Effect of real-time monitoring and notification of smoking episodes on smoking reduction
A pilot study of a novel smoking cessation app

Reuven Dar
ruvidar@post.tau.ac.il
The Problem

• Need to provide highly accessible smoking cessation treatment
• Until recently, the only widely available smoking cessation aids were over-the-counter nicotine delivery devices (NRT)
• Over-the-counter NRT has not been successful as a population means to reduce smoking
The failure of NRT

“This review concluded that the superiority of [over-the-counter] NRT over unaided smoking cessation has not been demonstrated convincingly.”


“Compared with smokers using none of the cessation aids---The use of NRT bought over the counter was associated with lower odds of abstinence (odds ratio, 0.68; 95% CI, 0.49-0.94).”

The failure of NRT

• “Thus, it seems clear that the vast majority of smokers will not be helped by nicotine replacement therapy. What then should our health care systems do for them?”

• Stanley TD. (in press). Considerations of statistical power and risk of bias question the strength of nicotine replacement therapy's effectiveness. *Journal of Clinical Epidemiology*. 
Smoking Cessation Apps

• There are currently hundreds of smoking cessation applications (apps) available to smartphone users

• Smoking cessation apps can provide cognitive-behavior therapy (CBT) for smokers wishing to reduce/quit smoking

• Can potentially meet the need for widely available and effective cessation aid
What is SmokeBeat?

• A smoking monitoring and cessation app that works with wearables (smartwatches, wristbands)
• Able to identify smoking gestures in real time and differentiate them from similar hand-to-mouth gestures (e.g., eating, drinking, shaving)
• Supported by a backend platform that enables storage and analysis of big data generated by the wearable and smartphone
Identifying Smoking Gestures

• Raw data are collected from the wearable’s accelerometer and gyroscope sensors
• Data undergo stabilization and noise filtering
• The SmokeBeat algorithm determines which hand-to-mouth movements performed by the user signify smoking
Smoking Gesture Recognition From Accelerometer and Gyroscope
Telling the difference from other gestures

Tooth Brushing

Eating

Drinking (cold)
Pilot Study

• 40 Smokers wishing to reduce or quit smoking

• Wait-list control design
  • Experimental group given smartwatches and received notifications for 30 days
    • Could also obtain statistical information on smoking pattern if chose to, but this wasn’t pushed to users
  • Control group completed questionnaires on days 1 and 30

• Goals
  • to gage and optimize smoking detection in “real life”
  • to assess effect of monitoring and feedback on smoking rate
Notifications pushed to participants
Information available in the app

Cigarette Smoked

- 0% Improvement
- $0.6 Money spent
- 00:22 Wasted hours of life

Cigarette Number Statistics
- Morning
- Noon
- Evening
- Night

Select Date: 20-11-2016

Smoking Patterns
- 474 Total number of cigarettes smoked
- $151.7 Total money spent
- 3 Avg. cigs/day
- 86 Total wasted hours of life
Pilot Study: Detection data

• Detection algorithm personalized for first 15 days, performance based on last 15 days
  • 64.2% of cigarettes were smoked while sitting
  • 18.1% of cigarettes were smoked while standing
• Correct detection rates were 87.3% for sitting, 89.7% for standing, 82.3% overall.
• False alarm rate was 2.8%
Pilot Study: Smoking rates

Reported Cigarettes per Day by Group

$F(1, 38) = 7.99, p = .007$

Vertical bars denote +/- standard errors

<table>
<thead>
<tr>
<th>Cigarettes per Day</th>
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<tbody>
<tr>
<td>Experimental</td>
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<tr>
<td>Control</td>
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<tr>
<td>Day 1</td>
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<td>Day 30</td>
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Actual Cigarettes per Day in Experimental Group

$F(29, 551) = 2.54, p = .00002$

Vertical bars denote +/- standard errors
Advantages of the SmokeBeat Technology

• Automatic monitoring of smoking
• Automatic notification in real time
• Automatic feedback on smoking patterns
• Providing interventions in real time
• Producing big data analytics
• Predicting smoking episodes
Advantages of the SmokeBeat Technology: Providing interventions in real time

• Incentives
• Financial
• Social
• Emotional
• Rational

• Tips and techniques
• Resisting craving
• Re-committing
• Using “mantras”
• Rewarding oneself

• can be tailored to individual smokers

SmokeBeat
We detect that you've taken 4 puffs. Can you exercise control and give up the rest of the cigarette?
Advantages of the SmokeBeat Technology: Big data analytics

• The backend platform collects massive data on the user’s smoking habits from
  • Wearable Sensors
  • Time
  • location (GPS)
  • Calendar events

• Processing is done in the cloud in order to find correlations between data entries

• Smoking patterns are produced at the individual and group levels

- Accelerometer
- Gyroscope
- Arousal (GSR)
- Capacitators
- Heart-rate
- Skin temperature
- Body fat
- Muscle tension
- Ambient light
- Barometer
- UV
Advantages of the SmokeBeat Technology:
Predicting smoking episodes

Notifications

SmokeBeat
We detect that you are commuting. Our system predicts that you are likely to smoke soon. Try to resist the temptation!

and suggests coping tips
Research on Big Data Generated by the SmokeBeat Platform

- General smoking patterns
  - by time, location, social setting
- Predictors of smoking episodes
  - Somatic indicators from sensors, drinking, eating, commuting, interacting with specific people
- Predictors of success in smoking cessation
  - Personal variables, baseline smoking patterns, reactivity to cues, responsiveness to interventions

- Within individuals
- Between individuals
- Interactions between the two
THANK YOU!

Questions?

ruvidar@post.tau.ac.il
Info@somatixinc.com

www.smokebeat.com