Understanding and Improving Token Systems and Related Instructional Arrangements through Behavioral Economics

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\[
S^D \rightarrow R \rightarrow S^{R+}
\]

stimulus value
Outline

- Reinforcement arrangements for children with ASD
  - “Conventional” preference and reinforcer assessment
  - What are we good at?
  - What remains to be understood?

- Behavioral economics: Tools for gauging stimulus value
  - Demand curves
    - Demand elasticity
    - Substitutable reinforcers
    - Interaction with interventions in ASD
  - Delay Discounting

- Some determinants of stimulus value
  - Contiguity: Reinforcer delay
  - Continuity: Reinforcer accumulation
  - Contingency: Historical effort and subsequent stimulus value

“I am not sure we need more preference assessment research...we are already very good at it”

Gary Pace, Ph.D.
“I am not sure we need more preference assessment research...we are already very good at it”

Gary Pace, Ph.D.

Do we need more preference assessment research?

We are done.
What’s Left to Do?

- Have we nailed it?
  - Developed methods
  - Examined stability
  - Effects of motivational operations
  - Matching methods to purpose & circumstance

Matching Methods to Purpose & Circumstance

![Decision Tree for Selecting Preference Assessment Methods]

*Virues-Ortega et al. (2014) American Journal on Intellectual and Developmental Disabilities*
What’s Left to Do?

- **Have We Nailed It?**
  - Developed methods
  - Examined stability and its determinants
  - Effects of motivational operations
  - Matching methods to purpose & circumstance

- **Getting Close?**
  - Do we really need a hierarchy?
  - Verbal and pictorial preference assessments
  - Preference assessments that match real work requirements or reinforcement parameters
  - Overjustification

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Do we really need a hierarchy?

- HP and LP stimuli in concurrent schedules
- Then LP stimuli in single-operant (FR1)
- Two Outcomes:
  1. LP stimulus produces rates as high as HP stimulus (Ellen)
  2. LP stimulus produces lower rates (Mark)
- Outcome 1 observed in 7 of 8 participants

**Conclude:** Concurrent schedules are more sensitive to relative reinforcement, but can mask absolute reinforcement effectiveness.

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*Roscoe, Iwata, & Kahng, 1999, Journal of Applied Behavior Analysis*
Verbal and Pictorial Preference Assessments

• Verbal assessments (e.g., Cohen-Almeida, Graff, & Ahearn, 2000; Northup, 2000).
  – Depends on language abilities

• Pictorial assessments (e.g., Clevenger & Graff, 2005; Conyers et al., 2002; Graff & Gibson, 2003; Graff, Gibson, & Galiatsatos, 2006)
  – Depends on picture-to-object matching abilities

Verbal and Pictorial Preference Assessments

• Conyers et al. (2002)
  – Determined preferences via paired-choice assessments
  – Compared “accuracy” (how often participants chose the known preferred food in 2-choice trials) under 3 conditions:
    • Object – presented actual items
    • Spoken – “Do you want X or Y”
    • Picture – presented pictures of the items
  – Examining correspondence of accuracy in these 3 modes as a function of abilities on the Assessment of Basic Learning Abilities (ABLA)
**SPA: Inclusion of activities**

- Level 3 = 2 choice visual discriminations
- Level 4 = a two-choice visual quasi-identity match-to-sample discrimination
  - E.g., a yellow cylinder in the yellow can and a red cube in the red box
- Level 6 = a two-choice auditory-visual combined discrimination
  - E.g., place a piece of foam into the container that was verbally requested by the tester (e.g., “yellow can” or “red box”, not necessarily matched on color).

**Conclude:** Verbal and pictorial SPAs can be accurate, but reserve them for individuals with established discrimination abilities.

Conyers et al., 2002, Journal of Applied Behavior Analysis

**Matching Actual Requirements and SR+ Parameters**

Steinhilber & Johnson (2007), Journal of Applied Behavior Analysis
Overjustification Effects in IDD

Q: Do extrinsic rewards decrease intrinsic motivation in persons with IDD?

Overjustification

 “…extrinsic motivators—including A's, sometimes praise, and other rewards—are not merely ineffective over the long haul but counterproductive with respect to the things that concern us most: desire to learn, commitment to good values, and so on.”

Alfie Kohn
Educational Leadership
Extrinsic Reinforcement & Intrinsic Motivation

- Eisenberger & Cameron (1996)
  - Meta-analysis & effect sizes
    - Aggregate outcomes on the same quantitative scale
  - Separated effects according to:
    - Contingency for delivery (quality dependent, completion-dependent, performance independent)
    - Type of reward (tangible, verbal)
  - Examined separate effects on engagement (“free time”) and attitudes towards task

But, what about effects specifically in persons with intellectual and developmental disabilities?

Eisenberger & Cameron, 1996, American Psychologist
Overjustification Effects in IDD

Q: Do extrinsic rewards decrease intrinsic motivation in persons with IDD??

• Analysis of published reinforcer assessments
  – Participants with an intellectual disability
  – ABA design with a clear reinforcement effect
  – Some responding during the initial no-reinforcement phase with at least three data points

• 65 qualifying data sets from 27 studies
Overjustification Effects in IDD

- Hedges $g$

\[
g = \frac{(M_1 - M_2)}{(SD_1 + SD_2) / 2} \times (1 - (3 / (4 * n - 9)))
\]

Negative $g$ – improvement effect  
Positive $g$ – overjustification effect

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Overjustification Effects in IDD

![Graph showing distribution of effect sizes](image)

**Figure 1.** Distribution of effect sizes for each individual included in the analysis. Effect sizes in the top graph were calculated using the entire phase, effects size in the bottom graph were calculated using only the last 3 sessions of each phase.

Levy, Martinez, Sigurdsson, Frank-Crawford, & DeLeon (accepted) Journal of Applied Behavior Analysis
**Overjustification Effects in IDD**

*Figure 2.* Distribution of difference scores (left panel) and mean responding for the last point of the first no-reinforcement phase and first point of the second no-reinforcement phase (right panels).

Levy, Martinez, Sigurdsson, Frank-Crawford, & DeLeon (accepted) Journal of Applied Behavior Analysis

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**Overjustification Effects in IDD**

*Figure 3.* Scatterplot depicting the relation between effect size and proportional response rates in baseline relative to response rates during reinforcement periods when the entire phases were used (top panel).

Levy, Martinez, Sigurdsson, Frank-Crawford, & DeLeon (accepted) Journal of Applied Behavior Analysis
Responding to Overjustification Concerns

- Reinforcement systems depend on task completion, performance quality, or both
  - These are reward procedures *not reliably* found to reduce intrinsic task interest.
  - Quality-dependent verbal rewards actually have a positive effect on intrinsic interest.

- Little evidence of systematic OJE in IDD
  - Effect sizes were just as likely to be negative or positive

Responding to Overjustification Concerns

- We generally do not program reinforcement for behaviors already occurring at high rates.

- Some effects may be best attributed to satiation
  - Esp. when reward does increase engagement, and
  - Effects are measured immediately afterwards

- Even if OJE occur, programmed contingencies:
  - Establish repertoires that place the individual in contact with more frequent SR+
  - Lay groundwork for adaptive functioning
What’s Left to Do?

• **Have We Nailed It?**
  – Developed methods
  – Examined stability and its determinants
  – Effects of motivational operations
  – Matching methods to purpose & circumstance

• **Getting Close?**
  – Do we really need a hierarchy?
  – Verbal and pictorial preference assessments
  – Preference assessments that match real work requirements or reinforcement parameters
  – Overjustification

• **Where are the data?**
  – But...does it enhance learning?
  – Ecological fitness?
  – Establishing reinforcers and transferring control
  – Determinants of reinforcer effectiveness

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**Does it Enhance Learning?**

Paden and Kodak (2015), *Journal of Applied Behavior Analysis*
Does it Enhance Learning?

- What’s the determining factor?
  - Variable preferences!

Thompson, DeLeon, Frank-Crawford, Triggs, & Carreau (in progress)
Does it Enhance Learning?

- Does varying reinforcers matter?
- Does choice matter?
- Does immediacy matter?
- Does schedule matter?
- Does quality matter?
- Does magnitude matter?
- Can we determine through pre-instructional assessments which child would or would not benefit from these variations.

Reinforcer Selection and Ecological Fit

<table>
<thead>
<tr>
<th>Category of Item Used</th>
<th>Percentage of All Responses</th>
<th>Percentage of Responses: BCBA/BCaBA</th>
<th>Percentage of Responses: Non-BCBA/BCaBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social praise/attention (riddles, high-fives, etc.)</td>
<td>91.5</td>
<td>94.4</td>
<td>90.0</td>
</tr>
<tr>
<td>Tokens/Points</td>
<td>65.6</td>
<td>81.3</td>
<td>57.6</td>
</tr>
<tr>
<td>Breaks from work</td>
<td>65.0</td>
<td>77.6</td>
<td>58.6</td>
</tr>
<tr>
<td>Edibles</td>
<td>50.2</td>
<td>69.3</td>
<td>40.5</td>
</tr>
<tr>
<td>Toys</td>
<td>49.0</td>
<td>71.0</td>
<td>37.6</td>
</tr>
<tr>
<td>Independent free play</td>
<td>49.0</td>
<td>59.8</td>
<td>43.3</td>
</tr>
<tr>
<td>Access to physical activities (e.g., running, sports, playground)</td>
<td>37.5</td>
<td>42.1</td>
<td>35.6</td>
</tr>
<tr>
<td>Sensory items (e.g., theraband, theraputty, muscle massager, fan)</td>
<td>33.8</td>
<td>43.0</td>
<td>29.0</td>
</tr>
<tr>
<td>Community-based activities</td>
<td>19.2</td>
<td>21.5</td>
<td>18.1</td>
</tr>
</tbody>
</table>

Graff & Karsten, 2012, Behavior Analysis in Practice
Reinforcer Selection and Ecological Fit

- Is it easily replenished?
- Does it cost much?
- Does it fit “organically” in the use environment?
- Can its use cause detrimental effects?
- Does its effectiveness wane easily across time?
- Does its delivery disrupt ongoing behavior?
- Does its delivery disrupt the behavior of others?

**Fig. 11.2** Figure depicting the relation between ecological fit and effectiveness for reinforcer selection

Reinforcer Selection Flowchart

DeLeon, Bullock, & Catania (2013), APA Handbook of Behavior Analysis, Vol. 2
Establishing Reinforcers & Transferring Control

- Do we have a good technology for establishing neutral stimuli as reinforcers?
- Do we have a good technology for fading from “contrived” reinforcers to social reinforcers?
- Do we have a good technology to transferring from “contrived” to “natural reinforcers.”
Determinants of Stimulus Value

- Behavioral Economics
  - Psychological concepts applied towards understanding human decision-making
  - Human irrationality; cognitive biases, suboptimal choice
- Behavioral Economics in Behavior Analysis
  - “...concepts from microeconomic theory are extended to the study of consumption by a range of species in the laboratory and the concepts of operant conditioning are extended to an understanding of demand for economic commodities.”
    Hursh, Madden, Spiga, DeLeon, & Francisco (2013)
  - Choice and consumption under conditions of constraint; determinants of stimulus value

Behavioral Economics

- Why microeconomic theory in BA?
  - Many points of convergence
    - Understanding determinants of the value of goods
    - Interest in the process of choice
  - Once parallels are drawn, suggests relations heretofore only considered by economists
    - New phenomena previously ignored
    - New functional relations previously unnamed
Behavioral Economics

- Commodities
  - Econ: Goods and services
  - B. Econ: Reinforcers

- Unit Price:
  - Econ: $$$ paid per unit of commodity (2.25 per gallon)
  - B. Econ: Number of responses “paid” per unit of reinforcer

- Consumption:
  - Econ: Total quantity of a commodity consumed, typically at the group or population level
  - B. Econ: Total amount of a reinforcer obtained per unit time, typically at the individual level

Behavioral Economics

Demand curves relate:
- Unit price of the commodity
- Amount of the commodity consumed

Law of Demand:
- All else being equal…
  - As unit price increases
  - demand (consumption) decreases
  - and vice versa
**Population Demand Curve**

Estimated demand curve based on scan data

Above, the estimated demand curve of Turning Leaf Merlot illustrates the inverse relationship between price and quantity.

**Group Demand Curve**

Proportion of Participants that Completed the Schedule

Solitary Play

Goldberg, Allman, Hagopian, Triggs, Frank-Crawford, Mostofsky, Denckla, & DeLeon (2016), Autism
Group Demand Curve

Goldberg, Allman, Hagopian, Triggs, Frank-Crawford, Mostofsky, Denckla, & DeLeon (2016), Autism

Individual Demand Curve

The same sort of relations influence consumption on the individual level.

Hursh (1991) JEAB
Elasticity of Demand

Elasticity of demand = sensitivity to price
   – extent to which changes in unit price influence consumption

Inelastic demand - Changes in price produce less than proportional changes in consumption
   E.g., 1% increase in price produces < 1% decrease in consumption

Elastic demand – Changes in price produce larger than proportional changes in consumption
   E.g., 1% increase in price produces > 1% decrease in consumption

What Influences Elasticity of Demand?

• Constraints on income re: “luxury goods” vs. “necessary goods”
   – Demand for luxury goods is more elastic

• Open vs. closed economies
   – The extent to you can access the commodity outside the conditions of constraint
   – Demand is more elastic under open economies
Open/Closed Economy Effects

- **PR Schedules**
  - Access to video
  - Constant UP, 10s per response

- **Conditions**
  - Open = up to 6 min free access after sessions
  - Closed = no free access

Result: Greater defense of consumption for same reinforcer under closed economy

Roane, Call, & Falcomata (2005) JABA
What Influences Elasticity of Demand?

• Constraints on income re: “luxury goods” vs. “necessary goods”
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• Open vs. closed economies
  – The extent to you can access the commodity outside the conditions of constraint
  – Demand is more elastic under open economies

• Availability and price of substitutable commodities
  – Demand is more elastic when substitutes are available
  – E.g. Demand for gasoline at is relatively inelastic; demand for Coca-Cola is not

Elasticity of Demand & Substitution

Q: How is reinforcer effectiveness influenced by the nature of other qualitatively different reinforcers in the environment?

• Stimuli with equivalent initial consumption under low cost conditions may have very different demand profiles
• More “durable” (less elastic) demand for a reinforcer, as the price increases, when it is dissimilar from the available alternatives.

Harsh (1991) JEAB
**Translational Behavioral Research in BA**

- Basic Research
  - “Borrowed” Concepts
  - “Found” Concepts

- Demonstrate Generality in Clinical Population

- Practical Implications & Utility
  - Questions Raised in Application
  - Use-Inspired Basic Research

- Failures to Translate
- Partial Outcomes
- Procedural differences?

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**Substitution and Demand Elasticity**

*Q: Do similar findings obtain in children with IDD?*

- **Stimuli with equivalent initial consumption under low cost conditions may have very different demand profiles**
- **More “durable” (less elastic) demand for a reinforcer, as the price increases, when it is dissimilar from the available alternatives.**

*DeLeon, Harsh, Frank-Crawford, Bullock, Triggs, & Carreau-Webster (accepted), JEAB*
Implications for the Treatment of PB?

Conventional course of intervention for PB in IDD:

- Functional assessment identifies the “functional reinforcer” maintaining problem behavior

- Some form of differential reinforcement
  - Provide functional reinforcer for alternative behavior
  - Extinction – disrupt contingency between PB and reinforcer

- Schedule thinning makes intervention practicable
Demand curves are less elastic when available alternatives are dissimilar.

Shape of Own-Price Demand Curve for Alt → Sr+ Relation when Sr+ is Similar

Shape of Own-Price Demand Curve for Alt → Sr+ Relation when Sr+ is Dissimilar?

Increases in this line represent the re-emergence of problem behavior as schedules are thinned!!!

Shape of Cross-Price Demand Curve for PB → Sr+ Relation when Sr+ is Similar

Shape of Cross-Price Demand Curve for PB → Sr+ Relation when Sr+ is Dissimilar?
What Does it Mean for the Treatment of PB?

In English….from the behaver’s point of view:

– Why should I work hard to produce an outcome that is more easily produced through another response?

– However, if what you are offering for my work is:
  • Valuable
  • Not something I can already produce through a different response

– Then perhaps I might be willing to work a little harder to get it.

Translation:  Substitution and Stimulus Value

Q: What are the clinical implications?

• Stimuli with equivalent initial consumption under low cost conditions may have very different demand profiles
• More “durable” (less elastic) demand for a reinforcer, as the price increases, when it is dissimilar from the available alternatives.
Translation: Substitution and Stimulus Value

- **If problem behavior continues to be reinforced, (extinction is impracticable), and**
  - The schedule for appropriate behavior is thinned
  - Arranges a situation analogous to:
    - Holding the cost of the reinforcer for problem behavior constant, while…
    - Increasing the cost of the reinforcer for the alternative behavior
    - In essence...a demand curve

- **Applying economic analysis lets us consider ways to enhance interventions based on what influences demand curves**
**Delay Discounting**

*Demand curves vary with similarity of available alternatives*
- Consumption declines more rapidly as *delay* increases when the alternative is functionally similar
- *Reinforcer delay is a “cost”*

![Graph showing consumption decline with delay](image)

**Q: How often do teachers deliver reinforcers immediately following a correct response?**

Descriptive assessment of integrity errors
- Observed 168 teaching trials
- Across 5 children with ASD attending EIBI clinics
- 9 teachers or paraprofessionals delivering instruction

![Bar graph showing consequence delivery within 5s](image)

Carroll, Kodak, & Fisher (2013) *Journal of Applied Behavior Analysis*
Q: How do reinforcer delays impact reinforcer effectiveness during skill acquisition?

Effects of Reinforcer Delay on Acquisition

◆ Immediate SR+ (both praise and preferred item)

△ Immediate Praise; Delayed SR+ (10-s delay to preferred item)

□ Delayed SR+ (10-s delay to both praise and preferred item)

Result: Delays result in less rapid acquisition

Carroll, Kodak, & Adolf (2016) Journal of Applied Behavior Analysis

Delay Discounting

• Delay discounting - how the present subjective value of a given reward declines as the delay to its receipt increases

$1000 now or $1000 after 5 yrs?
$900 now or $1000 after 5 yrs?
$800 now or $1000 after 5 yrs?
$700 now or $1000 after 5 yrs?
$600 now or $1000 after 5 yrs?

• Steeper discounting = value declines more rapidly given delays, immediacy is more important
  – Discounting of same commodity across differing populations
  – Discounting of different commodities in the same individual
Q: How much a delay is tolerable before detrimental effects are observed in acquisition?

- Parametric analysis of effects of delay to acquisition
- 3 children with ASD (2 shown)
- Discrete trials for mand acquisition
- Preferred edible + praise for correct responding with:
  - 0-second delay
  - 6-second delay
  - 12-second delay

Delay Discounting

- Delay discounting – the subjective value of money declines less steeply across delays than the subjective value of alcohol and food

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Odum & Rainaud (2003) Behavioral Processes
Q: How do delays impact the effectiveness of primary reinforcers vs tokens?

Token reinforcers lose their effectiveness at smaller delays than primary reinforcers
Immediate tokens with delayed exchange retain effectiveness similar to primary reinforcers

Continuity

- Reinforcer accumulation:
  “...reinforcers need not be consumed following each completion of a schedule requirement but rather can be accumulated, then collected and consumed later.”
  
  McFarland & Lattal (2001) JEAB

- We want kids to accumulate reinforcers
  - Does not interrupt ongoing behavior
  - Minimizes “handling costs”
  - Requires fewer teacher resources in delivering reinforcers
    - Usually involves a token system

- But…the inherent delay
What promotes accumulation?

**“Travel Costs”**

- Rats pressing levers for food in an 8-foot long operant chamber
- Each lever press resulted in one food pellet delivered into a food cup
- Across conditions, the distance from the response lever to the food cup was manipulated, distances of 20 - 240 cm.
- The number of lever presses before collection increased monotonically with distance

Killeen (1974), The Psychological Record

What promotes accumulation?

**Effort required to collect**

- Pigeons accumulating "tokens" at costs ranging 1-10 responses per token
- Exchange production schedule = earning the opportunity to exchange the tokens
- Number of tokens accumulated before exchange increased as a function of the exchange production FR
- The more effort required to exchange, the greater the number of tokens accumulated before exchange.

Yankelevitz, Bullock, & Hackenberg (2008), Journal of the Experimental Analysis of Behavior
What promotes accumulation?

**Interest for savings**

Mendres, Borrero, Bullock, & DeLeon (unpublished manuscript)

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What promotes accumulation?

**Does the type of reinforcer matter?**

“…unlike primary reinforcers, the reinforcing effectiveness of video depends at least partly on its *continuity* through time.”

**Continuity & Stimulus Value**

*Q: Is delayed accumulated reinforcement, mediated through tokens, just as effective as immediate reinforcement in supporting responding?*

**ABAB Reinforcer Assessment**

- A = no reinforcement BL
- B = Multielement comparison of accumulated vs distributed reinforcement conditions

*Measure: Rates of simple free-operant responses*
**Distributed Reinforcement**

10 task completions and 10 reinforcers earned (30 s each) = 300 s total

Access is immediate for each response requirement, but interrupted

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**Accumulated Reinforcement**

10 task completions and 10 reinforcers earned (30 s each) = 300 s total

Access is delayed until all work completed, but continuous
Continuity & Stimulus Value: Efficacy

- The highest mean rates of responding were observed in the accumulated reinforcement conditions for all participants
  - May be added value in arranging accumulated reinforcement?
  - “Handling Costs”?

DeLeon, Chase, Frank-Crawford et al. (2014), Journal of Applied Behavior Analysis
### Continuity & Stimulus Value: Preference

**Q:** Does the delay inherent in accumulated reinforcement render it less preferred than distributed reinforcement? Does the kind of reinforcer matter?

**Concurrent-chain reinforcer assessment**
- **Initial link** – choose accumulated or distributed
- **Terminal link** – complete 10 tasks under chosen arrangement
- **5 choice trials per session**

**Measure**
- **Cumulative choices**
- **Food and non-food conditions**

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**“Choose one.”**

| Accumulated | Distributed |
DeLeon, Chase, Frank-Crawford et al. (2014), Journal of Applied Behavior Analysis
Continuity & Value Interim Summary

• Accumulated reinforcement seems preferred by learners with IDD despite the inherent delay.

• Accumulated reinforcement mediated by tokens supports higher rates of free-operant responding despite the inherent delay.

• But…
  – Is response rate really the most relevant measure?
  – What about the amount of behavior supported by the stimulus?

Continuity & Stimulus Value: Amount of work

Q: Is demand for delayed, accumulated access more or less elastic as an equal amount of immediate, but distributed access?

2 Concurrent-schedule demand curves

First series:
• Test stimulus: Increasing FR across Phases (FR1, FR2, FR5, FR10, FR20, etc.)
• Second stimulus, constant FR1

Second series:
• Token later exchangeable for test stimulus: Increasing FR across Phases (FR1, FR2, FR5, FR10, FR20, etc.)
• Second stimulus, constant FR1
• 30s of Activity A = constant FR1 or 
• Token exchangeable for 30s of Activity B = increasing price

Bullock, DeLeon, Chastain, & Frank-Crawford, in preparation
“Dissimilar” reinforcers may produce more “durable” interventions when

- Problem behavior is reinforced, and
- Reinforcement of appropriate behavior is progressively thinned

Tokens, later exchanged for accumulated activity reinforcers

- Have the same desirable qualities as edibles
- May produce similar therapeutic effects
- Lack the “undesirable qualities”

Effort and Subsequent Value

- **Tokens, later exchanged for accumulated activity reinforcers**
  - Have the same desirable qualities as edibles
  - Lack the “undesirable qualities”
  - Appear to be just as “durable” in the face of schedule thinning

- **How does schedule thinning (unit price increases) impact the value (effectiveness) of the reinforcer?**

- The relation between historical effort and subsequent value
  - **The Law of Least Effort** - all else being equal, organisms prefer options associated with less cost
  - But what happens later to those stimuli historically associated with greater effort?

Contingency: Effort and Subsequent Value

- **Possibility 1**
  - Stimuli historically associated with greater effort, by virtue of being paired with an aversive event (i.e. greater effort), lose value over time and experience
  - A negative relation between “how much one has to work” for a reinforcer and how it is subsequently valued

- **Possibility 2**
  - Stimuli historically associated with greater effort, once current effort is equated, are “on sale.”
  - A positive relation between “how much one has to work” for a reinforcer and how it is subsequently valued
Contingency: Effort and Subsequent Value

“...such are the Tempers and dispossessions of Seamen in general that whatever you give them out of the common way, altho it be ever so much for their good yet it will not go down with them and you will hear nothing but murmurings gainest the man that first invented it; but the Moment they see their superiors set a Value upon it, it becomes the finest stuff in the World and the inventor an honest fellow.”

Captain James Cook, April, 1769

"The harder the conflict, the more glorious the triumph. What we obtain too cheap, we esteem too lightly."

Thomas Paine, The Crisis, 1776

Contingency: Effort and Subsequent Value

“The more you suffer, the more it shows you really care.”

Effort and Subsequent Value

Study: Brain Prefers Working for Cash
Posted: May 14, 2004 at 3:15 p.m.
ATLANTA (AP) -- It's nicer when you actually earn it. Lottery winners, trust-fund babies and others who get their money without working for it do not get as much satisfaction from their cash as those who earn it, a study of the pleasure center in people's brains suggests. Emory University researchers measured brain activity in the striatum — the part of the brain associated with reward processing and pleasure — in two groups of volunteers. One group had to work to receive money while playing a simple computer game; the other group was rewarded without having to earn it. The brains of those who had to work for their money were more stimulated.
Effort and Subsequent Value

  - Pigeons exposed to chain schedules:
  - Training: Two types of trials (50% / 50%)

  ![Diagram of experimental setup](image)

- Test: Concurrent choice, red S+ vs. green S+

Effort and Subsequent Value

**Q: Does the amount of work required to earn a reinforcer alter the value of that reinforcer?**

- **8 Children with ASD & MR (n = 8)**

- **Pre-test:**
  - Preference assessment
  - Progressive-ratio schedule for 4 moderately preferred items

- **Items assigned to one of four conditions for 4 weeks:**
  - FR1 delivery for academic tasks
  - Escalating FR delivery for academic tasks
  - Yoked noncontingent delivery
  - Restricted

- **Post-test:** preference assessment and PR schedule analysis
Determinants of Preference & Preference Change


Effort and Subsequent Value

Effort and Subsequent Value

- Free reinforcers lose value more rapidly than earned reinforcers
- Are interventions that involve contingent reinforcers more durable than interventions that involve noncontingent reinforcers?
- Is the loss of earned reinforcers more potent than the loss of free reinforcers?

Q: If effort is positively correlated with subsequent value, is it more aversive to lose reinforcers that required greater effort to earn?

- College students (n=28)
- Token Accumulation
  - Contingent group (n = 14):
    • Completes task to earn 20 tokens, later exchanged for $
  - Noncontingent group (n = 14)
    • 20 tokens delivered freely on schedule yoked to earner
- Test of sensitivity to loss
Earn Group

Do you see PTLE 3 or more times in the list? If so, press 'Y'
Do you see PTLE less than 3 times in the list? If so, press 'Y'
You have 70 seconds from the time the array appears.

[Array of numbers]

You have EARNED a token! You now have a total of 1 token.

When you are ready, press the SPACE BAR to continue.
Free Group

Effort and Subsequent Value

Test of Sensitivity to Loss

• Variation of the “Miami Door-Opening Task” (Daugherty & Quay, 1991)
• 2 responses:
  – Response “D”: Open the chest – produces either:
    • Another token
    • Loss of one token; ratio of gains to losses decreases across blocks of 10 trials
  – Response “K”: Cash out
• Primary D.V.: How many A responses before cashing out?
Fig. 1 Number of trials gambled (left panel) and net tokens (right panel) for contingent delivery (CD) and noncontingent delivery (NCD) participants in Phase 2. Each circle represents a value for one participant; the bars represent the group mean.

Miller, DeLeon, Toole, Lieving, & Allman (2016), The Psychological Record
Overall Results

- Earners were more sensitive to token loss
- Same effects obtained across all manipulations of effort and value – a robust effect
  - Differences in token value
  - Differences in level of effort
- Sensitivity in college students; less in children with IDD
  - Discrepancy related to earned vs. lost reinforcers?
  - Effects dependent on ability to form rules?
Grand conclusions

• Economic analyses tell us:
  
  – *Despite initial appearances, not all reinforcers “perform” equally*
  
  – “Value” (reinforcer effectiveness) is not an inherent or static property of the stimulus; it depends critically on context
    • What else is available?
    • How is the opportunity to consume arranged?
    • How has it been used historically?
  
  – *These relations can have meaningful implications, on the individual level, in applied contexts*

Review References


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