Presented Obesityweek • Nov 2013

Coordinating Sensor and Subjective Data in mHealth Studies

Jon K. Moon[1]; Jared Sieling[1]; Dale Bond[2]; Graham Thomas[2]
[1]MEI Research, Ltd. • [2]Weight Control and Diabetes Center, Brown University & The Miriam Hospital

The Miriam Hospital
A Lifespan Partner

Background

In research to understand and influence behavior, a key use of objective sensors should be to offload burden from participants. Freeing them to provide unique, timely and valuable subjective responses that place objective data in context. In other words, don't ask a participant to enter information that you can gather another way. However, challenges remain in evolving toward greater data integration and concurrency.

Participants don't tolerate errors well. It is important to have a mechanism to adjust information about participants and accommodate their schedules and personal preferences.

Data from multiple sensors must be integrated over extended periods. Then blended with schedule and other settings to create triggers, reminders, and queries.

Study Design

Purpose

To monitor sedentary time (ST) with the accelerometer onboard a smartphone and to compare three approaches to prompt an activity breaks with reinforcing feedback on ST.

Excessive ST is related to obesity and other adverse health outcomes, but there are few proven ways to interrupt ST.

Participants

Twenty seven overweight adults (mean 48 y.o, 85% female, BMI = 36.2 ± 7.7 kg·m^{-2}) were recruited from the Weight Control and Diabetes Research Center of Miriam Hospital.

Procedure

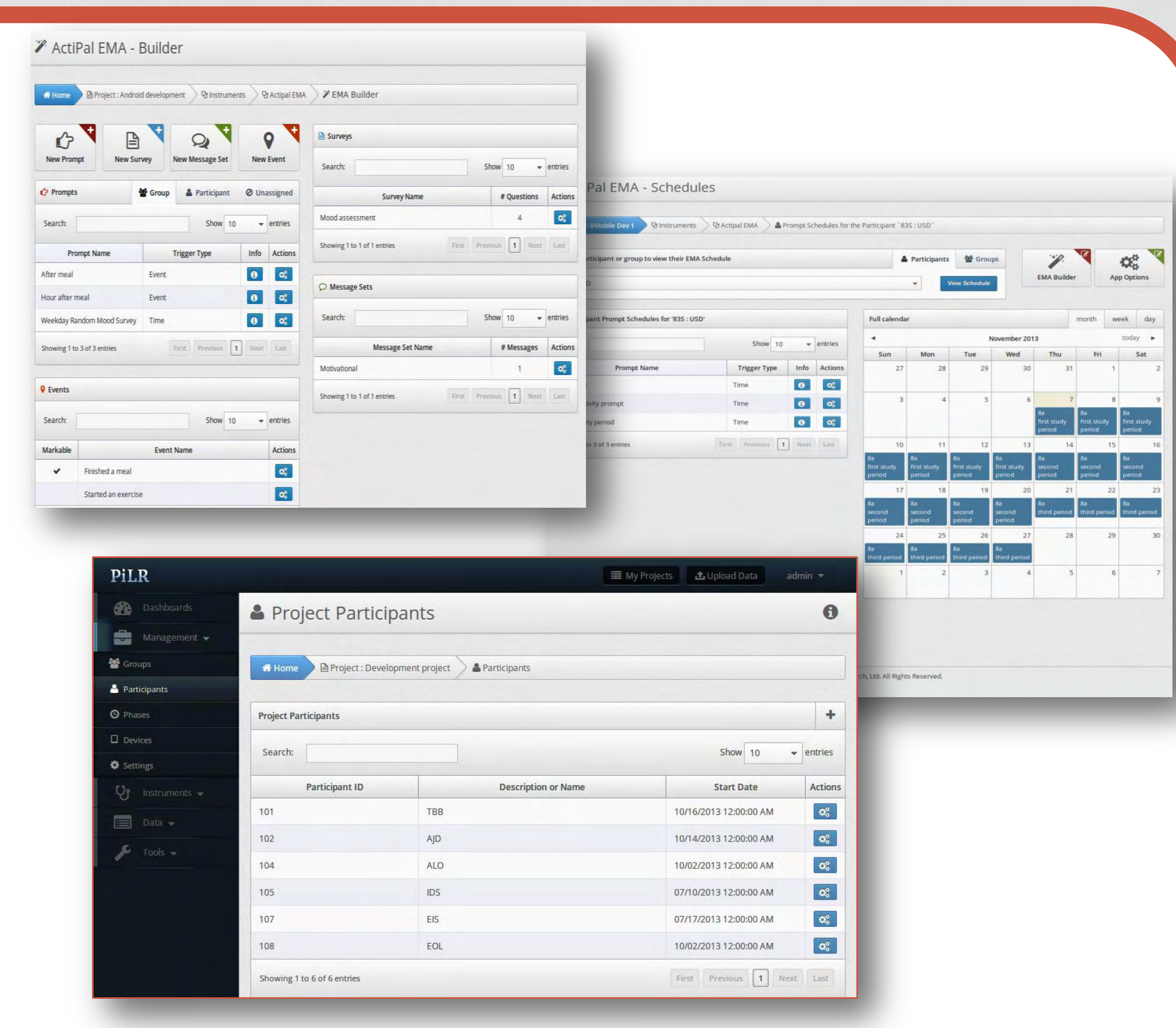
Participants carried a Galaxy Exhibit 2 smartphone for 21 days. The ActiPal mobile application separated accelerometer signals into sedentary, light and moderate levels of activity. A 'widget' prompted the participant to break prolonged ST (30, 60 or 120 min) with respective breaks of 3, 6 or 12 min. If they complied, a 'fuel tank' was filled by a corresponding amount and an incentive icon was presented. Total Active and Sedentary min that day were updated continuously.

PiLR Healthware managed the phone and interactions of the study by associating the device with respective participants, synchronizing configurations (including controlling 'crossover' between ST length phases), delivering positive messages and monitoring compliance and technical performance.

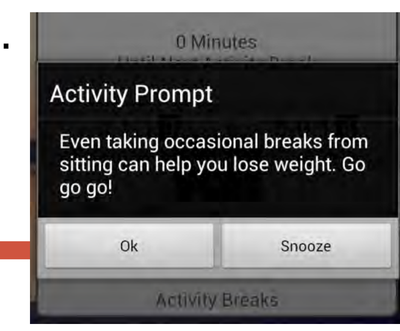
Technical Methods

Setup and Management

The system provided a central management service accessed through a website. Functions included registering enrolled participants, entering the smartphones by IMEI code, assigning participants to a smartphone and managing progress through the study and for daily interactions. The investigators set up the study protocol as a collection of EMA content, prompts, and triggers to a schedule customized by group or each participant.



The number of contiguous minutes classified as ST to trigger a "low-activity" prompt were configurable by the investigator for each participant. The number of repeated notifications also were configurable as the study progressed. Participants were able to hit a 'snooze' button to suppress further prompts.

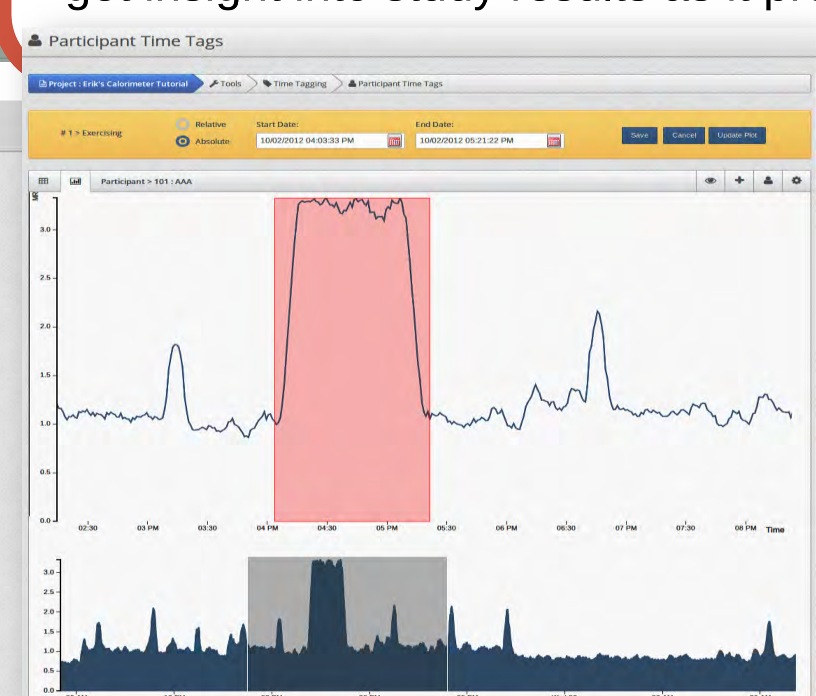


Real-time Monitoring and Assessment

Raw acceleration and minute-by-minute acceleration assigned to physical activity level categories were uploaded wirelessly to the server system in close to real-time. Data that were collected from the participant's smartphone is uploaded shortly after collected, so investigators can monitor compliance, and make sure equipment is working properly.

They also can view the data and perform initial analysis of participant progress , and get insight into study results as it progresses.

Data Cleaning and Export



The system provided tools to view and clean data that has were collected. verifying or shifting times of events before analysis. Cleaned data were available for export to statistical or other software (Excel, SAS, etc). Quality control, data segmentation and other analysis required to control progress of the study were performed right within the system using "R" language modules.

Discussion

Interventions delivered by a smartphone, or the always-present and always-on equivalent of the future, promise automation and objective sensing power that could markedly improve healthy behaviors without low burden. Objective data sources need to be selected based on information density and utility to discriminate behaviors and support subjective interactions. Common analysis methods and accepted algorithms for quality assessment, initial processing, imputation, data segmentation and summaries should be available with a concurrency equivalent to the intensity of effort asked of participants.

Behavioral experts working with engineers and software developers created the PiLR system to mediates personal behavior based on patterns of objective inputs. Participants were prompted to be active only if there was reasonable certainty that their ST exceeded the threshold. Thus, the study addressed more subtle questions on duration of ST, suggested duration of activity, with prompts and messages to produce the best response.

In addition to the intent of this study, the same technology could quantify an exercise activity, along with determining the time and the location. The accompanying subjective input would ask why the person chose that time, location and activity. If a frequent response relates to weather, then temperature and weather data from an objective source could be combined so that 'why' question need not be asked repeatedly.

Acknowledgement, Disclaimer and Contact

Supported in part by the National Cancer Institute, #HHSN261201300084C and HHSN261201100058C. Any opinions, findings, and conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the US Dept of Health and Human Services.

Jon Moon • jmoon@meinergy.com • (952) 373-1636 • www.ActiPal.com