Outline

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  - Social challenges for children with ASD in schools.
  - Need for adaptive treatment
- Purpose of our study
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- Results
- Summary
- Conclusion
Autism spectrum disorder (ASD) influences children’s development in the domains of communication, social skills, and behavioral flexibility.
Background
Interventions have been developed to address the social challenges experienced by many children with ASD, but with mixed success.

One-size-fits-all approach to social skills intervention may not maximize the potential of this wide range of children with ASD.
Adapting interventions based on children’s response to intervention is a necessary next step that is currently limited in the autism research literature.
Most interventionists rely on their own expert clinical judgment, the consensus judgment of those around them, and behavioral theory to determine when treatment should be altered.
Purpose of Study

- Our study focuses specifically on the following question: “For children with autism who are receiving a social skills intervention, *is it possible* to identify early who are the children in need of an intervention modification based on playground observations of peer engagement?”

- In order to begin developing high quality adaptive interventions in autism, an important open question is *how* to identify early on (i.e., during treatment) the children who need a modification in their treatment.
Current Study Design

- Randomized controlled trial comparing two different social skills interventions conducted in elementary schools
  - ENGAGE ($n=82$) and SKILLS ($n=68$).
- Excluded
  - Exhibited procedural deviation
  - Had engagement similar to typically developing peers at entry ($n=21$, 14%)
## Current Study

<table>
<thead>
<tr>
<th>Variable: Mean (SD)</th>
<th>All Children (N=92)</th>
<th>SKILLS (n=40)</th>
<th>ENGAGE (n=52)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male: n (%)</td>
<td>75 (81.50%)</td>
<td>21 (80.00%)</td>
<td>43 (82.70%)</td>
<td>0.953</td>
</tr>
<tr>
<td>Age</td>
<td>8.14 (1.39)</td>
<td>8.1 (1.46)</td>
<td>8.17 (1.34)</td>
<td>0.804</td>
</tr>
<tr>
<td>Race: n (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.83</td>
</tr>
<tr>
<td>African American</td>
<td>10 (10.87%)</td>
<td>4 (10.00%)</td>
<td>6 (11.54%)</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>39 (42.39%)</td>
<td>18 (45.00%)</td>
<td>21 (40.38%)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>16 (17.39%)</td>
<td>5 (12.50%)</td>
<td>11 (21.15%)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>16 (17.39%)</td>
<td>8 (20.00)</td>
<td>8 (15.38%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>4 (4.35%)</td>
<td>2 (5.00%)</td>
<td>2 (3.85%)</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>7 (7.61%)</td>
<td>3 (7.50%)</td>
<td>4 (7.69%)</td>
<td></td>
</tr>
<tr>
<td>ADOS Diagnosis: Autism n (%)</td>
<td>75 (81.52%)</td>
<td>30 (75.00%)</td>
<td>45 (86.54%)</td>
<td>0.253</td>
</tr>
<tr>
<td>ADOS Subscales</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4.26 (2.05)</td>
<td>4.00 (2.09)</td>
<td>4.46 (2.01)</td>
<td>0.286</td>
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<tr>
<td>Reciprocity</td>
<td>9.38 (3.00)</td>
<td>8.90 (3.06)</td>
<td>9.75 (2.92)</td>
<td>0.179</td>
</tr>
<tr>
<td>Social Communication</td>
<td>13.52 (4.86)</td>
<td>12.62 (5.10)</td>
<td>14.21 (4.60)</td>
<td>0.121</td>
</tr>
<tr>
<td>Imagination</td>
<td>0.92 (0.77)</td>
<td>0.95 (0.88)</td>
<td>0.90 (0.69)</td>
<td>0.778</td>
</tr>
<tr>
<td>Stereotypical</td>
<td>3.00 (2.28)</td>
<td>3.02 (2.36)</td>
<td>2.98 (2.24)</td>
<td>0.927</td>
</tr>
<tr>
<td>IQ (Stanford Binet 5)</td>
<td>89.58 (15.32)</td>
<td>90.62 (16.03)</td>
<td>88.81 (14.88)</td>
<td>0.580</td>
</tr>
<tr>
<td>POPE Engagement at Entry (%)</td>
<td>29.10 (22.40)</td>
<td>32.40 (22.95)</td>
<td>30.97 (22.65)</td>
<td>0.491</td>
</tr>
</tbody>
</table>
Methods: Measure

Playground Observation of Peer Engagement (POPE)

- The POPE is a time-interval behavior coding system.
- Observers watch for 40 seconds and code for 20 seconds.
- Outcome: POPE Engagement at end of study.
- Predictors: POPE Engagement at entry, midpoint, changes from entry to midpoint.

# Methods: Engagement States

<table>
<thead>
<tr>
<th>Solitary</th>
<th>Onlooking</th>
<th>Parallel</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Solitary" /></td>
<td><img src="image2" alt="Onlooking" /></td>
<td><img src="image3" alt="Parallel" /></td>
</tr>
<tr>
<td><img src="image4" alt="Parallel Aware" /></td>
<td><img src="image5" alt="Joint Engagement" /></td>
<td><img src="image6" alt="Games with Rules" /></td>
</tr>
</tbody>
</table>

Methods: Classification and Regression Tree (CART)


**Terminal subgroups: Set of Possible Outcomes**

Method: CART Overview

1. **Splitting rule:** search through all possible splits to choose the best splitter that minimizes impurity
   - Purity
     - **Regression Trees** (continuous measure): use sum of squared errors.
     - **Classification Trees** (categorical measure): choice of entropy, Gini measure, “twoing” splitting rule.

2. **Stopping rule:**
   - There is only one observation in each of the child subgroups
   - All observations within each subgroup have the identical distribution of predictor variables, making splitting impossible

3. **Assignment of each terminal subgroup to a class/value.**
   - Average of the outcome variable in the terminal subgroup
   - Normally simply assign class based on the majority class in then subgroup
Methods: Strengths and Limitations of CART

**Strengths**
- Extremely fast at classifying unknown records
- Easy to interpret for small-sized trees; visually appealing
- Accuracy is comparable to other classification techniques for many simple data sets

**Limitation**
- Over-fitting
- Pruning is a strategy for controlling overfitting.
Results: POPE Engagement CART Tree

Subgroup 1 (N=92)
Increased 14.01% of Total Time in Engagement by Midpoint?

No

Subgroup 2 (n=57)
Total % Time Engaged at Entry > 51%

No
Subgroup 4 (n=38)
Low and Steady Predicted Total % Time Engaged at Exit: 19.47%
MSE: 304.09

Yes
Subgroup 5 (n=19)
Moderate and Steady Predicted Total % Time Engaged at Exit: 54.84%
MSE: 784.76

Yes
Subgroup 7 (n=28)
Moderate and Increasing Predicted Total % Time Engaged at Exit: 69.61%
MSE: 555.01

Yes
Subgroup 3 (n=35)
Total % Time Engaged at Entry > 9.17%

No
Subgroup 6 (n=7)
Low and Increasing Predicted Total % Time Engaged at Exit: 44.34%
MSE: 575.65
Results: Trajectories of Engagement by Identified Subgroups
Results

- The CART approach identified four meaningful subgroups based on the 92 children’s total percentage of time engaged measured at entry and changes from entry to midpoint.

- Two subgroups of children who made little progress by midpoint were identified and this may suggest that they need additional supports to have positive peer engagement outcomes.
# Result

<table>
<thead>
<tr>
<th>Variable: Mean (SD)</th>
<th>Subgroup 4 Low and Steady</th>
<th>Subgroup 5 Moderate and Steady</th>
<th>Subgroup 6 Low and Increasing</th>
<th>Subgroup 7 Moderate and Increasing</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male: n (%)</td>
<td>30 (78.9%)</td>
<td>16 (84.2%)</td>
<td>7 (100%)</td>
<td>22 (78.6%)</td>
<td>0.571</td>
</tr>
<tr>
<td>Chronological Age</td>
<td>8 (1.47)</td>
<td>8 (1.45)</td>
<td>7.43 (0.98)</td>
<td>8.61 (1.23)</td>
<td>0.132</td>
</tr>
<tr>
<td>IQ (Stanford Binet 5)</td>
<td>85.32 (15.57)</td>
<td>94.16 (14.02)</td>
<td>91.86 (19.73)</td>
<td>91.54 (14.03)</td>
<td>0.160</td>
</tr>
<tr>
<td>Race: n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.070</td>
</tr>
<tr>
<td>African American</td>
<td>6 (15.79%)</td>
<td>2 (28.57%)</td>
<td>1 (5.26%)</td>
<td>1 (3.57%)</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>18 (47.37%)</td>
<td>2 (28.57%)</td>
<td>6 (31.58%)</td>
<td>13 (46.43%)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>3 (7.89%)</td>
<td>2 (28.57%)</td>
<td>3 (15.79%)</td>
<td>8 (28.57%)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>9 (23.68%)</td>
<td>0 (0%)</td>
<td>5 (26.32%)</td>
<td>2 (7.14%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0 (0%)</td>
<td>1 (14.29%)</td>
<td>2 (10.53%)</td>
<td>1 (3.57%)</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>2 (5.26%)</td>
<td>0 (0%)</td>
<td>2 (10.53%)</td>
<td>3 (10.71%)</td>
<td></td>
</tr>
<tr>
<td>ADOS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>4.92 (2.25)</td>
<td>4.26 (1.79)</td>
<td>4.43 (2.51)</td>
<td>3.32 (1.47)</td>
<td>0.017</td>
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<tr>
<td>Reciprocity</td>
<td>10.45 (3.01)</td>
<td>8.89 (2.47)</td>
<td>9.14 (4.18)</td>
<td>8.32 (2.64)</td>
<td>0.029</td>
</tr>
<tr>
<td>Social Communication</td>
<td>15.08 (5.33)</td>
<td>13.16 (4.02)</td>
<td>13.57 (6.45)</td>
<td>11.64 (3.67)</td>
<td>0.039</td>
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<tr>
<td>Imagination</td>
<td>1.03 (0.88)</td>
<td>0.95 (0.62)</td>
<td>0.71 (0.76)</td>
<td>0.82 (0.72)</td>
<td>0.646</td>
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<tr>
<td>Stereotypical</td>
<td>3.95 (2.68)</td>
<td>2 (2.05)</td>
<td>2.57 (0.98)</td>
<td>2.5 (1.53)</td>
<td>0.006</td>
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<tr>
<td>POPE Engagement %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry</td>
<td>16.79 (14.98)</td>
<td>62.1 (8.42)</td>
<td>3.62 (3.71)</td>
<td>35.93 (13.68)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Midpoint</td>
<td>10.75 (14.18)</td>
<td>43.26 (24.61)</td>
<td>53.53 (21.81)</td>
<td>72.48 (19.06)</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Exit</td>
<td>19.47 (17.67)</td>
<td>54.84 (28.78)</td>
<td>44.34 (25.92)</td>
<td>69.61 (23.99)</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>
Summary

- The 1st split serves as a proxy for determining a potential cutoff for establishing treatment responder status.

  Increased by 14.01% in total time spent engaged change from entry to exit?

- These 2nd and 3rd splits can help define the resulting responder group or slow-responder group into more detailed subgroups.

  Total % Time Engaged at Entry > 51%?
  Total % Time Engaged at Entry > 9.17%

These subgroups may be clinically relevant due to the different rates of response and different amounts of change in intervals spent engaged with peers from study entry to midpoint.
Conclusion

- Substantial heterogeneity in children’s response to treatment with multiple clinically salient subgroups embedded within the larger group
- Augmentation to the current intervention is needed
- CART can be useful in defining metrics that could be used to build an adaptive treatment sequences for children
- Future studies to further investigate these benchmarks may be useful in making treatment decisions
Acknowledgement

- Connie Kasari
- Stephanie Patterson Shire
- Michelle Dean
- Mark Kretzmann
- And everyone in the Kasari Lab

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Thank You