Effects of Three Motivationally Targeted Smartphone Apps on Initial Sedentary Behavior and Physical Activity Changes in Aging Adults

Abby King, Eric Hekler, Lauren Grieco, Sandra Winter, Jylana Sheats, Matthew Buman, Banny Banerjee, Tom Robinson, Jesse Cirimele

Stanford Healthy Aging Research & Technology Solutions Lab
Stanford Prevention Research Center
Stanford University School of Medicine
SBM 2016, Washington, DC

© Stanford University
EXPLOSION of Cellphones around the world

• About as many mobile phone subscriptions as people in the world

• 91 countries have more cell phones than people (2011)

• mobile phone growth regardless of economic development

Smartphone applications (apps) — Increasingly popular & ubiquitous change channel

• Huge # that passively assess movement via built-in sensors (i.e., accelerometer, GPS), often provide just-in-time feedback, goal-setting for behavior change

• But few employ other theoretically- or empirically-based strategies to systematically enhance motivation & behavior over time

Study Goals

• Provide initial 8-week test of 3 customized PA-sedentary behavior change apps drawn from conceptually distinct motivational frames vs. a commercially available control app (Calorific)

• 1 week baseline followed by 7-week intervention

• Major Outcomes:
  
  MVPA: Built-in accelerometer-derived mins/day (>301 counts/min based on prior validation work; Hekler, Buman et al., *JMIR* 2015)
  
  Sedentary time:
  - Accelerometer-derived mins/day (≤56 counts/min)
  - Self-reported daily sitting time (EMA, reported daily on app)
• Midlife & Older adults (ages 45+)
• Insufficiently active (<60min/wk of MVPA)
• Sedentary (i.e., 10+hrs/day of sitting)
• Safe to increase moderate PA (PAR-Q)
• Smartphone “naïve” (had used Android cell phones)
• Recruited via local electronic mailing lists, in-person activities at local settings; Craigslist ads
Smartphone Apps for walking more & sitting less (using different motivational frames)

Behavioral Science-Informed User Experience Design (BSUED)

Develop Concepts, Strategies Using Scientific Evidence Base & Theory

- Conduct Feasibility & Fidelity Testing

Conduct Informal Semi-Structured Interviews with Target User Groups

Adapt & Tailor Based on User Feedback

- Elicit Feedback:
  - Cognitive Walkthroughs
  - Individual & Group Discussions
  - Ethnographic Interviews

Develop Initial Prototypes
- Low-Fidelity (paper version)
- High-Fidelity (beta version)

Heckler E, King AC, Banerjee B, et al. Computer Human Interactions 2011; Vancouver, BC, Canada
“Move more/Sit Less” Apps – *Common Elements*

<table>
<thead>
<tr>
<th>Components</th>
<th>Smartphone Apps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Analytic</td>
</tr>
<tr>
<td>“Push” component (notification)</td>
<td>X</td>
</tr>
<tr>
<td>“Pull” component (info offered)</td>
<td>X</td>
</tr>
<tr>
<td>&quot;Glance-able&quot; display</td>
<td>X</td>
</tr>
<tr>
<td>Passive activity assessment</td>
<td>X</td>
</tr>
<tr>
<td>Real-time feedback</td>
<td>X</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>X</td>
</tr>
<tr>
<td>“Help” tab</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Components</th>
<th>Smartphone Apps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Analytic</td>
</tr>
<tr>
<td>Push component</td>
<td>X</td>
</tr>
<tr>
<td>Pull component</td>
<td>X</td>
</tr>
<tr>
<td>&quot;Glance-able&quot; display</td>
<td>X</td>
</tr>
<tr>
<td>Passive activity assessment</td>
<td>X</td>
</tr>
<tr>
<td>Real-time feedback</td>
<td>X</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>X</td>
</tr>
<tr>
<td>“Help” tab</td>
<td>X</td>
</tr>
<tr>
<td>Goal-setting</td>
<td>X</td>
</tr>
<tr>
<td>Feedback about goals</td>
<td>X</td>
</tr>
<tr>
<td>Problem-solving</td>
<td>X</td>
</tr>
<tr>
<td>Reinforcement</td>
<td>X</td>
</tr>
<tr>
<td>Variable reinforcement schedule</td>
<td>X</td>
</tr>
<tr>
<td>Attachment</td>
<td>X</td>
</tr>
<tr>
<td>&quot;Play&quot;</td>
<td>X</td>
</tr>
<tr>
<td>&quot;Jack pot&quot; random reinforcement</td>
<td>X</td>
</tr>
<tr>
<td>Social norm comparison</td>
<td>X</td>
</tr>
<tr>
<td>Competition/collaboration</td>
<td>X</td>
</tr>
</tbody>
</table>

Analytic App: Feedback/Goal-setting

You engaged in 47 minutes of physical activity this week.

Physical Activity
Oct 18-24

We suggest you increase your physical activity to 150 minutes per week by the end of the program.

How much would you like to increase your physical activity this week?

- 30 minutes more this week (about 5 minutes more per day)
- 60 minutes more this week (about 10 minutes more per day)
- 90 minutes more this week (about 15 minutes more per day)
Affect App: Week 1, Attachment
Affect app: *Daily Feedback*
Affect app: “Jack-pot” Reinforcement
Social app:

Home Screen
(“team 1” & “team 2” avatars)
Social app: Share function
Data Analysis:

Mixed model analysis used due to:

- intensive repeated-measures design
- ability to handle nested observations (multiple observations for each individual) and
- unbalanced (unequal) #s of observations, missing values
- Main effects for time, time x study arm interactions tested
- No Baseline differences for any Outcomes

Turning to the Results . . .
Initial Proof of Concept – **Reported Increase in Daily Walking** (2 mos)

(n = 68 adults ≥ 45 yrs, inactive, 1st contact with Smartphones)

King, Hekler, Grieco, et al., *PLOS One*, 2013
When tested in an Experiment
(8 weeks; with Calorific control app)

Using smartphone’s **built-in accelerometer**:

- **MVPA**: Social app did best (p<.05)
  - Other 2 apps = More variability in R (**which app for whom?**)

- **Sedentary time**: Social app = lower accel-derived daily sedentary time, &
  - Social & Affect apps decreased daily reported **sitting time** relative to Control & Analytic apps (p values<.05)

King, Hekler, Grieco, Winter, et al., *PLoS One*, accepted with revision
Accelerometer-derived MVPA (mins/week)
Accelerometer-derived Sedentary behavior (hours/day)
Daily Reports on Phone of Sitting (hours/day)

![Graph showing EMA assessed sedentary behavior (hours/day) over weeks with categories for Social, Analytic, Affect, and Control.]
What does the Future hold?
Technology that informs/motivates but “gets out of the way” of Active Living

Experiencing the World through a Screen (vs. “wearables”)
In Looking Ahead –
Some Thoughts about What We Can Do

• the Major Issue: *Sustained use over time* (provide info that surprises, excites, is valued by the individual)

• Explore ways to bring *different generations together* in using smartphone technology

• Look for opportunities to partner with *private sector*, as well as *community organizations* (data mining of ‘Big Data’ in the wild)

• Investigate ways to change *multiple behaviors* for bigger impact (e.g., 24-hour focus)
Some Thoughts about What We Can Do - continued

• **Differently framed apps** may work best for *different population segments* (‘whiches’ conundrum)

• Continue *‘stealth’* interventions that tap into non-health values & motives (e.g., ‘exergames’/fun, social connections, family, environ. sustainability, well-being)

• Continue to tackle issues of *privacy*, anonymity, informed consent

• Employ culturally informed technologies & processes to extend program reach for *all groups* to address *health disparities*
Thanks!