Errorless Learning and Schedules of Reinforcement for Establishing and Maintaining Behavior in Alzheimer’s Disease

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Introduction

• Alzheimer’s disease (AD) is the fifth leading cause of death in Americans ages 65 and older (Simms-Mebane, 2009)

• One in eight elders age 65 and older is diagnosed with AD (Alzheimer’s Association, 2010)

• Incidence of the disease expected to double over the next 20 years (Buchanan, Christenson, Houlihan, & Ostrom, 2010)

• Total annual costs in the US is estimated at $148 billion in direct (Medicare/Medicaid) and indirect (e.g., decreased income revenues) costs (Mebane-Simms, 2009).
Introduction

- Organic pathology associated with a variety of behavioral deficits and excesses (Teri, Larson, & Reifler, 1998)
- 55-90% exhibit significant problem behaviors in community settings (Cohen-Mansfield, Werner, Watson, & Pasis, 1995)
  - Leading cause for institutionalization
- Common behavioral deficits:
  - Independent toileting
  - Mobility
  - Bathing
  - Self-dressing
  - Self-feeding
  - Leisure and social skills
  - Verbal behavior
Introduction

• Behavioral interventions with AD largely understudied
  • 4 publications studying AD population cited in JABA
  • 251 publications with autism cited in JABA

• Skinner (1983) suggested:
  • Existing contingencies may reinforce ineffective behavior in elderly (e.g., prompted/dependent behavior)
  • May be a change in available reinforcers
    • Due to loss of functioning associated with aging, potential loss of reinforcing agents (i.e., spouse), and life changes (e.g., retirement)
  • Intermittent schedules may be too thin to support the acquisition and/or maintenance of desirable behavior
    • Also suggested by Tripp et al. (1999)
Introduction

• Limited analysis on effects of using intermittent reinforcement and delays to reinforcement with elderly
  • Most citations provide continuous reinforcement (CRF) to increase desirable behavior
  • Is this a problem?
    • Conditions unlikely in the natural environment
    • Poorer maintenance, prone to extinction (Bijou, 1958; Cowen & Walster, 1974; Ferster & Skinner, 1957; Hearst, 1961).
Purpose

To evaluate the following in participants with moderate to severe AD and related dementias in an applied setting;

a) Effectiveness of brief multiple stimulus without replacement (MSWO) method for identifying reinforcers

b) Whether errorless learning produces independent responding during a novel repetitive motor task

c) Patterns of responding under increasing VR and FR schedules compared to CRF

d) Maintenance of behavior
Method: Participants

- Four females diagnosed with probable AD
- One male diagnosed with frontotemporal dementia
- Mean age = 74.2 years (range, 59 to 86)
- 3 of 5 scored in the moderate range for cognitive impairment
- 2 of 5 scored in the severe range for cognitive impairment
Experiment 1
Method: Design

- Concurrent operant arrangement to evaluate effectiveness of consequence as a reinforcer

Loughrey et al., 2013
Method

1. Preference Assessment:
   - Daily brief MSWO (Carr et al., 2000)
   - Five food items based on modified RAISD (Fisher et al., 1996)

2. Reinforcer Assessment:
   - Assess effectiveness of highly preferred stimulus (HP)
   - Sessions began with pre-training and verbal instructions
   - Arbitrary response: depositing a poker chip into the slot of a container
   - Color of container paired with access to HP + praise or no programmed consequence = control
   - Sessions lasted 30 s to 1 min
Results: Preference Assessment

Sarah

Elizabeth

Victoria

Loughrey et al., 2013
Results: Preference Assessment

<table>
<thead>
<tr>
<th>Item</th>
<th>Ingrid</th>
<th>Robert</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBQ Chips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular Chips</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretzels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chocolate</td>
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<td></td>
</tr>
</tbody>
</table>

The graph shows the percentage of selections for each item by Ingrid and Robert. BBQ Chips is the most preferred item for both individuals.
Results:
Reinforcer Assessment

- **Sarah**
  - Sessions: -2, 0, 2, 4, 6, 8, 10, 12
  - Number of Deposits: 1, 2, 3

- **Ingrid**
  - Sessions: 1, 2, 3
  - Number of Deposits: 2, 2, 2

- **Victoria**
  - Sessions: 1, 2, 3
  - Number of Deposits: 14, 16, 18

**Graphs:**
- Control
- SR+

*Note: The graphs illustrate the number of deposits over sessions for each individual.*
Results: Reinforcer Assessment

<table>
<thead>
<tr>
<th>Reinforcer</th>
<th>Assessment</th>
<th>Number of Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
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<td>8</td>
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<td></td>
<td>10</td>
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<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

Control

Robert

SR+

Color change

Elizabeth
Discussion:

Brief MSWO:

• Results demonstrate relatively stable preferences over extended time (i.e., 2 to 4 months) for 4 of 5

Reinforcer Assessment:

• 4 of 5 participants allocated responding exclusively to SR+ container
• 1 participant showed undifferentiated responding
  – Failure to discriminate between the differential consequences
  – Whether food and/or praise did not function as a reinforcer for the arbitrary response
Experiment 2
Method: Design

- Non-concurrent multiple baseline design to evaluate errorless learning (EL)

Loughrey et al., 2013
Method: DVs

• Operationally definitions for tasks;

  a) **Jenga® block building:** placing three blocks vertically one at a time and then stacking three blocks horizontally in an alternating fashion until the session timer elapsed.

  b) **Sorting mail:** matching envelopes with the appropriate pile (i.e., with the matching name) or starting a new pile if no pile exists with the name.

  c) **Formation of the bracelet loop:** picking up two adjacent pieces of string, placing left string over the right string, pulling underneath and through the hole until a knot is formed at the top of the bracelet.
Method: Baseline (BL)

- 3 to 5-min sessions depending on task
- Started each session with instruction specific to task
- Participants seated at table
- Materials presented on table within arm’s reach
- No prompting or reinforcement
Method: Errorless Learning (EL)

- Most-to-least physical prompting at 0-s delay with or without verbal instructions
- Prompted responses resulted in verbal feedback (i.e., “yes”)
- Independent responses resulted in delivery of first chosen item from brief MSWO and verbal praise
- Training continued until at least 80% independence for three consecutive sessions
Discussion

EL

• Teaching procedure was effective
• 3 of 5 participants reached 80% during the first session
• Consistent with prior literature with AD (Clare et al., 2000, 2002; Clare, et al., 1999; Winter et al., 1999; Haslam, Gilroy, Black & Beesley, 2006)
Experiment 3
Method: Design

• Reversal design to compare CRF to increasing VR and FR schedules
• Following EL, responding rates measured on FR and VR schedules
• CRF used as a baseline comparison
• Investigator delivered edible according to schedule parameters
• No prompts similar to baseline

Loughrey et al., 2013
Method: Schedule Comparisons

• Salient stimuli (i.e., colored place mats) were associated with FR and VR schedules
• Conditions changed contingent upon stable response rates across 3-5 sessions:
  • Absence of trend
  • Session data within 20% difference from mean level
• Ratio size doubled under schedule with most stability and/or highest responding

Loughrey et al., 2013
Results: Schedule Comparisons

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Responses per Min</th>
<th>Number of Reinforcers Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRF</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FR6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CRF</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>VR6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>CRF</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

SR+ earned responses per min

Sarah

CRF

FR6

VR6

CRF

VR12

CRF

VR12
Results: Schedule Comparisons

Sessions

Responses per Min

Number of Reinforcers Earned

CRF
FR6
CRF
VR6
CRF
VR12
CRF
VR12

Elizabeth

Responses per min

SR+

Sessions
Results: Schedule Comparisons

Responses per Min

Number of Reinforcers Earned

Victoria

CRF
VR6
CRF
FR6

CRF
VR12
CRF
VR12
Results: Schedule Comparisons

Sessions

Number of Reinforcers Earned

Responses per Min

Responses per min

SR+ earned

Sessions

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45

Robert

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

0 5 10 15 20 25 30 35 40
Discussion:

• For all participants, intermittent schedules maintained responding
  • All participants showed same or higher levels of responding when ratio size increased
  • Consistent with basic research (Ferster et al., 1957; Hudson, Foster, & Temple, 1999; Wylie et al., 1998)
• All participants demonstrated maintenance of the skill during follow-up probes
Discussion

- 4 of 5 participants showed increased or less variable rates of responding under highest VR schedule
  - Reinforcers may have been more valuable when response requirements increased
  - Satiation less likely during leaner schedule

- 1 of 5 showed an increasing trend across all sessions
  - Practice effect
  - Task completion may have acquired reinforcing properties

- Findings demonstrate operant principles are generalizable to this population regardless of memory impairment
  - Intermittent schedules maintained or increased rates of responding
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Alzheimer's Foundation

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