Applying Learning Theory to Brief Experimental Analysis:
Using Skill by Treatment Interactions to Identify Tier 3 Interventions
Matthew Burns, Ph.D.

Interventions for Children with LD

Reading comprehension 1.13
Direct instruction .84
Psycholinguistic training .39
Modality instruction .15
Diet .12
Perceptual training .08

Kavale & Forness, 2000

Working Memory

Melby-Lervag & Hulme, 2012 – Working Memory

Verbal Ability .13
Word Decoding .13
Arithmetic .07

“There was no convincing evidence of the generalization of working memory training to other skills (nonverbal and verbal ability, inhibitory processes in attention, word decoding, and arithmetic).”

Executive Function

<table>
<thead>
<tr>
<th>Variable</th>
<th>k</th>
<th>Median</th>
<th>Adjusted Median</th>
<th>Hedges' g</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Functioning</td>
<td>3</td>
<td>.99</td>
<td>-.50 to .68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonological/Phonemic Awareness</td>
<td>11</td>
<td>.44</td>
<td>.24 to .64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Memory</td>
<td>1</td>
<td>.20</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading Fluency</td>
<td>11</td>
<td>.43</td>
<td>.29 to .57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>1</td>
<td>.13</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td>5</td>
<td>.33</td>
<td>.13 to .53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assessment Group

| Cognitive Measures              | 8  | .17    | -.07 to .41     |           |        |
| Phonological/Phonemic Awareness | 13 | .50    | .34 to .66      |           |        |
| Reading Fluency                 | 11 | .43    | .29 to .57      |           |        |

(Sadeh, Burns, & Sullivan, 2013)
Skill-By-Treatment Interaction

- Burns, Codding, Boice, & Lukito, 2008
- Interventions selected based on student functioning in the specific skill
- Systematically identify and manipulate environmental conditions that are directly related to a problem
- Isolate target skill deficits

MOTIVATION
(Gickling & Thompson, 1985)

- Independent Level
  - 98% - 100% known material
- Instructional Level
  - 93% - 97% known material
- Frustrational Level
  - Less than 93% known

Curriculum-Based Assessment

- Term was first coined by Gickling in 1977 (Coulter, 1988).
  - CBA was designed to systematically assess the "instructional needs of a student based upon the on-going performance within the existing course content in order to deliver instruction as effectively as possible" (Gickling, Shane, & Croskery, 1989, pp. 344-345).
- Assesses match between student skill and curriculum for instructional planning (Burns, MacQuarrie, & Campbell, 1999).

Curriculum-based approaches
CBA - ID CBM

- Measures accuracy
- Instructional, planning, managing, and delivery
- Assesses instructional level
- Measures fluency
- Instructional effectiveness
- Measures instructional level
RTI and Skill-by-Treatment Interaction

Problem Solving

- Tier I – Identify discrepancy between expectation and performance for class or individual *(Is it a classwide problem?)*
- Tier II – Identify discrepancy for individual. Identify category of problem. *(What is the category of the problem?)*
- Tier III – Identify discrepancy for individual. Identify causal variable. *(What is the causal variable?)*

Assess NRP Areas

- Phonemic Awareness
  - Phoneme segmentation fluency
- Phonics
  - Nonsense word fluency
  - 93% to 97% accuracy
- Fluency
  - Oral reading fluency
- Vocabulary/Comprehension
  - Measures of Academic Progress
  - Star Reading

Category of Problem MN HS

- 9-12 with approximately 1600 students
- 69.2% pass reading
- 9th-10th grade
- 28% low on MAP (~225)
- 45% Low on TOSCRF (~100)
  - 64% low on phonics (~65)
  - 36% acceptable phonics (~36)

Targeted Interventions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency Pretest</td>
<td>90.17</td>
<td>7.65</td>
<td>89.88</td>
<td>9.73</td>
<td>Na</td>
<td>Na</td>
</tr>
<tr>
<td>Fluency Posttest</td>
<td>98.33</td>
<td>7.27</td>
<td>94.32</td>
<td>8.77</td>
<td>Na</td>
<td>Na</td>
</tr>
<tr>
<td>MAP Fall</td>
<td>206.00</td>
<td>9.25</td>
<td>211.00</td>
<td>10.11</td>
<td>210.37</td>
<td>6.56</td>
</tr>
<tr>
<td>Map Winter</td>
<td>217.21</td>
<td>7.56</td>
<td>212.40</td>
<td>8.06</td>
<td>212.78</td>
<td>6.04</td>
</tr>
</tbody>
</table>

ANOVA for fluency: F(1, 42) = 4.98, p < .05, d = .50
ANOVA for MAP: F(2, 74) = 5.84, p < .05, partial eta squared = .14.
Tier 2 Interventions

• Small group
  – 2-5 students

• 15-30 minutes
  – 15 for Kindergartners; 30 for 3rd graders

• 4-5 times per week
  – Throughout entire school year

Mean (SD) For Curriculum-Based Measurement of Oral Reading Fluency (CBM-R) and Growth

<table>
<thead>
<tr>
<th>Grade</th>
<th>CBM-R WRCM per Week</th>
<th>Growth</th>
<th>Spring CBM-R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tier 1</td>
<td>Tier 2</td>
<td>Tier 1</td>
</tr>
<tr>
<td>Second Grade</td>
<td>74.19</td>
<td>26.66</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td>(35.50)</td>
<td>(19.55)</td>
<td>(.76)</td>
</tr>
<tr>
<td>n = 219</td>
<td>n = 169</td>
<td>n = 219</td>
<td>n = 169</td>
</tr>
<tr>
<td>Third Grade</td>
<td>93.42</td>
<td>44.93</td>
<td>1.14</td>
</tr>
<tr>
<td></td>
<td>(37.01)</td>
<td>(21.50)</td>
<td>(.75)</td>
</tr>
<tr>
<td>n = 192</td>
<td>n = 140</td>
<td>n = 192</td>
<td>n = 140</td>
</tr>
</tbody>
</table>

Tier 2 Intervention \( F(1,719) = 5.29, p < .05 \),
Grade \( F(1,719) = .78, p = .38 \)
d = .46 for 2nd grade, d = .58 for 3rd grade

• Tier 2 Problem Solving
  - Check student’s attendance – Does the student attend school regularly
  - Observe the student – Are behavioral difficulties interfering with the interventions?
  - Incentivize the intervention – Is the student sufficiently motivated?
  - Examine intervention fidelity – Is the intervention occurring as it should?
  - Examine the accuracy within skill and GOM data – Are the students receiving a proficiency intervention when they should be focusing on acquisition?
  - Compare skill and GOM data – Are students not generalizing (skill data are going up but GOM are not)

Deanna – 2nd Grade

<table>
<thead>
<tr>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GOM</td>
<td>39</td>
<td>40</td>
<td>38</td>
<td>51</td>
<td>32</td>
<td>65</td>
<td>40</td>
<td>40</td>
<td>47</td>
<td>.83</td>
</tr>
<tr>
<td>ORF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill</td>
<td>57</td>
<td>45</td>
<td>49</td>
<td>44</td>
<td>55</td>
<td>21</td>
<td>54</td>
<td>63</td>
<td>58</td>
<td>.75</td>
</tr>
</tbody>
</table>

Brief Experimental Design

• Using brief exposure to various instructional components to test the student’s response
• Uses a sensitive measure – CBM, specific skills
• Takes only about 30 to 60 minutes
• Focuses on short-term outcomes
• Must have a framework (don’t test two of the same intervention)
• Uses multi-element design
Common BEA Questions

1. They don’t want to
2. Haven’t spent enough time on it
3. They’ve not had enough help with it
4. They have not had to do it that way
5. It is too hard

BEA for Letter Formation

BEA for Writing Production

Instructional Hierarchy: Stages of Learning

Learning Process

- Acquire
  - Acquisition rate (less targets per sessions with more intervention sessions)
  - Make stimuli more salient and errorless
- Maintain
- Generalize
  - Increased repetition within lesson (IR)
  - Increased repetition across lessons (same number of targets with more intervention sessions)
  - Frequent review (same number of intervention sessions, but daily review)
- Generalize
  - Integrate a variety of forms of the letters/words, including those similar to how they are presented during assessment into intervention sessions

BEA - Acquire
- Identify enough unknown
- Acquisition rate (less targets per sessions with more intervention sessions)
- Make stimuli more salient and errorless
  - Bigger, color, contextualized (e.g., Zoo Phonics)
- Test – random sequence (two of each conditions)
- Replicate most and least effective

Lonnie

Retention Intervention
- Short sessions
- Twice per day
- Test retention at the end of each day
- Start with review
**Generalization**

![Generalization Diagram]

**Effectiveness**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre BEA</th>
<th>Post BEA</th>
<th>Signed Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter-Sound</td>
<td>0.77</td>
<td>2.93</td>
<td>Z = 2.02*</td>
</tr>
<tr>
<td>Oral Reading</td>
<td>0.25</td>
<td>1.92</td>
<td>Z = 2.67*</td>
</tr>
</tbody>
</table>

**Tier 3 BEA**

<table>
<thead>
<tr>
<th>Student</th>
<th>Measure</th>
<th># of Weeks Pre BEA</th>
<th># of Weeks Post BEA</th>
<th>Change in Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WRC</td>
<td>20</td>
<td>2</td>
<td>7.75</td>
</tr>
<tr>
<td>2</td>
<td>WRC</td>
<td>12</td>
<td>8</td>
<td>1.19</td>
</tr>
<tr>
<td>3</td>
<td>WRC</td>
<td>10</td>
<td>14</td>
<td>0.18</td>
</tr>
<tr>
<td>4</td>
<td>LSC</td>
<td>22</td>
<td>8</td>
<td>0.26</td>
</tr>
<tr>
<td>5</td>
<td>WRC</td>
<td>6</td>
<td>8</td>
<td>0.43</td>
</tr>
<tr>
<td>6</td>
<td>WRC</td>
<td>10</td>
<td>9</td>
<td>0.06</td>
</tr>
<tr>
<td>7</td>
<td>WRC</td>
<td>16</td>
<td>7</td>
<td>0.39</td>
</tr>
<tr>
<td>8</td>
<td>WRC</td>
<td>14</td>
<td>9</td>
<td>2.07</td>
</tr>
<tr>
<td>9</td>
<td>WRC</td>
<td>8</td>
<td>8</td>
<td>0.16</td>
</tr>
<tr>
<td>10</td>
<td>LSC</td>
<td>29</td>
<td>2</td>
<td>6.68</td>
</tr>
<tr>
<td>11</td>
<td>WRC</td>
<td>8</td>
<td>12</td>
<td>0.33</td>
</tr>
<tr>
<td>12</td>
<td>WRC</td>
<td>18</td>
<td>6</td>
<td>1.66</td>
</tr>
<tr>
<td>13</td>
<td>WRC</td>
<td>18</td>
<td>6</td>
<td>1.66</td>
</tr>
<tr>
<td>14</td>
<td>WRC</td>
<td>6</td>
<td>6</td>
<td>0.40</td>
</tr>
<tr>
<td>15</td>
<td>LSC</td>
<td>22</td>
<td>9</td>
<td>0.80</td>
</tr>
<tr>
<td>16</td>
<td>LSC</td>
<td>14</td>
<td>7</td>
<td>2.11</td>
</tr>
<tr>
<td>17</td>
<td>LSC</td>
<td>12</td>
<td>8</td>
<td>2.30</td>
</tr>
</tbody>
</table>

**SLD?**

- Districts identify as SLD – not us
- Approximately 10 students were identified as SLD in reading during 2011-2012
- An additional 5 to 10 were identified this year
- Work with approximately 1500 students in 6 urban schools
  - 13.1% = 196.5
  - Our max estimate is 20
- SLD construct and measurement are being simultaneously developed

burns258@umn.edu