CONCEPTUALIZING AUTISM AS A LEARNING DISABILITY
FROM PRESCHOOL RESEARCH TO SCHOOL-AGED ACADEMIC INTERVENTION

PETER MUNDY
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SCHOOL OF EDUCATION
• I RECEIVE ROYALTIES FOR A BOOK DISCUSSED IN THIS PRESENTATION.
  • AUTISM AND JOINT ATTENTION: DEVELOPMENTAL, NEUROSCIENCE AND CLINICAL FUNDAMENTALS,
    GUILFORD PUBLICATIONS, 2016

• I DO NOT HAVE FINANCIAL RELATIONSHIPS WITH ANY OF THE OTHERS ASSESSMENTS,
  INTERVENTIONS OR PRODUCTS THAT MAY BE MENTIONED IN THIS PRESENTATION

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JOINT ATTENTION IS A MENTAL CAPACITY THAT ENABLES THE ADOPTION OF A COMMON POINT OF REFERENCE AND ENGAGE IN COORDINATED INFORMATION PROCESSING
RESPONDING TO JOINT ATTENTION (RJA) AND A COMMON POINT OF VIEW

RJA in 9 months olds
Likely initial development 2-6 months

Picture of the *Early Social Communication Scales* (ESCS, Seibert, Hogan & Mundy 1982; Mundy et al. 2003)
INITIATING JOINT ATTENTION (IJA) AND A COMMON POINT OF VIEW

Spontaneously Sharing Experience at 9 months of Age
Likely initial development 5-8 months of age
SOCIAL DIAGNOSTIC CRITERIA FOR AUTISM (1994 FROM THE DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS OR DSM-IV)

- A LACK OF SPONTANEOUS SEEKING TO SHARE ENJOYMENT, INTERESTS, OR ACHIEVEMENTS (LACK OF SHOWING, POINTING, …)
- FAILURE TO DEVELOP PEER RELATIONS
- MARKED IMPAIRMENT UN NONVERBAL BEHAVIORS (EYE-CONTACT, FACIAL EXPRESSION, …)
- LACK OF SOCIAL EMOTIONAL RECIPROCITY

JOINT ATTENTION (videos from UCLA, 1982-1986; University of Miami, 2003)
THE AUTISM DIAGNOSTIC OBSERVATION SCHEDULE (ADOS) SOCIAL-AFFECT DIMENSION (GOTHAM ET AL. 2007, 2008)

- **MODULE 1: NO WORDS**
  - GAZE* & OTHER BEHAVIORS
  - FACIAL EXPRESSION
  - FREQUENCY OF VOCALIZATION
  - QUALITY OF SOCIAL OVERTURES
  - SHARED ENJOYMENT*
  - UNUSUAL EYE CONTACT
  - RESPONDS TO JOINT ATTENTION
  - GESTURES
  - SHOWING
  - INITIATES JOINT ATTENTION

- **MODEL 1 W/WORDS & MODULE 2**
  - GAZE* & OTHER BEHAVIORS
  - FACIAL EXPRESSION
  - FREQUENCY OF VOCALIZATION
  - QUALITY OF SOCIAL OVERTURES
  - SHARED ENJOYMENT*
  - UNUSUAL EYE CONTACT
  - POINTING
  - GESTURES
  - SHOWING
  - INITIATES JOINT ATTENTION
Autism Spectrum Disorders (ASD) involve social & learning impairments.

Disturbance of Learning with and from Others

Disturbance of Social Relatedness

Joint Attention Problems observed by 8- to 18-months of Age

Restricted & Repetitive Behaviors
Atypical Sensory Responses

Undifferentiated Development 0 – 4 months

Autism is still difficult to detect in the 1st six-months of Life
PAYING ATTENTION TO WHAT OTHER PEOPLE ATTEND TO (REFER TO) IS FUNDAMENTAL TO LEARNING.

BRUNER (1975)

PRACTICE WITH SHARING A COMMON POINT OF VISUAL REFERENCE NECESSARY TO SHARING A COMMON POINT OF MENTAL REFERENCE (SYMBOLS AND LANGUAGE)

WERNER & KAPLAN (1963)

SUCCESS WITH TEACHING, SCAFFOLDING, INSTRUCTION IN ANY CONTEXTS REQUIRES JOINT ATTENTION.

VULNERABILITY TO DISTURBED JOINT ATTENTION CONTRIBUTES TO LEARNING PROBLEMS IN ASD.
Figure 7. In the first year the development of joint attention involves the “learning to” integration of executive, motivation and imitation processes to support the routine, rapid and efficient (error free) execution of patterns of behavior that enable infants to coordination processing of overt aspects of visual self attention with processing of the social attention of other people. In the latter part of the first year and the second year infants can better monitor their own experiences and integrate it with information about the social partners during joint attention events. This provides a critical multi-modality source of information to the infants about the convergence and divergence of self and others experience and behavior during sharing information in social interactions. Theoretically, this provides the stage for the “learning from” phase of joint attention development. In this stage infants can control their attention to self organize and optimize information processing in social-learning opportunities. The integration of anterior and posterior self-other-attention processing (Fig. 5) provides a neural network that enriches encoding in social learning. The internalization of the overt joint processing of attention to the covert joint processing of attention to representations is part of an executive system that facilitates symbolic development and the social cognition. Indeed both symbolic thought and social cognition may be characterized by a transition from learning to socially coordinate overt attention to the capacity to socially coordinate covert mental representations of the attention of self and others.
Joint attention requires mental effort, but becomes easier with age in typical development.

How fast do infants follow gaze?

Joint attention becomes faster and easier over age.

Gredebeck et al. 2010
Joint attention increases infant’s likelihood of correctly associating new words with objects/events (referential mapping).

Figure 1. Cross-situational observation and social cues can be seamlessly integrated in a statistical learning model.
29 CHILDREN WITH ASD

MEAN AGE 46.5 MONTHS

ASSESSED TWICE OVER 12.4 MONTHS

0.45 TO 40 HRS PER WEEK OF LANGUAGE INTERVENTION

Only children with higher RJA displayed “dose related” language growth in response to intervention. RJA also related to initial Language Level
LEARNING FROM PHASE OF DEVELOPMENT

Self-Experience as a Mechanism for Learning About Others: A Training Study in Social Cognition

Andrew N. Meltzoff and Rechelle Brooks

Andrew N. Meltzoff and Rechelle Brooks, Institute for Learning & Brain Sciences, University of Washington

12-month-olds learn not to follow gaze of blind-folded tester after experience with blindfold.

18-month-olds learn to follow gaze of blind-folded tester after experience with transparent blindfold.
STUDIES REPORTING LONGITUDINAL CONTINUITY BETWEEN FREQUENCY OF JA AND TOM

- MOLL & MELTZOFF (PERSONAL COMMUNICATION, IN PRESS)
  12 MONTH IJA (POINTING) \rightarrow FALSE BELIEF 50 MONTH (N = 88)

- CHARMAN ET AL. (2000) 20 MONTH IJA (ALTERNATING GAZE) \rightarrow 44 MONTH TOM

- KUHN-POPP ET AL. (2015) 15 MONTH IJA (POINTING) \rightarrow MENTAL STATE TERMS IN TOY PLAY

- KRISTEN ET AL. (2011) 9 MONTH RJA \rightarrow MENTAL STATE LANGUAGE AT 36 MONTHS

- BROOK & MELTZOFF (2015) 10 MONTH RJA \rightarrow 30 MOS MENTAL STATE WORDS \rightarrow 54 MONTH TOM

- ABREU ET AL. (2014) 9 MONTH RJA \rightarrow 48 MONTH TOM

- NELSON ET AL. (2008) 18-20 MONTH JOINT ENGAGEMENT \rightarrow 43 AND 54 MONTH TOM

- ESKRITT ET AL. (1999) 2-3 YEAR OLDS USE DIRECTION OF GAZE OF OTHERS TO INFERR\rightarrow\INTENTIONS

- SCHIETTECATTE ET AL. (2012) 3 YEAR OLDS WITH ASD RJA RELATED TO INTENTION UNDERSTANDING
• ATTENTION CAN BE THOUGHT OF AS AN INTENTIONAL MENTAL PROCESS THAT WE USE TO SELECT OR HIGHLIGHT INFORMATION TO PROCESS BASED ON IMMEDIATE GOALS

• WHEN INFORMATION IS ILLUMINATED BY THE SPOTLIGHT OF ATTENTION INFORMATION PROCESSING PROCEEDS IN A MORE EFFICIENT FASHION.

• JOINT ATTENTION INVOLVES THE NEURODEVELOPMENT OF THE RESPONSE AND INITIATION OF SOCIAL CUES THAT ENHANCE INFORMATION PROCESSING IN INFANTS AND ACROSS THE LIFE SPAN.
SHORT COMMUNICATION
Neural mechanisms of joint attention in infancy

Tricia Striano,1,2,3 Vincent M. Reid2 and Stefanie Hoehl2
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2 Neurocognition and Development Group, Center for Advanced Studies, University of Leipzig, Otto-Schill Strasse, Leipzig, Germany
3 Department of Pediatrics and Kennedy Center for Human Development, Vanderbilt University, Nashville, TN, USA

Fig. 1. Display of two sequences in the joint attention condition. The adult gazed at the infant's face (top left) and then to a novel object that was displayed on a computer screen for one second (bottom left), and the infant engages with experimenter's face (top right), then attends to the object on the screen (bottom right).

Fig. 2. Display of two sequences in the non-joint attention condition. The adult gazed only at the novel object displayed on the computer screen, with the positions of their gaze fixed towards the monitor (top and bottom left), the infant attends to the adult's face (top right) then to the object on the screen (bottom right).
MOTIVATION AND THE EYE CONTACT EFFECT HYPOTHESIS

Motivated to orient to eyes or motivated to respond to being the object of attention?

The eye contact effect: mechanisms and development

Atsushi Senju* and Mark H Johnson

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Abstract

The “eye contact effect” is the phenomenon that perceived eye contact with another human face modulates certain aspects of the concurrent and/or immediately following cognitive processing. In addition, functional imaging studies in adults have revealed that eye contact can modulate activity in structures in the social brain network, and developmental studies show evidence for preferential orienting toward, and processing of, faces with direct gaze from early in life. We review different theories of the eye contact effect and advance a ‘fast-track modulator’ model. Specifically, we hypothesize that perceived eye contact is initially detected by a subcortical route, which then modulates the activation of the social brain as it processes the accompanying detailed sensory information.

**Picture Recognition in the RJA and IJA Study Conditions**

- **IJA**
  - % Correct Recognition: 70%
  - % False Positives: 17.5%

- **RJA**
  - % Correct Recognition: 53%
  - % False Positives: 35%

*Kim & Mundy (2012)*
- 26 undergraduates
- p < .013, $\eta^2 = .22$

*Mundy et al. (2016)*
- 32 ASD, 27 ADHD, 23 TD 8-16 year olds
- $F (2,83) = 7.74$, $p < .001$, $\text{Eta squared} = .16$
JOINT ATTENTION BEGINS TO DEVELOP NO LATER THAN 5- TO 6-MONTHS OF AGE

**Developmental Science**

PAPER

Frontolimbic neural circuitry at 6 months predicts individual differences in joint attention at 9 months

Jed T. Ellison, Jason J. Wolff, Debra C. Heimer, Sarah J. Paterson, Hongbin Gu, Heather C. Hazlett, Martin Styner, Guido Gerig, Joseph Piven, and for the IBIS Network

**Figure 1** Three-dimensional reconstructions of the white matter fiber tracts examined in the current study: red = uncinate fasciculi (UF), blue = inferior longitudinal fasciculi (ILF), grey = optic tract.

Fibers in the UF connect the inferior medial temporal lobe (including the amygdala), the rostral temporal pole, the fronto-insular cortex, and the orbital and ventral-medial prefrontal cortex. This tract likely transmits
IJA at 8 months correctly predicted 6/9 High Risk infants who received a DX of ASD at 36 months and 25/26 who did not.

Infant siblings display less IJA at 8 months at 10 & 12 months less IJA with smiles.
JOINT ATTENTION AND LEARNING IN PRESCHOOL AND SCHOOL AGED CHILDREN WITH AUTISM
Early Intensive Behavioral Treatment: Replication of the UCLA Model in a Community Setting

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MILA AMERINE-DICKENS, M.S.
Central Valley Autism Project, Modesto, CA

TRISTRAM SMITH, Ph.D.
Department of Pediatrics, University of Rochester Medical Center, Rochester, NY

- 42 CHILDREN
  - 24 - 36 MONTH OLDS
  - IQS 50-80, MEAN = 60
- 21 EARLY INTENSIVE BEHAVIORAL TREATMENT
  - 35 -40M HOURS OF BEHAVIORAL TREATMENT
- 21 COMMUNITY PUBLIC SCHOOLS
- TWO YEARS

- APPLIED BEHAVIORAL ANALYSIS (ABA)
  - ADULT DIRECTED
  - 3 TO 8 LEARNING TRIALS ADMINISTERED
  - 1 – 2 MINUTE BREAK
  - 50 MINUTES PER HOUR
  - SUCCESSIVE APPROXIMATIONS

- EXTERNAL REWARDS FOR LEARNING
  - ATTENDING TO TASK
  - USING GESTURES
  - FOLLOWING REQUESTS
  - USING SYMBOLS & WORDS
HIGH QUALITY ABA IMPROVES INTELLIGENCE SCORES FOR MANY PRESCHOOL CHILDREN
MOTHERS’ GAZE FOLLOWING INSTEAD OF DIRECTING HELPS DEVELOP JOINT ATTENTION & LANGUAGE

• SILLER & SIGMAN (2002)
  • CAREGIVER OF CHILDREN WITH AUTISM SHOW ‘TYPICAL’ LEVELS OF FOLLOWING ATTENTION
  • SYNCHRONIZED/”FOLLOWING” IN PREDICTS LANGUAGE GAINS OVER 1, 10 & 16 YEARS
    • “FOLLOWING IN” WITH “UNDEMANDING VOCALIZATIONS” BEST PREDICTOR
APPROACHES TO INTERVENTION

Discrete Trial

- **DISCRETE TRIAL**
  - A TYPE OF APPLIED BEHAVIOR ANALYSIS (ABA)
  - ADULT DIRECTED
  - MODELING OF BEHAVIOR
    - VERBAL & PHYSICAL PROMPTS
  - PRIMARY CONTINGENT REINFORCEMENT OF SUCCESSIVE APPROXIMATIONS (SHAPING)
    - LOVAAS (1987)
  - SPECIFIC SKILL DEVELOPMENT

ABA

- TRANSACTIONAL

Developmental

- DEVELOPMENTAL
  - CHILD DIRECTED
  - IMITATION & SHARED EXPERIENCE
  - SOCIAL REINFORCEMENT OF DEVELOPMENTALLY ADVANCED BEHAVIORS
    - VOICE TONE, AFFECT & GESTURE
    - GREENSPAN & WIEDNER (2000)
  - BUILDING MOTIVATION AND ABILITY FOR SOCIAL LEARNING
EARLY START DENVER MODEL (ESDM)
SALLY ROGERS, UC DAVIS M.I.N.D. INSTITUTE

- Two 2 hours school sessions 5 times per week.
- Parents also taught to use ESDM in home.
- Intervention study
  - 21 toddlers: ESDM group had 15 hours of individualized and 15 hours of home based intervention.
  - 21 toddlers: Assess & Monitor (AM) group had 18 hours various community based individualized and home TX

- ESDM
  - Child centered: Adults sensitive and responsive to child cues
  - Interpersonal exchange, increased positive affect
  - Interactions with real life materials and activities
  - Focus on nonverbal and verbal communication
  - Applied behavior analysis in incidental learning trials
ESDM also leads to improved intelligence scores in preschool children.
• 30 HOURS OF TARGETED JOINT ATTENTION INTERVENTION BOOSTS LANGUAGE LEARNING IN 2- TO 4-YEAR-OLDS WITH AUTISM WHO RECEIVED 1800 HOURS OF APPLIED BEHAVIOR ANALYSIS (ABA) TREATMENT.
• 61 SIX-YEAR-OLD MINIMALLY VERBAL CHILDREN WITH ASD
  • FEWER THAN 20 SPONTANEOUS WORDS IN 20 MINUTE SAMPLE.
  • ONE GROUP RECEIVED 12 WEEKS/24 SESSIONS OF JOINT ATTENTION
    SYMBOLIC PLAY ENGAGEMENT REGULATION (JASPER) + ENHANCED
    MILIEAU TEACHING (JASP+EMT) INTERVENTION.
  • THE OTHER GROUP RECEIVED 12 WEEKS/24 SESSIONS OF JASP+EMT,
    PLUS SPEECH GENERATING DEVICE (SPD)
INTERVENTION COMPONENTS

- **JASPER** is a naturalistic behavioral intervention focused on the development of prelinguistic gestures (pointing, showing, alternating gaze, pointing to request) and symbolic play skills (play with objects “as if” they were something else to increase the child’s experience and enjoyment of joint engagement with an adult.

- **EMT** is a naturalistic behavioral intervention that uses systematic responsiveness and modeling to promote the spontaneous use of spoken language.

- **SGD** involved use of iPad or Dynavox to enable children to touch a symbol to produce a word.
SPEECH GENERATING DEVICES

ipad

Dynavox
FIGURE 2  Primary aim results for the primary outcome (total social communicative utterances). Note: Open plotting characters denote observed means; closed denote model-estimated means. Error bars denote 95% CI for model-estimated means. JASP+EMT = spoken mode of JASPER plus Enhanced Milieu Teaching; JASP+EMT+SGD = spoken mode of JASPER plus Enhanced Milieu Teaching plus Speech Generating Device.
**Student Engagement in the Classroom: The Impact of Classroom, Teacher, and Student Factors**

Jessica R. Dykstra Steinbrenner · Linda R. Watson

‘Engagement’ in the classroom assessed with measures of joint attention

<table>
<thead>
<tr>
<th>Joint attention: the child initiates communicates in order to draw the adults attention to an object or event</th>
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<tbody>
<tr>
<td><strong>3-point gaze</strong></td>
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<tr>
<td><strong>Gives</strong></td>
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<tr>
<td><strong>Shows</strong></td>
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<tr>
<td><strong>Touch point</strong></td>
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<tr>
<td><strong>Distal point</strong></td>
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<tr>
<td><strong>Other JA gestures</strong></td>
</tr>
<tr>
<td><strong>Vocalizations/Verbalizations</strong></td>
</tr>
</tbody>
</table>
JOINT ATTENTION AFTER INFANCY

Practice with Joint Attention to External Objects leads Cognitive Development of Internal Mental Joint Attention

SOCIAL COGNITION
Thinking about how what others have seen or experience

SPONTANEOUSLY SHARING EXPERIENCE
(Collaboration, Cooperation)

REFERENCE AND DEIXIS
Deictic words have denotational meaning that varies with context (e.g. him, her)
JOINT ATTENTION IN OLDER CHILDREN

“Well, we went to Boston, Massachusetts through the town of Warrenville, Connecticut on Route 44A. It was very pretty and there was a church that reminded me of pictures of Russia from our book that is published by Time-Life. We arrived in Boston at 9:17. At 11 we went on a big tour of Boston on Gray Line 43, made by the Superior Bus Company like School Bus Six, which goes down Hunting Lodge Road where Maria lives and then on to Separatist Road and then to South Eagleville before it comes to our school. We saw lots of good things like the Boston Massacre site. The tour ended at 1:05. Before I knew it we were going home. We went through Warrenville again but it was too dark to see much. A few days later it was Easter. We got a cuckoo clock.”

It is an unconventional but hardly unobservant report. In truth, I didn’t care one bit about Boston on that spring day in 1963. Instead, I wanted to learn about Warrenville… I had memorized the map of Mansfield, and knew all the school-bus routes by heart ... But Warrenville was in the town of Ashford, for which I had no guide, and I remember the blissful sense of resolution I felt when I certified that Route 44A crossed Route 89 in the town center, for I had long hypothesized that they might meet there. Of such joys and pains was my childhood composed.
LEARNING DISABILITIES IN AUTISM

• JONES ET AL. 2009  
  N = 100 ADOLESCENTS  WITH IQS ABOVE 70
  • 73% LITERACY OR MATH 1 SD LOWER THAN IQ.
  • POOR READING COMPREHENSION MOST COMMON AND RELATED TO SOCIAL SYMPTOMS.

• ESTES ET AL. 2011  
  N = 30 SECOND GRADE CHILDREN  WITH IQS ABOVE 70
  • 60% PERCENT HAD SIGNIFICANTLY LOWER ACADEMIC ACHIEVEMENT THAN PREDICTED BY IQ (9 IN SPELLING, 8 WORD READING, 12 BASIC MATH). SOCIAL SYMPTOMS PREDICTED READING.

• MAYES & CALHOUN 2008  
  N = 30 ELEMENTARY AND SECONDARY STUDENTS WITH IQS ABOVE 70
  • 70 % OF ASD CHILDREN MEET DISCREPANCY CRITERIA FOR LEARNING DISABILITIES IN ONE OR MORE DOMAINS 37% READING LD, 17% FOR MATH LD, 63% FOR WRITTEN EXPRESSION
ONE BIG HYPOTHESIS

• THE SOCIAL COMMUNICATION IMPAIRMENTS THAT CHARACTERIZE ASD OVERLAP WITH THE COGNITIVE DEMANDS OF LEARNING READING COMPREHENSION, WRITING AND MATH.

• IF SO, VULNERABILITY TO ACADEMIC LEARNING DISABILITY MAY PART OF THE PHENOTYPE FOR MANY SCHOOL AGED CHILDREN WITH ASD.
SOCIAL ATTENTION & READING COMPREHENSION

COMPONENTS OF COMPREHENSION (Solari, 2013)
READING & LANGUAGE MEASURES

- **READING COMPREHENSION (TEXT READING)**
  - Gray Oral Reading Test-5 - GORT5 (TEXT FLUENCY ALSO)
  - Qualitative Reading Inventory-5 - QRI5

- **ORAL LANGUAGE COMPREHENSION/INFERENCE**
  - Test of Auditory Processing 3: Auditory Reasoning – (TAPS AR)
  - Clinical Evaluation of Language Fundamentals 4 (CELF): Recalling Sentences (RS)

- **DECODING (WORD READING)**
  - Comprehensive Test of Phonological Processing (CTOPP), Elision (Phonological Sensitivity), Rapid Digit and Letter Naming (RAN)
  - Non-Word Repetition (NWR), Test of Word Reading Efficiency (TOWRE), Sight Word Efficiency (SWE), Pseudoword Efficiency (PDE)

- **RECEPTIVE VOCABULARY (WIAT), EXPRESSIVE VOCABULARY (WASI)**
GORT-5 COMPREHENSION: DIAGNOSTIC GROUPS AND GRADE EQUIVALENCE SCORE (CONTROLLING FSIQ; MCINTYRE ET AL. IN PRESS)

HFA (n=81)  
ADHD (n=39)  
TD (n=44)

DX Group  
p < .008 (.11)

DX Group X  
Age Interaction  
p < .05, (.08)

81 eight- to sixteen-year-olds with ASD and Mean IQ = 100 (14) Latent Profile Analysis of Language, Word & Text Reading

Latent Classes monotonically associated with ADOS-2 scores
LANGUAGE COMPREHENSION

BACKGROUND KNOWLEDGE
(facts, concepts, etc.)

VOCABULARY
(breadth, precision, links, etc.)

LANGUAGE STRUCTURES
(syntax, semantics, etc.)

VERBAL REASONING
(inference, metaphor, etc.)

LITERACY KNOWLEDGE
(print concepts, genres, etc.)

SKILLED READING:
Fluent execution and coordination of word recognition and text comprehension.

WORD RECOGNITION

PHONOLOGICAL AWARENESS
(syllables, phonemes, etc.)

DECODING (alphabetic principle, spelling-sound correspondences)

SIGHT RECOGNITION
(of familiar words)
Explicit Questions: No group differences in initial recall condition
LB: HFA< ADHD = TD, * p ≤ .004

Implicit Questions: HFA = HFA+ADHD < TD * p ≤ .003
The relation of ADOS scores to reading was explained by relations of higher order language to ADOS and Reading. Reading problems are part of the social-communication features of ASD.
READING COMPREHENSION SIGNIFICANTLY RELATED TO MATH PROBLEM SOLVING IN ASD & ADHD GROUPS
BRIEF EXAMPLES OF RELATED READING
INTERVENTION AND COGNITIVE
NEUROSCIENCE
EXAMINE THREE METHODS OF INTERVENTION FOR READING COMPREHENSION IN 20 FIFTEEN YEAR OLDS WITH ASD

- INTENTIONAL STRATEGY, ASKING QUESTIONS, PRACTICE WITH PRONOUNS (ANAPHORIC CUING).

ANAPHORIC (PRONOUN) CUING WAS THE MOST EFFECTIVE

11 OF THE 20 STUDENTS MADE LARGE GAINS IN READING COMPREHENSION OVER 16 WEEKS.
The neural basis of deictic shifting in linguistic perspective-taking in high-functioning autism

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2 Department of Speech Language Pathology, Duquesne University, 403 Fisher Hall, Pittsburgh, PA 15282, USA
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Table 1 Participant characteristics

<table>
<thead>
<tr>
<th>Demographic Information</th>
<th>Autism</th>
<th>Control</th>
<th>t(28)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>24.7 ± 7.8</td>
<td>24.7 ± 7.7</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Full scale IQ</td>
<td>106.3 ± 10.7</td>
<td>108.7 ± 5.1</td>
<td>0.81</td>
<td>0.43</td>
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<tr>
<td>Performance IQ</td>
<td>106.9 ± 16.1</td>
<td>107.4 ± 6.1</td>
<td>0.12</td>
<td>0.91</td>
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<tr>
<td>Verbal IQ</td>
<td>104.4 ± 12.7</td>
<td>108.0 ± 5.8</td>
<td>1.00</td>
<td>0.33</td>
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<tr>
<td>Handedness (right:left)</td>
<td>11:4</td>
<td>14:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (male:female)</td>
<td>14:1</td>
<td>15:0</td>
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</tbody>
</table>

Values are represented as mean ± SD.
Figure 1. Schematic diagram of the experimental stimuli.

Table 2. Summary of conditions

<table>
<thead>
<tr>
<th>Type of Task</th>
<th>Deixis</th>
<th>FIXED (Name)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Task (‘What’ question)</strong></td>
<td><strong>SHIFT (Pronoun)</strong></td>
<td><strong>Carrot</strong></td>
</tr>
<tr>
<td>Target</td>
<td>‘What can you see now?’</td>
<td>‘What can John see now?’</td>
</tr>
<tr>
<td>SELF (Participant’s view)</td>
<td>Carrot</td>
<td>House</td>
</tr>
<tr>
<td>Answer choice</td>
<td>Carrot</td>
<td>House</td>
</tr>
<tr>
<td>OTHER (Depicted person’s view)</td>
<td>‘What can I see now?’</td>
<td>‘What can Sarah see now?’</td>
</tr>
<tr>
<td>Answer choice</td>
<td>Carrot</td>
<td>House</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th><strong>Pronoun</strong></th>
<th><strong>Name</strong></th>
</tr>
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<tbody>
<tr>
<td>‘Who can see the carrot now?’</td>
<td>‘Who can see the carrot now?’</td>
</tr>
<tr>
<td>‘Who can see the house now?’</td>
<td>‘Who can see the house now?’</td>
</tr>
</tbody>
</table>

SELF (Participant’s view) | ‘Who can I can’ | ‘Who can John can’ |
| Answer choice           | You can        | Sarah can         |
| OTHER (Depicted person’s view) | ‘Who can I can’ | ‘Who can John can’ |
| Answer choice           | You can        | Sarah can         |
Figure 2: Mean reaction time. (A) A reliable interaction between autism and fixed/shift conditions on response time. (B) Comparison of signal change between autism and control groups for fixed and shift conditions. (C) Functional connectivity between the right anterior insula and precuneus, showing differences between fixed and shift conditions for autism and control groups.
RECIPROCAL TEACHING & READING IS AN ACADEMIC PLATFORM FOR SOCIAL COMMUNICATION & COGNITIVE DEVELOPMENT
Reading and Academic Development (RAD) Center

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