Behavioral Economics: A Versatile Tool for Research (from Interventions to Participant Engagement)

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Challenges in Clinical Research

Behavioral Economics = Inform intervention design

Behavioral Economics = Inform strategies for increasing enrollment & retention, while efficiently using research dollars
Which is Better?

$42 a month

Win $1.40 daily

1:5 for $5
1:100 for $50

Lose $1.40 daily

35% met step goal

36% met step goal

45% met step goal

### Which is Better?

<table>
<thead>
<tr>
<th>Decision Errors</th>
<th>Behavioral Economic Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss aversion</td>
<td>Put rewards at risk if behavior is not achieved</td>
</tr>
<tr>
<td>Regret aversion</td>
<td>Tell people what they would have won if adherent</td>
</tr>
<tr>
<td>Present bias</td>
<td>Make rewards immediate and frequent</td>
</tr>
<tr>
<td>Overestimating Small Probabilities</td>
<td>Leverage lottery incentives</td>
</tr>
</tbody>
</table>

Standard Economics

- People are perfectly rational
- Size of reward is what’s important

Examples

- Pay participants more money to enroll in a clinical trial
- Health Belief Model: Likelihood of behavior change calculated as perceived benefits - barriers

Health Belief Model
(Becker, 1974, 1988; Janz & Becker, 1984)

Individual Perceptions
- Perceived Susceptibility to Disease “X”
- Perceived Severity (Severity) of Disease “X”

Modifying Factors
- Demographic variables (age, sex, race, ethnicity, etc.)
- Socio-psychological variables

Likelihood of Action
- Perceived benefits of preventive action minus perceived barriers to preventive action
- Likelihood of taking recommended preventive health action

Socio-psychological variables

- Mass media campaigns
- Advice from others
- Reminders: postcard from physician/dentist
- Illness of family member or friend
- Newspaper or magazine article

Adapted from Janz & Becker (1984).
Health Education Quarterly, 11, 1:47

http://brokelyn.com
Standard Economics

- People are perfectly rational
- Size of reward is what’s important

Examples
- Pay participants more money to enroll in a clinical trial
- Health Belief Model: Likelihood of behavior change based on calculating perceived benefits

Behavioral Economics

- People have unconscious biases
- Incentive delivery & choice environment are critical

Examples
- Accelerating the frequency of participant incentives
- Health Belief Model: Accounts for individual perception of uncertainty (e.g., risk tolerance)
Incentives in Behavioral Economics

- Interventions often leverage incentives

- Monetary
  - Individual
  - Non-Monetary

- Child care
  - CURFEW
  - Return of Research Results
Incentives in Behavioral Economics

- Interventions often leverage incentives

Individual

Monetary

Non-Monetary

Social

1. No social design: activities are private
2. Activities can be witnessed
3. Support from others is encouraged
4. Support is reciprocal
5. Reciprocal support is embedded in team incentives

Asch, Rosin. *NEJM*. 2017
Competition Can Be Effective

- Financial Incentives for Weight Loss
  - 105 CHOP employees, BMI 30-40

Social Incentives Can Improve Glycemic Control

- Social incentives vs Financial Incentives
  - 50-70 year old AA veterans with Type 2 DM

  - **Control**: Usual care
  - **Traditional Incentives**:
    - $100 to drop HbA1c one point
    - $200 to drop two points OR
      HbA1c <6.5%
  - **Peer Mentor**: Talk at least weekly

BE in CONTROL

Behavioral Economic Incentives to Improve Glycemic Control among Adolescents and Young Adults with Type 1 Diabetes: A RCT
Collaborators & Funding

- Mitesh Patel, MD MBA
- Carol Ford, MD
- Victoria Miller, PhD
- Steve Willi, MD
- Kathryn Murphy, PhD
- Jordyn Feingold, BS
- Alex Morris, BS
- Yoonhee Ha MSc Mphil
- Wenli Wang, MS
- Jingsan Zhu. MS MBA
- Dylan Small, PhD

Funding
- CHIBE-ITMAT, Grant Number UL1TR000003 from the National Center for Advancing Translational Science
- CHOP Division of Adolescent Medicine Research Fund
Type I Diabetes (T1D) in Adolescents and Young Adults

- Importance of glycemic control to reduce complications of T1D is well-recognized
- Daily glucose monitoring in T1D is fundamental
- Glycemic control often deteriorates during adolescence and the transition to young adulthood
  - Decreasing parental involvement
  - Developing maturity
Specific Aims

Determine among adolescents and young adults with T1D if daily financial incentives:

- Improve glycemic control
- Improve adherence to daily glucose monitoring goals
Study Design

- **2-Arm Randomized Clinical Trial**
  - **Intervention:** Daily loss-framed financial incentives
  - **Control:** Usual care

- **Study Duration**

<table>
<thead>
<tr>
<th>Intervention Period</th>
<th>Follow-Up Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 months</td>
<td>3 months</td>
</tr>
</tbody>
</table>

- **Participants**
  - 90 adolescents and young adults (14-20 years old) with poorly controlled T1D (HbA1c > 8.0%) at CHOP
Study Procedures

- **Daily Glucose Monitoring Goals**
  - ≥4 glucose checks/day
  - ≥1 readings in goal range (70-180)
Intervention

• **Daily loss-framed financial incentives**
  - Start with $60 in electronic account each month
  - Lose $2/day non-adherent with glucose monitoring goals

• **Daily text message or email notification**

  **Adherent**
  You met your glucose monitoring goals yesterday. Keep it up! You have $60 remaining in your account.

  **Non-Adherent**
  Sorry, you did not meet your glucose monitoring goal yesterday (at least 4 checks with 1 in goal range). You lost $2 from your account. Remaining Balance = $58.
Analysis

• Primary outcome
  - Change in HbA1c at 3 months

• Secondary outcomes
  - Adherence to glucose monitoring
  - Change in HbA1c at 6 months

• Intention-to-treat

• Exit interviews
181 Assessed for eligibility

91 Excluded
- Did not meet inclusion criteria (40)
- Declined to participate (4)
- Study closed before enrollment complete (47)

90 Randomized

45 Assigned to Intervention
44 Completed 6-month Study

45 Assigned to Control
44 Completed 6-month Study
## Participant Demographics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Intervention (n=45)</th>
<th>Control (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, n (%)</td>
<td>26 (58)</td>
<td>26 (58)</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>16.0 (1.75)</td>
<td>16.5 (1.93)</td>
</tr>
<tr>
<td>Race/Ethnicity, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White non-Hispanic</td>
<td>32 (71)</td>
<td>32 (71)</td>
</tr>
<tr>
<td>Black non-Hispanic</td>
<td>3 (7)</td>
<td>7 (16)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6 (13)</td>
<td>5 (11)</td>
</tr>
<tr>
<td>Other non-Hispanic</td>
<td>4 (9)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Private Insurance, n (%)</td>
<td>31 (69)</td>
<td>33 (73)</td>
</tr>
</tbody>
</table>
# Baseline T1D Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Intervention (n=45)</th>
<th>Control (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline HbA1c, mean (SD)</strong></td>
<td>9.84 (1.64)</td>
<td>9.88 (1.68)</td>
</tr>
<tr>
<td>8-10%, n (%)</td>
<td>29 (64.4)</td>
<td>29 (64.4)</td>
</tr>
<tr>
<td>&gt;10%, n (%)</td>
<td>16 (35.6)</td>
<td>16 (35.6)</td>
</tr>
<tr>
<td><strong>Insulin Regimen, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injectable</td>
<td>18 (40)</td>
<td>19 (42)</td>
</tr>
<tr>
<td>Pump</td>
<td>27 (60)</td>
<td>26 (58)</td>
</tr>
</tbody>
</table>
Adherence to Glucose Monitoring Goals by Arm

Proportion adherent to daily glucose monitoring

Week

Financial Incentive Period | Follow-Up Period (no incentives)
## Proportion Adherent to Glucose Monitoring Goals

<table>
<thead>
<tr>
<th></th>
<th>Control (n=45) mean (SD)</th>
<th>Intervention (n=45) mean (SD)</th>
<th>Adjusted Difference (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3-Month Intervention</strong></td>
<td>18.9% (23.7)</td>
<td>50.0% (30.4)</td>
<td>27.2 (9.5, 45.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>6-Month Follow-Up</strong></td>
<td>8.7% (16.4)</td>
<td>15.3% (19.3)</td>
<td>3.9 (2.0, 9.9)</td>
<td>0.083</td>
</tr>
</tbody>
</table>

Adjusted for baseline HbA1c, demographics, calendar month, insulin regimen
## Proportion Adherent to Glucose Monitoring Goals

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Adjusted for baseline HbA1c, demographics, calendar month, insulin regimen
Change in HbA1c by Arm

Control Arm

Baseline
3 Month
6 Month

HbA1c (%)

Intervention Arm

Baseline
3 Month
6 Month

HbA1c (%)

Baseline
3 Month
6 Month

HbA1c (%)

Duke Clinical Research Institute
Change in HbA1c by Arm

Control Arm

Intervention Arm
# Change in HbA1c

<table>
<thead>
<tr>
<th></th>
<th>Control (n=45)</th>
<th>Intervention (n=45)</th>
<th>Adjusted Difference (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3-Month</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>-0.24 (-0.66, 0.17)</td>
<td>-0.56 (-0.97, -0.14)</td>
<td>-0.31 (-0.91, 0.28)</td>
<td>0.299</td>
</tr>
<tr>
<td><strong>6-Month Follow-up</strong></td>
<td>-0.17 (-0.51, 0.17)</td>
<td>-0.43 (-0.89, 0.03)</td>
<td>0.03 (-0.55, 0.60)</td>
<td>0.366</td>
</tr>
</tbody>
</table>

Adjusted for baseline HbA1c, demographics, calendar month, insulin regimen, HbA1c interval
Multiple imputation used for missing data
Discussion

• Financial incentives showed promise for improving T1D self-monitoring behaviors among adolescents and young adults

• Daily loss-framed financial incentives
  — Increased glucose monitoring adherence
  — Did not improve glycemic control at 3-months
Financial incentives in youth motivated behavior change

• Loss-framed financial incentives motivated behavior change
  – “If I had a bad day, I didn’t lose too much. But if I had a really bad week then I would lose a lot of money and it was really just when things started stacking up.”

• Incentivize process (glucose checks) & outcome (HbA1c)
  – “…because a lot of the times, I can just test my sugar & not do my insulin because it’s in another room or I’m busy doing something”

• Further research needed on how to best tailor financial incentives for young people
Sustainability of Effect

- Waning adherence effect after financial incentives removed

- Habit formation
  - “I don’t think I really needed the email reminder sent after [the intervention period ended] - I was already in the loop of it.”

- Preventing serious health deterioration would be a valuable accomplishment in a developmentally critical transition period
Limitations

• Limited generalizability
  – Single study site
  – Participants required to have a smartphone

• Missing glucose monitoring data if participants used other glucometers
  – Could manually enter glucose levels into study device
Neurodevelopmental Framework for Behavioral Economics in Youth
The Teenage Brain

- Frontal lobe connectivity developing
- Behavioral economic interventions = “frontal lobe assist”
- Nudge youth towards positive risks as they explore

Gogtay, et al. PNAS. 2004
# Behavioral Economic Interventions May be More Potent in Youth

<table>
<thead>
<tr>
<th>Decision Errors</th>
<th>Related Adol &amp; Young Adult (AYA) Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present bias</td>
<td>AYAs have a weaker future orientation than adults (Willing to accept a smaller reward delivered sooner than a larger one that is delayed)</td>
</tr>
<tr>
<td>Relative social ranking</td>
<td>AYAs more strongly influenced by peer comparisons (Heightened in the world of social media)</td>
</tr>
<tr>
<td>Framing Effects</td>
<td>AYAs have heightened reward-sensitivity, especially during monetary reward tasks (Smaller financial incentives may be more effective because of transitioning socioeconomic roles)</td>
</tr>
</tbody>
</table>

Leveraging Behavioral Economics for Research Participant Engagement
WE'VE MAPPED THE WORLD. NOW LET'S MAP HUMAN HEALTH.

Join us on a journey to better understand health and prevent disease.
Increasing Enrollment

Click Below If You Want to Participate in the Study

ENROLL
Increasing Enrollment: Social Norm

Click Below If You Want to Participate in the Study

ENROLL

Click Below If You Want to Participate in the Study

APPLY NOW

Please note that we have a long wait list, so it may be several weeks before one of our team members contacts you.
**Increasing Enrollment: Enhanced Active Choice +/- Social Norm**

Would you like to schedule an enrollment visit?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Yes</td>
<td>☐ No</td>
</tr>
<tr>
<td>☐ Yes, morning appointments</td>
<td>☐ No</td>
</tr>
<tr>
<td>☐ Yes, afternoon appointments</td>
<td></td>
</tr>
<tr>
<td>☐ Yes, weekend appointments</td>
<td></td>
</tr>
<tr>
<td>☐ No</td>
<td></td>
</tr>
<tr>
<td>☐ Yes, I’d like to enroll and help better understand health</td>
<td>☐ No</td>
</tr>
</tbody>
</table>

# Increasing Enrollment

<table>
<thead>
<tr>
<th>Behavioral Principle</th>
<th>Example</th>
</tr>
</thead>
</table>
| Social norms         | • Display & announce long waiting list  
                       • Leverage altruism  
                       • Recruit through friend recommendations  
                       • Identify participant champions |
| “Enhanced” active choice | • Force choice from a discrete list of options  
                             • Highlight consequences associated with preferred & non-preferred alternatives |
| Reciprocity          | • Highlight why *YOU* were chosen to participate with personalized information |

### Smarter Participant Individual Incentives

#### Traditional Incentive Scheme

<table>
<thead>
<tr>
<th>Visit Type</th>
<th>Baseline Visit</th>
<th>3mo Study Visit</th>
<th>6mo Study Visit</th>
<th>End of Study Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$30</td>
</tr>
</tbody>
</table>

#### Incentive Scheme Informed by Behavioral Economics (same amount of money)

<table>
<thead>
<tr>
<th>Visit Type</th>
<th>Baseline Visit</th>
<th>3mo Study Visit</th>
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<th>End of Study Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$10 + Lottery</td>
<td>$10 + Lottery</td>
<td>$10 + Lottery</td>
<td>$30 +</td>
</tr>
</tbody>
</table>
**Informational Incentive: Return of Research Results**

- **Plenty of challenges**

<table>
<thead>
<tr>
<th></th>
<th><strong>Validated</strong></th>
<th><strong>Not Validated</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinically Actionable</td>
<td>Likely indicated (PGT, EKG, MRI)</td>
<td>Possibly indicated (genetic variant weakly a/w heart condition)</td>
</tr>
<tr>
<td>(recognized therapeutic or preventive intervention)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Clinically Actionable</td>
<td>Possibly indicated (genetic dx of Huntington’s)</td>
<td>Likely not indicated (genetic variant of unknown meaning)</td>
</tr>
</tbody>
</table>

- **Opportunities for participant engagement**
  - Make it fun (e.g., missions, milestones)
  - Amplify the actionability (health & non-health outcomes)
# Smarter Participant Individual Incentives

## Traditional Incentive Scheme

<table>
<thead>
<tr>
<th></th>
<th>Baseline Visit</th>
<th>3mo Study Visit</th>
<th>6mo Study Visit</th>
<th>End of Study Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
<td>$30</td>
</tr>
</tbody>
</table>

## Incentive Scheme Informed by Behavioral Economics (same amount of money)

- **Baseline Visit**
  - $20 for visit
  - 400 points in electronic account

- **3mo Study Visit**
  - $10 for visit
  - ↓ 50 points for no show visit
  - ↓ 50 points for incomplete survey

- **6mo Study Visit**
  - $10 for visit
  - ↓ 50 points for no show visit
  - ↓ 50 points for incomplete survey

- **End of Study Visit**
  - $10 for visit
  - ↓ 100 points for no show visit
  - ↓ 100 points for incomplete survey

### POINT PAYOUT

10 points = $1
## Smarter Participant Individual Incentives

<table>
<thead>
<tr>
<th>Behavioral Principle</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overestimating small probabilities</td>
<td>• Lottery financial incentives (+ guaranteed incentive)</td>
</tr>
<tr>
<td>Salience</td>
<td>• Meaningful non-monetary prizes (e.g., childcare, travel vouchers, return of research results)</td>
</tr>
<tr>
<td>Loss aversion</td>
<td>• Loss-framed incentives</td>
</tr>
<tr>
<td>Mental accounting</td>
<td>• Distribute “points”</td>
</tr>
<tr>
<td>Immediacy</td>
<td>• Frequency of incentive distribution</td>
</tr>
<tr>
<td>Goal gradients</td>
<td>• Devise achievable goals &amp;/or financial incentives proportional to amount achieved</td>
</tr>
</tbody>
</table>
Incorporate Participant Social Incentives

- Social Recognition
- Support from Others
- Reciprocal Support
- Group Incentives
Incorporate Participant Social Incentives

- Social Recognition
- Support from Others
- Reciprocal Support
- Group Incentives

Sponsor Network

MARGOLIS CENTER
for HEALTH POLICY

Duke
MARGOLIS CENTER
for Health Policy

Duke Clinical Research Institute
Incorporate Participant Social Incentives

- Social Recognition
- Support from Others
- Reciprocal Support
- Group Incentives
Incorporate Participant Social Incentives

- Social Recognition
- Support from Others
- Reciprocal Support
- Group Incentives
## Incorporate Participant Social Incentives

<table>
<thead>
<tr>
<th>Principle</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social recognition</td>
<td>• Leader board (social benchmarking)</td>
</tr>
<tr>
<td></td>
<td>• Social media page</td>
</tr>
<tr>
<td></td>
<td>• Public commitments/recognition</td>
</tr>
<tr>
<td>Support from others</td>
<td>• Research team asks family/friends to help motivate continued participation</td>
</tr>
<tr>
<td></td>
<td>• Sponsor (e.g., family or friend who is automatically notified if participant does not wear study device x 3 consecutive days)</td>
</tr>
<tr>
<td>Reciprocal support</td>
<td>• Put participants in pairs or team</td>
</tr>
<tr>
<td>Group incentives</td>
<td>• Participant teams compete for financial incentives (relative social ranking)</td>
</tr>
</tbody>
</table>
Ethics of Behavioral Economics and Participant Engagement

- Interventions explicitly intended to augment enrollment and retention rather than coerce

- Concerns
  - Do they lead participants to make decisions they would rather not make?
  - Stronger influences in different populations (e.g., More effective among poorer populations?)

- Further research is needed

Behavioral Economics in Clinical Research

• Informing Interventions
  - Show promise for motivating behavior change
  - Opportunities for leveraging behavioral economics in youth populations

• Improving Research Participant Engagement
  - Menu of options that could be utilized
  - More research needed
Thank You

“It’s sort of like this concept of $1.00 being sort of dollar menu McDonald’s type $1.00. But then $2.00, whoa.”

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@DrCharleneWong

Additional Collaborators
• Peter Ubel, MD (Duke University)
• Kevin Volpp, MD PhD (University of Pennsylvania)
• David Asch, MD MBA (University of Pennsylvania)
• Adrian Hernandez, MD (Duke University)
• Shabnam Hakimi, PhD (Duke University)
EXTRA SLIDES
Incentive Design is Key

• Fitness Program Incentive
  – Get up to $150 back for joining and using a gym!
  – Complete 120 workouts in 365 days
  – Up to $150 reimbursement

• Design Flaws
  – Rewards fulfilled only once a year
  – Single high threshold
  – Targets wrong people
  – Retrospective reimbursement
Policy Implications

- Crucial to identify interventions that facilitate & empower young people to manage their chronic diseases effectively

- Financial incentives proved to be a promising strategy that deserve further exploration in youth with T1D
  - Can be implemented in various contexts (e.g., family unit, Medicaid program)
Connected Glucometers

• “I liked that I could connect my glucometer to other phones so my mother didn't have to call and ask me. She got updates sent to her phone and it was up to date technology.”