# Egocentric Vision: Potential Applications for Very Early Intervention in Autism

**Michael S. Gaffrey, Ph.D.**

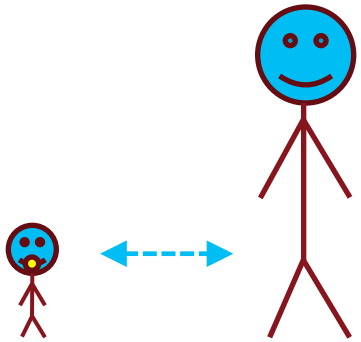
Early Preventive Intervention Clinic
William Greenleaf Eliot Division of Child Psychiatry

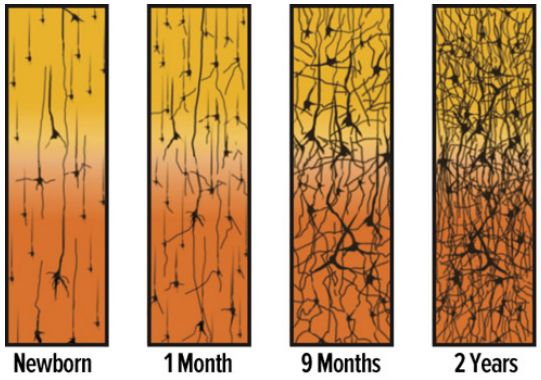
Washington University in St. Louis
School of Medicine

# Overview

- Joint engagement and development
- ASD and joint engagement
- Parent-mediated intervention for ASD
  - Joint engagement as a primary target
- Dyadic head mounted eye tracking as a tool
- Future directions

# Joint Engagement is Critical for Development



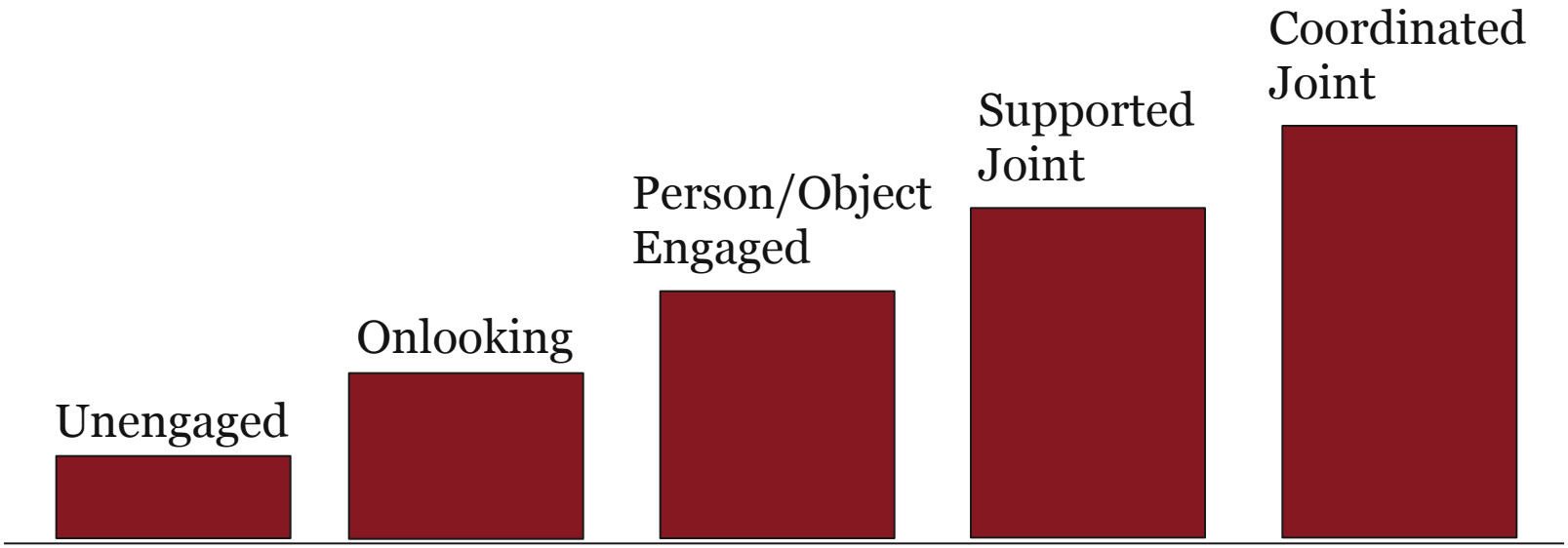



Brain development

Communication development

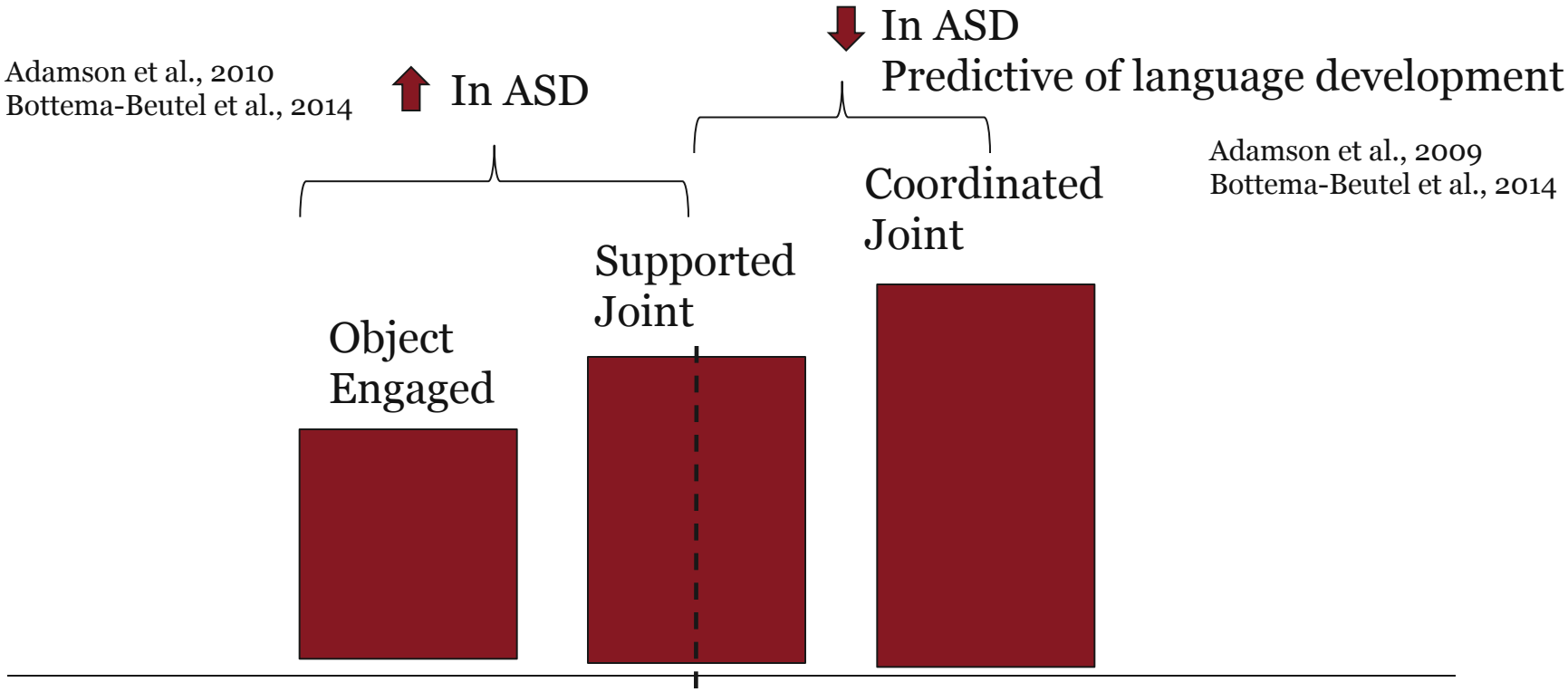
Play development

# Joint Engagement is Critical for Development



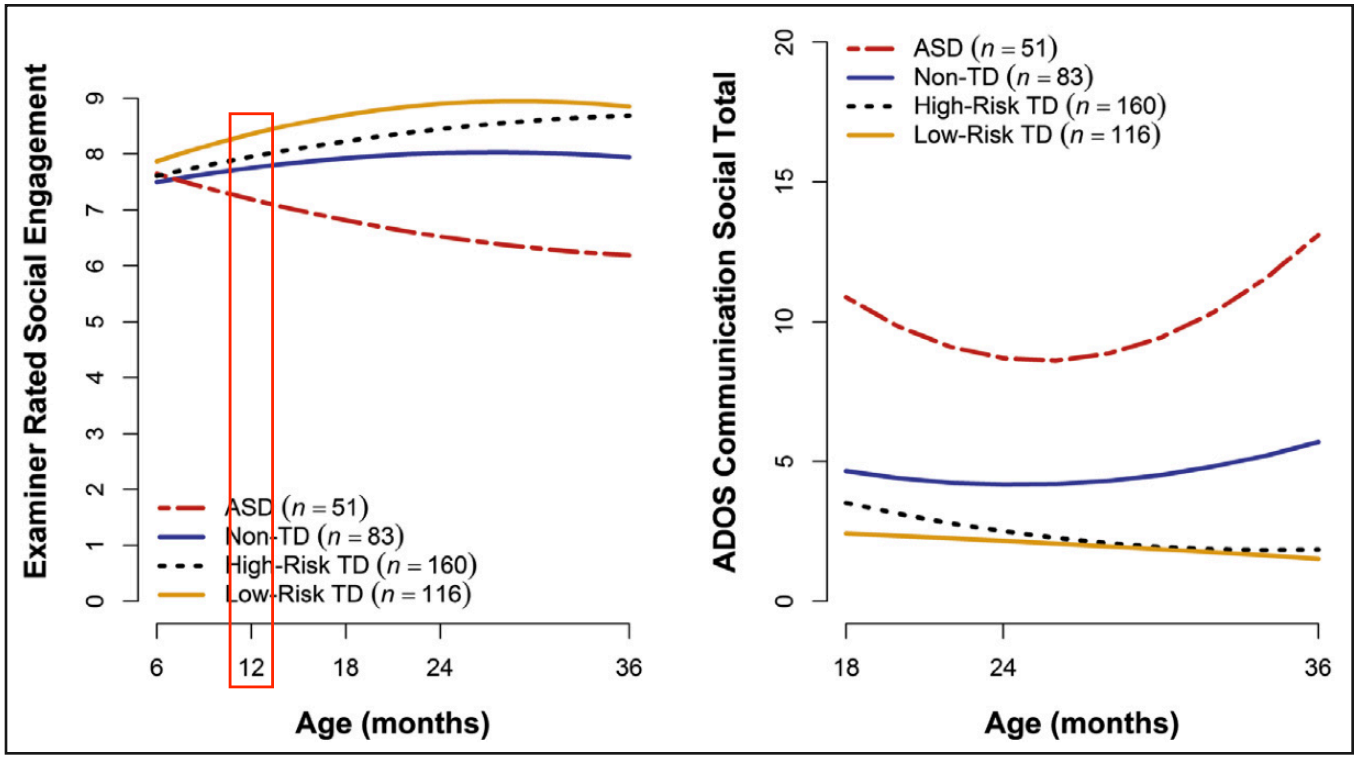

Levels of Joint Engagement (Adamson et al. 2004)
Can move through multiple engagement states during interaction

# Joint Engagement is Critical for Development




Levels of Joint Engagement (Adamson et al. 2004)
Can move through multiple engagement states during interaction

# Autism Spectrum Disorder: Trajectory Towards ASD




Ozonoff et al., JAACAP, 2014

# Autism Spectrum Disorder: Early Diagnostic Stability

**Table 1** Previously published stability studies of children diagnosed with autism spectrum disorder (ASD) before age 3

| | ASD *n* | Not ASD *n* | Time 1 age | Time 2 age | True positives | False positives | False negatives | True negatives | Sensitivity (%) | Specificity (%) | Positive predictive value (Stability) (%) | Negative predictive value (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All ASD, no non-spectrum | | | | | | | | | | | | |
| Stone 1999 | 37 | 0 | 31 m | 43 m | 31 | 6 | | | | | 84 | |
| Takeda 2005 | 57 | 0 | 31 m | 67 m | 57 | 0 | | | | | 100 | |
| Turner 2007 | 48 | 0 | 2 y | 4 y | 30 | 18 | | | | | 63 | |
| Paul 2008 | 37 | 0 | 22 m | 37 m | 37 | 0 | | | | | 100 | |
| Itzchak 2009 | 68 | 0 | 25 m | 37 m | 66 | 2 | | | | | 97 | |
| Both ASD & non-spectrum – clinically ascertained | | | | | | | | | | | | |
| Eaves 2004 | 43 | 6 | 33 m | 57 m | 40 | 3 | 0 | 6 | 100 | 67 | 93 | 100 |
| Lord 2006 | 130 | 42 | 2 y | 9 y | 124 | 6 | 11 | 31 | 92 | 84 | 95 | 74 |
| Chawarska 2007 | 27 | 4 | 14–25 m | - | 27 | 0 | 1 | 3 | 96 | 100 | 100 | 75 |
| Sutera 2007 | 73 | 17 | 16–30 m | - | 60 | 13 | 0 | 17 | 100 | 57 | 82 | 100 |
| Kleinman 2008 | 61 | 16 | 27 m | 53 m | 46 | 15 | 0 | 16 | 100 | 52 | 75 | 100 |
| Chawarska 2009 | 61 | 28 | 22 m | 47 m | 61 | 0 | 3 | 25 | 95 | 100 | 100 | 89 |
| Worley 2011 | 53 | 61 | 23 m | 31 m | 38 | 15 | 12 | 49 | 76 | 77 | 72 | 80 |
| Corsello 2013 | 26 | 6 | 30 m | 3–8 y | 20 | 5 | 2 | 4 | 91 | 44 | 80 | 67 |
| Both ASD & non-spectrum – community ascertained | | | | | | | | | | | | |
| Cox 1999 | 12 | 38 | 20 m | 42 m | 12 | 0 | 9 | 29 | 57 | 100 | 100 | 76 |
| Ventola 2007 | 46 | 17 | 27 m | - | 38 | 8 | 0 | 17 | 100 | 68 | 83 | 100 |
| van Daalen 2009 | 53 | 78 | 26 m | 45 m | 46 | 7 | 2 | 76 | 96 | 92 | 87 | 97 |
| Guthrie 2013 | 56 | 26 | 19 m | 37 m | 56 | 0 | 3 | 23 | 95 | 100 | 100 | 88 |

Note: m, months; y, years; -, age not reported; TN, true negatives; TP, true positives; FN, false negatives; FP, false positives.
Sensitivity = TP/(TP + FN); Specificity = TN/(TN + FP); Positive predictive value = TP/(TP + FP); Negative predictive value = TN/(TN + FN).

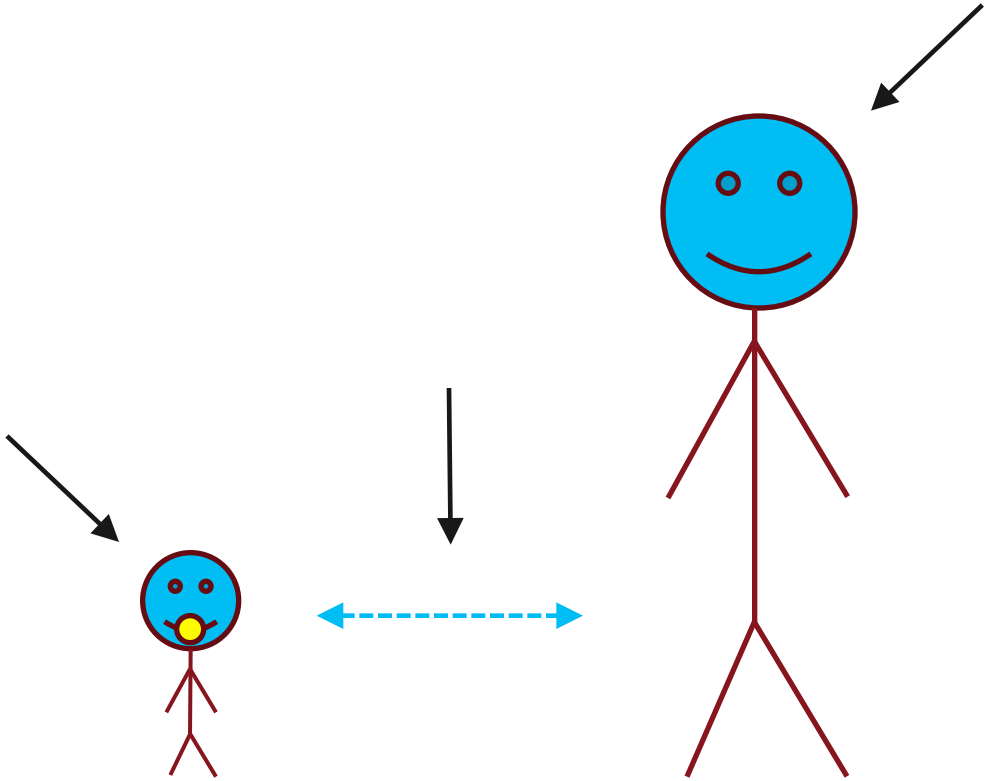
Ozonoff et al., JCPP, 2015

**Table 4** Patterns of Clinical Best Estimate outcome classifications across visits

| Clinical Best Estimate Outcome | | | Total ($n$ = 418) | ASD at 36 months ($n$ = 110) | Not ASD at 36 months ($n$ = 308) | Classification |
|---|---|---|---|---|---|---|
| 18 months | 24 months | 36 months | | | | |
| A | A | A | 38 | 35% | – | True positives |
| A | A | N | 2 | – | 0.7% | False positives |
| A | N | N | 1 | – | 0.3% | False positives |
| N | A | N | 12 | – | 4% | False positives |
| A | N | A | 3 | 3% | – | False negatives |
| N | A | A | 27 | 25% | – | False negatives |
| N | N | A | 42 | 38% | – | False negatives |
| N | N | N | 293 | – | 95% | True negatives |

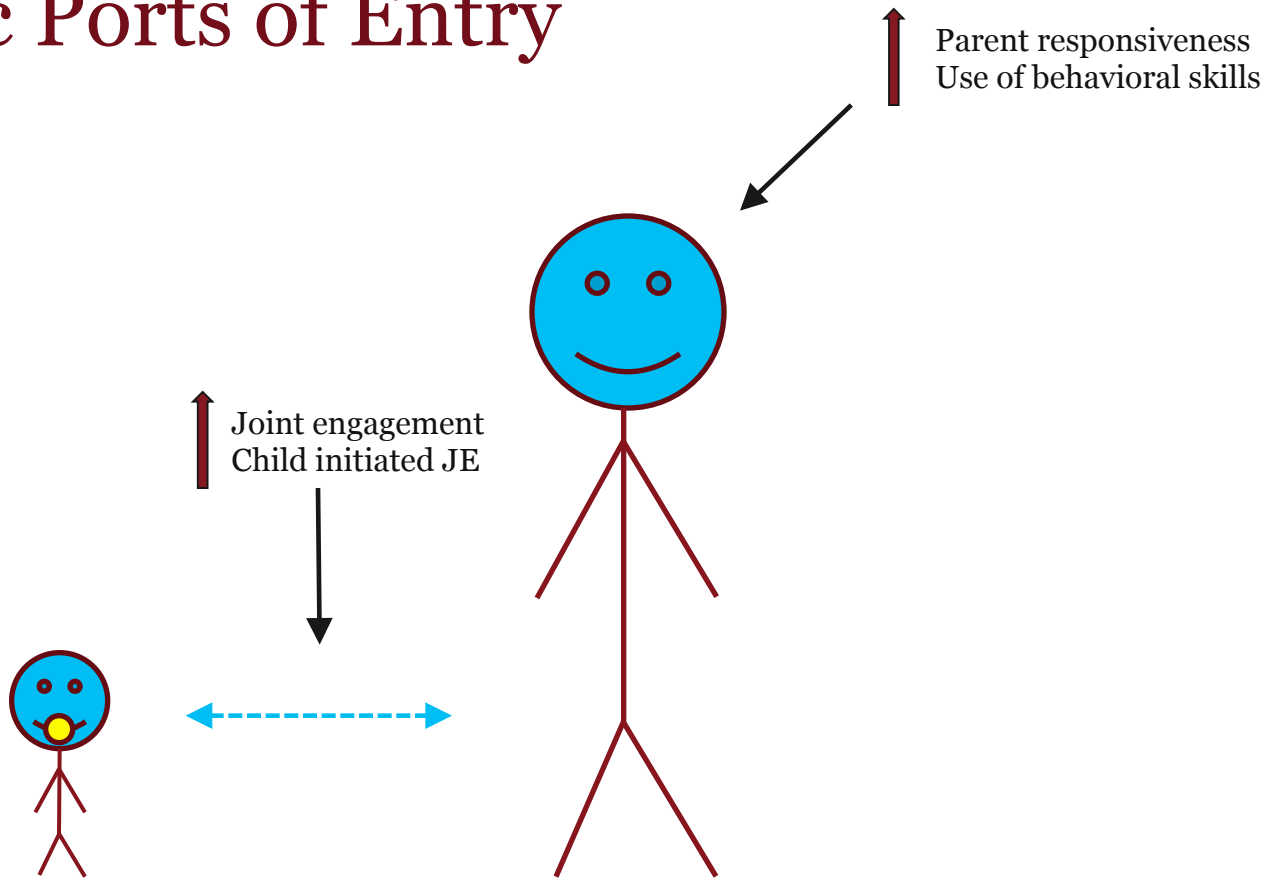
ASD, autism spectrum disorder; A, ASD; N, Not ASD.

# Therapeutic Ports of Entry



Stern, 1995

# Therapeutic Ports of Entry




Shire, Gulsrud, & Kasari, 2016

# ASD Intervention: Common Principles

ORIGINAL PAPER

**Naturalistic Developmental Behavioral Interventions: Empirically Validated Treatments for Autism Spectrum Disorder**

**Laura Schreibman · Geraldine Dawson · Aubyn C. Stahmer · Rebecca Landa · Sally J. Rogers · Gail G. McGee · Connie Kasari · Brooke Ingersoll · Ann P. Kaiser · Yvonne Bruinsma · Erin McNerney · Amy Wetherby · Alycia Halladay**

ESDM

Koegel Autism: Pivotal Response Treatment (PRT)® Training and Services

Project ImPACT


| JA | SP | E | R |
|---|---|---|---|
| Joint Attention | Symbolic Play | Engagement | Regulation |

# NDBI: Core Components

- Focus on socio-communicative learning via interactions with others
  - Joint engagement
- Learning is enhanced when embedded in activities that contain emotionally meaningful social interactions
    - Transforming common daily activities into motivating 'play' routines
- Begin as very simple action sequences
  - As duration and quality of interaction increases 'teachable moments' are identified and used to expand child's skills using well validated behavioral techniques
    - Joint attention, imitation, language

Schreibman et al., JADD, 2015

Initial Evaluation

Week 1: L.O.V.E. I.T.

Week 2: Attentional Spotlight

Week 3: Sharing the Play

Week 4: Play as Learning/ABCs

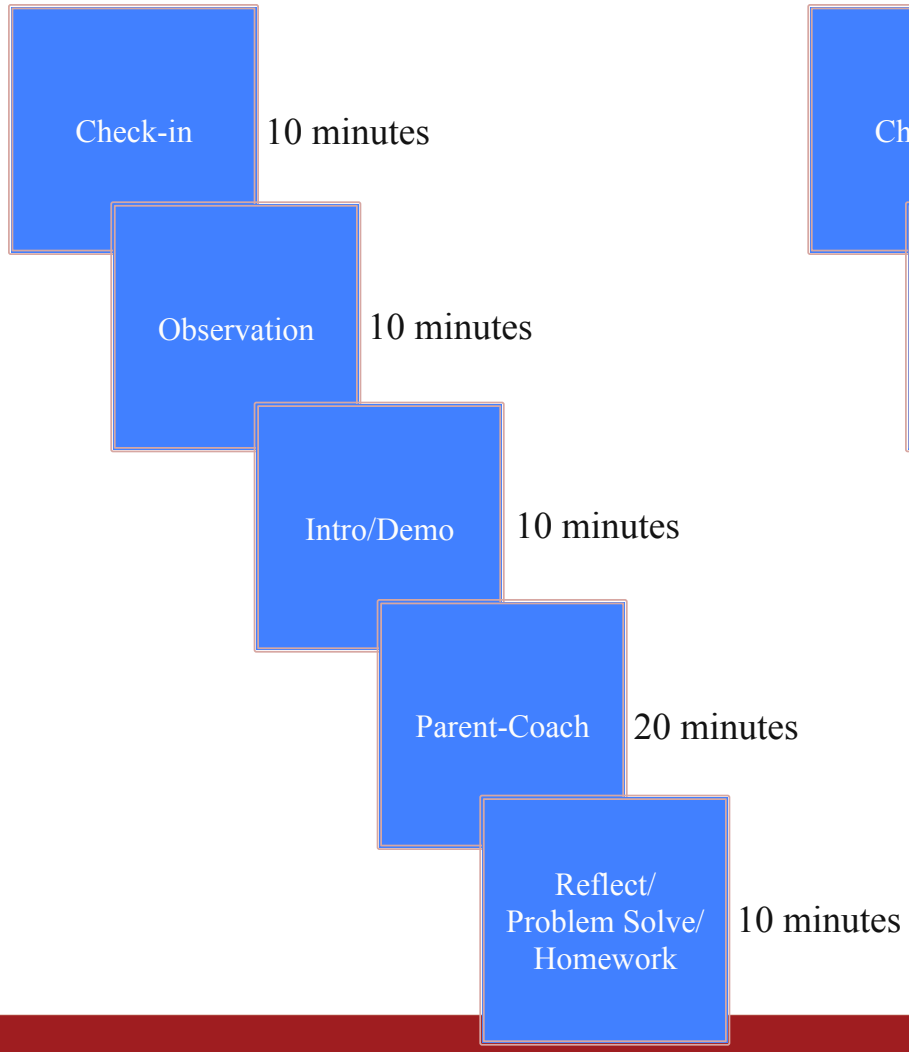
Weeks 5 & 6: First Steps to First Words

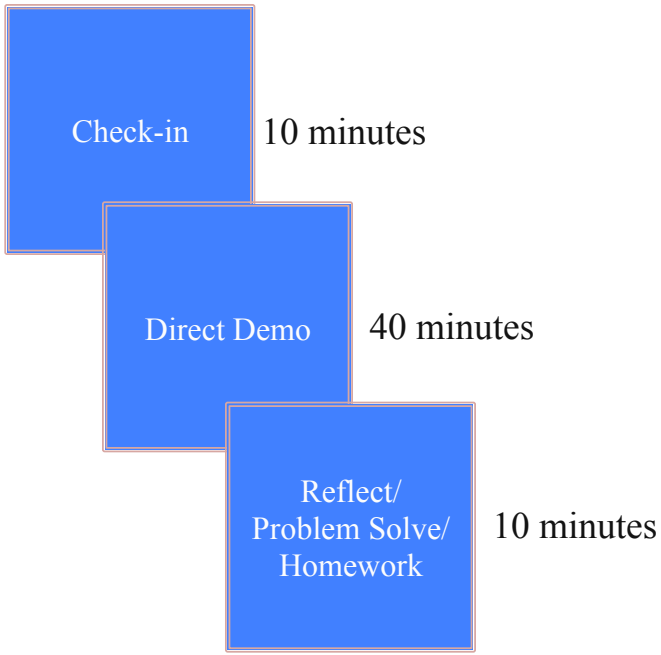
Weeks 7, 8, 9, & 10: Parent Guided

Weeks 11 & 12: G.E.T. I.T. Booster Sessions

Post Evaluation/ Next Steps

# Session Outline



# NDBI: Increasing Join Engagement

Object engaged

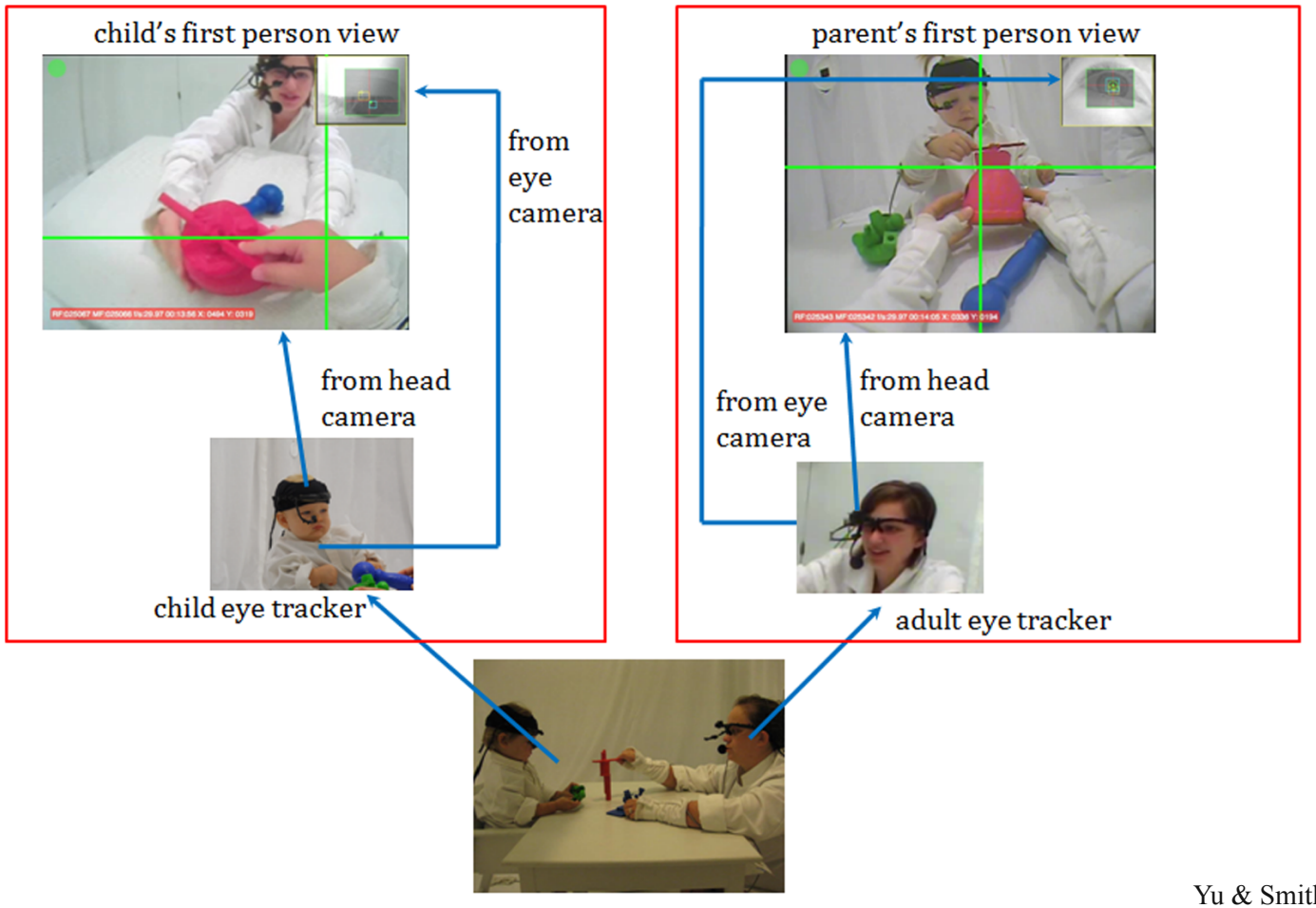
Coordinated Joint

# Facilitating Joint Engagement: A Therapeutic Port of Entry for ASD

Infants who are able to incorporate a partner into their play experience are effectively engaging in rudimentary social exchanges through objects. By increasing the amount of time an infant with ASD spends in joint engagement with others, we create increased access to play situations where social communication is relevant and opportunities for facilitating development and learning can be capitalized upon.

**However, the mechanisms of change underlying the positive effects of NDBI remain largely unknown**

# Dyadic Head-Mounted Eye Tracking: Tracking Visual Engagement and Play




Yu & Smith, PLoS ONE, 2013

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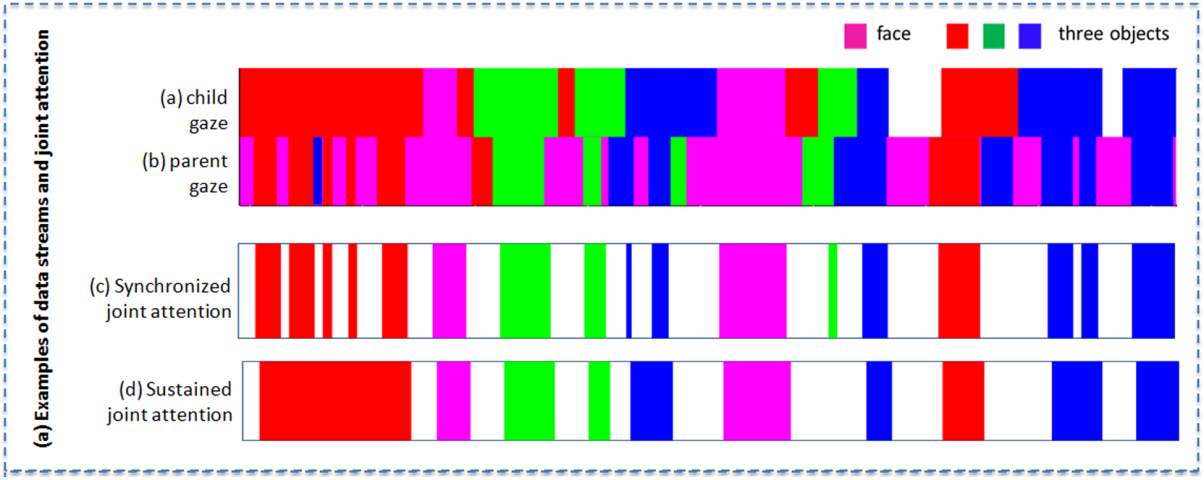
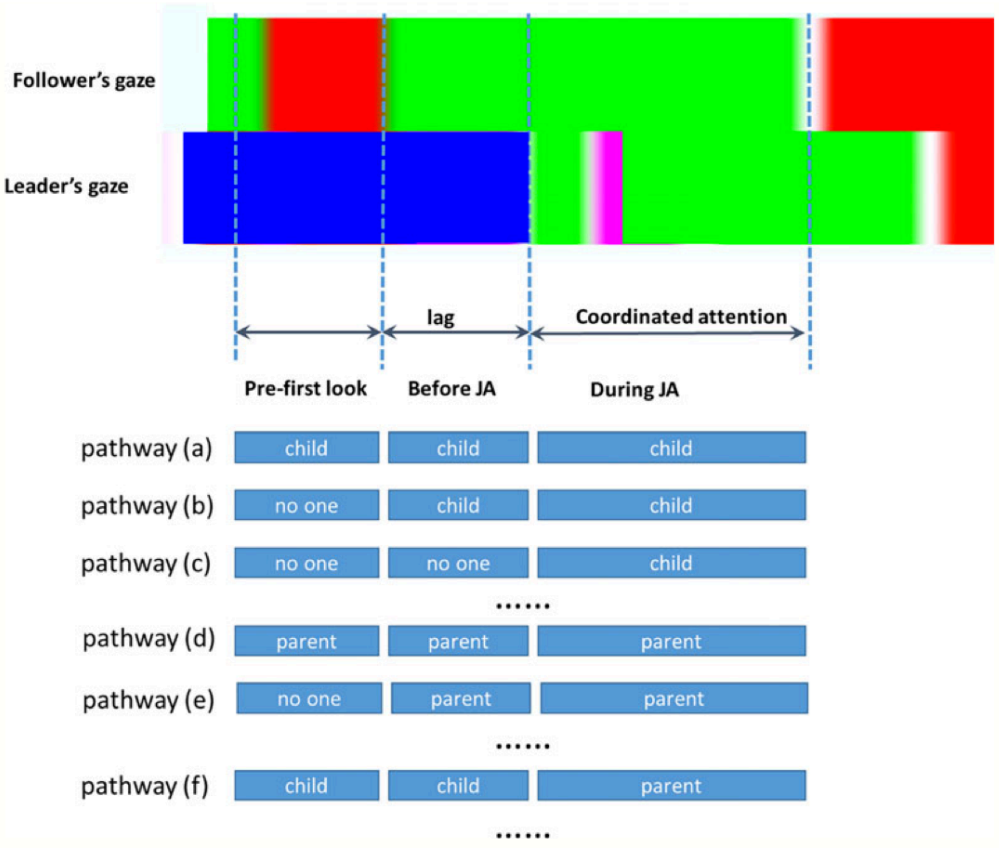
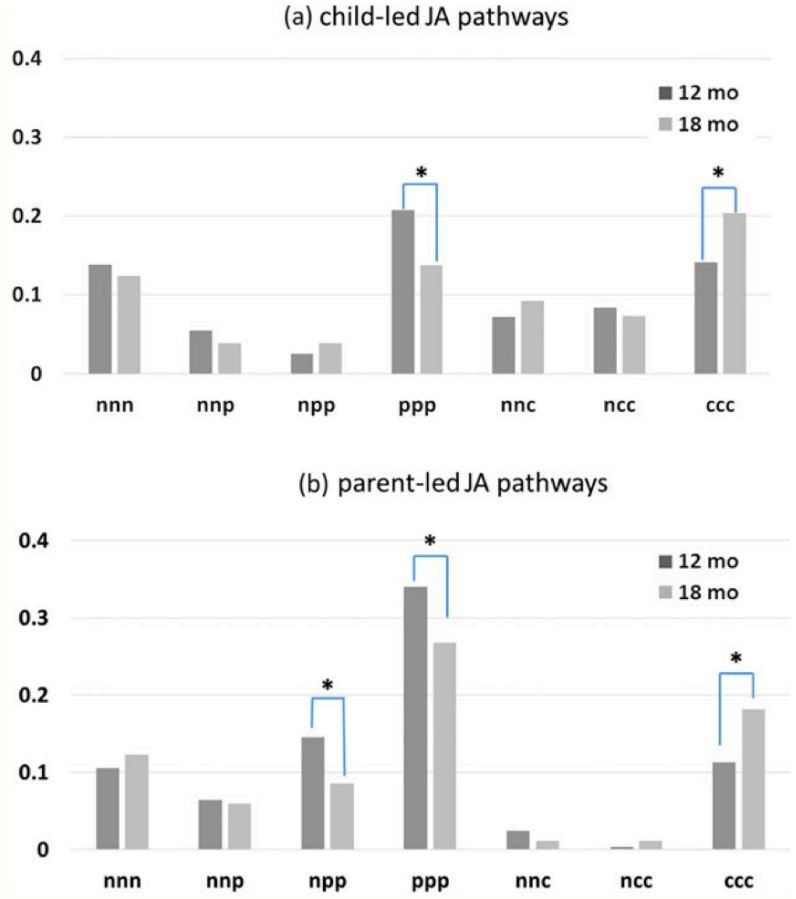


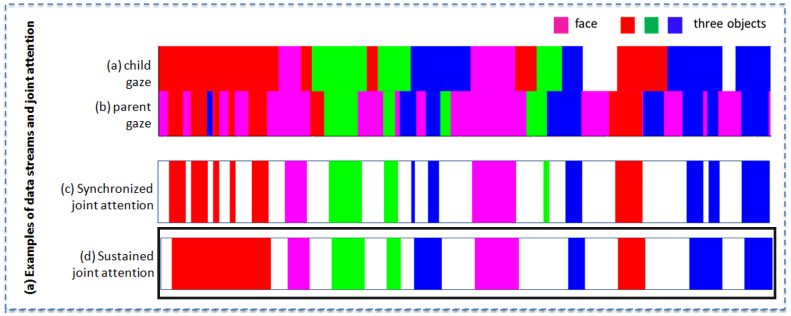

| | | synchronized attention | sustained coordinated attention |
|---|---|---|---|
| **Proportion (% of time)** | Overall | 42.56 (11.35) | 51.35(5.41) |
| | mutual gaze | 9.76 (5.85) | 9.45(3.23) |
| | Object | 32.80 (7.63) | 41.55(6.46) |
| **Frequency (rate/min)** | overall | 22.58(5.06) | 9.29(1.63) |
| | mutual gaze | 4.85(2.37) | 2.24(1.38) |
| | object | 17.73(4.19) | 7.05(1.63) |
| **mean duration (in second)** | overall | 0.85 (0.30) | 2.45(0.95) |
| | mutual gaze | 0.86(0.28) | 1.85(0.41) |
| | object | 0.82(0.31) | 2.53(1.02) |

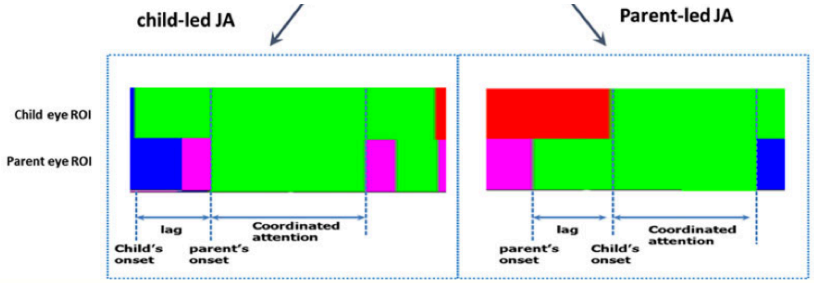
# Dyadic Head-Mounted Eye Tracking: Tracking Visual Engagement and Play

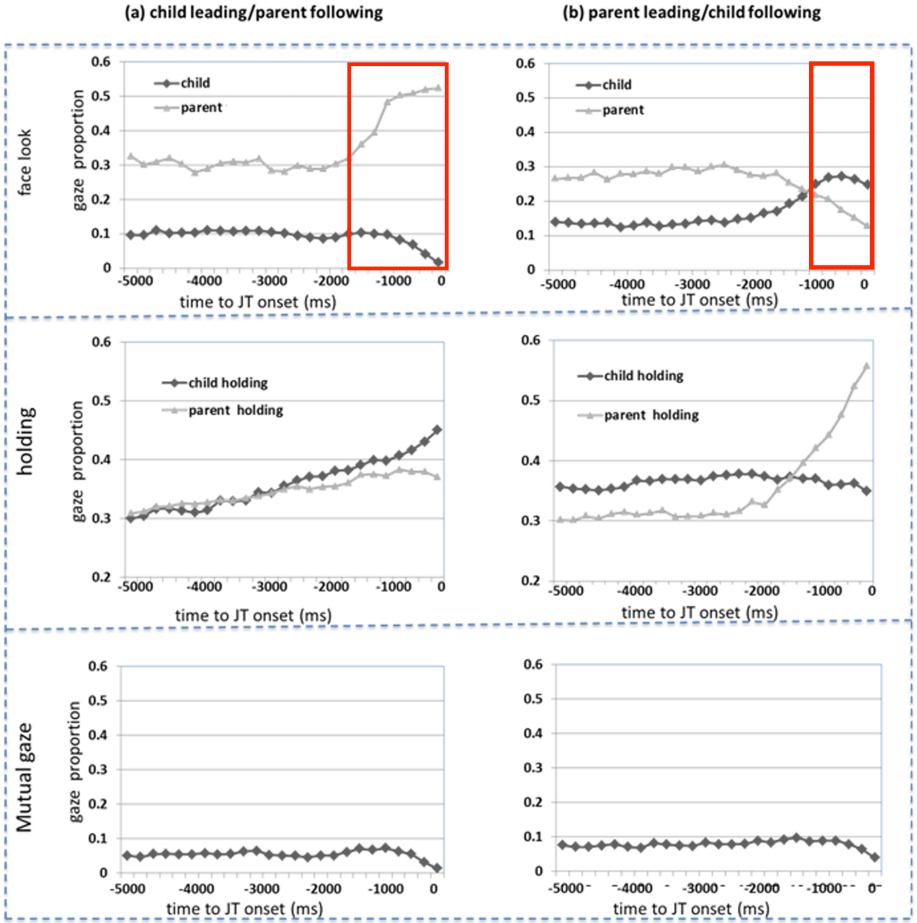


# Dyadic Head-Mounted Eye Tracking: Tracking Visual Engagement During Play



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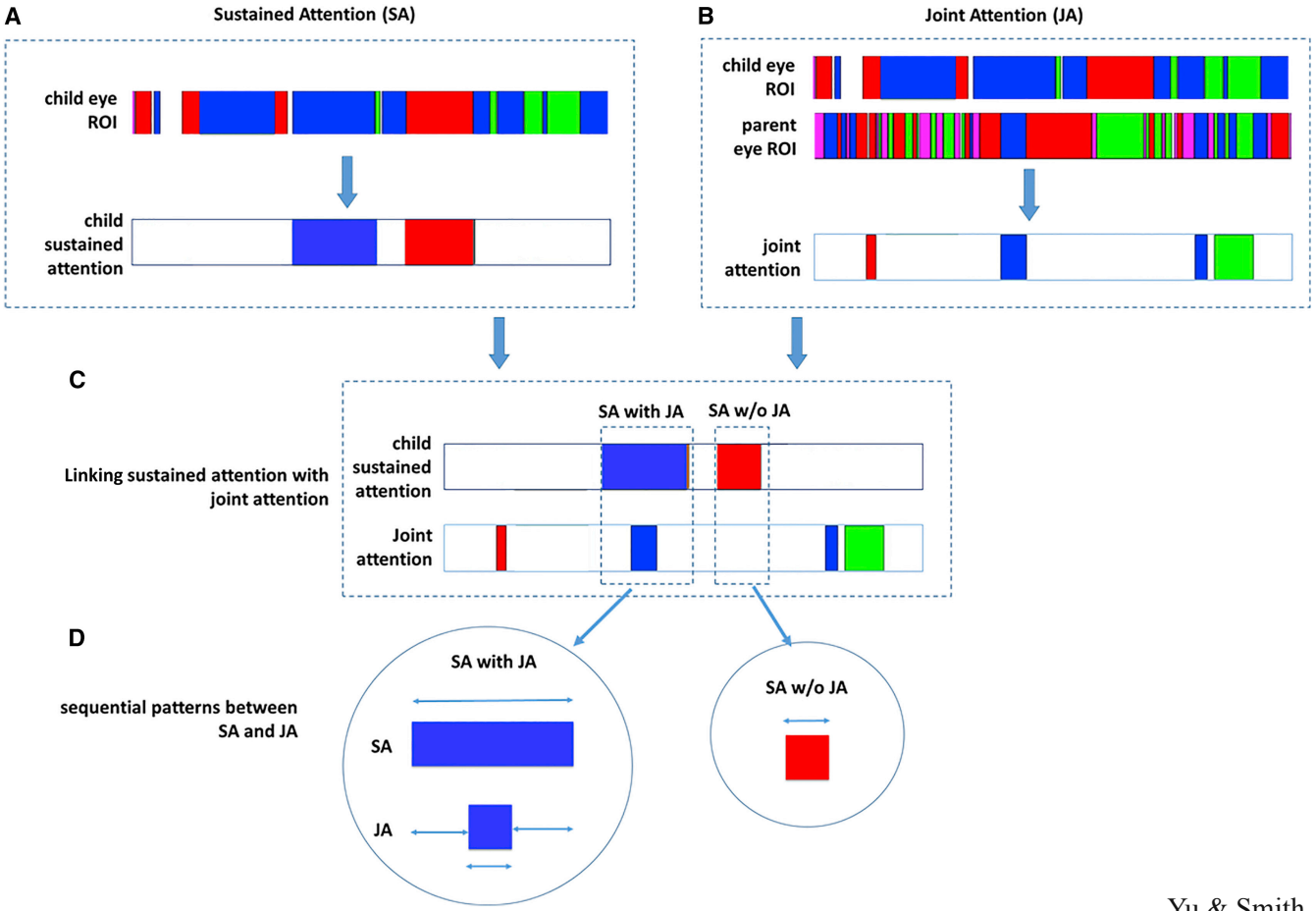


Yu & Smith, Current Biology, 2016

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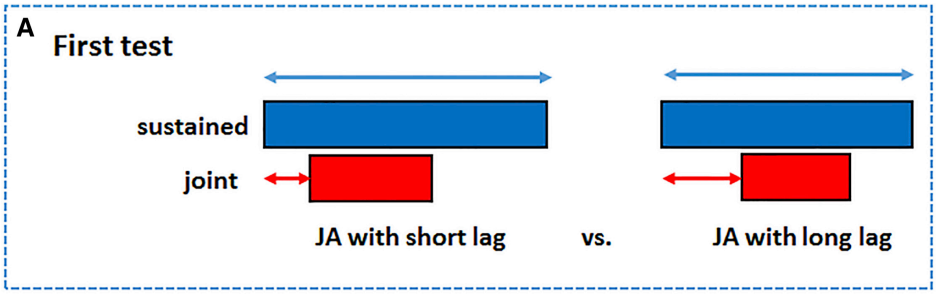
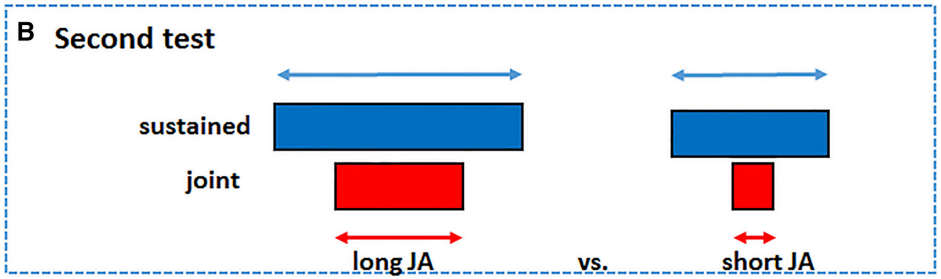
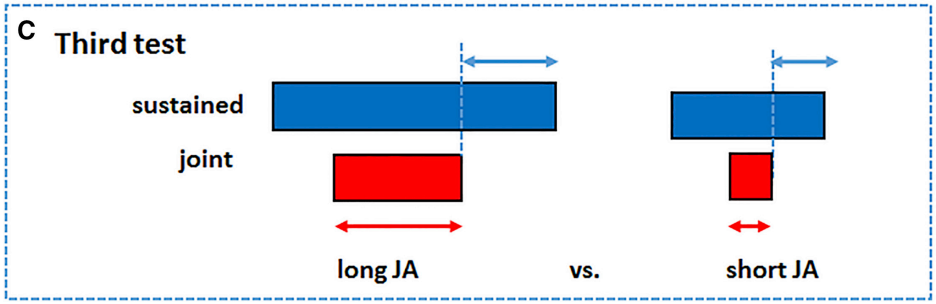



$M_{long\text{-}lag}$ = 5,231 ms; $M_{short\text{-}lag}$ = 4,876 ms
b = 0.07, SE = 0.17, not significant

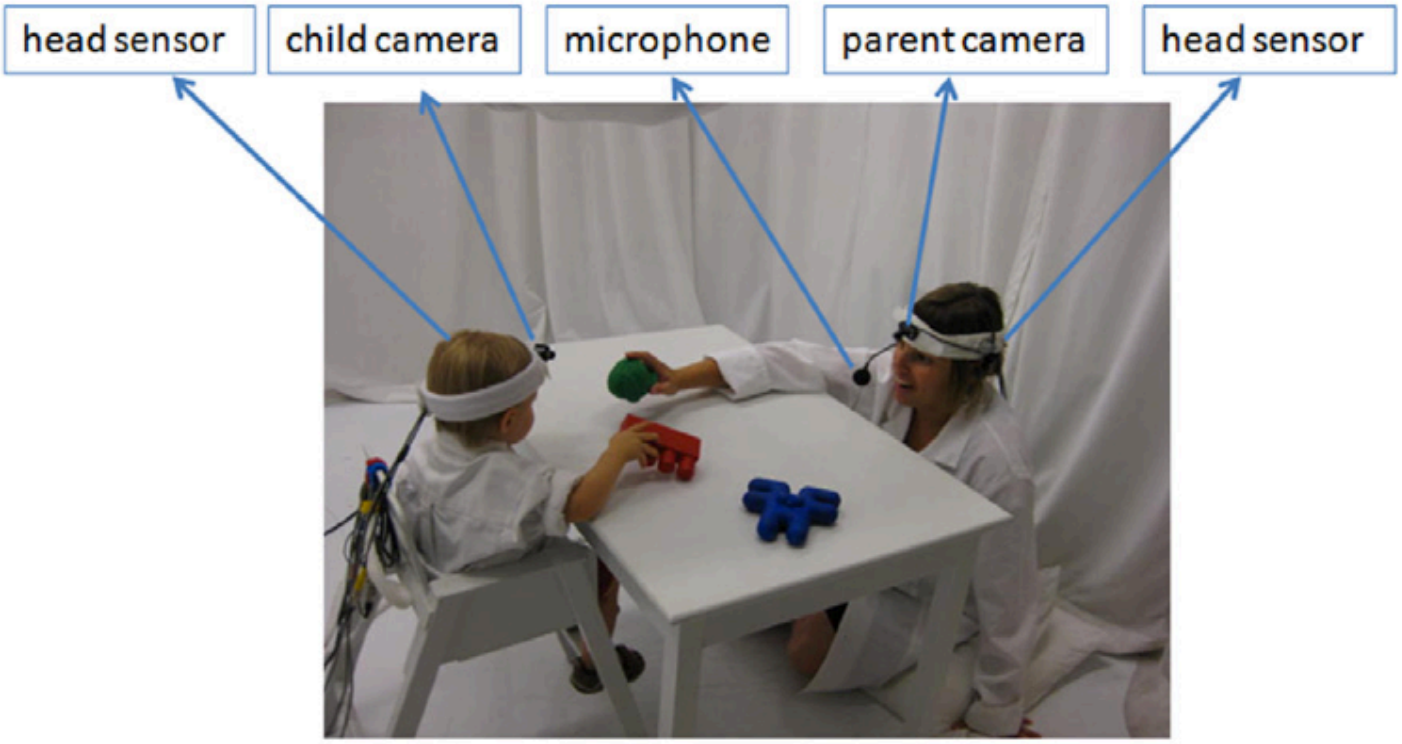



$M_{long\text{-}JA}$ = 6,540 ms; $M_{short\text{-}JA}$ = 4,293 ms
b = 0.87, SE = 0.17, $p < 0.001$




$M_{long\text{-}JA}$ = 2,146 ms; $M_{short\text{-}JA}$ = 959 ms
b = 0.82, SE = 0.09, $p < 0.001$

# Dyadic Head-Mounted Eye Tracking: Tracking Visual Engagement and Play




N=6; ~18.5 months old

Yu & Smith, Cognition, 2012

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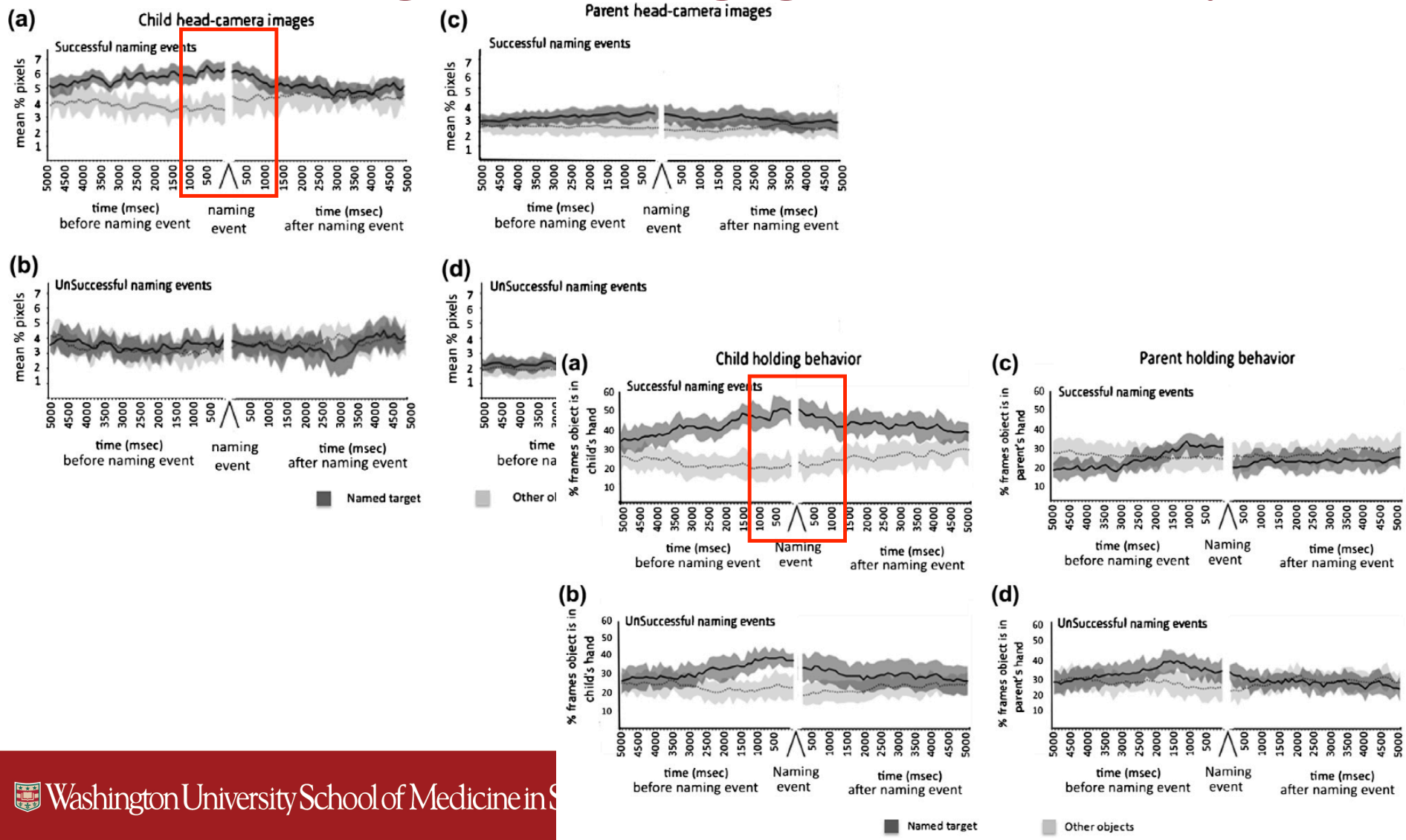

# Summary

- ASD interferes with joint engagement
- NDBI current best practice for infant ASD
- Egocentric vision techniques would likely provide new insights into therapeutic targets and mechanisms of change in NDBI
  - Inform treatment strategies
  - Inform treatment progress and outcome
  - Inform how paths toward engagement could be used synergistically
    - Scaffolding
    - Alternative

# Future Directions

- Currently using DHMET to investigate visual joint engagement and play in 12-24 month olds with and without ASD

- Planning launch of pilot RCT of NDBI using DHMET and data from other related eye-tracking techniques as measures of outcome and to predict treatment response

- Intriguing potential for synergy with other approaches
  - Neuroimaging

Michael S. Gaffrey, Ph.D.
Assistant Professor
Department of Psychiatry (Child)
Washington University SOM
Campus Box 8514
4444 Forest Park Avenue
St. Louis, MO 63108
(314) 273-8009

gaffreym@wustl.edu