An Empirical Evaluation of Treatment Factors That Improve Outcomes in Autism Services

Dennis Dixon, Ph.D.

Why?

To do the most good for our clients with the resources that we have.

- We believe:
  - We must do our best for our clients
  - We must be responsible with funding and resources
  - We must maximize gains for every hour of treatment

Acknowledgement

- Erik J. Linstead, Ph.D.
  - Assistant Professor, Computer Science and Software Engineering, Chapman University
  - Principal Investigator, Machine Learning and Assistive Technology Lab, Chapman University

Predictors

- Child-specific
- Treatment-specific

Child-Specific Predictors

- Younger Age (Ben-Itzchak and Zachor 2011; Eidevik et al. 2012; Flanagan et al. 2012; Granpeesheh et al. 2009; Harris and Handleman 2000; Makrygianni and Reed 2010; Perry et al. 2011; Virués-Ortega et al. 2013)
- Lower Severity of ASD (Ben-Itzchak and Zachor 2011; Eidevik et al. 2012; Perry et al. 2011; Remington et al. 2007; Smith et al. 2000)
- Greater Adaptive Skills (Eidevik et al. 2010; Flanagan et al. 2012; Magiati et al. 2011; Makrygianni and Reed 2010; Perry et al. 2011; Remington et al. 2007; Sallows and Graupner 2005)
- Stronger Language Skills (Ben-Itzchak and Zachor 2011; Eidevik et al. 2009; Magiati et al. 2007; Magiati et al. 2011; Sallows and Graupner 2005)
- Greater Social Skills (Ben-Itzchak and Zachor 2007; Sallows and Graupner 2005)

Treatment Specific Predictors

- Greater Treatment Intensity (Eidevik et al. 2010; Granpeesheh et al. 2009; Makrygianni and Reed 2010; Remington et al. 2007)
- Longer Treatment Duration (Lustig et al. 2000; Makrygianni and Reed 2010)
- Higher Overall Intervention Time (Virués-Ortega 2010; Virués-Ortega et al. 2013)
Treatment Intensity

- Treatment Intensity - Mastered Exemplars (Granpeesheh et al. 2009)
  - 14% of variance in learning outcome mastery explained by treatment intensity alone
  - Linear regression model (least squares)
  - N=245

Purpose

- Revisit linear relationship between treatment intensity and learning outcomes given more data
- Examine goodness of fit of non-linear models
- Explore appropriateness of machine learning (artificial neural networks) to model estimation


Data

- Candidate pool of 1258 children from Skills™ database
- Inclusion criteria
  - Age between 18 months and 12 years
  - Diagnosis of ASD, Autistic Disorder, PDD-NOS, Asperger’s
  - Minimum 20 hours/month ABA therapy, with one full month of treatment
- Final sample
  - 598 Males (mean age 7.46 years)
  - 128 Females (mean age 7.59 years)
  - 72.81 Average monthly therapy hours (SD=36.31)

Distribution of Hours and Learning Objectives

Regression Parameters

- Intercept: -0.65
- Hours: 1.65
- R²: 0.35
- F-Test: p < 0.000
Applying Artificial Neural Networks (ANNs)

- Supervised machine learning technique
- Universal approximators
- Learn mapping of input to output via gradient descent of measured error (backpropagation)

ANN Methodology

- Partition data (65% training, 30% test, 5% validation)
- $R^2$ of 0.60

Conclusion

- Strong relationship between treatment intensity and learning gains using simple linear model
- Artificial neural networks improve goodness of fit at the cost of interpretability
  - Machine learning in ASD domain offers significant opportunities, but significantly underutilized.

Maximizing Other Things

- What about supervision?
- Purpose:
  - To evaluate the impact of supervision intensity and supervisor credentials, years of experience, and caseload on skill acquisition within a large dataset collected from a community-based clinical setting

Supervision

- Studies implementing supervisor training protocols based on the UCLA model produced greater gains in IQ than studies employing other training procedures. (Reichow and Wolery, 2009)
- Eikeseth and colleagues (2009) identified a strong relationship between greater supervision intensity and improved treatment outcomes.
  - IQ increased 0.21 points for each hour of supervision

ABA Providers and Credentials

- Love and colleagues (2009) surveyed ASD treatment providers to identify the percentage of those with graduate degrees who also hold a BACB certification.
  - 211 supervisors
  - 72% of respondents reported having a graduate degree
  - 42% reported having a BCBA or BCBA-D
BACB Guidelines

- Supervision Intensity:
  - 2 hr a week per every 10 hr of treatment, with a minimum of 2 hr of supervision provided a week.

- Caseload:
  - Comprehensive ABA treatment programs range between 6 and 16 cases
  - Focused treatment programs range between 10 and 24 cases.


Methods

- Clinical records were gathered from a pool of 836 children between the ages of 18 months and 12 years who were receiving ABA services

- Inclusion Criteria:
  - diagnosis of ASD, autistic disorder, PDD-NOS, Asperger’s disorder
  - At least 20 hours per month of ABA therapy
  - At least one full month of treatment data

### Age Autistic Disorder ASD PDD-NOS Asperger’s

<table>
<thead>
<tr>
<th>Male</th>
<th>Age</th>
<th>7.42 years</th>
<th>317</th>
<th>166</th>
<th>41</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Age</td>
<td>7.53 years</td>
<td>73</td>
<td>30</td>
<td>6</td>
<td>1</td>
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</table>

<table>
<thead>
<tr>
<th>Mean</th>
<th>Range</th>
<th>Monthly Treatment Hours</th>
<th>71.01</th>
<th>20.02 - 197.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Range</td>
<td>Monthly Supervision Hours</td>
<td>10.98</td>
<td>4.40 - 67.40</td>
</tr>
</tbody>
</table>

R² = 0.320

**Therapy Intensity and Learning Outcomes**

![Graph showing therapy intensity and learning outcomes](image)

<table>
<thead>
<tr>
<th>Linear Regression Coefficients for Therapy and Treatment Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervision</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>Supervision</td>
</tr>
<tr>
<td>Therapy</td>
</tr>
<tr>
<td>R²</td>
</tr>
<tr>
<td>F-Test</td>
</tr>
</tbody>
</table>
Joint Effect of Therapy and Supervision Intensities on Learning Outcomes

\[ R^2 = 0.338 \]

<2% more than treatment hours alone

### Regression Coefficients for Supervisor Attributes

<table>
<thead>
<tr>
<th></th>
<th>Credential</th>
<th>Experience</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.315</td>
<td>0.353</td>
<td>0.512</td>
</tr>
<tr>
<td>BCBA</td>
<td>0.232</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Experience</td>
<td>-</td>
<td>0.015</td>
<td>-</td>
</tr>
<tr>
<td>Cases</td>
<td>-</td>
<td>-</td>
<td>-0.053</td>
</tr>
<tr>
<td>Adj. (R^2)</td>
<td>0.087</td>
<td>0.031</td>
<td>-0.010</td>
</tr>
<tr>
<td>F-Test</td>
<td>p = 0.002</td>
<td>p = 0.050</td>
<td>p = 0.764</td>
</tr>
</tbody>
</table>

### Applying the Numbers

**Mastery** = 0.232 (Credential) + 0.315

- **Credential**: BCBA = 1, None = 0
- **Mastery with BCBA**: 0.232 (1) + 0.315 = 0.547
- **Mastery without BCBA**: 0.232 (0) + 0.315 = 0.315
- **BCBA = 74% more learning objectives per hour**

**Mastery** = 0.015 (Years) + 0.353

- **Years**: the number
- **Mastery with 0 years as a supervisor**: 0.015 (0) + 0.353 = 0.353
- **Mastery with 1 year as a supervisor**: 0.015 (1) + 0.353 = 0.368
- **Mastery with 10 years as a supervisor**: 0.015 (10) + 0.353 = 0.503
- **4% more learning objectives per year**

### Conclusion

- Increased supervision hours:
  - did not show a meaningful increase in treatment outcomes.
- Supervisor credentials matter:
  - supervisors with BCBA certifications produce 74% greater skill acquisition per hour as compared to supervisors without a BCBA.
- Supervisor years of experience:
  - improved outcomes 4% for every year of experience. (e.g. 10 years experience = 40% more)
- Caseloads:
  - did not have a meaningful relationship to skill acquisition.

### Purpose

- To investigate whether children with ASD make more progress during HBS or CBS by comparing the relative rates of mastery in each location.
Service Location

• What about the ABA treatment location?

• Purpose:
  – To investigate whether children with ASD make more progress during HBS or CBS by comparing the relative rates of mastery in each location.


CBS vs HBS

• Minimal differences in outcomes for home-based, outpatient, and residential treatments (Sherman et al., 1988)
  – There were significant differences in each condition such as intensity of intervention and parental involvement.
• Children receiving CBS with a concurrent parents program made more gains than those receiving HBS with parent program (Roberts et al., 2011)
  – The procedures and intensity of treatment differed across the two conditions.

Methods

• Clinical records were gathered from a pool of 313 children between the ages of 3 months and 12 years who were receiving ABA services.
• Inclusion Criteria:
  – Diagnosis of ASD, autistic disorder, PDD-NOS, Asperger’s disorder
  – At least one full month of treatment data

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>276</td>
<td>7.11</td>
</tr>
<tr>
<td>Autistic Disorder (ASD)</td>
<td>229</td>
<td>30</td>
</tr>
<tr>
<td>PDD-NOS</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>Asperger’s</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>276</td>
<td>7.1</td>
</tr>
<tr>
<td>Range</td>
<td>7.01</td>
<td>229</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weekly Treatment Hours</th>
<th>HBS</th>
<th>CBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>13.5</td>
<td>16.9</td>
</tr>
<tr>
<td>Range</td>
<td>9.3 – 32.6</td>
<td>4.3 – 35.9</td>
</tr>
</tbody>
</table>

Between Groups Analysis

• Children mastered more learning objectives per hour of treatment in the CBS group (M = 0.103) than in the HBS group (M = 0.053).
• An ANCOVA was conducted on the log transformed data.
• Covariates:
  – No significant effect from age
  – Significant effect from treatment intensity
• Location:
  – CBS = 94% more per hour
Within-Groups Analysis

- Children mastered significantly more learning objectives per hour during CBS sessions (M = 0.14) than during HBS sessions (M = 0.07).
- Paired-samples t-test was conducted on the log transformed data. t(43) = 3.489, p = 0.001
- CBS = 100% more per hour

Conclusions

- Not an experimental manipulation
  - We don’t know which aspects of CBS were important, simply that these children mastered more per hour during those sessions
- CBS
  - More control of the environment
  - More intentional inclusion of parents
  - More opportunities for socialization
  - More therapist accountability

Conclusion

- Location matters
  - Should not be determined by what is convenient or what is “business as usual”

So What Should We Do?

- Research propelled autism insurance reform.
- Research continues to justify intensity and duration and treating adolescents and adults, as well as children.
- Research can inform our decisions about treatment intensity, supervision, caseload, and setting.

Treatment Intensity

Research demonstrates that treatment intensity is the most critical variable.

**Public Policy Implication:** In states where funding sources repeatedly seek to limit hours, research can be used to engender support for clarifying regulations and enforcement actions.

**Treatment Intensity**

- NOTHING matters more than getting the prescribed treatment hours.
Supervisor Credentials

Research demonstrates a clear benefit in supervision delivered by a BCBA with 74% greater skills acquisition.

• The BCBA credential matters.
• The years of experience will add up. New supervisors should consult with senior staff.

Supervisor Caseload

Research shows that the number of cases a behavior analyst oversees should not be arbitrarily limited but should be determined by clinical judgment with an eye on behavior analyst’s well-being.

• Caseload should be left to the professional judgment of the behavior analyst.

Service Location

Research demonstrates that skill acquisition is significantly greater during center-based services.

• Oppose limitations on location. In states where center-based services are not an option, use the research to remove limitations on location.
• Discuss the issue of service location with your child’s treatment supervisor.

A word about service location...

• Treatment recommendations should not change because a health plan says it doesn’t authorize services in schools or houses of worship or anywhere else.
• The location where services are delivered doesn’t affect whether the treatment is medically necessary, and that includes delivering medically necessary treatment in a school, a church, or at a camp.

Caregiver Participation

Skill acquisition rate during center-based services demonstrates that individuals benefit from ABA without caregiver participation.

• Caregiver participation is optimal, but not required.
• Caregiver participation should be determined by the behavior analyst. Caregiver participation as a condition of medically necessary treatment must be eliminated.

A word about caregiver participation...

While caregiver participation in the treatment plan plays an important role in a client’s progress, caregiver participation supplements treatment; it doesn’t supplant it. Caregivers are not responsible for providing medically necessary treatment, and lack of caregiver participation is not a reason to reduce or deny medically necessary treatment.
Empowering Caregivers

- The treatment provider determines how many hours of ABA are medically necessary to treat your child.
- No funding agent, policy, or problem should prevent your child from receiving their medically necessary treatment.

Thank You

Dennis Dixon, Ph.D.
d.dixon@centerforautism.com