Heart-Defined Sustained Attention in Infant Siblings of Children with Autism

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INTRODUCTION
“High Risk” Infants

• Autism spectrum disorder (ASD) affects 1:42 U.S. males
  • Impaired social communication, repetitive behaviors
  • No biomarker

• Predicting ASD in infants → early detection, prevention

• Infant siblings of children with ASD (ASIBs) = 19% risk
  • Over 100 ASIB studies in last decade

• ASIBs at risk for multiple outcomes
  • Warrants mechanism-specific research
“High Risk” Infants

Two complementary approaches to “high risk” studies:

1. **Examine prodromal features of ASD**
   - Outcome: identify predictors of later diagnoses
“High Risk” Infants

Two complementary approaches to “high risk” studies:

1. Examine prodromal features of ASD
   - Outcome: identify predictors of later diagnoses

2. Examine endophenotypes

   **Endophenotype:** a measurable, heritable trait that associated with a clinical profile
   (Gottesman & Gould, 2003)

   - Characterize broader phenotype
   - Outcome: characterize genetic associations, risk
“High Risk” Infants

**Broader Autism Phenotype:** subthreshold autism-associated features in first-degree relatives of individuals with autism (Baron-Cohen, 2004; Folstein & Rutter, 1977)

Discrete Trait

Continuum

Retrieved from www.theautcast.com
Attention in ASD

Is abnormal attention an **endophenotype** of ASD?

Areas of abnormal attention in ASD

- Over-engagement in objects
- Following gaze
- Orienting to name
- Social aloofness
- Sticky visual attention
Attention in ASD

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Orienting and Disengagement

• Infants at risk for ASD show impaired disengagement from 6-12 months of age (Elsabbagh et al., 2009, 2013; Zwaigenbaum et al., 2005; Elison et al., 2013)
Orienting and Disengagement

- Infants at risk for ASD show impaired disengagement from 6-12 months of age (Elsabbagh et al., 2009, 2013; Zwaigenbaum et al., 2005; Elison et al., 2013)
Arousal

- Abnormal polyvagal functioning implicated in ASD (Bal et al., 2010; Klusek et al., 2015; Quintana et al., 2012)

**Polyvagal Theory:** Human autonomic system has evolved to maintain behavioral and psychosocial characteristics (Porges, 1995)

- Parasympathetic activity = regulated by vagus

- Vagus also controls
  - Facial muscles
  - Visceral processes (e.g. metabolic function, digestion)

- Abnormal arousal, facial expression, visceral processes in ASD
Arousal

Figure 2. Cross-sectional interaction between age and interbeat interval (IBI) during toy play in the group with fragile X syndrome. CARS = Childhood Autism Rating Scale (Schopler, Reichler, & Renner, 1988). At younger ages, IBI was positively related with CARS outcomes. At older ages, IBI was negatively related with CARS outcomes. m = months.

Heart-Defined Attention

• Visual orienting and physiological arousal intersect (e.g. Casey & Richards, 1991; Richards, 2000)

• Infants in sustained attention are less distractible during:
  • computerized tasks (Casey & Richards, 1988; Richards, 1997)
  • behavioral tasks (Lansink & Richards, 1997; Roberts et al., 2011)

Could sustained attention inform orienting deficits in ASD?
Greater sustained attention will be associated with greater behavioral looking.

ASIBs will display “extreme” behavioral and heart-defined sustained attention compared to controls.

Abnormal behavioral and heart-defined attention will predict clinical autism risk at 11-14 months.
METHODS
Participants

- 43 participants
  - 21 infant siblings (ASIBs)
  - 22 low risk (LR) controls

- Attention assessed between 1-3 occasions ($n=77$ total)

- Attention data at all assessments; clinical data at 11-14 months

- Missing data: 22.2% ($n=11$ per group)
  - 30% looking required for SA calculations (excluded 6 ASIB, 3 LR)
  - Physiological data excluded if >5% artifact
Behavioral Measures

Behavioral Looking

- *Baby Einstein* video (135s)
  - Inter-rater reliability = 83%
  - Coded using Noldus Observer

Clinical Autism Risk

- *Autism Observation Scale for Infants* Total Score
  - Research reliability
  - Inter-rater reliability = 89%

Mental Age

- *Mullen Scales of Early Learning* Early Learning Composite
Heart Activity

Collection
Alive System

Conversion
ATS Convert

Editing
CardioEdit

Global Heart Activity
CardioBatch
IBI, RSA, IBI SD

If > 5% Error
Use behavior only

If ≤ 5% Error

Heart Defined SA
Richards’ SAS Algorithms
%SA, IBI Change, IBI SD

IBI Change

Beats of Sustained Attention
## Analyses: MLM

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Analyses: MLM

Level 1 (Unconditional Models): Examine DVs across age

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- Across our sample, what are DVs at the mean age of our sample, and how do these levels change over time?
Analyses: MLM

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**Level 2** (Conditional Models): Effects of “predictors” on trajectories
- Group
- Clinical autism risk
Results

• Proportion of time in behavioral and heart-defined attention correlated ($\rho = -.69, p < .001$)
• Proportion of time in behavioral attention not associated with global heart activity or features of SA
Results

**CROSS-GROUP DIFFERENCES**

ASIBs failed to display typical decreases of behavioral and sustained attention across age.
Among ASIBs with AOSI data (n=19; 39 assessments), higher clinical autism risk associated with abnormal trajectories of:

- Global IBI (overall IBI, IBI SD)
- Sustained attention (IBI change, IBI variability)
- Behavioral variables ns
Summary

• Abnormal arousal present in infancy in ASIBs, prior to onset of autism symptomatology
• Substantial heterogeneity in profiles

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**Distinguished Groups**

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Predicted ASD Risk
Take-Home Points

BIOBEHAVIORAL ASSOCIATIONS

Proportion of time in behavioral attention correlated with proportion of time in SA, but not SA features

CROSS-GROUP DIFFERENCES

Abnormal behavioral and heart-defined attention emerged within the first year of life in ASIBs

CLINICAL SIGNIFICANCE

Abnormal physiological profiles (not behavior) predicted clinical ASD risk
3 Key Outcomes:

- Supports abnormal orienting as
  - Endophenotype of ASD
  - Potential predictor of clinical risk

- Deficits may be emerging earlier than previously reported
  - Longitudinal methods revealed nuanced changes
  - Further work needed to establish longitudinal outcomes

- Heart activity – not behavior – sensitive to within-group risk
  - SA as potential biomarker
  - Increased sensitivity to growth – treatment monitoring?
Limitations & Next Steps

Limitations:
• Underpowered to examine sex and nuanced age effects
• G-O task design
• Lack of outcome data

Next Steps:
• Examine outcomes (ASD, developmental, language, anxiety)
• Examine additional indicators of attention
• Design tasks to test visual processing versus arousal $H_0$
Long-Term Impact

• Inform early detection, prevention and intervention
• Improve diagnostic tools in NDDs
• Promote school readiness
• Support families and teachers

“For the first time, prevention of ASD is plausible. Prevention will entail detecting infants at risk before the full syndrome is present and implementing treatments designed to alter the course of early behavioral and brain development.”

- Geraldine Dawson (2008)
Thank you!

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  • John Richards

• NDD Lab

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  • Erica Mazur
  • Bailey Tackett

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