Applying Behavioral Principles in the Neurorehabilitation of People with Brain Injury

Joseph N. Ricciardi, PsyD, ABPP, BCBA-D, CBIST
Seven Hills NeuroCare
Seven Hills Foundation
Today’s topic

Applied behavior analysis and **neurorehabilitation**?

“I thought you guys were all about intellectual disability?”

“ABA is a treatment for kids with autism, right?”

There are far more applications of behavior analytic principles to support neurorehabilitation than many might realize
Today’s topic

What is ABA? A brief background
  - Origins
  - Current practices and practitioners

Some examples of applications
  - Within ABI population
  - Problem behavior
  - Acquisition of functional skills, life skills, and cognitive skills

Behavioral learning principles
  - Basic principles of learning and behavior change
  - Teaching techniques and strategies

Writing and organizing a learning plan

Behavioral skills training
  - Strategies for training and supervising implementing staff
Applied behavior analysis (ABA)

- The application of the principles of learning and motivation from behavior analysis, and the procedures and technology derived from those principles, to the solution of problems of social significance.

Behavior Analysis: Two primary areas of study

- **Experimental analysis of behavior**
  - Basic research. Scientific research on behavior, learning, behavior change, etc. This is the basic science behind ABA.
  - Emerging ties to neuroscience (learning, memory, rewarded-behavior)

- **Applied behavior analysis**
  - This is applied research. Principles of learning are used to solve socially significant problems and experimentally validated. The result are techniques and procedures used as interventions.
What is ABA? A brief background

**Practices**

- **Applied.** The application of the *basic science of learning* to solve problems.

- **Behavioral.** The focus is always on what can be observed and measured. “Behavior is what someone does”.

- **Data-based.** Data-based: careful observations, measurement, review, analysis.

- **Technological.** Uses techniques that can be described adequately so they can be used by others (the concept of a detailed “treatment plan”).

**Practitioners: Who is qualified to provide behavior analytic services?**

- Current standard of practice: Board Certification (BCBA, BCBA-D)
- LBA: Licensed Behavior Analyst (Massachusetts)
- BCABA and RBT (registered behavior technician)
ABA is employed across a range of populations and for a variety of clinical problems

- Populations referenced in ABA literature
  - Intellectual disability
  - Autism
  - Chronic and persistent mental illness
  - Brain injury

- ABI clinical problems referenced in behavior analytic literature
  - Reduction of challenging behavior
  - Functional improvement of motor skills (ADLs, IADLs)
  - Functional improvement of cognitive skills
An example: The work of Edward Taub

- Behavior analyst
- Was experimentally testing the "reflex" theory of behavior
- Following surgical abolition of sensation from a forelimb, the animal would no longer use the limb
- Behavioral model: "learned non-use"

  - Taub was able to show that with "operant conditioning" (B. F. Skinner), the animal could be trained to move the limb again

- Later experiments, he would restrain the unaffected limb for long periods, provoking improved movement and resumption of functional use in the affected ("dis-used") limb

- Constraint induced movement therapy
Recent meta-analysis of ABA-based approaches applied in cases of brain injury (Heinicke & Carr, 2014)

- 112 studies meeting inclusion standards for experimental procedures and documentation of ABI
- Studies included children and adults
- Studies included both behavior reduction and skills acquisition using ABA

ABA for ABI?

Recent meta-analysis of ABA-based approaches applied in cases of brain injury (Heinicke & Carr, 2014▲)

- ABA interventions classified as **Well-Established** or **Probably Efficacious** for acquiring/re-learning skills and adaptive behaviors (moderate to large effect-sizes):
  - Positive reinforcement
  - Modifying antecedents (adding visual cues, modifying schedules and routines, etc.)
  - Self-management

- And, **Well-Established** or **Probably Efficacious** for **reducing challenging behaviors**:
  - Differential reinforcement
  - Antecedent control
  - Self-management
  - Extinction
An older review evaluated 65 studies focused on behavioral intervention for problem behavior only (Ylvisaker et al., 2007)

- 65 studies, 172 participants
- Contingency management (26), PBS+ABI (22), PBS (17)

<table>
<thead>
<tr>
<th>Type of behaviour problem</th>
<th>Number of participants</th>
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<tbody>
<tr>
<td>Unspecified aggression</td>
<td>24</td>
</tr>
<tr>
<td>Physical aggression</td>
<td>51</td>
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<tr>
<td>Verbal aggression (threats, obscenities, etc)</td>
<td>46</td>
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<tr>
<td>Uncontrolled verbal output (e.g. demands)</td>
<td>12</td>
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<tr>
<td>Anger management problems</td>
<td>8</td>
</tr>
<tr>
<td>Self-injurious behaviour</td>
<td>6</td>
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<tr>
<td>General impulsiveness, disinhibition, disruptiveness</td>
<td>27</td>
</tr>
<tr>
<td>General non-compliance, refusal to participate</td>
<td>26</td>
</tr>
<tr>
<td>Sexually inappropriate talk or activity</td>
<td>13</td>
</tr>
<tr>
<td>General anxiety</td>
<td>4</td>
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<tr>
<td>Unsafe behaviour</td>
<td>4</td>
</tr>
<tr>
<td>Poor hygiene</td>
<td>2</td>
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An older review evaluated 65 studies focused on behavioral intervention for problem behavior only (Ylvisaker et al, 2007\(^\uparrow\))

- 65 studies, 172 participants
- Contingency management (26), PBS+ABI (22), PBS (17)
- Most studies employed a **multi-component approach** where 2 or more interventions were combined in a package

### Modify environment and teach new skills

- Modified structure and routine
- Modifying task expectations to ensure success
- Well understood daily routine (schedules, counsel, etc.)
- Choice and control over activities
- Personally meaningful activities (preferences) added to day
- Positive behavioral momentum before difficult tasks
- Errorless learning techniques
- Positive feedback (reinforcement), support, encouraging interactions
- Teaching communication alternatives to challenging behavior

An older review evaluated 65 studies focused on behavioral intervention for problem behavior only (Ylvisaker et al, 2007▲)

They argue that PBS is well-suited for problem behavior in ABI:

1. **Ventral frontal lobe injury**: reduces capacity to learn from consequences

2. **Dorsal frontal lobe injury**: initiation impairment, limiting “contingency contracting”

3. **Frontal-corticolimbic injury**: impaired contingency learning, impaired social judgment and perceptiveness; emotional regulation/self-control

Clinical Application: Addressing Challenging Behavior

Differential reinforcement (Petscher et al, 2008): Acquiring an alternative to challenging behaviors

JENNIFER

- 33 year-old woman who is 6 years post-brain injury
- TBI: fall from significant height; closed head. Hypoxic at accident site for about 18 minutes; required intubation
- Coma for about 5 months (Glasgow 3/4); then slowly Glasgow 6/7 for several more weeks
- Several years later, a second hypoxic event (lasting 20 minutes) caused by a seizure
Differential reinforcement (Petscher et al, 2008): Acquiring an alternative to challenging behaviors

JENNIFER

Neuropsychological challenges

- Severe aphasia (non-fluent and fluent / expressive and receptive)
  - Generally, no speech; or intrusive, irrelevant words
- Poor attention, concentration, and mental flexibility
- Easily angered/frustrated by routine events (for example: taking the wrong turn, pouring meds “the wrong way”, someone completing a domestic chore when it was her turn)

Behavioral challenges

- Outbursts of swearing, provocative gestures, aggressive posture
- Physical aggression
Differential reinforcement (Petscher et al, 2008): Acquiring an alternative to challenging behaviors

“The occurrence of a problem behavior is an occasion to teach”

“What else should this person be doing?”

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<th>B</th>
<th>C</th>
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<tr>
<td>Antecedent</td>
<td>Behavior</td>
<td>Consequence</td>
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<tr>
<td>A setting, activity, or stimulus that “triggers” the behavior</td>
<td>Challenging behavior</td>
<td>Event that follows and increases the rate of the behavior</td>
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ALTERNATIVE BEHAVIOR

TEACHING PLAN
Teaching Communication, In Vivo?

A variation of functional communication training

- An ABA-based intervention with a long record of application for challenging behavior in people with communication challenges
- There is sufficient research to classify it as an empirically-supported intervention (Kurtz et al., 2012)
One approach: Have staff alternate between three strategies (Lennox et al, 2013) with a goal of shaping adaptive communication

1. **Help**
   - Cue engagement by asking, “What can I do to help you?” “What’s going on Jenn?” “What happen?”
   - Engage in listening to concerns, and problem solving or acceptance

2. **Wait**
   - If the person is reluctant to engage, continues challenging behavior, or escalates, then disengage, and wait for an opportunity to engage

3. **Prompt**
   - When engaging the person, prompt more effective problem solving behaviors (in this case, prompt communication strategies)
   - Communication (prompted or independent) secures staff engagement, support, and problem solving
Multi-component behavior support plans (Ricciardi, 2006): Re-engineering the environment

A multi-component plan is not a single intervention, but a set of interventions usually covering four critical areas:

1. Establish preventative strategies
2. Teach alternative behaviors
3. Reinforce positive behaviors
4. When problems occur, manage them therapeutically

RICHARD

- 46 year-old man who is 11 years post-brain injury
- ABI: meningitis, coma, respiratory distress, intubation; cardiac arrest upon extubation leading to anoxia
- Remained in long-term care (nursing home) x 10 years, then transitioned to community-based residence (ABI Waiver)
Case Example 2

Multi-component behavior support plans (Ricciardi, 2006): Re-engineering the environment

RICHARD

Neuropsychological challenges

- Non-ambulatory: generalized muscle weakness, fatigues easily
- Incontinence (urine and bowel)
- Severe memory impairment: short-term deficits; difficulty forming and retrieving long-term memories
- Low attention span/poor concentration
- Sexual disinhibition (verbal and physical contact)
- Inflexible preoccupation with snacking, smoking (“always asking”)
- Low initiation, appears disinterested in most activities offered; excessively passive
- Disruptive and aggressive behaviors (yelling, grabbing things he wants, kicking caregivers)
Behavioral challenges

- After 6 months of relative stability in day program, gradually began exhibiting behavioral deterioration, but not at home:
  - Increased disruptive and aggressive episodes
  - Elopement from assigned programming room/schedule
  - Refusing to cooperate with scheduled toileting or changing
  - Food stealing
- Day placement at risk: behavioral needs beginning to exceed capacity of the setting

Case Formulation

- Disruptive behaviors intermittently reinforced by escape or avoidance of low preference activities
- Frontal injury contributes to form and intensity; and aversiveness of low preference activities
Case Example 2

The problem behavior achieves escape/avoidance of time on task and low preference activities

- **Antecedent**
  - Too long on same activity
  - Activities we “know” he doesn’t like
  - Egress interrupted

- **Behavior**
  - Yelling, kicking staff

- **Consequence**
  - Removed from activity (some of the time)
  - Request to leave room denied
  - Propels self out of room/Attempts
  - Yelling, kicking staff
  - Removed from activity
  - Removed from activity (some of the time)
**Case Example 2**

**Prevent**

- Add snacks and smoke breaks
- Add a visual activity schedule
  - Programming activities
  - Snacks and smoke breaks
  - Bathroom break
- Incorporate preferred activities within schedule (library, listen to music)
- Offer choice of alternative activity when bored, requests something else to do (reading, music, take a stroll out of classroom)
- Avoid interrupting egress—prompt alternative (requesting)

**Teach**

- Following a visual activity schedule, praise following schedule, access to highly preferred activities (eating and smoking)
- Prompt alternatives when bored, attempt to egress
- Teach return to schedule (5-minute, then review schedule/prompt)
We employ two basic behavioral principles: stimulus fading and transfer of stimulus control

Stimulus fading as treatment for obscenity in a brain-injured adult

Pace, Ivancic, Jefferson (1994). *Journal of Applied Behavior Analysis*

- 49 y.o. man, 9 mos. post-TBI
- Obscenities when simple requests (“demands”) placed on him
- Aggression follows obscenities
We employ two basic behavioral principles: stimulus fading and transfer of stimulus control

- **Stimulus fading**: The eliciting stimulus (*the thing that triggers Richard, i.e., his day program routine) is removed and gradually “faded” into his presence

- **Transfer of stimulus control**: “Richard does really well with Marc from the residence. Can’t Marc just come here and work with Richard from now on?”

**PLAN**

Fading: Arrives at lunch time, eats lunch, then goes into library (preferred), then leaves after half an hour. Then add another half hour, and another, and so on. Gradually ease back into a full day.

Transfer of stimulus control: A day staff person works side-by-side with Marc, then takes on more and more of the interactions, until Marc is more or less in the background. As more hours are spent on site, more staff enter the staffing rotation until he’s working entirely with day staff.
Case Example 2

The toileting issue

Antecedent: “Time to use the bathroom”
   Brought into bathroom and prompted to sit
   Prompted for change soiled briefs

Behavior: Yelling, kicking staff
   Sexualized comments
   Touching staff sexually

Consequence: Activity is terminated or avoided altogether

CMO-R: Conditioned Motivating Operation, Reflexive type.
The onset of the demand, or the presentation of stimuli associated with it immediately evokes negatively reinforced behavior.
Case Example 2

The toileting issue

**A** Antecedent

“Richard, it’s time for your cigarette break. But first, let’s try the bathroom....”

“You don’t have to go inside, just take a look and let me know if you have to go....”

**B** Behavior

Looks inside bathroom.

“No. I don’t need to go....”

Yell, kick, sexualized comments.

**C** Consequence

Access to cigarette break.

Help

Wait

Prompt
The toileting issue

**PLAN**

**Strategically adjusted schedule:** Cigarette breaks (2) are always preceded by toilet opportunity.

**Shaping toileting behavior:** Using “classic shaping” we reward successive approximations to the goal:

1) Look in the bathroom
2) Look in, move into bathroom
3) Move into bathroom, check brief (change if wet?)
4) Check brief, sit and try
5) Sit and produce

- The idea is to present the “demand” in a way that is unlikely to elicit the problem behavior.
- Gradually fade the demand, while following with reinforcement each time, thus reconditioning him so that “toilet = access to smoking”
Shaping: A Basic Principle of Learning

- **Shaping**: The differential reinforcement of successive approximations to the goal

- **Goal**: sit on the toilet and produce
  1) Look in the bathroom
  2) Look in, move into bathroom
  3) Move into bathroom, check brief (change if wet?)
  4) Check brief, sit and try
  5) Sit and produce

Each bar press is followed by food.
The rate of bar pressing increases.
Clinical Application: Re-Learning Basic Life Skills

Now, applying behavioral learning principles to teach life skills

- **Prompting/prompt fading technique**
  - An entire multi-step, complex skill is taught in sequence, and success is ensured by verbal prompting

- **RIRD (response interruption and redirection) technique**
  - Errors or interfering behaviors are managed by verbal interruption, and directing an appropriate action

**Behavioral goal:**
- Consumption of solid foods in a person with g-tube

**Challenges:**
- Overcoming habitual refusal “I don’t like it”
- Overcoming spitting out foods
- Re-learning proper sequence: bite, chew, swallow, bite ...
Using prompting/prompt fading (an “errorless learning” technique) to teach food consumption

Sandy

- 26 year-old woman who is 2 years post-brain injury
- TBI: motor vehicle accident; seizing and not breathing at accident site; intubated at site
- Coma for about 5 weeks (induced); post-TBI amnesic syndrome
- Right depressed skull fracture; parietal lobe

Neuropsychological challenges

- Problems with attention, concentration, focus
- Disinhibited (touch, inappropriate words)
- Hypersensitivities? Shows twitchy movements during ADL personal care; complains of “too hot” and “too cold” with neutral temperature shower, etc.
- G-tube soon after coma lifted due to food refusals
- No dysphagia—can swallow normal liquids. Refuses all solids
PLAN

Preparation
1. Provide continuous, 1:1 supervision during meals. Stay nearby. Talk to her throughout the meal.
2. Cut meats and difficult to chew foods into bite sized pieces (about size of thumbnail). Cut sandwich in half.
3. Set drink aside; encourage small sips periodically, rather than big gulps.
   - Use encouraging, gentle voice tone

Interactions to encourage eating
4. Encourage “small bites” and to swallow before taking another bite. Sometimes she will try to eat too much at once, or add more food to her mouth before swallowing.
5. Redirect attempts to spit out foods. If you see her bringing food from mouth to her lips, quickly remind her, “Don’t spit it out. Try to chew it. You can do it.” Be encouraging.
6. Remind her to swallow when you see excessive chewing. She may chew foods “too much” creating a paste in her mouth that makes her gag; prompt swallowing.
7. Encourage her to try when she refuses, says “I don’t like it”.
   - Don’t simply “accept” refusal statements. Instead, prompt her to keep trying.
   - Remind her that it’s all new for her; she is working on getting used to eating foods again. “It feels cold, but if she keeps working on it, she’ll get used to it.”
   - Suggest she eat something else on her plate, if available.
   - Encourage a brief pause—wait 30 seconds and then prompt again.
8. Praise bites and swallows periodically. Recognize her successes.

Ending the meal
9. She says she is done, but there is still a lot of food. Treat it like refusing or saying “I don’t like it” (step 7, above).
10. Seems like she really is full. You can use your judgment and consider the meal over. Aim for consuming at least 75% of foods presented, but don’t struggle over it if she is not interested.
Some Basic Science?

**Parietal ablation in monkeys**

Displayed “rejection behavior”—
1. Withdrawal and avoidance of food, and other stimuli they normally interacted with
2. Sensitivity to contact, touch, especially head—withdraw or avoided
3. Anxious

**A human analogue in humans with parietal brain injuries**
Lots of very specific technique in this plan. Here are some important considerations when writing a behavior intervention plan.

**Incorporate antecedent control technology**

- Antecedent strategies come **before** problem behavior to **reduce** the likelihood of problems behavior and to **increase** the likelihood of positive behaviors (Luiselli & Cameron, 1998)
- Technological terms “antecedent control strategies...” are minimized or avoided when possible (”plain language BSP”)
- Use plain language, clear descriptions in the plan. Explain the clinical concepts in trainings, meetings, handouts, etc. (Always be training)
Case Example 3

This is a teaching plan, so specific interactions are directed that facilitate learning, and prevent rejection of instruction

- Voice tone and attitude matter

- Your plan is aimed at staff performance. Avoid any language that might connote control, coercion, punishment:
  - “Do not permit drink until she has consumed at least 50% of meal”
  - “She must eat 75% before she can leave the table”
  - “Do not let her throw food away”

- While we are at it: Likewise, work on a clinically informed, sensitive language during staff meetings by listening and gently “correcting” language when needed:
  - “I think she knows she can get away with it with some people”
  - “She does it for the attention”
Lots of very specific technique in this plan. Here are some important considerations when writing a behavior intervention plan:

You should aim for a logically ordered plan (chronological?)

Break complex interventions into “chunks” to facilitate acquisition
- If there are logical groupings of steps, it helps to break them into these “chunks”

Succinct, clear steps
Anticipate all possibilities when you write the plan

How? Review with staff
- “So, what do you think?”
- What staff are thinking: “But what if she...” and “If you do that, she’ll ...”
- So we need to show staff the plan, ask them what will happen, revise per their guidance
- The objective is NOT to tell staff what to do, but to listen to their wisdom

Special tips? Sometimes you learn some special tips for staff, pointers, or you can add some for emphasis of a particular point.
- So, we can create another section for this
- Trying to “capture the wisdom of the floor”
Evidence-based Instructional Approaches

- Comprehensive reviews suggest that systematic teaching is more effective than “learning through error” (traditional model)
- Effective instructional procedures seem to **share certain features:**

1. Minimize errors
2. Use explicit models
3. Apply engagement strategies
4. Employ guided practice

1. **Minimize errors.** Teacher approaches instruction so the learner is making few errors, through technique
   - Prompting/fading and graduated guidance
   - Error correction procedures
     - Interrupt error, prompt correct, fading, end on correct

Clinical Application: Learning a Discrete Cognitive Skill

2) **Explicit models.** Teacher uses modeling or demonstration as part of standard process
   - Before starting a task or a specific step, "So this is how you..."
   - During task, part of an error correction:
     - Interrupt error, model correct, practice step

3) **Engagement strategies.** Teacher takes action to ensure engagement

   **Pre-work**
   - Involve the learner in selection of a meaningful goal
   - Ensuring optimal level of challenge (not too easy)

   **During instruction**
   - Explain/discuss the lesson and goal with the learner
   - Positive interactions: support, encourage, praise
   - Engage in reflective processes: awareness training
   - Act on signs of inattention, eyes off task, fatigue
Clinical Application: Learning a Discrete Cognitive Skill

4) Guided practice. Practice/repetition employed and directed
   o Massed practice: Little/no rest in between. Rapid practice, often during error correction as prompting is faded
   o Distributed practice: After a period of rest (actual mental rest, change of set), return to work on a previously practiced item
     • Within session (brief period of actual rest, return to item)
     • Between session (daily practice sufficient)
Case Example 4: Training in Name-to-face recall

**PLAN**

*Flashcard Training*

1. Do this once per shift.
2. Gather the flashcards and data recording sheet, and when XXX is ready, invite her to begin the practice session.
3. Mix up the cards (random order). Show her one card at a time.
4. Show the card, ask: “XXX, who is this?” Pause 2-3 seconds.
   - If she answers correctly: Praise—great job!
   - If she answers incorrectly, provide the correction procedure.
   - If she does not answer within 3 seconds, provide the correction procedure.
5. Correction procedure:
   1) Immediately correct: “No, that’s [give name]. XXX, say [give name].”
   2) Prompt again, right away: Show card, ask: “XXX, who is this?” [give name]. When she repeats, praise.
   3) One more time for practice: Show card, “XXX who is this?” Pause 2-3 seconds.
      - If she answers correctly, Praise.
      - If incorrect, correct her “No it’s [give name]. Say [give name]”
6. Continue for all pictures done 2 X, then done.
7. Record data as you go along.

*Natural Training*

1. Practice names throughout the day. Practice your name. Bring other staff over “XXX, who is this?”
2. If she answers correctly, praise. If incorrect, apply the correction procedure describe above.
3. Throughout the day, if she uses a name incorrectly, apply the correction procedure.
Staff Implementation Training

Behavioral Skills Training

- Sometimes called “checklist-based training” or “competency-based training”
- The training content is “operationalized” as a series of discrete, directly observable behaviors/skills—a “task analysis” of a skill set

6-Step Behavioral Skills Training Protocol
1. Describe target skill
2. Provide succinct, written description of skill
3. Demonstrate target skill
4. Require trainee practice of the target skill
5. Provide feedback during practice
6. Repeat steps 4-5 as needed
Questions or handouts?

jricciardi@sevenhills.org