

MyBehavior: Automatic Personalized Health Feedback from User Behaviors and Preferences using Smartphones

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ACM UbiComp 2015

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IS 809
Spring 2016

Problem

- * Obesity is a declared global epidemic (WHO)
- * One third of Americans are obese
- * Search for scalable solutions to promote a healthier lifestyle
- * Feedback usually involves statistics of self-tracked data or general suggestions
- * Need for personalized health suggestions

Proposed Solution

- * MyBehavior: Mobile application used to track eating and exercise patterns
- * Patterns used to generate personalized and actionable suggestions
- * Uses two decision theory models:
 - * Multiarmed bandit (MAB)
 - * Pareto-frontier

Motivation/Vision

- * Low effort and self-efficacy
 - * Create a tool that prompts for low effort actions
 - * The more self-efficacy increases the less effortful the action
- * Personalization of suggestions
 - * Better than one-size fits all
- * Mobile recommender system for health feedback
 - * Filling an existing gap in the area

MyBehavior Application Development

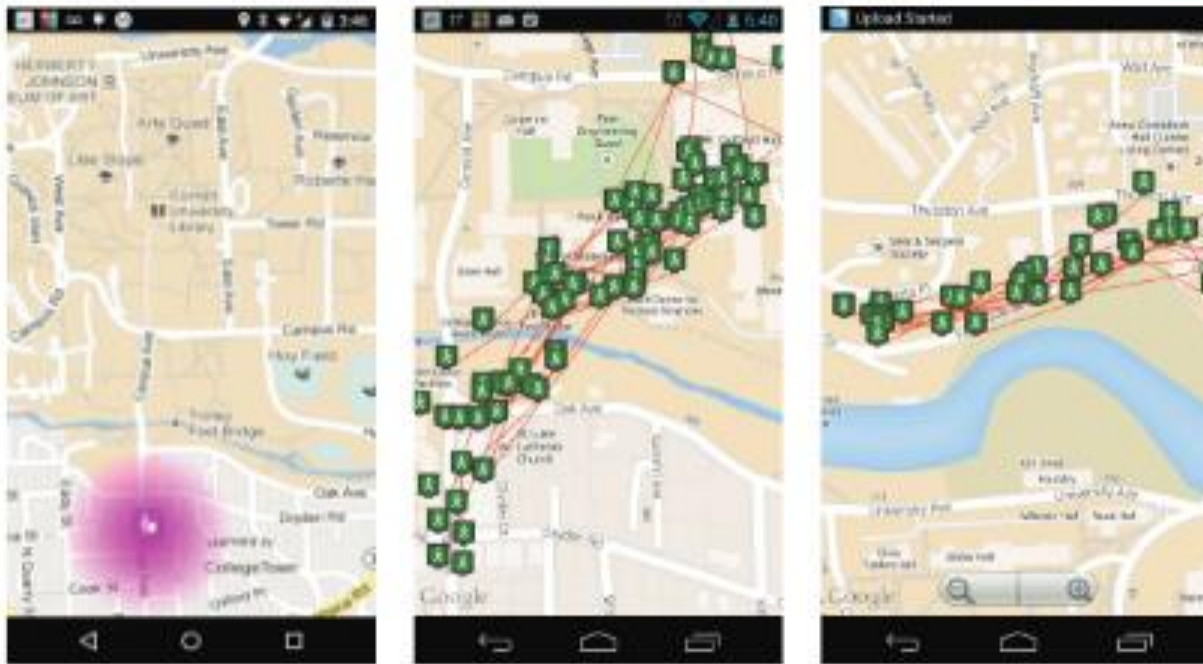
- * The application development used an iterative process that spanned for 2.5 years
- * Several prototypes were developed
- * The paper discuss two major versions, MyBehavior 1.0 and 2.0

MyBehavior 1.0

- * Transforms log data to personalized suggestions
- * Suggests small changes that maximize calorie loss
- * Uses automated sensing and manual logging



Physical Activities



(a)

(b)

(c)

Figure 3: A few clusters representing different user behaviors (a) a stationary cluster (b) a walking cluster (c) another walking cluster

Version 1.0 : Approach part 1

- * Unsupervised clustering algorithms are used for both physical activities and food categorization
- * Once behavior is learned, a set of calorie loss suggestions is created with small changes to user behavior
- * Frequent (90%) and past infrequent behaviors (10%) are explored to create suggestions
- * 10 activity and 10 food independent suggestions are generated
- * Uses MAB algorithm(online algorithm, computationally efficient, privacy feature)

Version 1.0 : Approach part 2

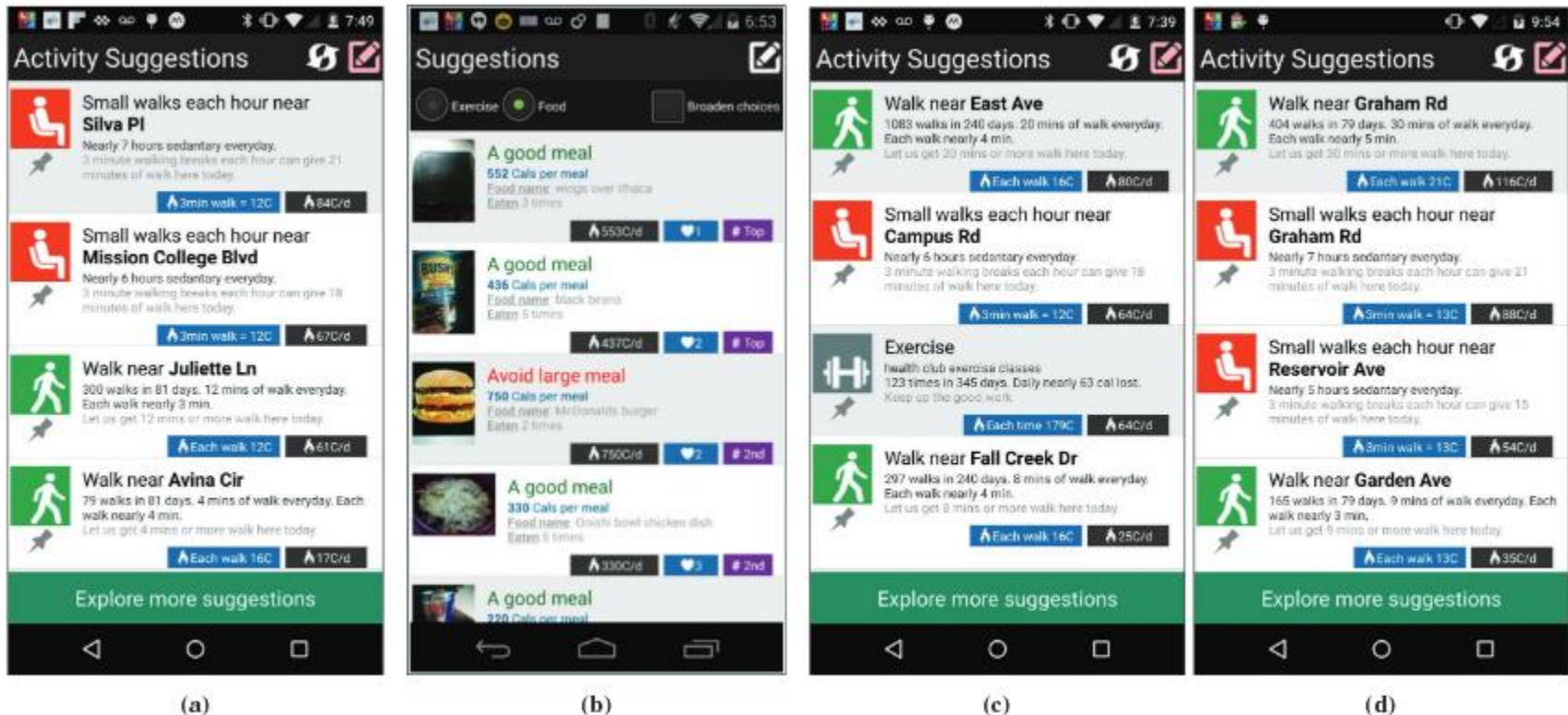


Figure 4: MyBehavior app screenshots (a) a set of activity suggestions for a user (b) a set of food suggestions for the same user (c) a set of suggestions at a different time for the same user (d) a set of activity suggestions for a different user

Version 1.0: Deployment and Lessons learned

- * 3 week pilot with 9 users (4 female). Users rated suggestions an average 3.4 out of 5
- * Suggestions were actionable and provided important feedback
- * Users reported:
 - * Difficulty in manual logging, searching for was food long and cumbersome
 - * Lack of human control
 - * Slow to adapt to lifestyle changes
 - * User cannot remove or prioritize suggestions

MyBehavior version 2.0

- * Customized app to include user suggestions
 - * Easier logging: Using crowd-sourcing function to obtain calorie information using photographs
 - * Ability to select from a list of past performed activities
- * Incorporating human customization in suggestion
 - * User can remove suggestions
 - * Ability to re-order suggestions priority
- * Use of the pareto-frontier theory
 - * Balances between the low-effort and preference
 - * Ranks low-effort and preference between actions and selects the one with the higher rank

Version 2.0: Deployment

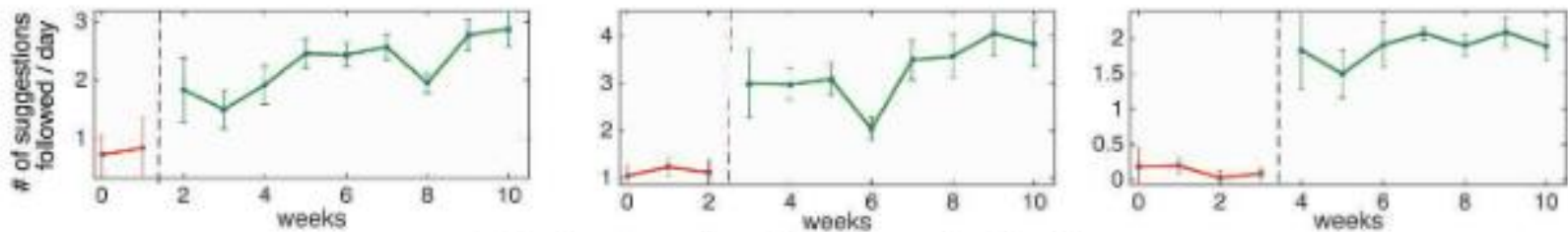
- * 3 week pilot with 7 users (3 female). Users rated suggestions an average 4.2 compared to version 1.0 of 3.4 out of 5 (19% increase)
- * 14 week evaluation study after improvements
 - * Participants were exposed to 3 weeks of baseline and 2,3, or 4 weeks of control condition
 - * The experiment condition lasted between 7 to 9 weeks
 - * An invitation was sent through email to participate in the experiment and 16 participants were selected and compensated with \$120

Variable	n(%)
<i>Gender</i>	
Male	7(43.7)
Female	9(56.3)
<i>Age</i>	
18 - 29	4(25.0)
30 - 39	6(37.5)
40 - 49	3(18.7)
> 50	3(18.7)
<i>Stage of behavior change before the study</i>	
Ready	7(43.7)
Acting	9(56.3)
<i>Previous experience with self-tracking</i>	
Maintained food diary	13(81.3)
Maintained exercise diary	11(68.7)

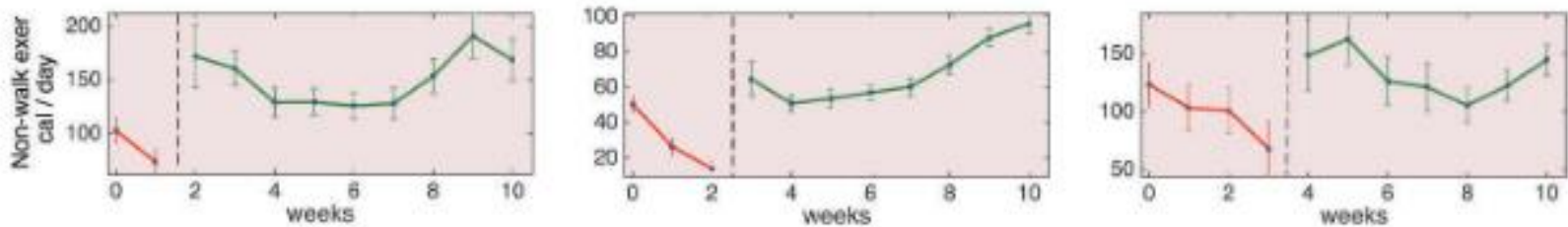
Daily phone survey

1. How many suggestions were you able to follow today?
 2. How many suggestions did you want to follow?
 3. How well did the suggestions relate to your life.
 - likert scale 1-7
 - 1- doesn't relate to your life
 - 7- relates to your life perfectly
 4. Did you encounter any barrier to follow the suggestions today (e.g., weather or deadline)?
 - Yes/No
 5. Rate your emotional state today
 - photographic affect meter (PAM) scale [44]
-

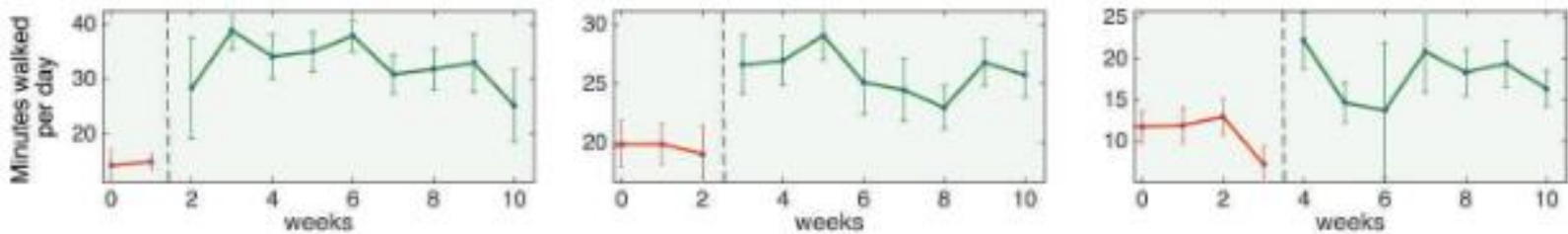
Table 2: Users answered the above 5 questions in a daily phone survey



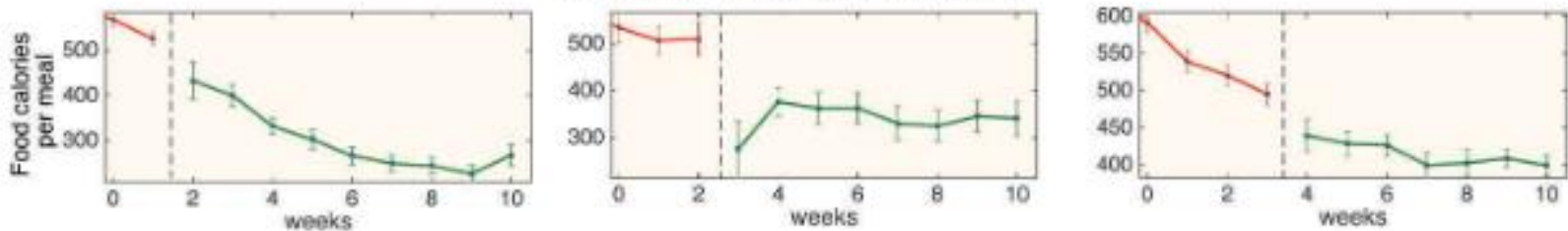
(a) Number of suggestions followed over weeks of the study.



(b) Calories lost in non-walking exercises per day across the study



(c) Minutes walked per day during the study



(d) Calories consumed in per meal

Figure 6: Changes in user behavior as predicted by the mixed model for multiple baseline design. The dotted lines represent the start of the intervention of MyBehavior. Left, middle, and right figures respectively show results from participants where intervention were started after 2, 3 and 4 weeks of using the control. Red color represents control phase where as green represents periods of using MyBehavior.

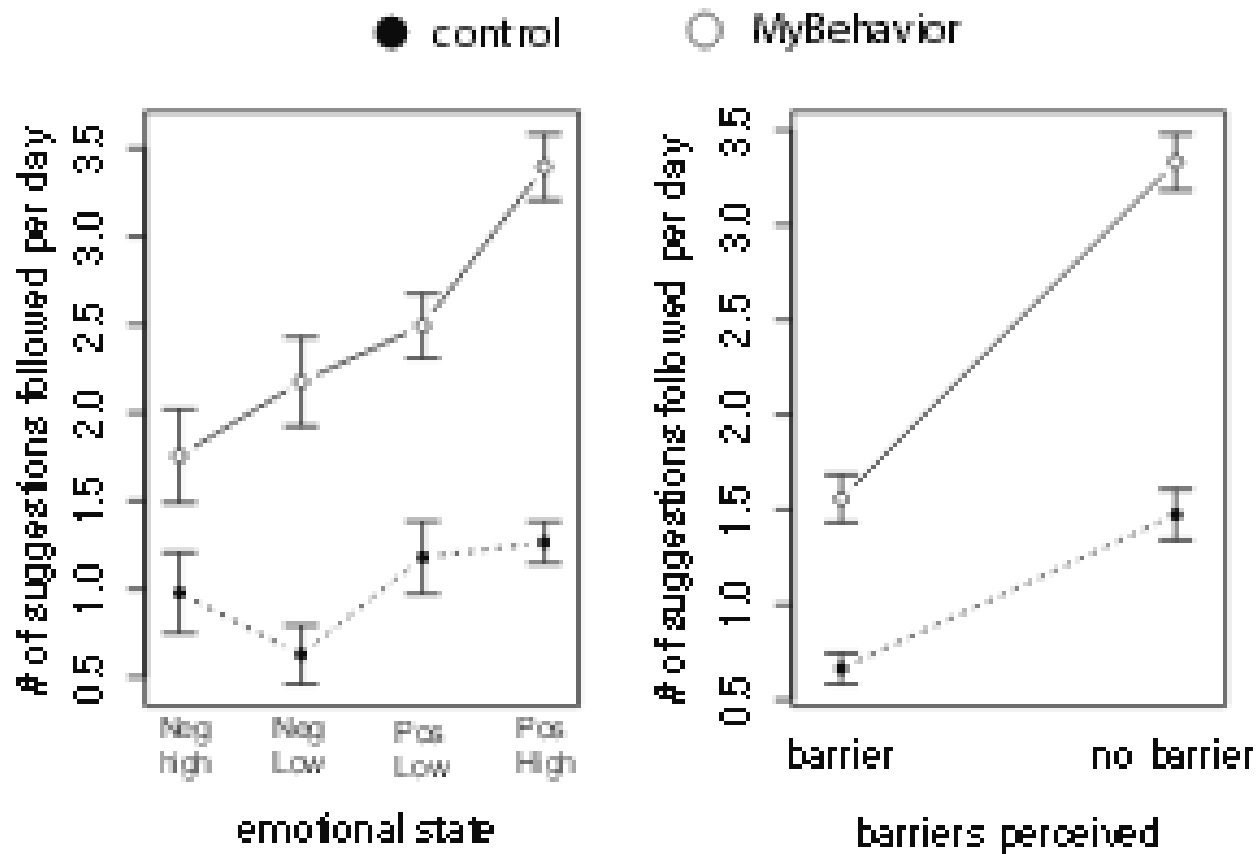


Figure 7: Number of suggestions followed for control and experiment conditions with respect to barriers and emotional states

Related work and MyBehavior

- * The app offers personalized actions compared to existing apps that offer only statistics.
- * First automated system that treats each user differently in creating suggestions
- * First time the area of low-effort suggestions is explored (strong as motivation)
- * Multi-armed Bandit (MAB) usage:
 - * Online learning algorithm that learns adapts and decides simultaneously.
 - * Not heavily parameterized
 - * Process only from the latest data
 - * Less battery need compared to a competing technique Markov Decision process (MDP)

Critique part 1

- * Overall a great concept and great start, the future will bring more personalized apps
- * Positive app features:
 - * Low-effort suggestions
 - * Ability to enter pictures and associate with calories
 - * Personalized recommendations
 - * Liked the connection between emotional state and motivation

Critique part 2

* Issues identified:

- * User enters desired weight loss and app calculates calories per day to loose. I disagree with the concept for health reasons
- * The pareto-frontier gives equal weight to preference and low effort
- * The 16 study participants were picked based on willingness to participate and how smart phone savvy they were.
- * In the future may can add a how to you feel today feature and can adjust recommendations based on the mood of the user

