

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

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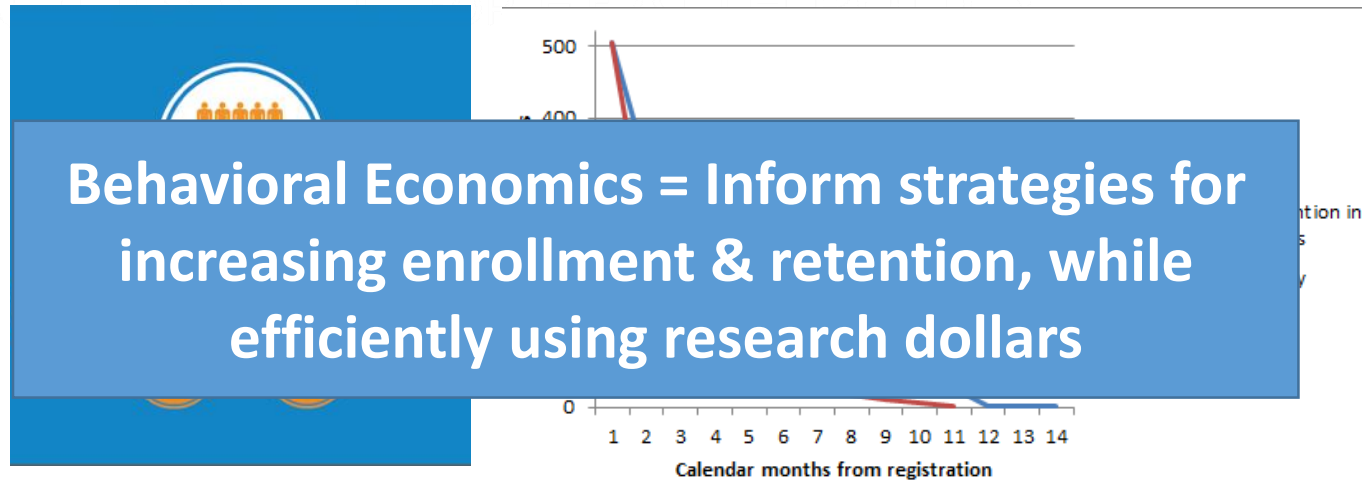
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Challenges in Clinical Research

**Behavior
Change**

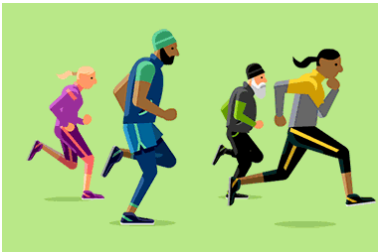
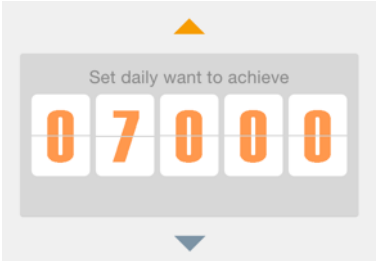


**Research
Participant
Engagement**



well.blogs.nytimes.com; elderdrugs.com; DiabetesCare.net; Forterresearch.com

Which is Better?



\$42 a month

\$42 a month

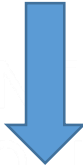
\$42 a month



**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**

Patel et al. *Annals of IM*. 2016

Which is Better?

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

Patel et al. *Annals of IM*. 2016



Standard Economics

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

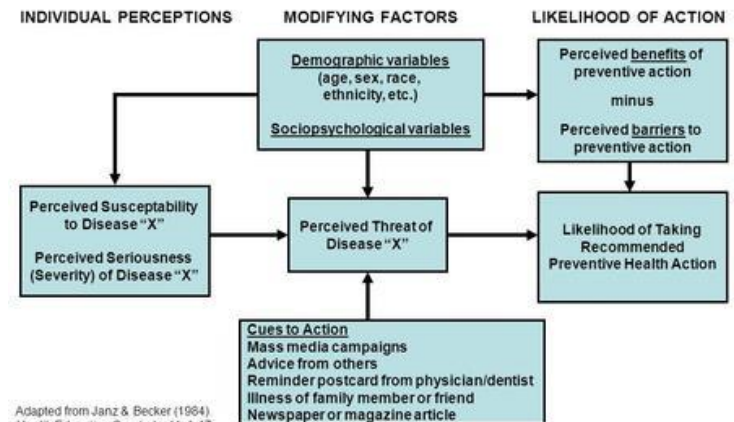
Examples

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



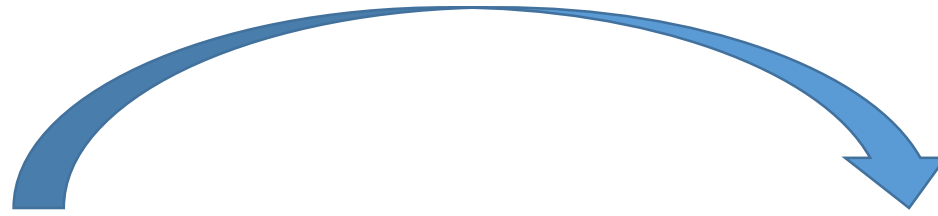
Health Belief Model

(Becker, 1974, 1988; Janz & Becker, 1984)



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

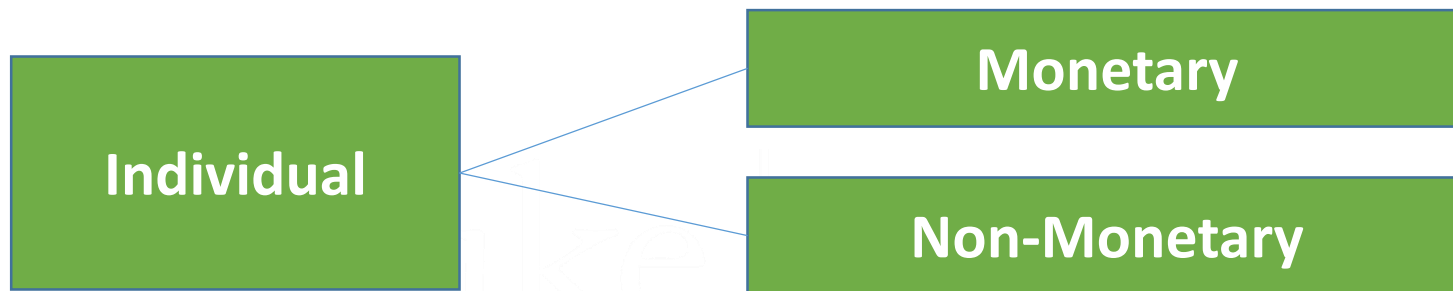
Examples

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

Incentives in Behavioral Economics



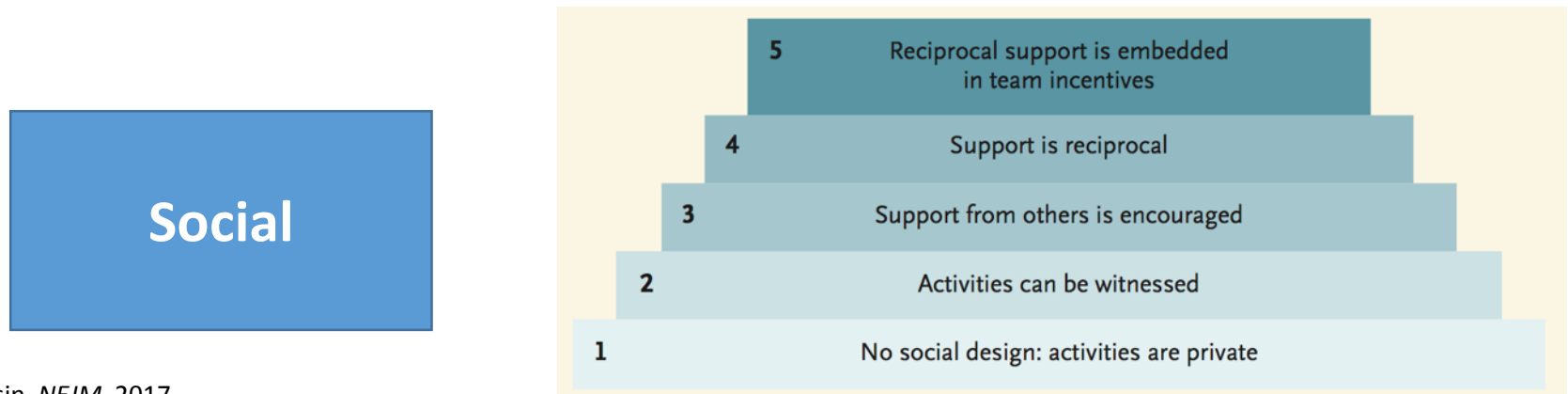
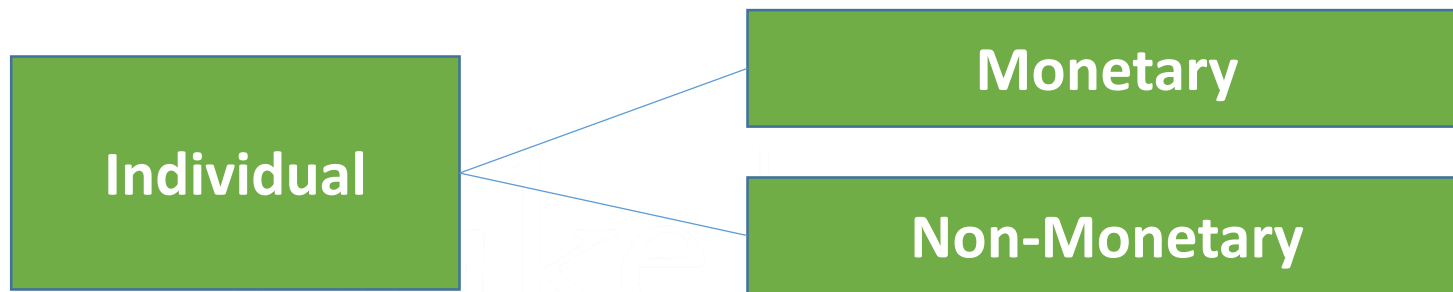
- Interventions often leverage incentives



Incentives in Behavioral Economics



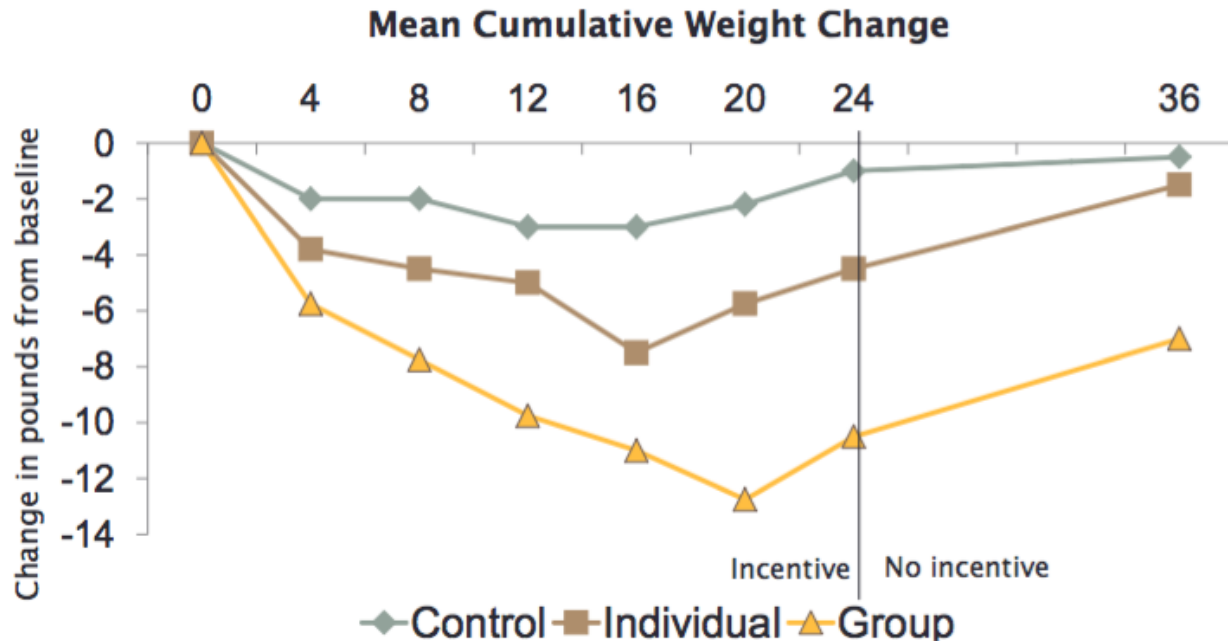
- Interventions often leverage incentives



Asch, Rosin. *NEJM*. 2017

Competition Can Be Effective

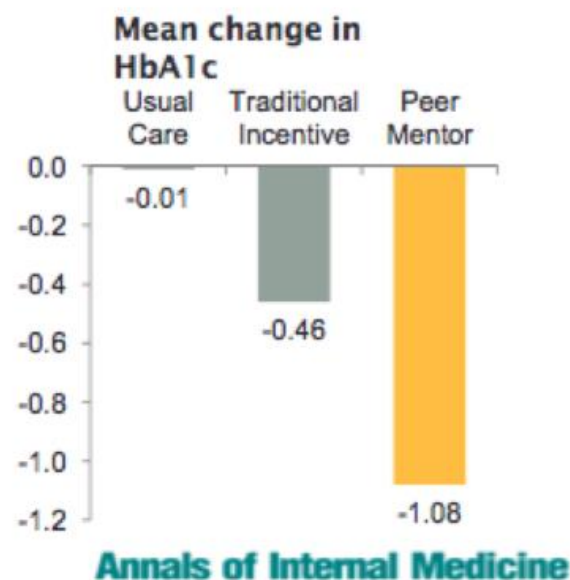
- **Financial Incentives for Weight Loss**
 - 105 CHOP employees, BMI 30-40



Kullgren, et al. *Annals of IM*. 2013.

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



Long, et al. *Annals of IM*. 2012

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**



- **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)



*Way
To
Health*



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.

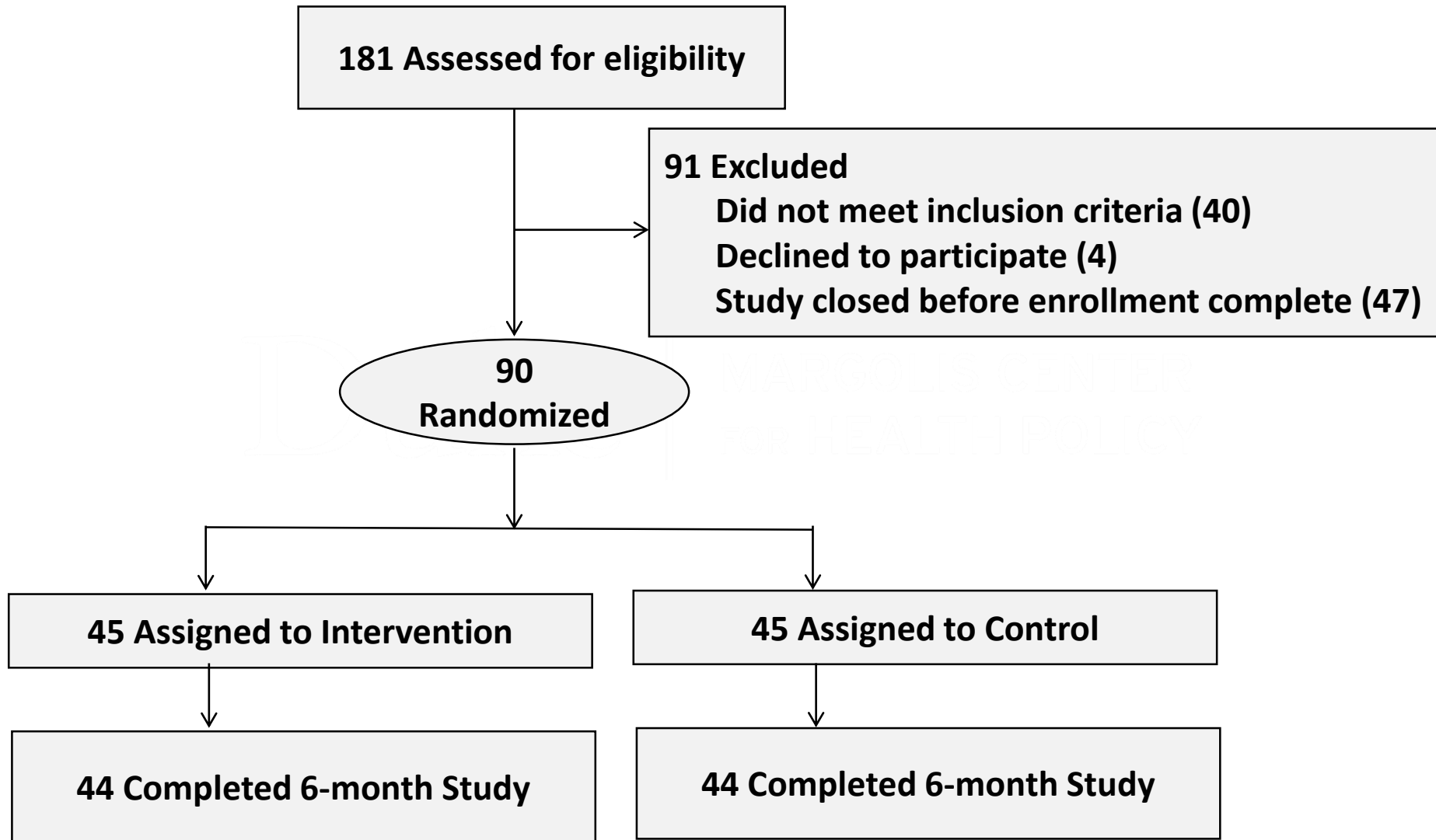
Non-Adherent

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**

Consort Diagram



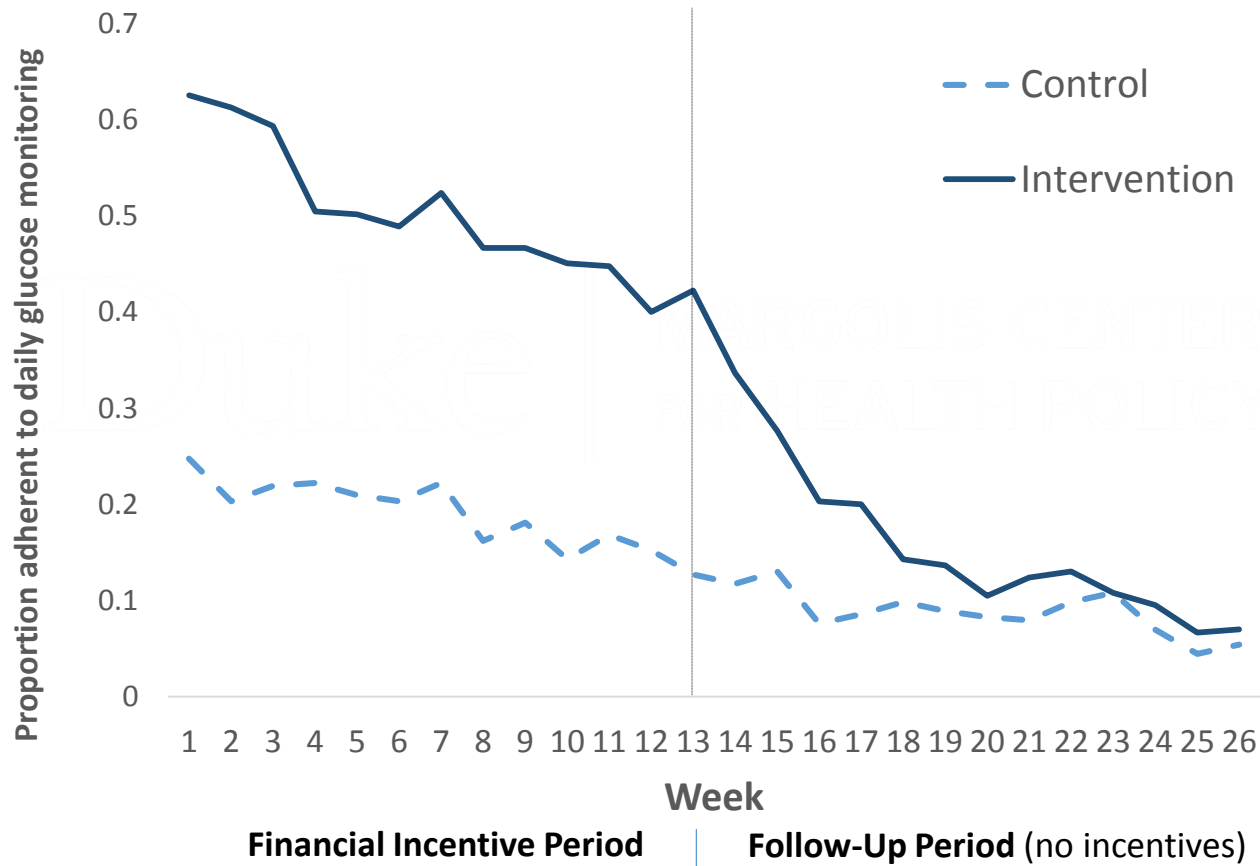
Participant Demographics

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

Baseline T1D Characteristics

Characteristic	Intervention (n=45)	Control (n=45)
Baseline HbA1c, mean (SD)	9.84 (1.64)	9.88 (1.68)
8-10%, n (%)	29 (64.4)	29 (64.4)
>10% , n (%)	16 (35.6)	16 (35.6)
Insulin Regimen, n (%)		
Injectable	18 (40)	19 (42)
Pump	27 (60)	26 (58)

Adherence to Glucose Monitoring Goals by Arm



Proportion Adherent to Glucose Monitoring Goals

	Control (n=45) mean (SD)	Intervention (n=45) mean (SD)	Adjusted Difference (95% CI)	p- value
3-Month Intervention	18.9% (23.7)	50.0% (30.4)	27.2 (9.5, 45.0)	<0.001
6-Month Follow-Up	8.7% (16.4)	15.3% (19.3)	3.9 (2.0, 9.9)	0.083

Adjusted for baseline HbA1c, demographics, calendar month, insulin regimen

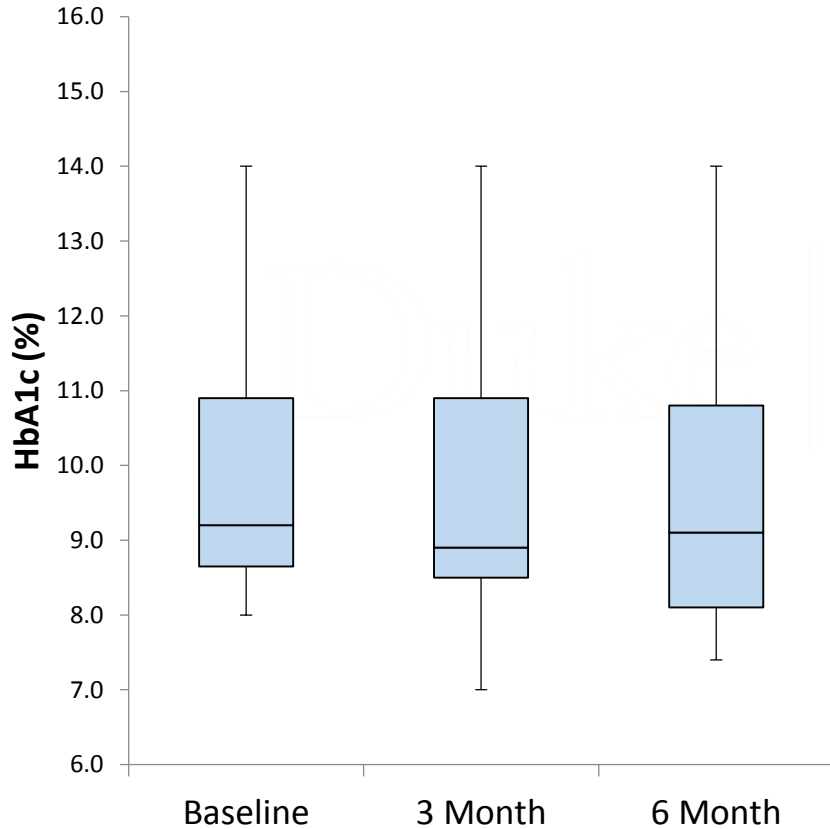
Proportion Adherent to Glucose Monitoring Goals

	Control (n=45) mean (SD)	Intervention (n=45) mean (SD)	Adjusted Difference (95% CI)	p- value
3-Month Intervention	18.9% (23.7)	50.0% (30.4)	27.2 (9.5, 45.0)	<0.001
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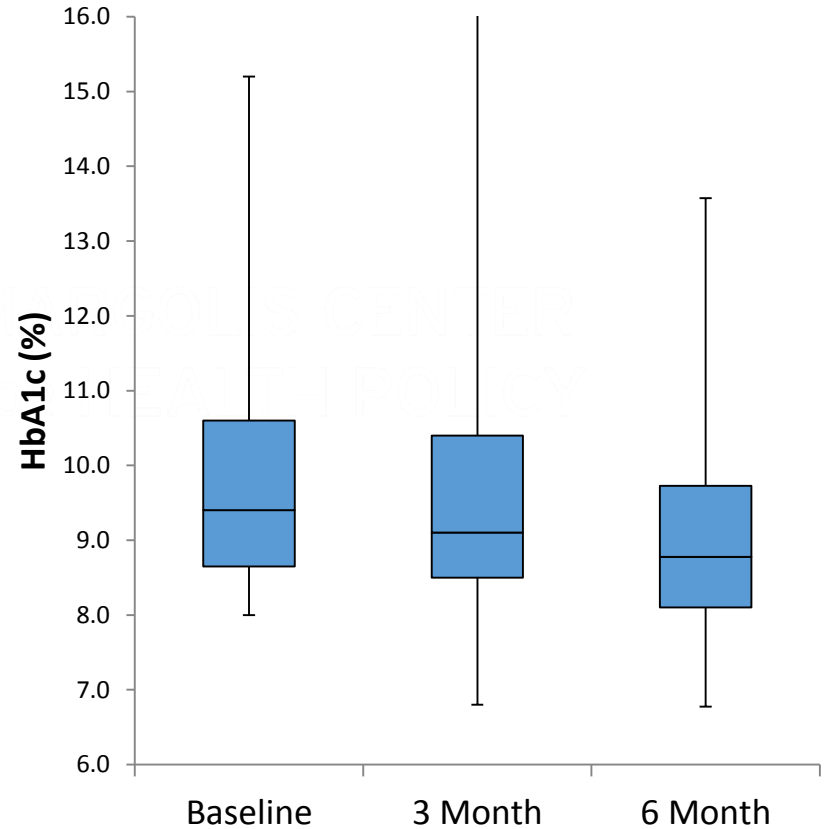
Adjusted for baseline HbA1c, demographics, calendar month, insulin regimen

Change in HbA1c by Arm

Control Arm

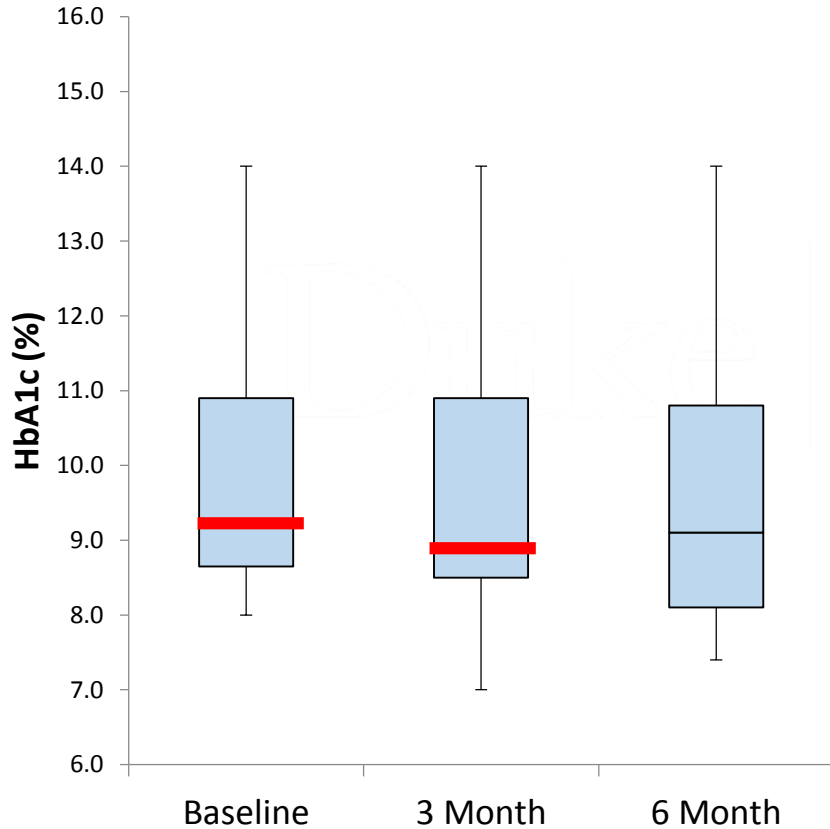


Intervention Arm

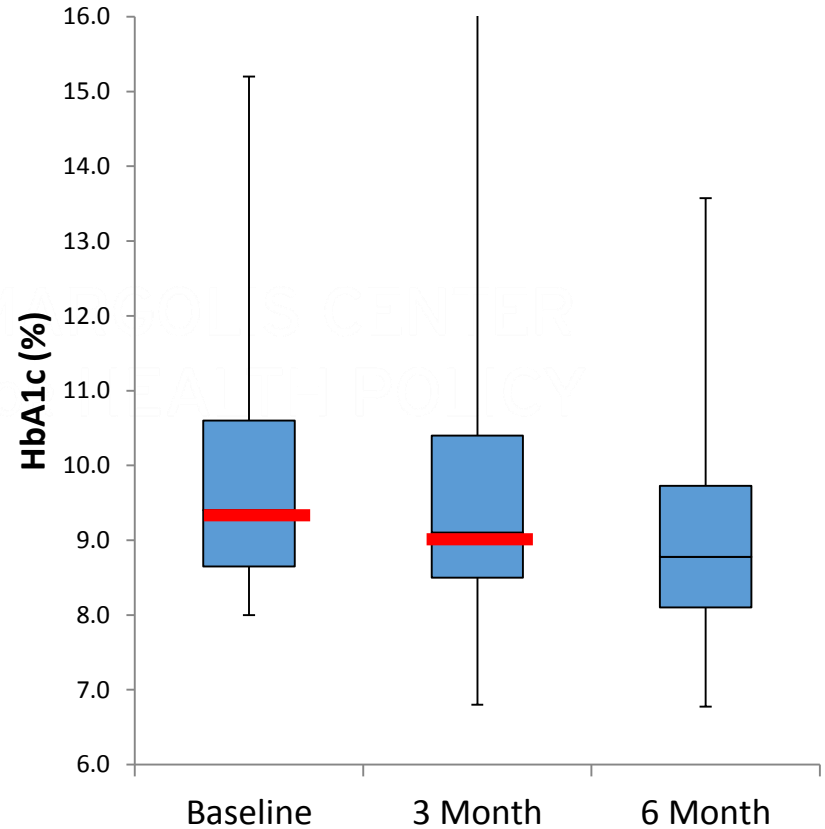


Change in HbA1c by Arm

Control Arm



Intervention Arm



Change in HbA1c

	Control (n=45)	Intervention (n=45)	Adjusted Difference (95% CI)	p- value
3-Month Intervention	-0.24 (-0.66, 0.17)	-0.56 (-0.97, -0.14)	-0.31 (-0.91, 0.28)	0.299
6-Month Follow-up	-0.17 (-0.51, 0.17)	-0.43 (-0.89, 0.03)	0.03 (-0.55, 0.60)	0.366

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

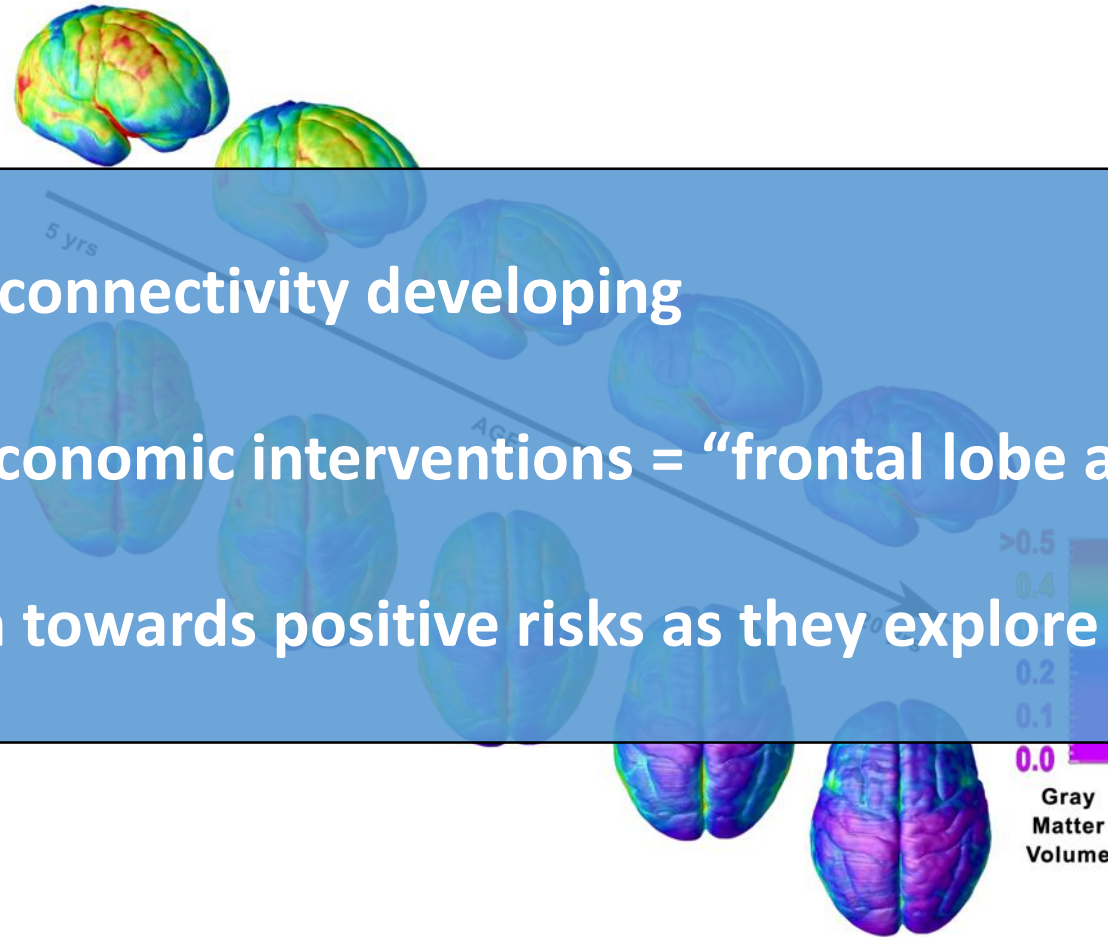
- **Waning adherence effect after financial incentives removed**
- **Habit formation**
 - “I don’t think I really needed the email reminder sent after [the intervention period ended] - I was already in the loop of it.”
- **Preventing serious health deterioration would be a valuable accomplishment in 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

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

Steinberg et al. *Child Development*. 2009.

Smith, et al. *Dev Cogn Neurosci*. 2015.

Rademacher, et al. *Soc Cogn Affect Neurosci*. 2014.

Leveraging Behavioral Economics for Research Participant Engagement

WE'VE MAPPED THE WORLD. NOW LET'S MAP HUMAN HEALTH.

MY MOOD TODAY



Enthusiastic
80%
Scared
20%

MY SLEEP LAST NIGHT



Times awakened
2
Sleep duration
7.5 hr

MY HEARING TEST



Left ear
Normal
Right ear
Normal

MY ECG TODAY



Heart rate
72 bpm
PR Interval
0.17

MY DIET TODAY



Coffee
2 cups
Water
8 oz

MY IMMUNIZATION RECORD



Tetanus
Yes
Pertussis
Yes

MY MOVEMENT TODAY



Strenuous activity
Often
Minutes walked
45 min



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

Duke

MARGOLIS CENTER
FOR HEALTH POLICY

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?

Yes

No

Yes, morning appointments

Yes, afternoon appointments

Yes, weekend appointments

No

Yes, I'd like to enroll and help better understand health

No

Keller, et al. *J Consumer Psych.* 2011; VanEpps, et al. *Sci Trans Med.* 2016

Increasing Enrollment





Behavioral Principle	Example
Social norms	<ul style="list-style-type: none">• Display & announce long waiting list• Leverage altruism• Recruit through friend recommendations• Identify participant champions
“Enhanced” active choice	<ul style="list-style-type: none">• Force choice from a discrete list of options• Highlight consequences associated with preferred & non-preferred alternatives
Reciprocity	<ul style="list-style-type: none">• Highlight why <i>YOU</i> were chosen to participate with personalized information

Smarter Participant Individual Incentives

Traditional Incentive Scheme

Baseline Visit	3mo Study Visit	6mo Study Visit	End of Study Visit
\$20	\$20	\$20	\$30

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

Baseline Visit	3mo Study Visit	6mo Study Visit	End of Study Visit
\$10 + Lottery 	\$10 + Lottery 	\$10 + Lottery 	\$30 + 

Informational Incentive: Return of Research Results



- **Plenty of challenges**

	Validated (widely recognized by med community; regulatory approval FDA, CLIA, CMS)	Not Validated
Clinically Actionable (recognized therapeutic or preventive intervention)	Likely indicated (PGT, EKG, MRI)	Possibly indicated (genetic variant weakly a/w heart condition)
Not Clinically Actionable	Possibly indicated (genetic dx of Huntington's)	Likely not indicated (genetic variant of unknown meaning)

- **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

Baseline Visit	3mo Study Visit	6mo Study Visit	End of Study Visit
\$20	\$20	\$20	\$30

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

Baseline Visit	3mo Study Visit	6mo Study Visit	End of Study Visit
<ul style="list-style-type: none"> • \$20 for visit • 400 points in electronic account 	<ul style="list-style-type: none"> • \$10 for visit • ↓ 50 points for no show visit • ↓ 50 points for incomplete survey 	<ul style="list-style-type: none"> • \$10 for visit • ↓ 50 points for no show visit • ↓ 50 points for incomplete survey 	<ul style="list-style-type: none"> • \$10 for visit • ↓ 100 points for no show visit • ↓ 100 points for incomplete survey <p>POINT PAYOUT 10 points = \$1</p>



Smarter Participant Individual Incentives

Behavioral Principle	Examples
Overestimating small probabilities	<ul style="list-style-type: none">• Lottery financial incentives (+ guaranteed incentive)
Saliency	<ul style="list-style-type: none">• Meaningful non-monetary prizes (e.g., childcare, travel vouchers, return of research results)
Loss aversion	<ul style="list-style-type: none">• Loss-framed incentives
Mental accounting	<ul style="list-style-type: none">• Distribute “points”
Immediacy	<ul style="list-style-type: none">• Frequency of incentive distribution
Goal gradients	<ul style="list-style-type: none">• Devise achievable goals &/or financial incentives proportional to amount achieved

Incorporate Participant Social Incentives



Social Recognition

Support from Others

Reciprocal Support

Group Incentives

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for HEALTH POLICY

Incorporate Participant Social Incentives



MARGOLIS CENTER
FOR HEALTH POLICY

Social Recognition

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Incorporate Participant Social Incentives



GROUP
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

Principle	Example
Social recognition	<ul style="list-style-type: none">• Leader board (social benchmarking)• Social media page• Public commitments/recognition
Support from others	<ul style="list-style-type: none">• Research team asks family/friends to help motivate continued participation• Sponsor (e.g., family or friend who is automatically notified if participant does not wear study device x 3 consecutive days)
Reciprocal support	<ul style="list-style-type: none">• Put participants in pairs or team
Group incentives	<ul style="list-style-type: none">• Participant teams compete for financial incentives (relative social ranking)

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

Dunn, et al. *JAMA* 2005. Halpern, et al. *Arch Int Med*. 2004

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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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.”



HEALTH
POLICY