Why Health Behavior Matters

Proportional Contribution to Premature Death

- Genetic predisposition: 30%
- Behavioral patterns: 40%
- Social circumstances: 15%
- Environmental exposure: 5%
- Health care: 10%

Schroder. NEJM 2002
Watching Over the 5000 Hours

• The average person spends only a few hours a year with a doctor or nurse

• In contrast, we spend more than **5000 waking hours** doing everything else within our everyday lives

Asch et al. *NEJM* 2012
Automated Hovering

- Reactive, visit-based model is not sufficient
- Shifting to a more proactive model

Asch et al. *NEJM* 2012
Three Evolving Market Trends

- **Population Health**
  - Innovations in mobile technology allow us to better monitor health behaviors

- **Technology**
  - Our understanding of the science of motivation has evolved

- **Incentives**

Health care financing is shifting focus
Science of Motivation has Evolved

- Unaware
  - Provide education
- Standard economics
  - Act rationally and maximize value
  - Increase size of incentive
- Behavioral economics
  - Act irrationally, but in predictable ways from common decision errors
  - The design and delivery of an incentive and feedback is often more important than its magnitude alone
Common Decision Errors
Default Bias

Organ Donor Status

<table>
<thead>
<tr>
<th>Country</th>
<th>Effective Consent Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>4.25</td>
</tr>
<tr>
<td>Netherlands</td>
<td>27.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>17.17</td>
</tr>
<tr>
<td>Germany</td>
<td>12</td>
</tr>
<tr>
<td>Austria</td>
<td>99.98</td>
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<tr>
<td>Belgium</td>
<td>98</td>
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<tr>
<td>France</td>
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<tr>
<td>Hungary</td>
<td>99.97</td>
</tr>
<tr>
<td>Poland</td>
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<tr>
<td>Portugal</td>
<td>99.64</td>
</tr>
<tr>
<td>Sweden</td>
<td>85.9</td>
</tr>
</tbody>
</table>

Johnson et al. Science. 2003
Present-Biased Preferences

The Marshmallow Test
Overweighting Small Probabilities

State Jackpot Lotteries ~ $70 billion annually
Loss Aversion

Endowment Effect

Information Framing and Salience

<table>
<thead>
<tr>
<th>Calories</th>
<th>Sugar</th>
<th>Fat</th>
<th>Sat Fat</th>
<th>Salt</th>
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</thead>
<tbody>
<tr>
<td>353</td>
<td>0.9g</td>
<td>20.3g</td>
<td>10.8g</td>
<td>1.1g</td>
</tr>
</tbody>
</table>

Each 1/2 pack serving contains
Regret Aversion

Past Emotions Impact Future Decisions
Social Norms

Neighborhood Energy Consumption

Change in Daily Energy Consumption

- Above Average
- Below Average

Schultz et al. Psych Science. 2007
## Leveraging Insights from Behavioral Economics

<table>
<thead>
<tr>
<th>Decision Errors</th>
<th>Example Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default bias</td>
<td>Change path of least resistance</td>
</tr>
<tr>
<td>Present-biased preferences</td>
<td>Make rewards immediate and frequent</td>
</tr>
<tr>
<td>Overweighting small probabilities</td>
<td>Provide variable rewards</td>
</tr>
<tr>
<td>Loss aversion</td>
<td>Put rewards at risk if behavior is not achieved</td>
</tr>
<tr>
<td>Framing, salience and social norms</td>
<td>Make rewards tangible and in a familiar context</td>
</tr>
<tr>
<td>Regret aversion</td>
<td>Tell individuals what they would have won had they been adherent</td>
</tr>
</tbody>
</table>

Loewenstein et al. *JAMA*. 2007  
Volpp et al. *Health Aff.* 2009
Wearable Devices for Changing Health Behaviors
Wearable Devices for Population Health

• Enlarging market of population health
  - Apple, Google, Samsung, Microsoft, and many others

• Use of wearable devices
  - 1-2% of the United States population
  - Estimated that sales will increase to $50 billion over the next few years
Wearable Device Technology

- **Bluetooth Low Energy radio**
  - First device to implement BLE was the iPhone 4S in 2011

- **Wireless charging coil**
  - Qi standards-based products first hit market in 2013

- **MEMS accelerometer**
  - Price has fallen 4X in the last five years

- **Offloaded computation**
  - Signal processing from sensors is handled in cloud via iPhone

Rock Health. 2014 Report
## Wearable Device Companies

<table>
<thead>
<tr>
<th>Company</th>
<th>Feature</th>
<th>Feature</th>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amiigo</td>
<td>Movement</td>
<td>Heart Rate</td>
<td>Sleep</td>
<td>Temperature</td>
</tr>
<tr>
<td>Basis</td>
<td></td>
<td></td>
<td></td>
<td>Hydration</td>
</tr>
<tr>
<td>JAWBONE</td>
<td></td>
<td></td>
<td></td>
<td>Glucose</td>
</tr>
<tr>
<td>withings</td>
<td></td>
<td></td>
<td></td>
<td>Oxygen Level</td>
</tr>
<tr>
<td>iHealth</td>
<td></td>
<td></td>
<td></td>
<td>Heart Rate Variability</td>
</tr>
<tr>
<td>iHealth</td>
<td></td>
<td></td>
<td></td>
<td>Muscle Activity</td>
</tr>
<tr>
<td>proteus</td>
<td></td>
<td></td>
<td></td>
<td>Blood Pressure</td>
</tr>
<tr>
<td>proteus</td>
<td></td>
<td></td>
<td></td>
<td>Eye Tracking</td>
</tr>
<tr>
<td>proteus</td>
<td></td>
<td></td>
<td></td>
<td>Ingestion</td>
</tr>
</tbody>
</table>

*Rock Health. 2014 Report*
Wearable Devices for Population Health

• Hope is that these devices can educate and motivate individuals towards better habits and better health

• Little evidence that these devices alone can change behavior for those who need it most

Patel et al. JAMA. 2015
Four Key Challenges for Wearable Devices

1. Access
   - Individuals that need them the most are not using them

2. Sustainability

3. Accuracy

4. Motivation
Wearable Devices Must Be Affordable

- If effective, they could be financed similar to prescription drugs
- Insurers and employers may offer them to their members
Four Key Challenges for Wearable Devices

1. **Access**
   - Individuals that need them the most are not using them

2. **Sustainability**
   - About half of people that buy a wearable stop using it within a few months

3. **Accuracy**

4. **Motivation**

Patel et al. JAMA. 2015
(2) Regularly Using Wearable Devices

- Regularly wear, recharge, and sync the device
  - New behaviors from individuals that have already identified that they have trouble changing behavior

- Endeavor Partners survey of wearable device users
  - 50% stopped wearing the device, one-third did so within 6 months

Patel et al. JAMA 2015
Evolution of Activity Trackers

Passively carry
Actively wear
Actively carry

Behavior

Cost
Free $99 - $349
$10 - $50

Effort
Manually log data

Adoption
High
Low
Low

Correction: The text is about the evolution of activity trackers, discussing different methods of tracking and their associated costs and efforts. It highlights how these devices have evolved from being passively carried to actively worn and carried, with corresponding changes in cost and effort required for usage.
iPhone HealthKit
Four Key Challenges for Wearable Devices

1. Access
   – Individuals that need them the most are not using them

2. Sustainability
   – About half of people that buy a wearable stop using it within a few months

3. Accuracy
   – Most devices have not been well evaluated

4. Motivation
Accuracy of Devices for Physical Activity

Case, Burwick, Volpp, Patel. JAMA. 2015
Accuracy of Devices for Physical Activity

Figure 1. Device Outcomes for the 500 Step Trials

<table>
<thead>
<tr>
<th>Device</th>
<th>No. of Observations</th>
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<tbody>
<tr>
<td>Galaxy S4 Moves App</td>
<td>27</td>
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<tr>
<td>iPhone 5s Moves App</td>
<td>28</td>
</tr>
<tr>
<td>iPhone 5s Health Mate App</td>
<td>28</td>
</tr>
<tr>
<td>iPhone 5s Fitbit App</td>
<td>28</td>
</tr>
<tr>
<td>Nike Fuelband</td>
<td>28</td>
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<td>Jawbone UP24</td>
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</tr>
<tr>
<td>Fitbit Flex</td>
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</tr>
<tr>
<td>Fitbit One</td>
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<tr>
<td>Fitbit Zip</td>
<td>27</td>
</tr>
<tr>
<td>Digi-Walker SW-200</td>
<td>28</td>
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Case, Burwick, Volpp, Patel. JAMA. 2015
## Accuracy of Devices for Physical Activity

**Figure 2. Device Outcomes for the 1500 Step Trials**

<table>
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<td>Digi-Walker SW-200</td>
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</tr>
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</table>

![Graph showing device accuracy](image_url)
Four Key Challenges for Wearable Devices

1. **Access**
   - Individuals that need them the most are not using them

2. **Sustainability**
   - About half of people that buy a wearable stop using it within a few months

3. **Accuracy**
   - Most devices have not been well evaluated

4. **Motivation**
   - Technology and education are necessary, but not sufficient

Patel et al. JAMA. 2015
RCT Using MyFitnessPal for Weight Loss

- 80 million users
- 212 obese primary care patients randomly assigned to usual care or use of MyFitnessPal
- 6 month evaluation
  - Weight loss
  - Blood pressure
  - App use

RCT Using MyFitnessPal for Weight Loss

- **Weight loss**
  - -0.3kg
  - 95% CI: -1.5, 1.0; P=0.63

- **Blood pressure**
  - -1.7 mm Hg
  - 95% CI: -7.1, 3.8; P=0.55

- **Used calorie goal**
  - 2.0 times in last 7 days
  - 95% CI: 1.1, 2.9; P<0.001

Figure 2. Number of logins among MyFitnessPal users, by month.
Leveraging Behavioral Economics

• **Leveraging variable rewards**
  – 1 in 5 chance of winning $10
  – 1 in 100 chance of winning $100

• **Inducing regret aversion**
  – Met weight goal and won lottery
    • *Congratulations, you met your weight goal yesterday and won $10 in today’s lottery! Weigh in daily to be eligible for the next lottery.*
  – Did not meet weight goal but won lottery
    • *Congratulations, you won $100! However, you did not meet your weight goal yesterday so you are not eligible to collect the reward. Weigh each day for a chance to be eligible for the next lottery.*
Financial Incentives for Device Adherence

- 75 diabetics given a glucometer, home BP cuff, and home weight scale
- Compared low incentive (~$1.40/d) and high incentive (~2.80/d) to control

Change in HbA1c
- Control: - 0.7%
- Low incentive: -1.5%
- High incentive: -1.2%

Sen et al. JGIM. 2014
Behavior Change Techniques in Top-Ranked Mobile Apps for Physical Activity

David E. Conroy, PhD, Chih-Hsiang Yang, MEd, Jaclyn P. Maher, MS

Results: Most descriptions of apps incorporated fewer than four behavior change techniques. The most common techniques involved providing instruction on how to perform exercises, modeling how to perform exercises, providing feedback on performance, goal-setting for physical activity, and planning social support/change. A latent class analysis revealed the existence of two types of apps, educational and motivational, based on their configurations of behavior change techniques.

Conclusions: Behavior change techniques are not widely marketed in contemporary physical activity apps. Based on the available descriptions and functions of the observed techniques in contemporary health behavior theories, people may need multiple apps to initiate and maintain behavior change. This audit provides a starting point for scientists, developers, clinicians, and consumers to evaluate and enhance apps in this market.
• Use a trigger to grab the individuals attention

• Reward behaviors

• Build new habits
  – Turn external motivations into internal ones (which is hard)
  – Sustain external motivations (which is also hard)
Using a Trigger

**EXTERNAL TRIGGERS**
The information for what to do next is within the trigger.

- **Text message**
  - Remember to exercise

- **Sign**
  - Take the stairs

- **Alarm**
  - Reminder to workout
Using a Trigger

- **Lonely**
  - Check Facebook

- **Unsure**
  - Search on Google

- **Bored**
  - Browse Youtube

**INTERNAL TRIGGERS**
The information for what to do next is informed through an association in the user’s memory.
Examples of Targeting Specific Health Behaviors
Physical Activity

- Goal setting
- Feedback
- Nudges
Weight Loss

- **Connected weight scales**
  - Tracks daily changes
  - Syncs with smartphones

- **Food**
  - Tracking behaviors
  - Logging calories
Medication Adherence
Hydration
Summary

• Insights from behavioral economics can help design interventions that anticipate and leverage predictable barriers to health behavior change.

• Wearable devices may help facilitate monitoring of health outcomes, but alone may not drive behavior change.

• Effective engagement strategies must be combined with these technologies to build new healthy habits.