Interventions Derived From Behavioral Momentum Theory: Past and Present

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Research supported by 1 RO1 HD064576 Eunice K. Shriver National Institute of Child Health and Human Development (NICHD)

Key Objectives of Workshop

• What is basic research?
• What is translational research?
• What is behavioral momentum theory (BMT)?
• How has basic BMT research informed behavioral interventions?

National Institutes of Health “Bench-to-Bedside” Program

HIV-AIDS Example

Discovery that HIV was the cause of AIDS led to an explosion of basic research

- HIV composition, life cycle, and viral mutation
- New anti-viral medications to kill HIV and interrupt replication
- Clinical research aimed at long-term management
- Early advances in a vaccine

Bi-Directional Translational Research

Basic Behavioral Research
Basic Behavioral Research

Our Favorite Partners in Research

How do we progress from this....?

To this.....

Bench-to-Bedside

In the field of Applied Behavior Analysis

What is the Role of Translational Research?

• To establish the generality of basic non-human research findings
• To stimulate the development of behavioral technologies
• To stimulate basic research that will discover behavioral principles that have clear implications for:
  ▪ Understanding of human behavior
  ▪ Development of behavioral technologies
Translational Research: Behavioral Momentum Theory

Behavioral Momentum

• A metaphor based on an analogy between physical momentum and the tendency for behavior to persist even when conditions change.

Physical Momentum

A bus can have a large momentum even if it is moving very slowly, because it has a large mass.

\[ \text{Momentum} = \text{mass} \times \text{velocity} \]

Behavioral Momentum

• Metaphor developed by John A. (Tony) Nevin
• Refers to the tendency for a pattern of behavior, once established, to persist despite some opposition to the response-reinforcer relationship.
• Physical momentum is the tendency for an object in motion to continue at the same velocity unless opposed by a physical force.
• Momentum = mass \times velocity
Behavioral Momentum

• In the behavioral momentum metaphor, behavioral momentum is the product of behavioral mass and behavioral velocity
• Behavioral velocity is equal to (baseline) response rate
• Behavioral mass is the resistance of the baseline response rate to change when the response-reinforcer relationship is disrupted

Response-Reinforcer Disruptors

• Extinction
• Satiation
• Dark key food (periods between components)
• Punishment
• Alternative reinforcement
  • DRA
  • FT or VT reinforcer deliveries
• Distraction

Two Distinct Aspects of Behavior

Nevin (JEAB, 1974; 1983)

• Baseline multiple VI 1-min, VI 3-min schedule
• 1. Frequency of behavior (left panel)
• 2. Resistance of that frequency to change (right panel)

Important Limitation in Nevin et al. (1983)

• General finding: the higher the rate of reinforcement in a given context, the more persistent behavior will be in that context
• Unclear: Is momentum the result of how much reinforcement follows behavior? Or how much reinforcement occurs in a given context?

Nevin et al. (1990) to the rescue!
Tests of Species Generality

Fine for pigeons! True for us?

Key Significant Finding

- Reinforcing “good” behavior makes “problem” behavior more persistent

Types of Behavioral Translational Research

- Species generality research
- Confirm hypothesized fundamental behavioral processes emerging from clinical research
- Animal and human laboratory models of human behavior
- Development of new behavioral technologies that solve specific human problems

Translational Research: Tests of Species Generality

- Mace et al. (1990)
  - Purpose—to test the species generality of Nevin’s 1983 and 1990 findings
  - Experiment 1—Sorting plastic dinnerware on a multiple VI 60s VI 240s baseline
  - Preferred video introduced following stable baseline
  - Replicated Nevin et al. 1983
Mace et al. JEAB (1990)

Experiment 2
- Sorting on a multiple VI 60s VT 60s, VI 60s baseline
- Preferred video introduced following stable baseline
- Replicated Nevin et al 1990

Species Generality of Behavioral Momentum

Other Inter-Species Replications
- Goldfish (Igaki & Sakagami, 2004)
- Rats (Mauro & Mace, 1996)
- Children with DD (Dube & McIlvane, 2001)
- College students (Cohen, 1996)

Whew! This is tedious. Time for lab comics!
Back to the grind!

Translational Research:
Clinical Applications of Behavioral Momentum

The High-P instructional sequence:
A procedure for increasing compliance to Low-P instructions

Mace, Hock, Lalli, West, Relford, Pinter & Brown (1988)
- Inspired by Nevin’s basic research on behavioral momentum
- Rationale—use high rate reinforcement to establish a momentum of compliance that will be resistant to change when a low-p instruction is presented
- General Procedure:
  - Identify a set of 6-10 instructions yielding > 80% compliance
  - Identify a set of 6-10 instructions yielding ≤ 30% compliance
  - Present 3-4 high-p instructions with an IPT of 5-10 sec
  - Praise compliance to all instructions
  - Following compliance to 3 consecutive high-p instructions, deliver low-p instruction within 5 s
  - 1-min inter-trial interval

Experiment 1
33 yr-old male with severe MR
Weighed 105 kg and severely aggressive
A pool of low-p ‘do’ and ‘don’t’ commands under baseline and psychiatric intervention conditions, and smear application and withdrawal of the high-probability command sequence.

Types of Hi-P and Low-P Instructions
Killu, Sainato, Davis, Ospelt, & Paul, 1998

<table>
<thead>
<tr>
<th>Hi-P Instructions</th>
<th>Low-P Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Ask me to do this.&quot;</td>
<td>&quot;Tell me to do this.&quot;</td>
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McComas et al. 1998
Compliance with Medical Procedures

Figure 3. Percentage compliance to low-p requests with and without high-p requests. Triangles represent compliance with low-p requests and differential treatment, and circles represent compliance with low-p requests and standard treatment (GLM ANOVA, p < .05).
Ardroin et al. 1999
Compliance with Transitions

Webby & Hollahan, 2000
Decrease Compliance Latency & Increase Engagement

Davis et al. 1994
Increasing Social Initiations

Examples of High-P Applications
- Increasing compliance and reducing problem behavior
- Increasing food acceptance (with EE)
- Increasing words written
- Increasing letters completed
- Decreasing latency to begin activities
- Increasing percentage of time in task engagement
- Increasing social interaction in socially withdrawn children
- Increasing accurate completion of difficult academic assignments associated with severe behavior problems
- Increasing domestic and self-care skills
- Increasing medication compliance
- Increasing communication
- See Lee (2005) for review and meta-analysis

Factors Affecting the Effectiveness of the High-P Instructional Sequence
- Inter high-p—low-p interval

Mace et al. 1988
Houlihan et al. 1994

Factors Affecting the Effectiveness of the High-P Instructional Sequence
- Inter high-p—low-p interval
- Variability of the high-p instructions

Davis & Reichle 1996

Factors Affecting the Effectiveness of the High-P Instructional Sequence
- Inter high-p—low-p interval
- Variability of the high-p instructions
- Reinforcer quality for high-p compliance

Unifying Theory of Behavioral Momentum

Nevin & Grace (Brain & Behavioral Sciences, 2000)
- Unifying theory of choice and momentum
- Demonstrated that the variables that affect choice (or preference) also affect momentum (or persistence)
  - Relative reinforcement rate
  - Relative reinforcer quality
  - Relative reinforcer delay
  - Relative response effort
- These variables combine to determine Behavioral Mass

How can this information be used to make a failed intervention effective?
**Effects of Reinforcer Quality on Behavioral Persistence**

*Mace, Mauro, Boyajian & Eckert (1997)*

- A subset of low-p instructions were unresponsive to the conventional high-p treatment
- Rationale based on Nevin & Grace:
  - Increasing reinforcer quality for high-p compliance may increase the persistence of compliance

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**Mace et al. 1997**

WOW! More effective treatment based on basic research with pigeons!

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**This worked clinically, but how do I know this is a general behavioral relation?**

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**Bi-directional Translational Research: (Mace et al. 1997)**

_Hypothesis:_ Reinforcer quality affects behavioral momentum

_Procedure (Mace et al., 1997):_

- 2-bottle preference assessment with rats (sucrose vs. citric acid solutions)
- BL—multiple VI 60 (sucrose) VI 60 (citric acid)
- EXT—successive cycles of extinction
- Significance: first basic non-human study testing the reinforcer quality hypothesis
- Stimulated by Nevin & Grace (2000)
Theoretical Accounts of the Effects of the High-P Instructional Sequence

- Behavioral momentum
- Generalization
- Motivating Operations

Translational Research: Correlational Demonstrations of Behavioral Momentum

Behavioral Momentum in College Basketball
Mace, Lalli, Shea & Nevin (1992)

Procedure
- 5 classes of events scored from 14 video-taped NCAA college basketball games
- Reinforcers (points, favorable turnovers)
- Adversities (missed shots, unfavorable turnovers, fouls)
- Response to adversities (favorable/unfavorable outcomes with next possession following adversity)
- Time Out (target team calls a timeout)
- Response following time out (access a reinforcer or adversity)

Behavioral Momentum in College Basketball
Mace, Lalli, Shea & Nevin (1992)

Hypothesis 1
- As the rate of rein 3 min prior to an adversity increases, the probability of a favorable response to an adversity increases

Hypothesis 2
Timeout will be an effective intervention because it reduces the opponents rate of reinforcement

Developing Cooperation or Compliance

- Developing compliance/cooperation is an efficient and effective method of promoting prosocial behavior and reducing or avoiding undesirable and unsafe behavior
- Noncompliance is a lack of stimulus control
- How is compliance developed?
An effective method of developing compliance

- Whenever possible identify a teacher without a history with the child
- Conduct a reinforcer preference assessment
- Correlate the teacher with VT deliveries of preferred reinforcers
- Use an orienting cue to develop an orienting response
- Deliver the orienting cue at the moment of a schedule changeover
- When an orienting response reliably follows the orienting cue, introduce a simple instruction (e.g., "Bud, take it.")
- Couple preferred reinforcer deliveries with varied enthusiastic social reinforcement
- Gradually increase the response requirements in the instruction
- Thinned schedule of tangible reinforcers while maintaining FR1 social reinforcement
- Repeat the initial steps of compliance training in abbreviated form for the first 5-10 days of compliance training
- Gradually extend the number and range of settings for compliance training
- Gradually extend the number of teachers involved in compliance training
- Identify instructions that have a low probability of yielding compliance that are key instructions for success

Borgen et al. 2013

Treatment Relapse

- Recurrence of problem behavior following successful treatment
- Reflects a failure to maintain or generalize treatment effects
- A commonly reported phenomenon that is under-assessed (Nevin & Wacker, in press; Osnes & Lieblein, 2003)
Behavioral Momentum Theory and Treatment Relapse

- Treatment relapse reflects the persistence of problem behavior when conditions change
- General and robust findings:
  - Persistence is a function of the total reinforcement correlated with a specific context
  - Higher context-reinforcer rate → greater persistence
- BMT may stimulate effective technologies to reduce or avoid treatment relapse

Factors Related to Treatment Relapse

- Lapses in Treatment Integrity
  - Resumption of reinforcement of problem behavior
  - Failure to maintain reinforcement of alternative behavior
  - Failure to maintain schedule of noncontingent reinforcers
- Reintroducing client to the context previously correlated with reinforcement of PB
- Introducing a client to a context not correlated with treatment

Animal Models of Treatment Relapse

Resurgence
What happens when problem behavior is eliminated but later prosocial behavior is not reinforced?

Reinstatement
What happens when DRA and EXT are effective but later these same reinforcers are provided?

Renewal
What happens when problem behavior is eliminated in one setting but the child is later returned to the setting in which problem behavior was originally reinforced?

Modern Developments in Behavioral Momentum Theory

Resurgence Paradigm
- A target response is established
- It is then placed on EXT while reinforcing an alternative response (analogous to DRA with EXT)
- If reinforcement of the alternative is subsequently diminished, there is a resumption of the target response
- What are the clinical implications of this finding?

Reinstatement Paradigm
- A target response is established
- It is then eliminated with EXT or high-rate DRA
- Subsequently reinforcement of problem behavior occurs
- What are the clinical implications of this finding?

Renewal Paradigm
- A target response is eliminated in a context different from the baseline context
- Recovery of the target response is observed with the reintroduction of the baseline context despite ongoing treatment
- What are the clinical implications of this finding?
Ok, back to Nevin et al. (1990).............

- You cannot possibly be suggesting that frequently reinforcing ‘good’ behavior can make ‘problem’ behavior more persistent???

Resurgence: DRA Increases the Persistence of Problem Behavior

Participants and Target Behaviors
- Tom—7 yr, Down’s Syndrome—food stealing
- Jackie—4 yr, severe MR—aggression
- Andy—7 yr, autism & severe MR—hair pulling

Baseline Reinforcement of Problem Behaviors
- Tom—access to stolen food—CRF schedule
- Jackie—access to edibles—VI 60 s schedule
- Andy—access to attention—VR3 schedule

DRA
- Baseline rates of reinforcement for problem behaviors remained in place
- Tom—food contingent on appropriate eating—VI 300 s schedule (165% of BL)
- Jackie—food contingent on appropriate toy play—VR 2 schedule (185% of BL)
- Andy—attention contingent on appropriate toy play—VI 30 s schedule (195% of BL)

Extinction
- Response blocking and withholding food (Tom/Jackie) and attention (Andy)

Clinical Demonstration: FCT in a Separate Setting Reduces Persistence

Participants and Target Behaviors
- Mickey—11 yr, severe MR—disruptive behavior
- Paul—21 yr, severe MR—severe disruptive behavior
- Terry—4 yr, autism—disruptive behavior
- FA showed disruption maintained by escape from tasks

Baseline Reinforcement
- Multiple Concurrent Schedule
  - C1 (Yellow)—VI 75 s (disruption)
  - C2 (Blue)—FI 20 s (mand), VI 75 s (disruption)
  - C3 (White)—FI 30 s (mand), EXT (disruption)

DRA—Functional Communication Training (FCT)
- Baseline rates of reinforcement for problem behaviors remained in place
- Prompts to communicate with FC cards presented on FI 20 s schedule
- Represented 37% of BL reinforcement of disruption

Ok, we have a problem….any ideas?
Clinical Demonstration: FCT in a Separate Setting Reduces Persistence

Participants and Target Behaviors
- Mickey—11 yr, severe MR—disruptive behavior
- Paul—21 yr, severe MR—severe disruptive beh
- Terry—6 yr, autism—disruptive behavior
- FA showed disruption maintained by escape from tasks

Baseline Reinforcement
- Multiple Concurrent Schedule
  - C1 (yellow)—EXT (mand), VI 75 s (disruption)
  - C2 (blue)—FI 20 s (mand), VI 75 s (disruption)
  - C3 (white)—FI 20 s (mand), EXT (disruption)

DRA—Functional Communication Training (FCT)
- Baseline rates of reinforcement for problem behaviors remained in place
- Prompts to communicate with FC cards presented on FI 20 s schedule
- Represented 375% of BL reinforcement of disruption

Extinction
- Task prompts presented every 10 s regardless of disruptive behavior
- White–Yellow stimulus compound—White therapist provides task instruction in the Yellow setting
- Response to mands—"I'm glad you asked for a break, you can have one after you finish your work"

Baseline
0 20 40 60 80 100
Mickey Paul Terry
Median disruptions/hr
Disrupt
Mand+Disrupt
Mand only

Reducing the Magnitude of Treatment Relapse Using Low-Rate Reinforcement

F. Charles Mace, Kenneth Shamlian, Tara Sheehan, Keith Lit, Danielle Tarver and Stephanie Trauschke
Nova Southeastern University
Duncan Pritchard and Marguerite Hoerger
Bangor University and Aran Hall School
Brian Harris, Lisa Kovacs and Heather Penney
Aran Hall School

Study Hypotheses
Comparatively low-rate reinforcement of pro-social behavior will reduce the magnitude of treatment relapse following:
1. Reinstatement of baseline reinforcement (reinstatement model)
2. Discontinuation of treatment (EXT) (resurgence model)

Method
Participant and Setting
- 17 yr-old male with Autistic Disorder and Severe Intellectual Disability

Target Behaviors and Data Collection
- Aggression—hitting, pinching, kicking, biting, spitting, forceful pushing, throwing objects at the therapist
- Disruption—throwing objects, tearing paper

Ok, we have a problem….. any other ideas?
**Method—Experimental Phases and Conditions**

**Functional Analysis**
- Attention—VI 60-s attention for aggression and disruption delivered by Therapist 1 and Therapist 2
- Play—near continuous noncontingent attention delivered by Therapist 1 and Therapist 2

**Contingent/Noncontingent Attention at Different Rates (plus EXT)**
- Therapist 1—On a quasi-random variable 30-s schedule, therapist approached participant and prompted use of PECS card. If no response, therapist praised engagement in a pro-social activity or provided noncontingent attention
- Therapist 2—same as Therapist 1 but on VI VT 120-s schedule

**Equal Reinforcer Reinstatement**
- Both therapists reinforced aggression and disruption on VI 60-s schedules

**Extinction (Resurgence Model)**
- No attention plus response blocking as needed
Resurgence and Reinstatement Replications

Method

Participants and Setting
- 11 yr-old male with Autistic Disorder and Severe Mental Retardation
- 12 yr-old male with high-functioning Autistic Disorder

Target Behaviors and Data Collection
- Self-Injurious Behavior—self-hitting to the head and body
- Aggression—hitting, kicking, biting, and forceful pushing
- Disruption—hitting objects, loud vocalizations, loud and forceful clapping, pushing materials or table
- Data Collection—count within 10-s intervals converted to occurrences per minute

Method—Experimental Phases and Conditions

Functional Analysis
- Tangible—Access restricted after 2 min free access. VI 60-s access for 20 s for aggression and disruption delivered by Therapist 1 and Therapist 2
- Control—near continuous noncontingent attention and access to DVD delivered by Therapist 3

DRA (DVD Access Signaled by Timer) + EXT
- Therapist 1—Therapist set an audible cell phone timer. When the timer sounded an alarm on FI 30-s schedule, therapist provided access to the DVD or iPad video for 60 s timed by cell phone timer
- Therapist 2—same as Therapist 1 but on a FT 120-s schedule

Extinction
- After an initial 2-min access to the video, timers were set on the same schedules as in treatment but access to the video was not provided following requests for the video or for any other reason

Resurgence Test During Extinction

Summary Means for All Phases
Resurgence Test

Summary Means for All Phases

Mean Resurgence Following High- vs. Low-Rate DRA

Concluding Comments

- Translational research is vital to the "health" of basic research and technology development
- Consideration of basic research can stimulate new and more effective technologies
- Consideration of socially relevant human problems can stimulate basic research with relevance and greater value to the culture
- Collaborative and bi-directional translational research may be especially profitable