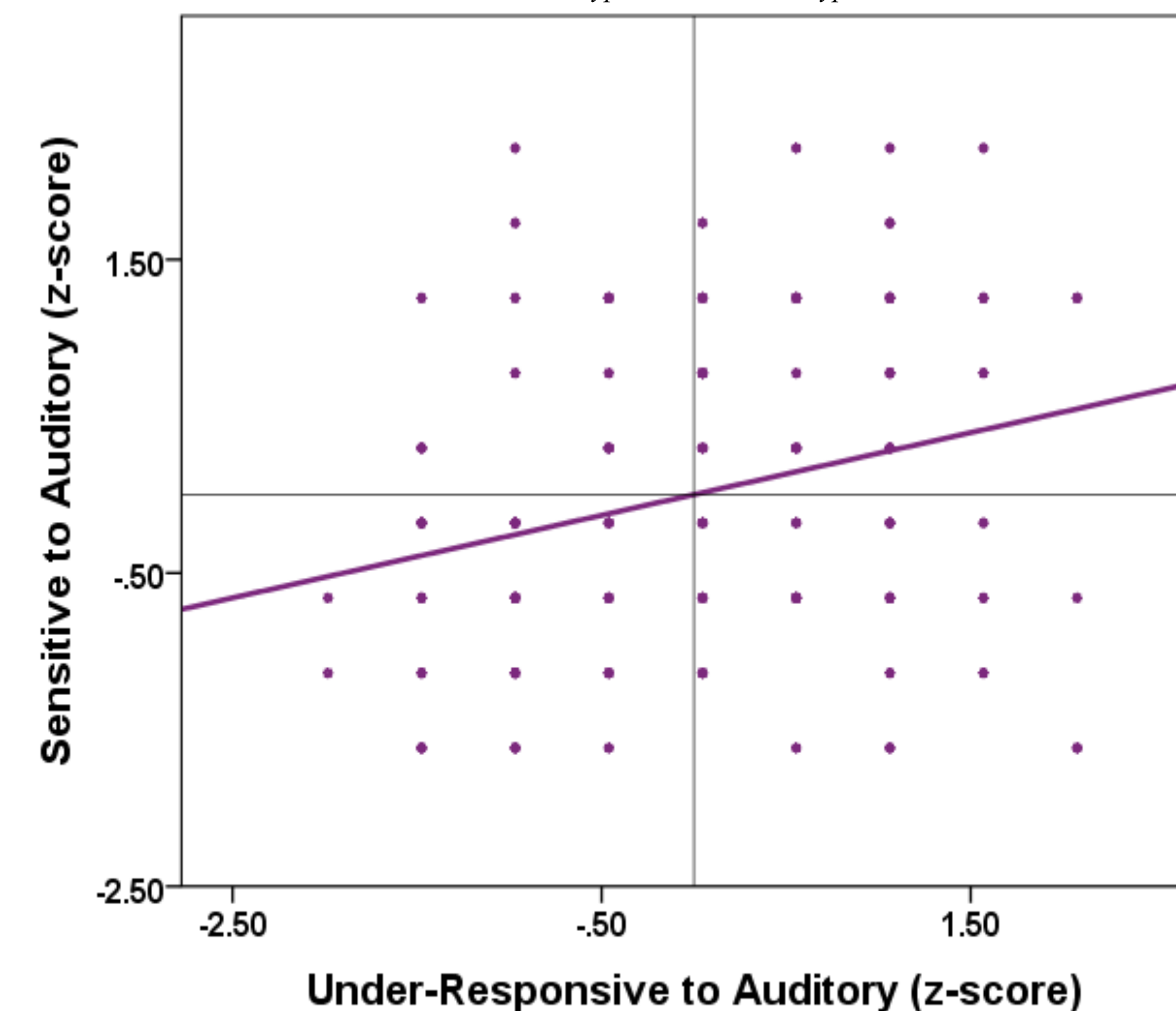
	Sensitivity Severity	Under-Responsive Severity	Distracted by Auditory Severity
Inattention Severity	0.35, $p < .001$	0.41, $p < .001$	0.47, $p < .001$
Full Scale IQ	-0.02, $p = .868$	0.16, $p = .098$	0.00, $p = .973$
Age	0.11, $p = .197$	-0.11, $p = .200$	0.13, $p = .127$

Note: values are two-tailed Pearson correlations

Objective 3:

- Participants showed elevated behaviors on sensitive and under-responsive factors
- Hypo/hyper sensitivity is not a continuous trait
- This is contrary to our hypothesis

Correlation between Hypersensitive and Hyposensitive Children



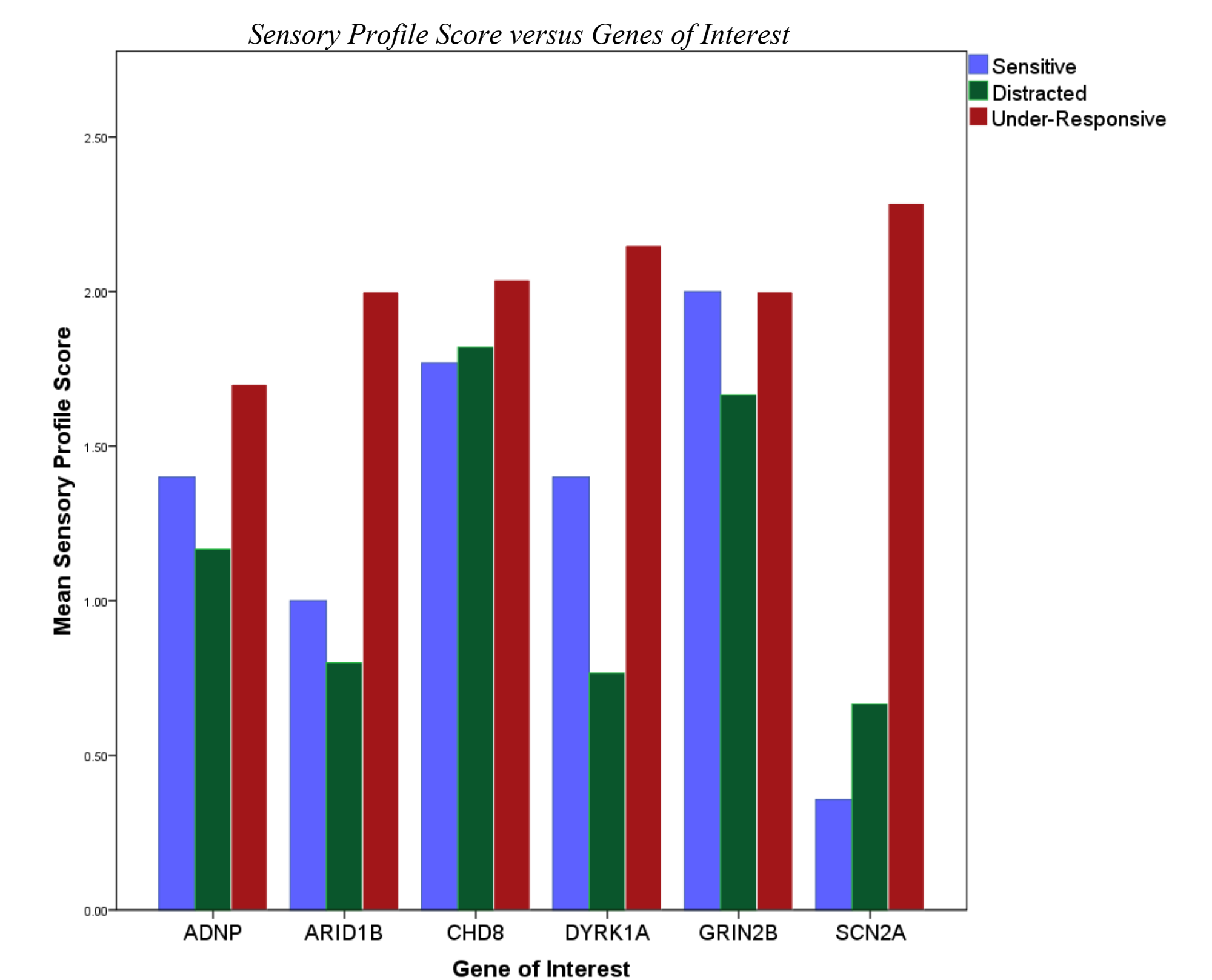
Results (Continued)

No difference in sensory factors between LGD+ and LGD- children overall ($p > .05$)

Among affected genes with ≥ 5 individuals:

Unique profiles of sensory responsivity across gene groups:

- Sensitivity severity: $F(5,44)=3.03, p=.021$
- Distracted severity: $F(5,44)=2.46, p=.050$
- Under-responsive severity: $F(5,44)=0.183, p=.967$



Discussion

- Atypical response to auditory stimuli fall into three distinct factors: distracted by auditory, sensitive, and under-responsive to auditory
- Neither sex, ASD diagnosis, nor having a likely gene disrupting mutation (LGD) predicts particular patterns of sensory processing behaviors, although there may be specific patterns within affected gene groups
- Consistent with research on children with ADHD, in our sample children with ASD who also showed high levels of inattention were more likely to have an atypical response to auditory stimuli;
- This suggests a common underlying etiology for attention problems and sensory behaviors, regardless of ADHD symptoms
- Prior research has implicated white matter tract integrity in atypical sensory behaviors (Chang et al., 2016) regardless of ASD diagnosis; white matter connectivity has also been implicated in studies of attention
- Future research should aim to identify common underlying neural circuitry that explains attention, sensory, and social behaviors
- Better understanding of atypical auditory sensory processing could lead to a better and more accurate diagnosis of children with ASD, and inform individualized treatment strategies

LIMITATIONS

- The Sensory Profile Questionnaire is filled out by a parent/caregiver so the answers and therefore our data depends on their interpretation of their child's atypical responses
- Past studies have found greater validity using laboratory assessments of sensory behavior
- Parent-report assessment of sensory behaviors is an area of need in neurodevelopmental research

References

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