Efficiently Forming Equivalence Classes: Strategies and Applications

http://www.rapidshare.com.cn/8qhxdHC

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Goals and Objectives

• Define stimulus equivalence and the three major properties
  – Reflexivity, symmetry, and transitivity (Sidman & Tailby, 1982)
• Provide examples of applications for teaching specific skills
• Identify and arrange stimulus-stimulus relations to be taught/emerge
Sidman, 1971

- Participant: 17 year old male diagnosed with mental retardation and microcephaly
- Demonstrated 60 emergent relations after being taught only 20 auditory-visual conditional discriminations

**Figure 2.** Schematic summary of the experiment. Of the stimulus equivalences, I-IV, the subject came to the experiment knowing I. Of the naming tasks, V and VI, he could do V. After being taught equivalence II, he could then do III, IV, and VI.
• Reflexivity – “Each stimulus bears the relation to itself” (Sidman & Tailby, 1982, p. 6)
• “if R is the conditional relation, reflexivity requires, “if a, then a, if b, then b, etc.” (Sidman, Rauzin, Lazar, Cunningham, Tailby, & Carrigan, 1982, p. 24)
• Tested by generalized identity matching
  – A=A
Identity Matching-To-Sample (MTS)
Tests of Equivalence

• Symmetry - “Symmetry requires the relation R to hold bi-directionality between two different stimuli” (Sidman et al., 1982, p. 24)
• Requires functional sample-comparison interchangeability of stimuli (Sidman et al., 1982; Sidman, Willson-Morris, & Kirk, 1986)
• Symmetry – must show if A=B then B=A without any additional training (Sidman and Tailby, 1982)
Symmetry
• Transitivity - Relation amongst three stimuli (Sidman et al., 1982)
• Transitivity – a derived relation that develops following other trained relations (Sidman & Tailby, 1982)
  – If A=B and A=C then B=C and C=B
Transitivity
Equivalence Triangle

A = A

B

C
Applied Studies

Math Skills
• Coin Equivalence (McDonagh, McIlvane, & Stoddard 1984)
• Fraction, decimal relations (Lynch & Cuvo, 1995)
• Multiplication and Division relations (Persson, Maguire, & Cameron, 2009)
• Geometry relations (Sumner, Maguire, & Cameron, 2010)

Geography
• Geography relations (LeBlanc, Miguel, Cummings, Goldsmith, & Carr, 2003)

Reading Comprehension
• Reading skills (Mackay, 1985)
Match-to-Sample

• Match-to-sample: In the presence of a conditional or sample stimulus, the participant selects the S+ from an array of comparison stimuli.

• Common format for equivalence-based instruction.
Country Music Hall of Fame

Johnny Cash  Nirvana  Easy E
Country Music Hall of Fame

Sample Stimulus

Johnny Cash

S+

Nirvana

S-

Run DMC

S-
Demonstration of Equivalence

• Refer to your packet
• Demonstration

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### Stimulus Class Table

<table>
<thead>
<tr>
<th>Potential Class</th>
<th>A-Stimuli</th>
<th>B-Stimuli</th>
<th>C-Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Country Music Hall of Fame</td>
<td>Johnny Cash</td>
<td>Nashville</td>
</tr>
<tr>
<td>2</td>
<td>Rock and Roll Hall of Fame</td>
<td>Nirvana</td>
<td>Cleveland</td>
</tr>
<tr>
<td>3</td>
<td>Hip Hop Hall of Fame</td>
<td>Run DMC</td>
<td>New York City</td>
</tr>
</tbody>
</table>
Experimental Schematic

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Demonstration Slides

Hip Hop Hall of Fame

Johnny Cash       Run DMC       Nirvana
PRE-TEST ALL RELATIONS: A-B, A-C, B-A, C-A, B-C, C-B

Instructions: Participants should select the comparison stimulus that matches the sample presented on the slide by marking the bullet to the left. An answer key is provided for scoring purposes.

<table>
<thead>
<tr>
<th></th>
<th>Country Music Hall of Fame</th>
<th>Score</th>
<th></th>
<th>Nirvana</th>
<th>Score</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Run DMC</td>
<td></td>
<td></td>
<td>Country Music Hall of Fame</td>
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</tr>
<tr>
<td></td>
<td>Nirvana</td>
<td></td>
<td></td>
<td>Rock and Roll Hall of Fame</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Johnny Cash</td>
<td></td>
<td></td>
<td>Hip Hop Hall of Fame</td>
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<table>
<thead>
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<th></th>
<th>Rock and Roll Hall of Fame</th>
<th>Score</th>
<th></th>
<th>New York City</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>Nirvana</td>
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<td></td>
<td>Cleveland</td>
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<td>Johnny Cash</td>
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<td>Nashville</td>
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<tr>
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<table>
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<th>Cleveland</th>
<th>Score</th>
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<tbody>
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<td>Run DMC</td>
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<td>New York City</td>
<td></td>
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<tr>
<td></td>
<td>Nirvana</td>
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<table>
<thead>
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<th>Score</th>
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<th>Nashville</th>
<th>Score</th>
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<td></td>
<td>New York City</td>
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<tr>
<td></td>
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<td>Cleveland</td>
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</table>

10. Johnny Cash

<table>
<thead>
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<th></th>
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<tbody>
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</tr>
<tr>
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<td>Nashville</td>
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</table>

11. Nirvana

<table>
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<tbody>
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<td>Nashville</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New York City</td>
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</table>

12. Run DMC

<table>
<thead>
<tr>
<th></th>
<th>Run DMC</th>
<th>Score</th>
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<tr>
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<td></td>
<td>New York City</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cleveland</td>
<td></td>
</tr>
</tbody>
</table>
A-B Pre-Test

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Country Music Hall of Fame

Run DMC  Nirvana  Johnny Cash
Rock and Roll Hall of Fame

Nirvana      Johnny Cash      Run DMC
Hip Hop Hall of Fame

Johnny Cash  Run DMC  Nirvana
A-C Pre-Test

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

* Solid lines within the schematic represent trained relations
* Dashed lines within the schematic represent emergent (untrained) relations
Rock and Roll Hall of Fame

Cleveland  Nashville  New York City
Hip Hop Hall of Fame

Nashville    New York City    Cleveland
Country Music Hall of Fame

New York City    Cleveland    Nashville
B-A Pre-Test

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Run DMC

Country Music Hall of Fame

Hip Hop Hall of Fame

Rock and Roll Hall of Fame
Johnny Cash

Hip Hop Hall of Fame

Rock and Roll Hall of Fame

Country Music Hall of Fame
B-C Pre-Test

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Johnny Cash

New York City  Cleveland  Nashville
Nirvana

Cleveland  Nashville  New York City
Run DMC

Nashville    New York City    Cleveland
C-A Pre-Test

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Cleveland

Rock and Roll Hall of Fame

Country Music Hall of Fame

Hip Hop Hall of Fame
Nashville

- Hip Hop Hall of Fame
- Rock and Roll Hall of Fame
- Country Music Hall of Fame
C-B Pre-Test

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
New York City

Johnny Cash  Run DMC  Nirvana
Nashville

Run DMC    Nirvana    Johnny Cash
Cleveland

Nirvana  Johnny Cash  Run DMC
A-B Training Step 1

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Country Music Hall of Fame

Run DMC  Nirvana  Johnny Cash
Correct!
Hip Hop Hall of Fame

Johnny Cash  Run DMC  Nirvana
Correct!
Rock and Roll Hall of Fame

Nirvana  Johnny Cash  Run DMC
Correct!
A-B Training Step 2

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Hip Hop Hall of Fame

Johnny Cash  Run DMC  Nirvana
Correct!
Country Music Hall of Fame

Run DMC    Nirvana    Johnny Cash
<table>
<thead>
<tr>
<th>Nirvana</th>
<th>Johnny Cash</th>
<th>Run DMC</th>
</tr>
</thead>
</table>

Rock and Roll Hall of Fame
Correct!
A-B Training Step 3

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Rock and Roll Hall of Fame

Nirvana  Johnny Cash  Run DMC
Correct!
Hip Hop Hall of Fame

Johnny Cash  Run DMC  Nirvana
Correct!
Country Music Hall of Fame

Run DMC  Nirvana  Johnny Cash
Correct!
A-C Training Step 1

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Country Music Hall of Fame

New York City  Cleveland  Nashville
Correct!
Hip Hop Hall of Fame

Nashville  New York City  Cleveland
Correct!
Rock and Roll Hall of Fame

Cleveland          Nashville          New York City
Correct!
A-B Training Step 2

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Hip Hop Hall of Fame

Nashville

New York City

Cleveland
Correct!
Country Music Hall of Fame

New York City  Cleveland  Nashville
Correct!
Rock and Roll Hall of Fame

Cleveland    Nashville    New York City
Correct!
A-B Training Step 3

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Rock and Roll Hall of Fame

Cleveland  Nashville  New York City
Correct!
Hip Hop Hall of Fame

Nashville  New York City  Cleveland
Correct!
Country Music Hall of Fame

New York City    Cleveland    Nashville
Post-Test Intermixed Relations

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Country Music Hall of Fame

Run DMC  Nirvana  Johnny Cash
Rock and Roll Hall of Fame

Cleveland    Nashville    New York City
Run DMC

Country Music Hall of Fame

Hip Hop Hall of Fame

Rock and Roll Hall of Fame
Johnny Cash

New York City    Cleveland    Nashville
<table>
<thead>
<tr>
<th>Rock and Roll Hall of Fame</th>
<th>Country Music Hall of Fame</th>
<th>Hip Hop Hall of Fame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleveland</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
New York City

Johnny Cash  Run DMC  Nirvana
Rock and Roll Hall of Fame

Nirvana  Johnny Cash  Run DMC
Hip Hop Hall of Fame

Nashville     New York City     Cleveland
Johnny Cash

Hip Hop Hall of Fame

Rock and Roll Hall of Fame

Country Music Hall of Fame
New York City

Country Music Hall of Fame

Hip Hop Hall of Fame

Rock and Roll Hall of Fame
Nashville

Run DMC  Nirvana  Johnny Cash
Hip Hop Hall of Fame

Johnny Cash

Run DMC

Nirvana
Country Music Hall of Fame

New York City    Cleveland    Nashville
Nirvana

Rock and Roll Hall of Fame
Country Music Hall of Fame
Hip Hop Hall of Fame
<table>
<thead>
<tr>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nashville</td>
</tr>
<tr>
<td>New York City</td>
</tr>
<tr>
<td>Cleveland</td>
</tr>
</tbody>
</table>
Nashville

Hip Hop Hall of Fame

Rock and Roll Hall of Fame

Country Music Hall of Fame
Cleveland

Nirvana  Johnny Cash  Run DMC
<table>
<thead>
<tr>
<th>Potential Class</th>
<th>A-Stimuli</th>
<th>B-Stimuli</th>
<th>C-Stimuli</th>
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<tbody>
<tr>
<td>1</td>
<td>Country Music Hall of Fame</td>
<td>Johnny Cash</td>
<td>Nashville</td>
</tr>
<tr>
<td>2</td>
<td>Rock and Roll Hall of Fame</td>
<td>Nirvana</td>
<td>Cleveland</td>
</tr>
<tr>
<td>3</td>
<td>Hip Hop Hall of Fame</td>
<td>Run DMC</td>
<td>New York City</td>
</tr>
</tbody>
</table>
Experimental Schematic

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Reflexivity slide

Nirvana

Nirvana  Johnny Cash  Run DMC
A-B Training

**A-Stimuli**
A1 = Country Music Hall of Fame  
A2 = Rock and Roll Hall of Fame  
A3 = Hip Hop Hall of Fame

**B-Stimuli**
B1 = Johnny Cash  
B2 = Nirvana  
B3 = Run DMC

*Solid lines within the schematic represent trained relations  
*Dashed lines within the schematic represent emergent (untrained) relations
A-C Training

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Symmetry Post-Test

**A-Stimuli**
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

**B-Stimuli**
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

**C-Stimuli**
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Transitivity Post-Test

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

Transitivity
Experimental Schematic

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
Scoring and Reporting on Results
Scoring Pretest Results

**PRE-TEST ALL RELATIONS: A-B, A-C, B-A, B-C, C-A, C-B**

*Instructions:* Participants should select the comparison stimulus that matches the sample presented on the slide by marking the bullet to the left. An answer key is provided for scoring purposes.

**A-B**

<table>
<thead>
<tr>
<th>1. Country Music Hall of Fame</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run DMC ✓</td>
<td></td>
</tr>
<tr>
<td>Nirvana</td>
<td></td>
</tr>
<tr>
<td>Johnny Cash</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Rock and Roll Hall of Fame</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nirvana</td>
<td></td>
</tr>
<tr>
<td>Johnny Cash ✓</td>
<td>+</td>
</tr>
<tr>
<td>Run DMC</td>
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</table>

<table>
<thead>
<tr>
<th>3. Hip Hop Hall of Fame</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>Johnny Cash</td>
<td>+</td>
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<tr>
<td>Run DMC ✓</td>
<td></td>
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<tr>
<td>Nirvana</td>
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**A-C**

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<tr>
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<tbody>
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<th>5. Hip Hop Hall of Fame</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>New York City ✓</td>
<td>+</td>
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<td>Cleveland ✓</td>
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**B-C**

<table>
<thead>
<tr>
<th>9. Nirvana</th>
<th>Score</th>
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<tr>
<td>Country Music Hall of Fame ✓</td>
<td></td>
</tr>
<tr>
<td>Hip Hop Hall of Fame</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10. Johnny Cash</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York City</td>
<td></td>
</tr>
<tr>
<td>Cleveland</td>
<td></td>
</tr>
<tr>
<td>Nashville ✓</td>
<td>+</td>
</tr>
</tbody>
</table>

**B-A**

**C-A**

<table>
<thead>
<tr>
<th>11. Nirvana</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleveland</td>
<td></td>
</tr>
<tr>
<td>Nashville ✓</td>
<td>-</td>
</tr>
<tr>
<td>New York City</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. Run DMC</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nashville</td>
<td></td>
</tr>
<tr>
<td>New York City</td>
<td></td>
</tr>
<tr>
<td>Cleveland</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13. Cleveland</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock and Roll Hall of Fame</td>
<td></td>
</tr>
<tr>
<td>Country Music Hall of Fame ✓</td>
<td></td>
</tr>
<tr>
<td>Hip Hop Hall of Fame</td>
<td>-</td>
</tr>
</tbody>
</table>
Scoring Pretest Results

**DATA SHEET SUMMARY**

**PRE-TEST SUMMARY**

*Instructions:* Participants should circle numbers that they scored correctly. Calculate the total number of items circled per row and write the total number of correct responses in the corresponding rows.

<table>
<thead>
<tr>
<th>Relation</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Total # correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>A-C</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>B-A</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>B-C</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>C-A</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>C-B</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>0</td>
</tr>
</tbody>
</table>

A-B relation: \( \frac{\text{Number correct}}{3} \times 100 = \frac{1}{3} \times 100 = 33\% \) correct

A-C relation: \( \frac{\text{Number correct}}{3} \times 100 = \frac{2}{3} \times 100 = 66\% \) correct

B-A relation: \( \frac{\text{Number correct}}{3} \times 100 = \frac{0}{3} \times 100 = 0\% \) correct

C-A relation: \( \frac{\text{Number correct}}{3} \times 100 = \frac{1}{3} \times 100 = 33\% \) correct

B-C relation: \( \frac{\text{Number correct}}{3} \times 100 = \frac{1}{3} \times 100 = 33\% \) correct

C-B relation: \( \frac{\text{Number correct}}{3} \times 100 = \frac{0}{3} \times 100 = 0\% \) correct
Hypothetical Pretest Results

![Bar chart showing percentage of correct responses for relations A-B, A-C, B-A, B-C, C-A, and C-B. The chart indicates a high percentage for relation A-C and lower percentages for the other relations.]
Hypothetical Pretest Results

Percentage of correct responses

Relations

A-A  B-B  C-C  A-B  A-C  B-A  B-C  C-A  C-B
### POST-TEST SUMMARY

**Instructions:** Participants should circle numbers that they scored correctly. Calculate the total number of items circled per row and write the total number of correct responses in the corresponding rows.

<table>
<thead>
<tr>
<th>Relation</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Total # correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-B</td>
<td>1</td>
<td>7</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>A-C</td>
<td>2</td>
<td>8</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>B-A</td>
<td>3</td>
<td>9</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>B-C</td>
<td>4</td>
<td>14</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>C-A</td>
<td>5</td>
<td>11</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>C-B</td>
<td>6</td>
<td>12</td>
<td>18</td>
<td>3</td>
</tr>
</tbody>
</table>

\[
\text{A-B relation} = \frac{\text{Number correct}}{3} \times 100 = \frac{3}{3} \times 100 = 100\% \text{ correct}
\]

\[
\text{A-C relation} = \frac{\text{Number correct}}{3} \times 100 = \frac{3}{3} \times 100 = 100\% \text{ correct}
\]

\[
\text{B-A relation} = \frac{\text{Number correct}}{3} \times 100 = \frac{3}{3} \times 100 = 100\% \text{ correct}
\]

\[
\text{C-A relation} = \frac{\text{Number correct}}{3} \times 100 = \frac{2}{3} \times 100 = 88\% \text{ correct}
\]

\[
\text{B-C relation} = \frac{\text{Number correct}}{3} \times 100 = \frac{3}{3} \times 100 = 100\% \text{ correct}
\]

\[
\text{C-B relation} = \frac{\text{Number correct}}{3} \times 100 = \frac{3}{3} \times 100 = 100\% \text{ correct}
\]
Hypothetical Posttest Results

Percentage of correct responses

Relations

A-A  B-B  C-C  A-B  A-C  B-A  B-C  C-A  C-B
Trained Relations

![Bar chart showing percentage of correct responses for different relations. The chart highlights the difference between A-B and A-C relations.]
Symmetry

![Bar graph showing percentage of correct responses for different relations (A-A, B-B, C-C, A-B, A-C, B-A, B-C, C-A, C-B). The graph highlights the symmetry in responses across different relations.](image-url)
Transitivity

![Bar chart showing transitivity percentages for different relations (A-A, B-B, C-C, A-B, A-C, B-A, B-C, C-A, C-B). The chart highlights the percentage of correct responses across these relations.](image)
Various Visual Displays

Table 1
Order of Training and Testing Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Relations*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent relations pretests and posttests</td>
<td>AC</td>
</tr>
<tr>
<td>Given dictated name, select printed price</td>
<td>CB</td>
</tr>
<tr>
<td>Given printed price, select actual coin</td>
<td>DB</td>
</tr>
<tr>
<td>Given dictated price, select actual coin</td>
<td>BE</td>
</tr>
<tr>
<td>Given actual coin, say spoken name</td>
<td>DE</td>
</tr>
<tr>
<td>Given dictated price, say spoken name</td>
<td>AF</td>
</tr>
<tr>
<td>Conditional discrimination training</td>
<td>CF</td>
</tr>
<tr>
<td>Given printed price, say spoken price</td>
<td>AB</td>
</tr>
<tr>
<td>Given dictated name, select actual coin</td>
<td>BC</td>
</tr>
<tr>
<td>Given actual coin, select printed price</td>
<td>DC</td>
</tr>
<tr>
<td>Given dictated price, select printed price</td>
<td>AB, BC, DC</td>
</tr>
<tr>
<td>Mixed training (review)</td>
<td>AB, BC, DC</td>
</tr>
</tbody>
</table>

* A = dictated coin name (e.g., “dime”), B = actual coin, C = printed price, D = dictated price (e.g., “10 cents”), E = spoken coin name, F = spoken price.

Keintz, Miguel, Kao, & Finn (2011)
Various Visual Displays

<table>
<thead>
<tr>
<th>Condition</th>
<th>Relations(^\text{a})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent relations pretests and posttests</td>
<td>AC</td>
</tr>
<tr>
<td></td>
<td>CB</td>
</tr>
<tr>
<td></td>
<td>DB</td>
</tr>
<tr>
<td></td>
<td>BE</td>
</tr>
<tr>
<td></td>
<td>DE</td>
</tr>
<tr>
<td></td>
<td>AF</td>
</tr>
<tr>
<td></td>
<td>CF</td>
</tr>
<tr>
<td>Conditional discrimination training</td>
<td>AB</td>
</tr>
<tr>
<td></td>
<td>BC</td>
</tr>
<tr>
<td></td>
<td>DC</td>
</tr>
<tr>
<td>Mixed training (review)</td>
<td>AB, BC, DC</td>
</tr>
</tbody>
</table>

\(^{a}\) A = dictated coin name (e.g., “dime”), B = actual coin, C = printed price, D = dictated price (e.g., “10 cents”), E = spoken coin name, F = spoken price.

Keintz, Miguel, Kao, & Finn (2011)
Various Visual Displays

Keintz, Miguel, Kao, & Finn (2011)
Visual Analysis

Figure 3. Overall percentage of correct responses on pretests (top panel) and posttests (bottom panel) for Ed.

Cowley, Green & Braunling-McMorrow (1992)
Tests for Delayed Emergence
Evaluating Individual Relations
Evaluating Individual Relations

• A-A = A1-A1, A2-A2, A3-A3
• B-B = B1-B1, B2-B2, B3-B3
• C-C = C1-C1, C2-C2, C3-C3
• A-B = A1-B1, A1-B2, A3-B3
• A-C = A1-C1, A2-C2, A3-C3
• B-A = B1-A1, B2-A2, B3-A3
• C-A = C1-A1, C2-A2, C3-A3
• B-C = B1-C1, B2-C2, B3-C3
• C-B = C1-B1, C2-B2, C3-B3
Individual Relations

Pre-Test Results

- A-C = 49% correct
- B-C = 66% correct
- C-B = 55% correct

- Criteria was less than 66% correct at baseline
- Student had stimulus class 1 already in their repertoire
Designing Equivalence-Based Instruction

1. Evaluate pre-requisite skills
2. Identify target skills
3. Determine stimulus class size and number of classes
4. Decide training structure and identify trained/emergent relations
5. Identify training and test acquisition criteria
6. Determine number of training and test trials
7. Decide mode of presentation
8. Identify prompting procedures
9. Arrange stimuli within design structure
10. Pre-test all possible relations
11. Data analysis
12. Train specified relations to criteria
13. Post-test all possible relations
14. Data analysis
1. Evaluate pre-requisite skills

- Identity matching-to-sample
- Arbitrary matching-to-sample
- Attending duration
2. Identify Target Skills

• Identify specific skills to be demonstrated and target stimuli

• Consider prior history

• Avoid faulty stimulus control
  • Irrelevant features can control responding, so need to plan for this
  • Size of stimuli
  • Color
  • Length of word/phrase
  • Initial letter
Degas
Degas
Jaguar
Jaguar
alpaca

chrysalis   cria   cygnet
alpaca
crow  cria  crib
tick track truck
3. Stimulus Class Size and Number of Classes

• Minimum class size is 3

• Can have larger classes

• Determine number of classes to be demonstrated
Experimental Schematic

A-Stimuli
A1 = Country Music Hall of Fame
A2 = Rock and Roll Hall of Fame
A3 = Hip Hop Hall of Fame

B-Stimuli
B1 = Johnny Cash
B2 = Nirvana
B3 = Run DMC

C-Stimuli
C1 = Nashville
C2 = Cleveland
C3 = New York City

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations
## Stimulus Class Table

<table>
<thead>
<tr>
<th>Potential Class</th>
<th>A-Stimuli</th>
<th>B-Stimuli</th>
<th>C-Stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Country Music Hall of Fame</td>
<td>Johnny Cash</td>
<td>Nashville</td>
</tr>
<tr>
<td>2</td>
<td>Rock and Roll Hall of Fame</td>
<td>Nirvana</td>
<td>Cleveland</td>
</tr>
<tr>
<td>3</td>
<td>Hip Hop Hall of Fame</td>
<td>Run DMC</td>
<td>New York City</td>
</tr>
</tbody>
</table>
Figure 1. Schematic of potential three, 3-member stimulus classes to be formed. Solid lines denote relations to be trained. Dashed lines denote potential emergent relations.
**Black Line** = Established Relations Prior to the Study

**Red Line** = Taught Relations

**Dashed Line** = Potential Emergent Relations

---

**A - AUDITORY STIMULI**

A1 “Truck”
A2 “Tick”
A3 “Track”

---

**B - PICTURE OF ITEM**

B1
B2
B3

---

**C - PRINTED WORD**

C1 Truck
C2 Tick
C3 Track

---

**D - Spelling**

D1 truck
D2 tick
D3 track

---

(Breault, 2015)
"flower"  "flower"

LISTENER  TACT

*Solid lines within the schematic represent trained relations
*Dashed lines within the schematic represent emergent (untrained) relations

(King, 2015)
4. Training Structures

- One to many (OTM)
- Many to one (MTO)
- Linear series (LS)
Linear Series (Arntzen, 2012)
One to Many (Arntzen, 2012)
Many to One (Arntzen, 2012)
cranberry

bog  Ocean Spray

Linear Series

cranberry

bog  Ocean Spray

OTM

cranberry

bog  Ocean Spray

MTO
Which is best?

• Overall, research indicates Linear Series is the least effective (Arntzen, 2012)

• Varied results comparing MTO and OTM in terms of which is most effective
Figure 2. Percent correct during pretesting for one hypothetical participant.
Figure 3. Percent correct during pretesting for one hypothetical participant.
Figure 4. Percent correct during pretesting for one hypothetical participant.
5. Training and Testing Criteria

• Establish acquisition criteria for training and testing phases
Figure 5. Percent correct during pretesting for one hypothetical participant.
Figure 6. Percent correct per trained relation for one hypothetical participant.
6. Decide number of training and test trials

• During testing, need to present all sample stimuli and comparison stimuli an equal number of times

• No rule as to how many times need to present - too few - could be by chance; too many - could see effects of fatigue
<table>
<thead>
<tr>
<th># classes</th>
<th># stimuli within class</th>
<th># presentations per stimulus</th>
<th>Total # trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
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<td>54</td>
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<td>4</td>
<td>6</td>
<td>72</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>6</td>
<td>72</td>
</tr>
</tbody>
</table>
7. Decide Mode of Presentation

• Low tech
  – present on paper
  – respond to Sd by: pointing, circle, stamp (benefits of permanent product)

• Computer-based
  – may be preferred mode for student
  – can efficiently incorporate stimulus prompting and differential reinforcement
  – some softwares will collect data
### Stimulus Equivalence Data Sheets

#### A-B Test 18

<table>
<thead>
<tr>
<th>Target Stimulus</th>
<th>Left</th>
<th>Middle</th>
<th>Right</th>
<th>+/-</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vek</td>
<td>☐</td>
<td></td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. Cug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3. Zid</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4. Zid</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>5. Vek</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6. Cug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>7. Vek</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>8. Vek</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>9. Zid</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>10. Cug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>11. Vek</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>12. Cug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>13. Zid</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>14. Cug</td>
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<td>☐</td>
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<td>☐</td>
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<tr>
<td>15. Vek</td>
<td>☐</td>
<td>☐</td>
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</tr>
<tr>
<td>16. Cug</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>17. Zid</td>
<td>☐</td>
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</tr>
<tr>
<td>18. Zid</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

(King, 2015)
STEP 1: PRE TEST FOR REFLEXIVITY  | Total Responses

**RESPONSES**
- 1 TOTAL RESPONSES
- 1 SURVEYS STARTED
- 0 SURVEYS IN PROGRESS

**QIOTA**
- 0/0 TOTALS
- 0 Trend
- 0 Today

There have been no responses in the last 374 days. Consider closing this survey or sending a new distribution.

---

**All Surveys**

<table>
<thead>
<tr>
<th>Active</th>
<th>Name</th>
<th>Responses</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td>Test Survey - Copy</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modified on: Sep 25, 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>Step 1: Pre Test for Reflexivity</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modified on: Sep 25, 2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>Test Survey</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
(King, 2015)
1.

<table>
<thead>
<tr>
<th>#</th>
<th>Answer</th>
<th>Bar</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="https://via.placeholder.com/153x43" alt="Image" /></td>
<td></td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>2</td>
<td><img src="https://via.placeholder.com/153x43" alt="Image" /></td>
<td></td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
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<td>1</td>
<td>100%</td>
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</tbody>
</table>

Total: 1

2.

<table>
<thead>
<tr>
<th>#</th>
<th>Answer</th>
<th>Bar</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="https://via.placeholder.com/153x43" alt="Image" /></td>
<td></td>
<td>1</td>
<td>100%</td>
</tr>
</tbody>
</table>

| 2 | ![Image](https://via.placeholder.com/153x43) |   | 0        | 0% |

Total: 1
8. Prompting Procedures

• Errorless instruction (Terrace, 1963a)
  • Stimulus fading
  • Stimulus highlighting
  • Positional prompting
  • Exaggeration
  • Time delay
  • Stimulus shaping

• Response prompts
Stimulus Highlighting

- Popsicles
- Chicken Nuggets
- Pizza
- Toothpaste
- Soap
- Deodorant
- Milk
- Cheese
- Eggs
Stimulus Highlighting

- Popsicles
- Chicken Nuggets
- Pizza
- Toothpaste
- Soap
- Deodorant
- Milk
- Cheese
- Eggs
Stimulus Highlighting

- Popsicles
- Chicken Nuggets
- Pizza
- Toothpaste
- Soap
- Deodorant
- Milk
- Cheese
- Eggs
Exaggeration

SKINNER

MEDIocre

AMATEUR

GENIUS
Exaggeration

SKINNER

GENIUS

AMATEUR

MEDIocre
Exaggeration

SKINNER

MEDIocre

AMATEUR

GENIUS
Superimposition

PENGUIN
Superimposition
Superimposition
Positional Prompts

A=A

Symmetry

Transitivity

Reflexivity
Positional Prompts

A=A

Symmetry  Transitivity  Reflexivity
Positional Prompts

A=A

Symmetry  Transitivity  Reflexivity
9. Arrange stimuli within design

• Each trial will have the same number of comparison stimuli – at least 2 comparison stimuli per trial

• Counterbalancing rules
Counterbalancing Rules

• Each stimulus presented in linear array in each position an equal number of times.

• Comparison stimuli presented as discriminative stimuli and stimulus deltas an equal number of times.

• If discriminative stimuli occur more than once in the same position for consecutive trials, this should occur for all other positions as well.

• Counterbalance presentation of sample stimuli across trials.
<table>
<thead>
<tr>
<th>Samples</th>
<th>Left</th>
<th>Center</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conditional Identity MTS (pictures)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pictures</td>
<td>spoon</td>
<td>knife</td>
<td>fork</td>
</tr>
<tr>
<td></td>
<td>fork</td>
<td>spoon</td>
<td>knife</td>
</tr>
<tr>
<td></td>
<td>knife</td>
<td>fork</td>
<td>spoon</td>
</tr>
<tr>
<td><strong>Arbitrary MTS (visual–visual)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objects</td>
<td>spoon</td>
<td>knife</td>
<td>fork</td>
</tr>
<tr>
<td></td>
<td>fork</td>
<td>spoon</td>
<td>knife</td>
</tr>
<tr>
<td></td>
<td>knife</td>
<td>spoon</td>
<td>knife</td>
</tr>
<tr>
<td><strong>Arbitrary MTS (auditory–visual)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoken words</td>
<td>&quot;spoon&quot;</td>
<td>fork</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;fork&quot;</td>
<td>spoon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;knife&quot;</td>
<td>knife</td>
<td></td>
</tr>
</tbody>
</table>

Note  MTS = match-to-sample

(Green, 2001)
10. Pre-test all relations

• Referencing schematic, identify all possible trained and emergent stimulus-stimulus relations

• Pre-test identity matching-to-sample

• No feedback for any test trials

• If needed, can intersperse known trials to be reinforced
11. Data Analysis

Figure 2. Percent correct during pretesting for one hypothetical participant.
12. Train specified relations

• Train specified relations using selected prompting procedure

• Continue training until specified criteria is demonstrated

• Can train relations separately or together
13. Post-test all relations

• Post-tests should be same as pre-test trials
14. Data Analysis

• If all relations are not demonstrated to criteria during 1st post-test, post-test again

• After several post-tests, re-visit training - may need to train again
<table>
<thead>
<tr>
<th></th>
<th>Identity Matching</th>
<th>Trained Relations</th>
<th>Potential Emergent Relations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>78</td>
<td>100</td>
<td>16</td>
</tr>
<tr>
<td>Posttest I</td>
<td>100</td>
<td>88</td>
<td>100</td>
</tr>
<tr>
<td>Posttest II</td>
<td>-----</td>
<td>-----</td>
<td>100</td>
</tr>
<tr>
<td>Posttest III</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

Table 1
Pre-Test and Post-Test Results for all Stimulus-Stimulus Relations
“Despite the number of important demonstrations... in some ways the work has just begun”

(O’Donnell & Saunders, 2003, p. 146)
Thank you!

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Sumner, Maguire, & Cameron (2010). Geometry relations. *In Preparation.*