

# Happier and Healthier.. with Smartphone Data

@neal\_lathia  
Cambridge Science Festival





much it's

**INSIDE EVERY  
THIRTY YEAR OLD  
IS AN EIGHTEEN  
YEAR OLD ASKING  
‘WHAT  
HAPPENED?’**

2  
-07-00

Long-term Conditions (LTCs) are defined on the Department of Health website as:

“those conditions that cannot, at present, be cured, but can be controlled by medication and other therapies. The life of a person with a LTC is forever altered – there is no return to ‘normal’.”

15 million people in the UK live with a long-term health condition.

That is approximately 1 in 4 of us, or about 2 times the population of London.

Patients with long-term health conditions account for 7 out of every 10 pounds spent by the National Health Service.



*Handbook of  
Research Methods  
for Studying  
Daily Life*

*edited by*  
Matthias R. Mehl  
Tamlin S. Conner

# **DIARY METHODS: Capturing Life as it is Lived**

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**Niall Bolger, Angelina Davis, and Eshkol Rafaeli**

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**Key Words** experience sampling method, longitudinal designs, electronic data collection, self-report measures, multilevel models

**■ Abstract** In diary studies, people provide frequent reports on the events and experiences of their daily lives. These reports capture the particulars of experience in a way that is not possible using traditional designs. We review the types of research questions that diary methods are best equipped to answer, the main designs that can be used, current technology for obtaining diary reports, and appropriate data analysis strategies. Major recent developments include the use of electronic forms of data collection and multilevel models in data analysis. We identify several areas of research opportunities: 1. in technology, combining electronic diary reports with collateral measures such as ambulatory heart rate; 2. in measurement, switching from measures based on between-person differences to those based on within-person changes; and 3. in research questions using diaries to (a) explain why people differ in variability rather



“by 2025, when most of today’s *psychology* undergraduates will be in their mid-30s, more than 5 billion people on our planet will be using ultra-broadband, sensor-rich smartphones far beyond the abilities of today’s iPhones, Androids, and Blackberries.”



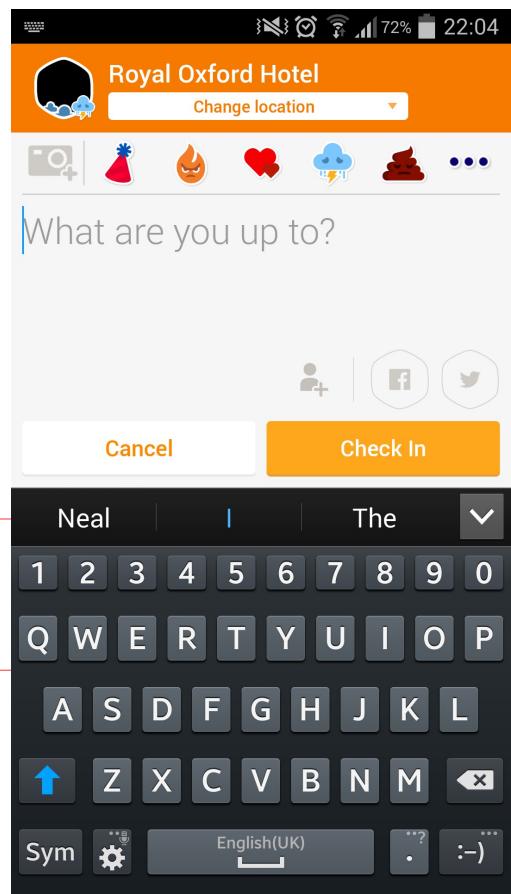


Neal Lathia  
@neal\_lathia  
Senior Research Associate @Cambridge\_Uni,  
working on @EmotionSense  
City of London · cl.cam.ac.uk/~nkl25/  
632 FOLLOWING 1,395 FOLLOWERS

Tweets Photos Favourites

Parra @denisparra 54m  
Our #sigir2015 Workshop proposal on  
Social Personalization & Search  
accepted, w/@peterpaws @ctrattner  
@abellogin & @lbalby, updates soon !  
4 2

What's happening?  



Royal Oxford Hotel  
Change location

What are you up to?

Cancel Check In

Neal | The 

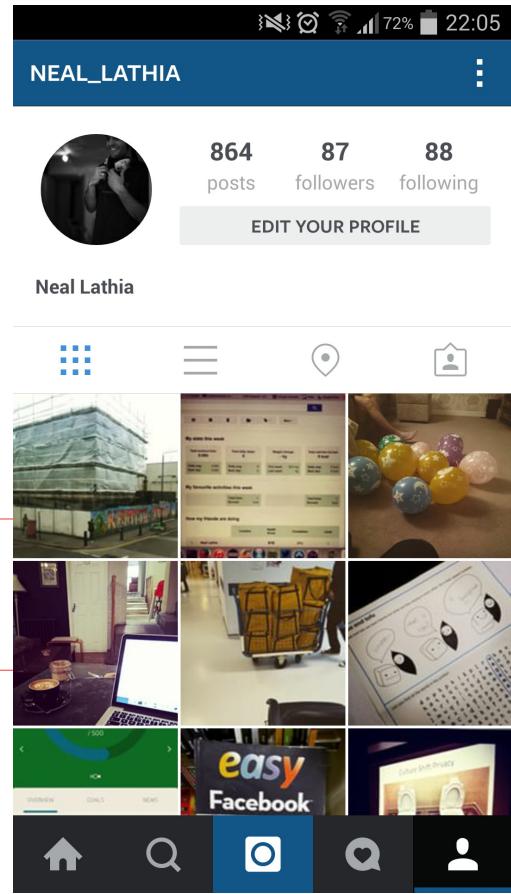
1 2 3 4 5 6 7 8 9 0

Q W E R T Y U I O P

A S D F G H J K L

Z X C V B N M 

Sym  English(UK)  . :-)



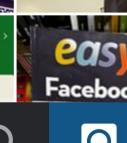
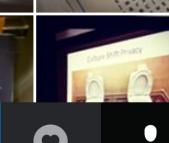
NEAL\_LATHIA

864 posts 87 followers 88 following

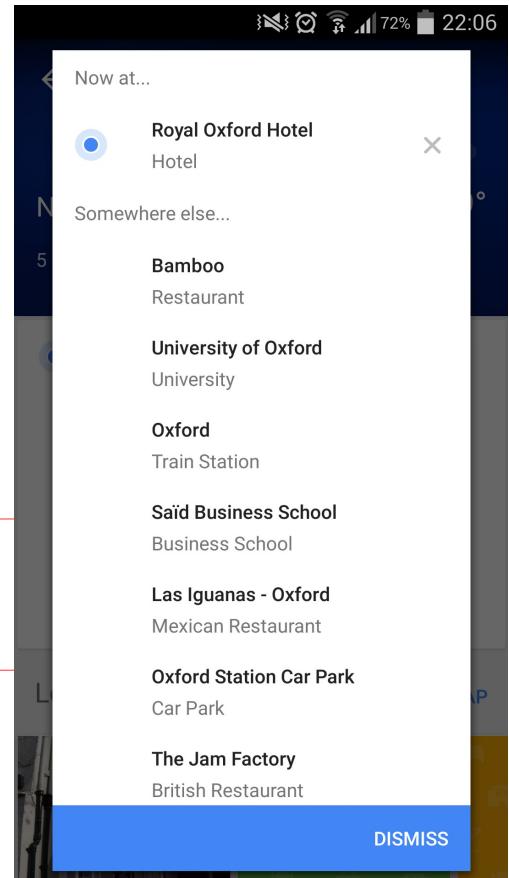
EDIT YOUR PROFILE

Neal Lathia



Now at... 

Royal Oxford Hotel  
Hotel

Somewhere else...

Bamboo  
Restaurant

University of Oxford  
University

Oxford  
Train Station

Saïd Business School  
Business School

Las Iguanas - Oxford  
Mexican Restaurant

Oxford Station Car Park  
Car Park

The Jam Factory  
British Restaurant

DISMISS

Accelerometer  
GPS / Wi-Fi  
Gyroscope  
Bluetooth  
Microphone  
Humidity  
Temperature  
Phone / Text Logs  
Device Logs  
Social Media APIs  
App Usage



Accelerometer | Physical Activity  
GPS / Wi-Fi | Mobility  
Gyroscope | Orientation  
Bluetooth | Co-Location  
Microphone | Ambient Audio  
Humidity | Environment  
Temperature | Environment  
Phone / Text Logs | Socialising  
Device Logs | Network  
Social Media APIs | Socialising  
App Usage | Information Needs



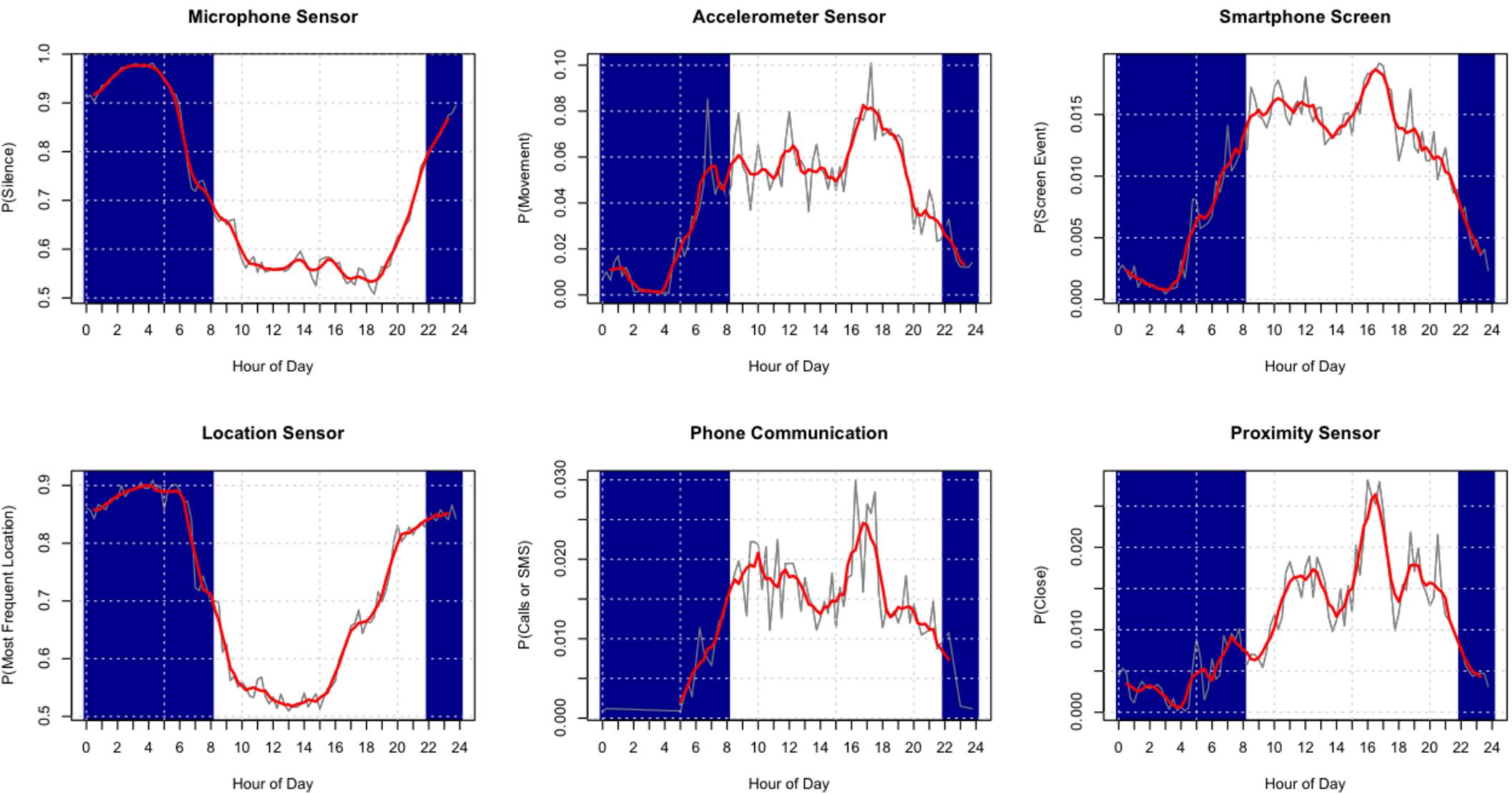
Yesterday

1 hr 18 min



● 29 min walking  
Wembley • 19:39

● 15 min cycling  
11 min walking  
Cambridge • 18:06



# Case 1: Subjective Wellbeing & Behaviour

N. Lathia, G. Sandstrom, P. Rentfrow, C. Mascolo (in prep). *Happy People Live Active Lives*. 2015.

# What is Emotion Sense?

Emotion Sense is a collection of Android libraries to quickly build applications that collect sensor, mobile phone usage, and survey response data from participants of human interaction or social psychology experiments.

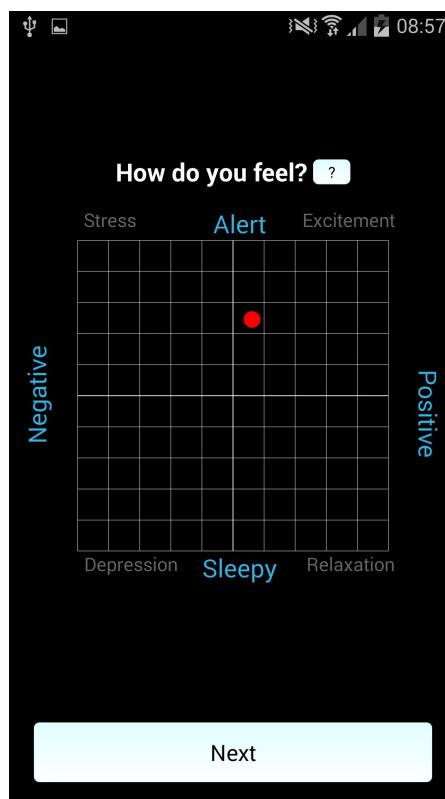
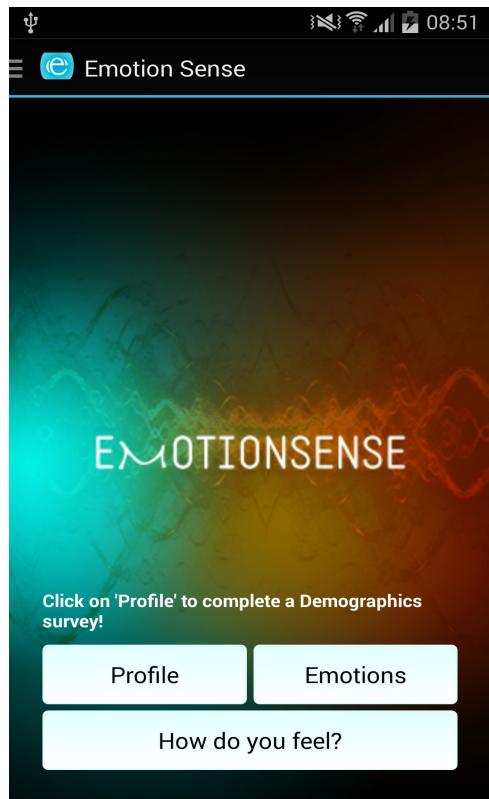
The tools are fully configurable: social scientists can define what sensor data they would like to collect, a range of surveys with questions they would like to ask, and the conditions that should trigger each survey. Similarly, participants can set the application to meet their own personal preferences, by setting when they are available to answer surveys. The application is fully automated, and its configuration can be remotely updated, in order to adapt experiments as they are ongoing.

## Recent Publications

[pdf] **SociableSense: Exploring the Trade-offs of Adaptive Sampling and Computation Offloading for Social Sensing.** In Proceedings of the 17th Annual International Conference on Mobile Computing and Networking (MobiCom 2011). Las Vegas, USA, September 2011.  
*K. Rachuri, C. Mascolo, M. Musolesi, P. J. Rentfrow.*

[pdf] **EmotionSense: A Mobile Phones Based Adaptive Platform for Experimental Social Psychology Research.** In Proceedings of the 12th ACM International Conference on Ubiquitous Computing. Copenhagen, Denmark. September 2010.  
*K. Rachuri, M. Musolesi, C. Mascolo, P. J. Rentfrow, C. Longworth, A. Aucinas.*



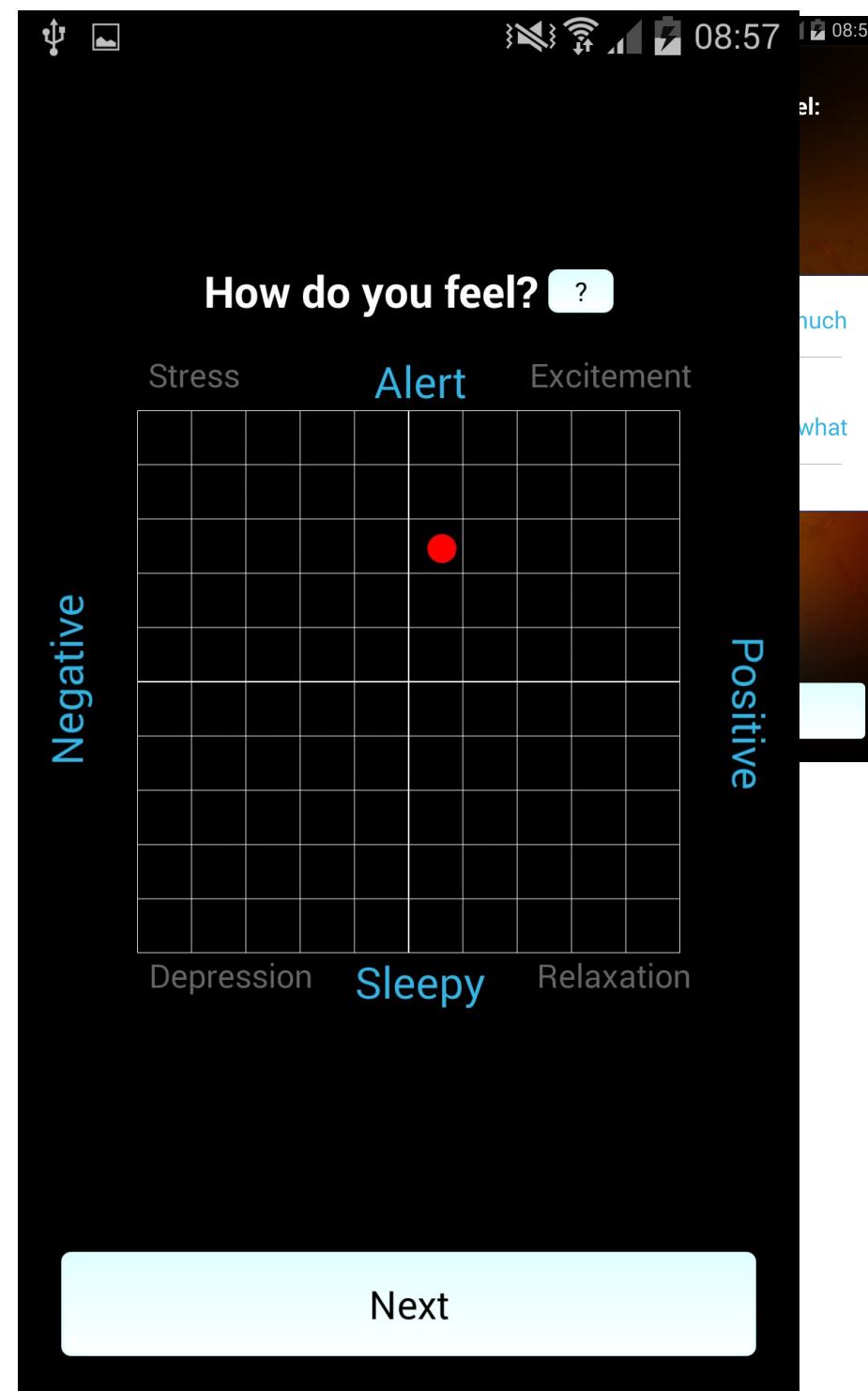
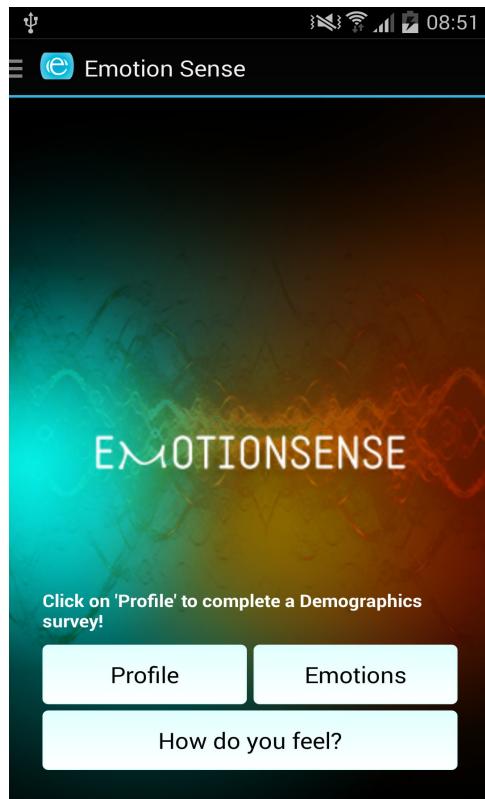


The title "Page 1/10" and subtitle "To what extent do you feel:" are at the top. Below are two horizontal sliders. The first slider is labeled "1. Calm?" with endpoints "Very much" (right) and "Somewhat" (left). The second slider is labeled "2. Anxious?" with the same endpoints. Both sliders have blue circular markers near the "Somewhat" position.

The title "Page 7/10" and subtitle "In the last 15 minutes, have you been...?" are at the top. A list of activities with checkboxes follows:

Sitting	<input type="checkbox"/>
Standing	<input type="checkbox"/>
Walking	<input checked="" type="checkbox"/>
Running	<input type="checkbox"/>
Lying Down	<input type="checkbox"/>
Cycling	<input type="checkbox"/>
Other	<input type="checkbox"/>

A large "Submit" button is at the bottom.



A survey page titled 'Page 7/10' with the question 'In the last 15 minutes, have you been...?'. The page lists several activities with checkboxes:

- Sitting
- Standing
- Walking
- Running
- Lying Down
- Cycling
- Other

A large white button labeled 'Submit' is at the bottom.

Page 7/10

In the last 15 minutes, have you been...?

Sitting

Standing

Walking

Running

Lying Down

Cycling

Other

Submit

The image displays four screenshots of the Emotion Sense mobile application, showing various features and user data.

**Screenshot 1: My Profile**

This screen shows the user's account information and recent activity:

- Account: neal.lathia
- Join Date: 6 Apr 2014
- Notifications: 488
- Responses: 252
- Demographics
- Personality (View)
- Gratitude (View)

**Screenshot 2: My Profile - Personality**

This screen lists personality traits with "View" buttons:

- Personality
- Gratitude
- Health
- Sociability
- Job Satisfaction
- Life Aspirations
- Connectedness

**Screenshot 3: Mood Tracking**

This screen shows a mood scale from Stress to Excitement at 10:24:

How do you feel? ?

Stress      Alert      Excitement

**Screenshot 4: Personality Report**

This screen displays personality reports with "READ" buttons:

- Conscientiousness**: You scored on the lower end of the average range for conscientiousness (lower than 50% of all people). Conscientious people tend to be efficient, organized and thorough, and tend not to be careless, lazy or impulsive.
- Emotional Stability**: You scored quite high on emotional stability (higher than 75% of all people). Emotionally stable people tend to be contented and self-confident, and tend not to be tense, irritable, shy or moody.
- Extraversion**: You scored on the upper end of the average range for extraversion (higher than 50% of all people).

Emotion Sense

How do you feel? ?

Stress Alert Excitement

10:24

My Profile

Account

Join Date

Notifications

Responses

Demographic

View Persona

View Gratitudo

Time Of Day

Alert

Stress Excitement

Negative Positive

Sleepy

Depression Relaxation

Data: Last 30 days.

Colours

Page 1/10 To what extent do you feel:

Page 7/10 In the last 15 minutes, have you been...?

Sitting

Conscientiousness READ

My Emotions ?

Time Of Day

Location

SMS Patterns

Accelerometer

Phone Screen

Microphone

Call Patterns

Personality

Sociability

Conscientiousness READ

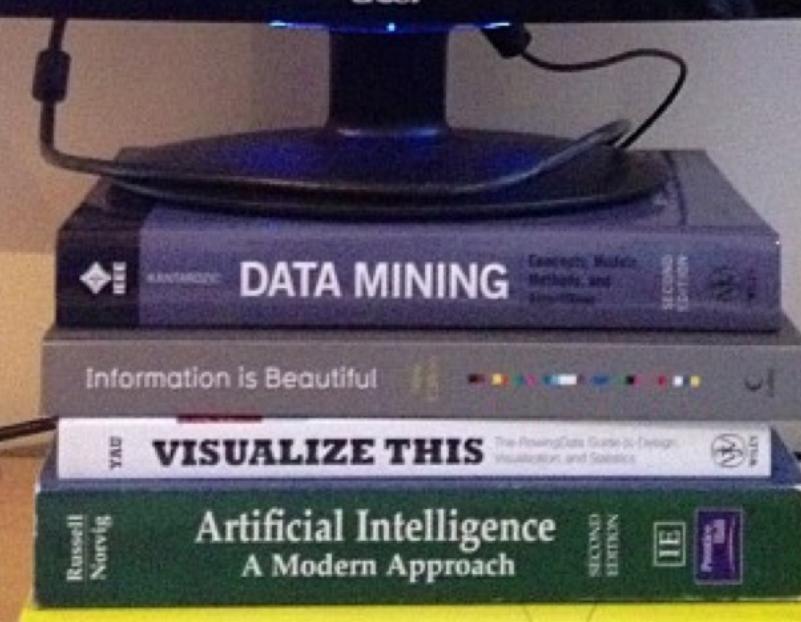
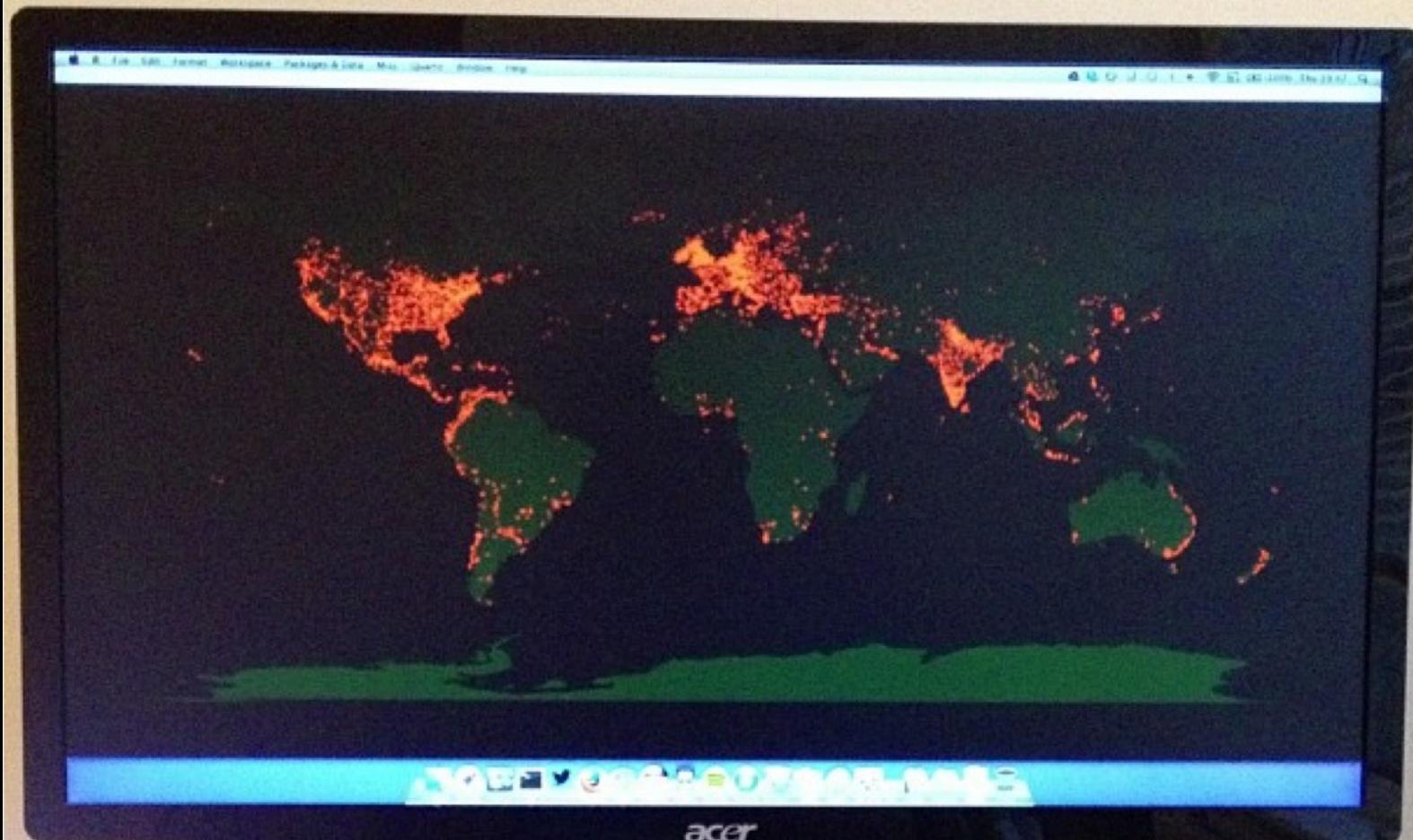
Stability READ

the lower end of the scale for conscientiousness (lower than most people). People tend to be organized and thorough, but also be careless, lazy.

quite high on stability (higher than most people). Stable people tend to be calm and self-confident, but also be tense, irritable.

in the upper end of the range for extraversion (higher than 90% of all people).

Survey Stats





“[...] We compared the upper 10% of consistently very happy people with average and very unhappy people. The very happy people were highly social, and had stronger romantic and other social relationships than less happy groups...”

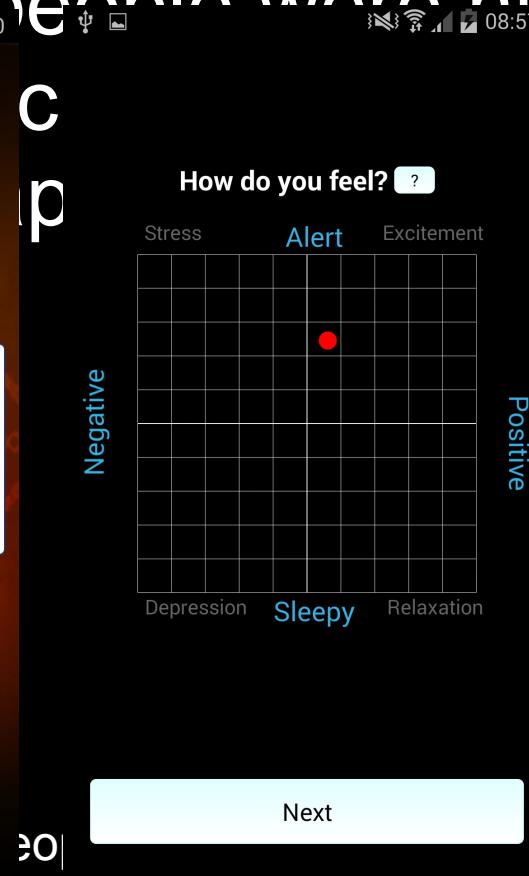
[...] We compared the upper 10% of consistently very happy people with average and very unhappy people. The very happy people were highly social and had strong relationships.

Page 1/5:  
To what extent do you agree:

In most ways my life is close to my ideal.  
Slightly agree



Submit



Page 1/10  
To what extent do you feel:

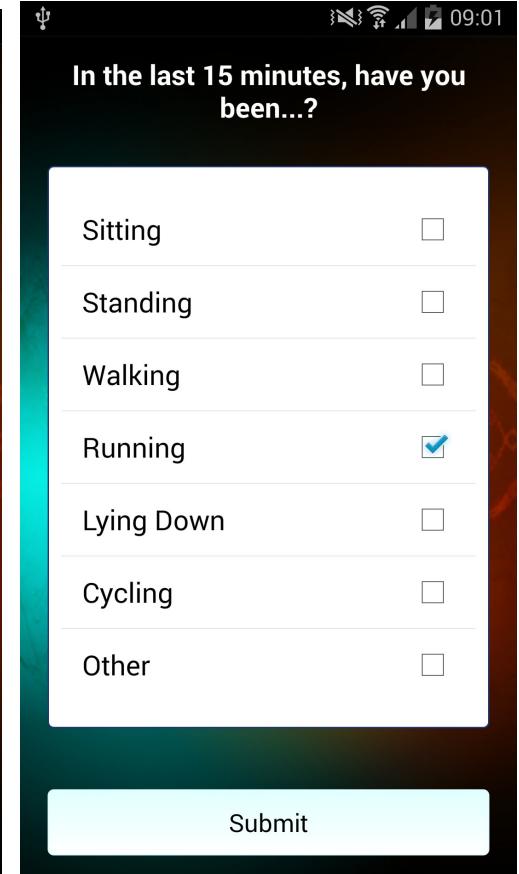
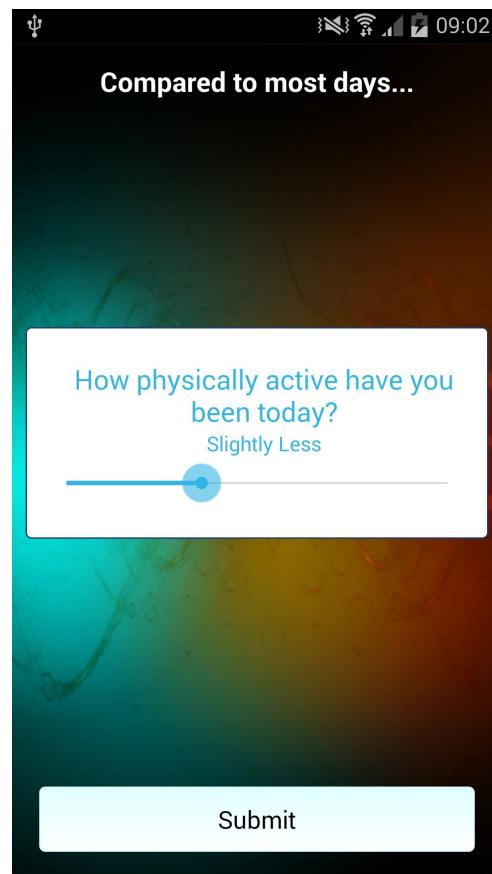
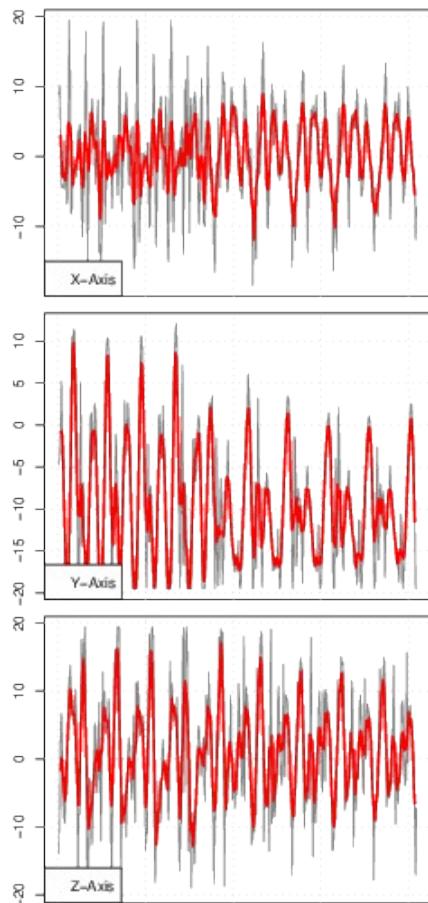
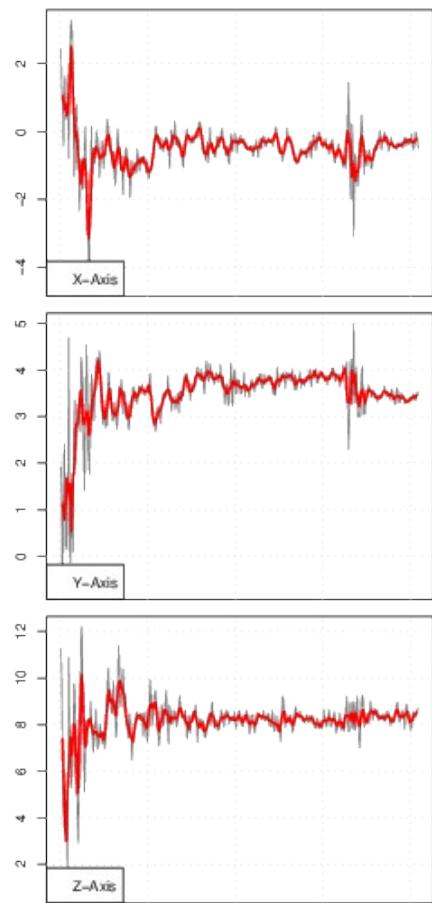
1. Calm?  
Very much



2. Anxious?  
Somewhat



Submit



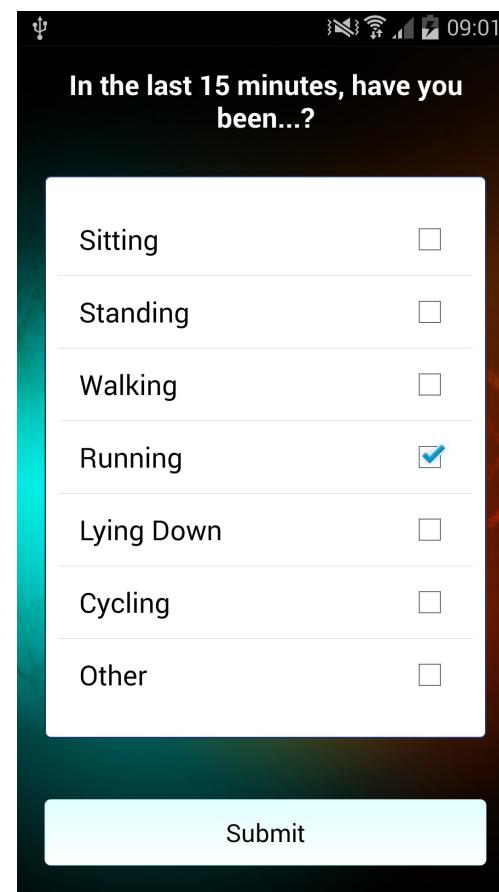
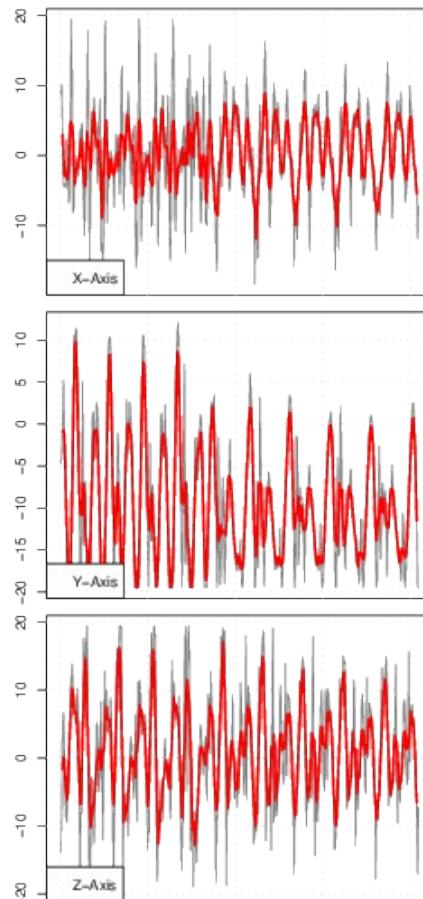
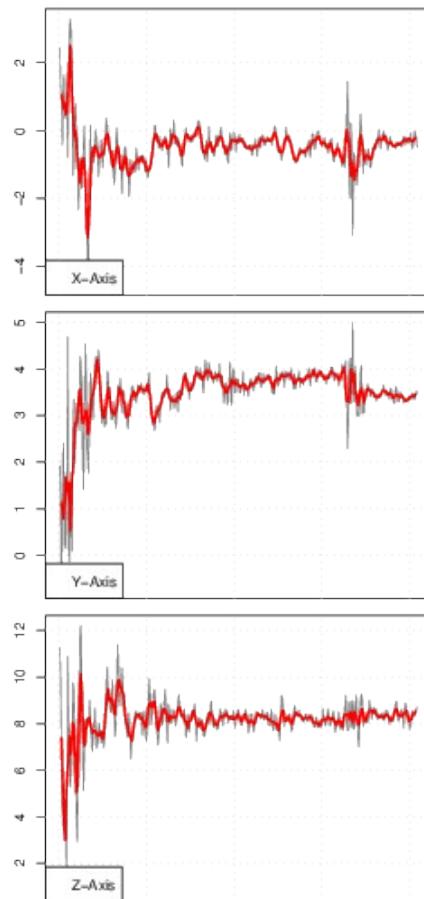
**Statistical**: mean, standard deviation, median, etc.

**Time**: auto-correlation, mean-crossing rate, etc.

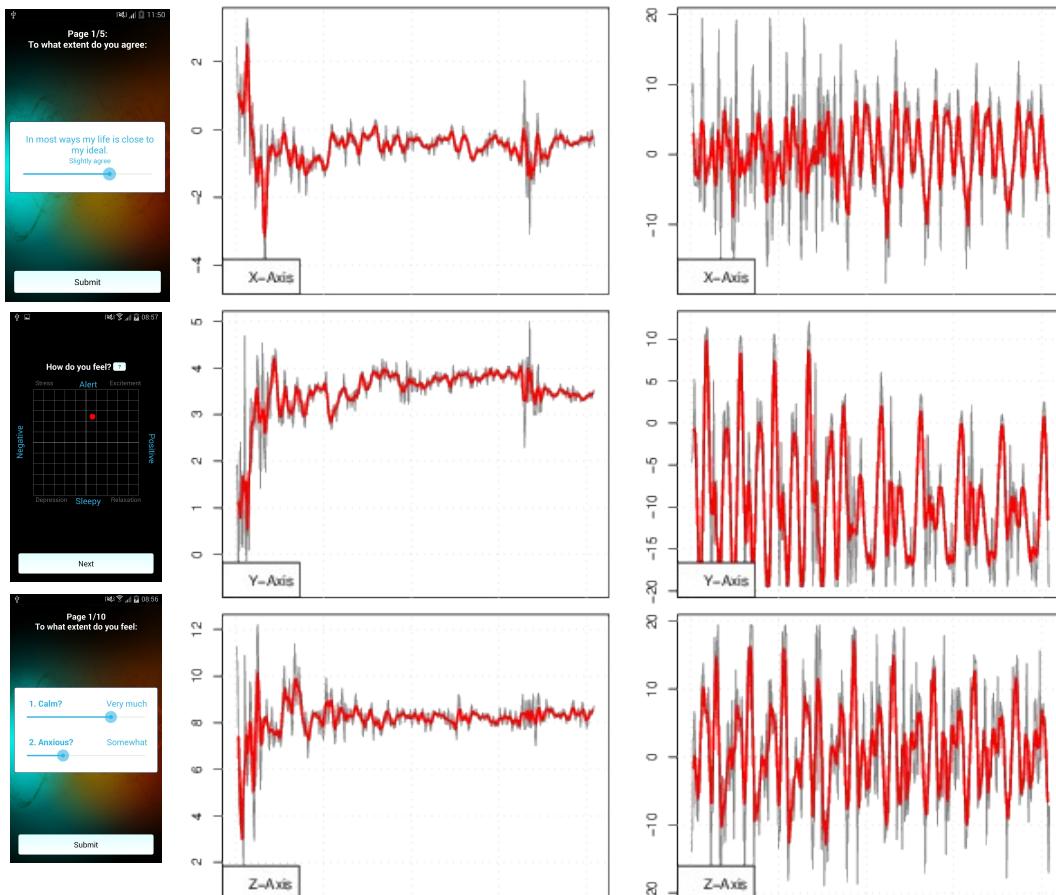
**Frequency**: FFT, spectral energy, etc.

**Peak**: volume, intensity, skewness, etc.

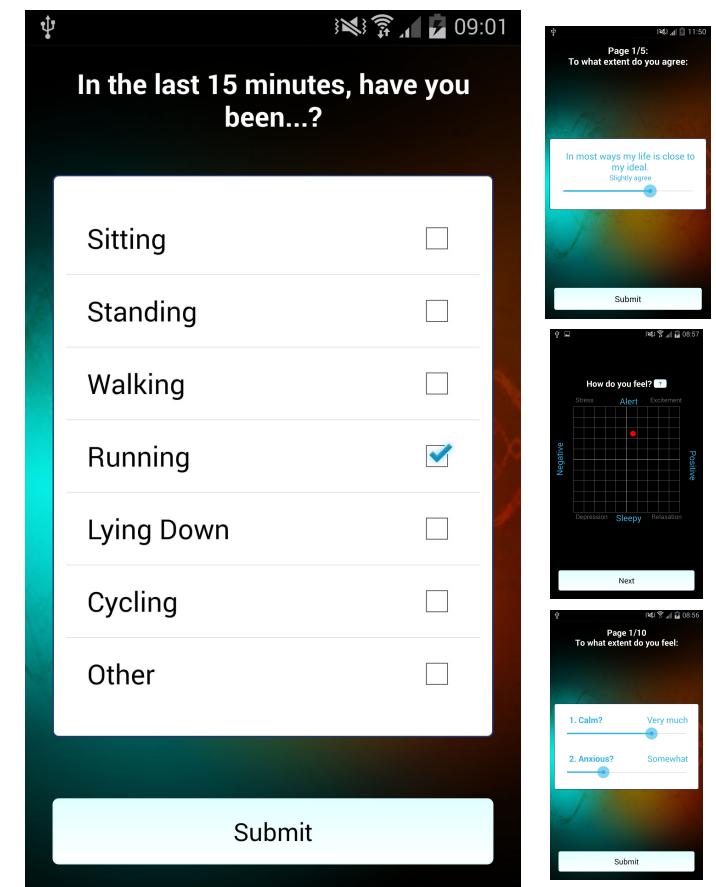
**Segment**: e.g., velocity change rate



$$r(24,201) = .37, p < .001 \quad d = .80$$

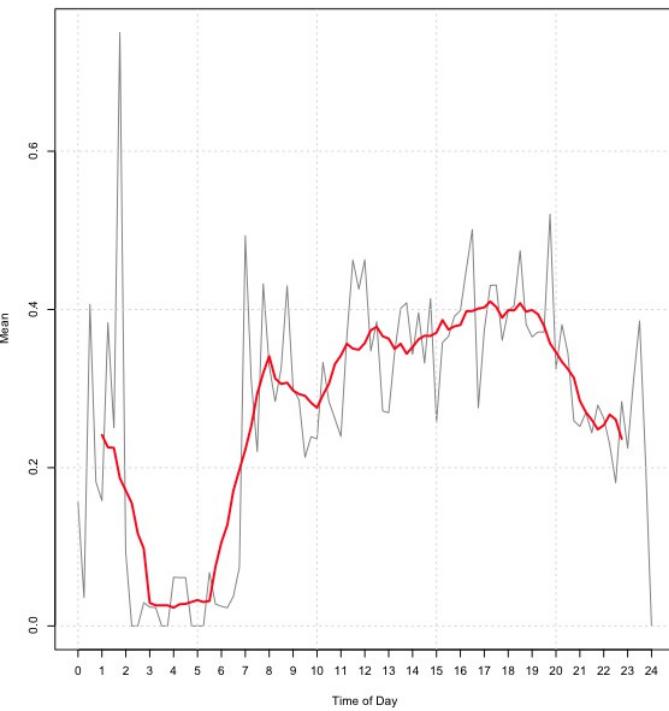


$$r(10,376) = .03, p < .001 \quad d = .07$$

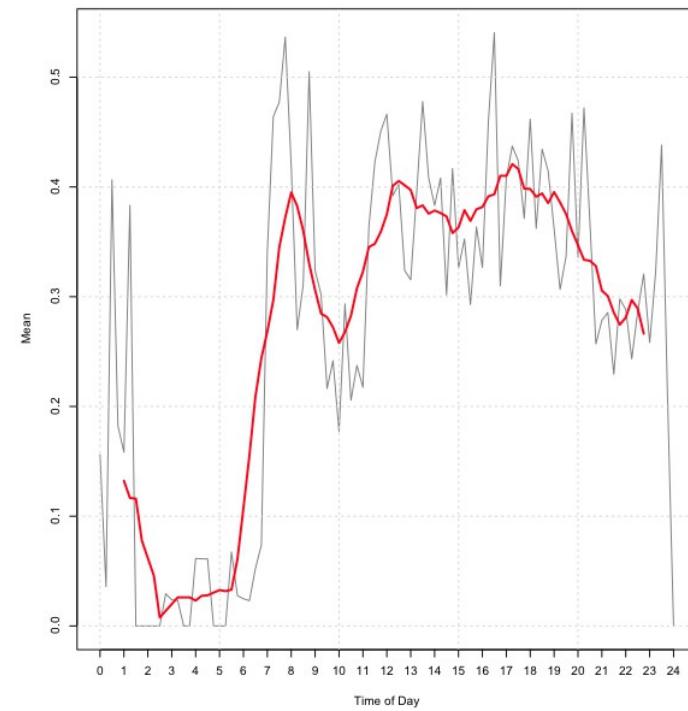


$$r(2,969) = .10, p < .001 \quad d = .19$$

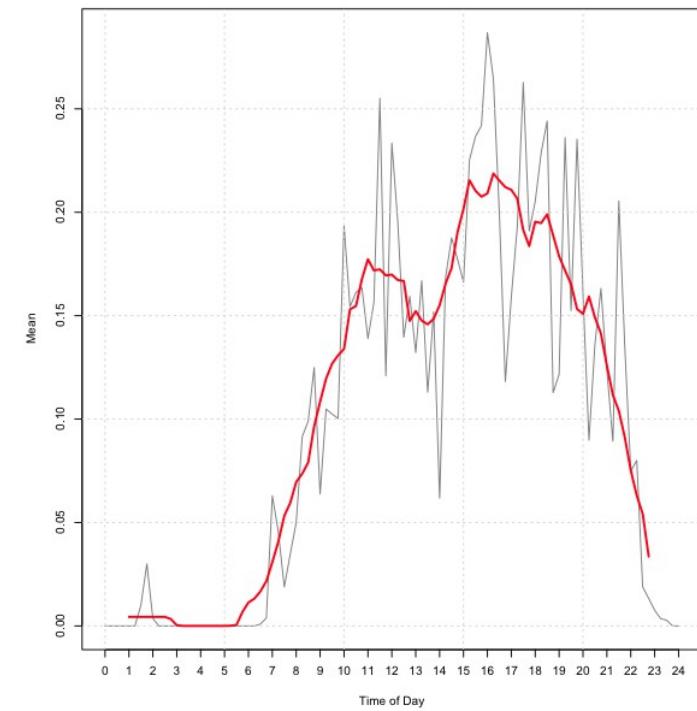
summary\_all\_axes\_sd.csv



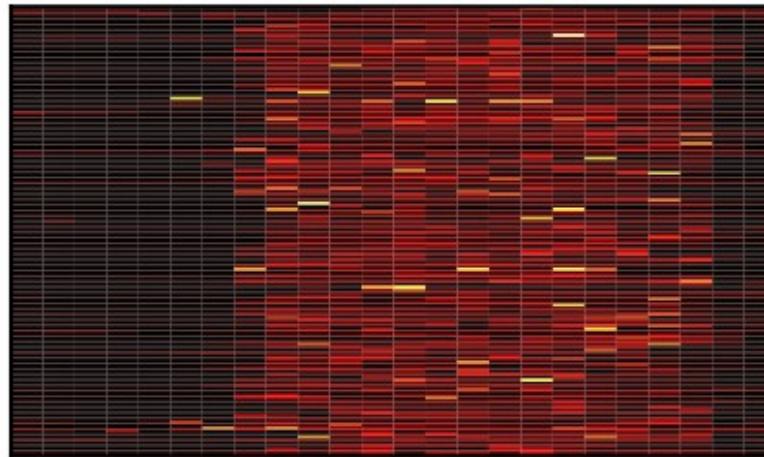
summary\_week\_day\_axes\_sd.csv



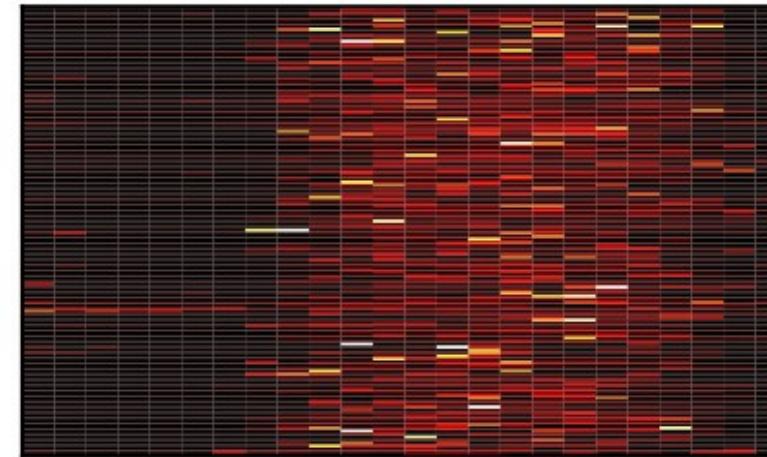
summary\_week\_end\_axes\_sd.csv



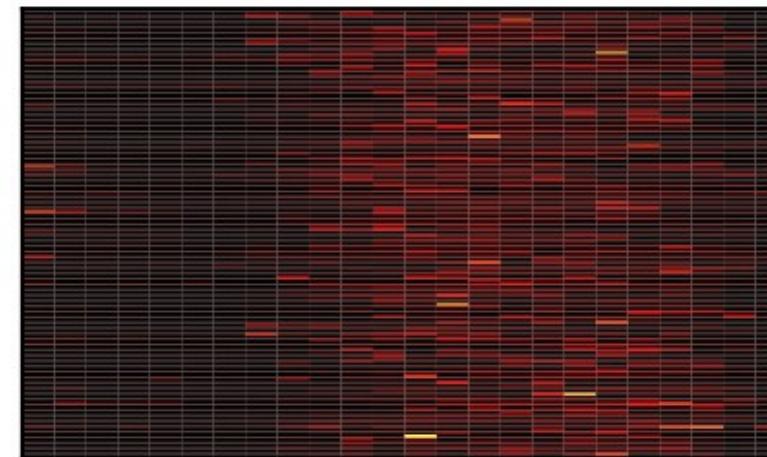
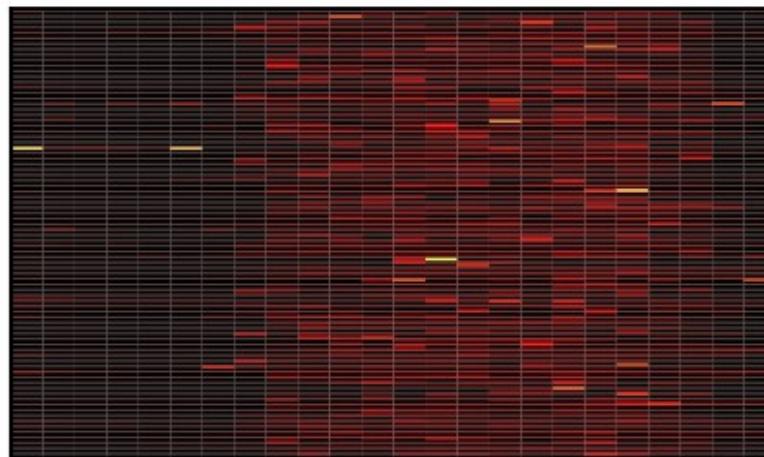
Weekday Sample



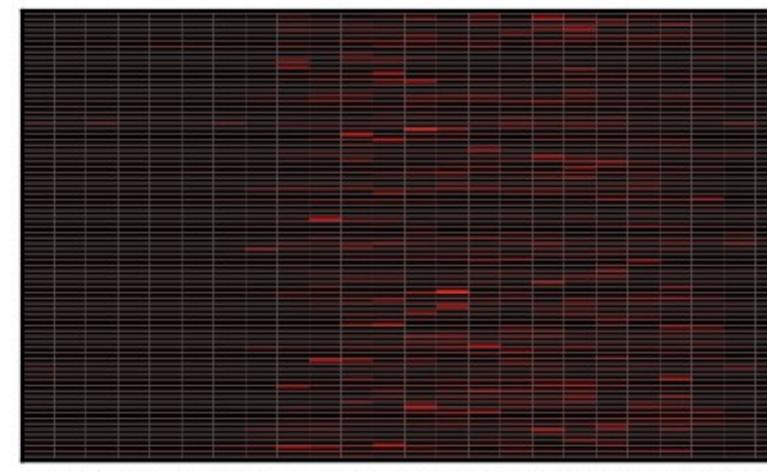
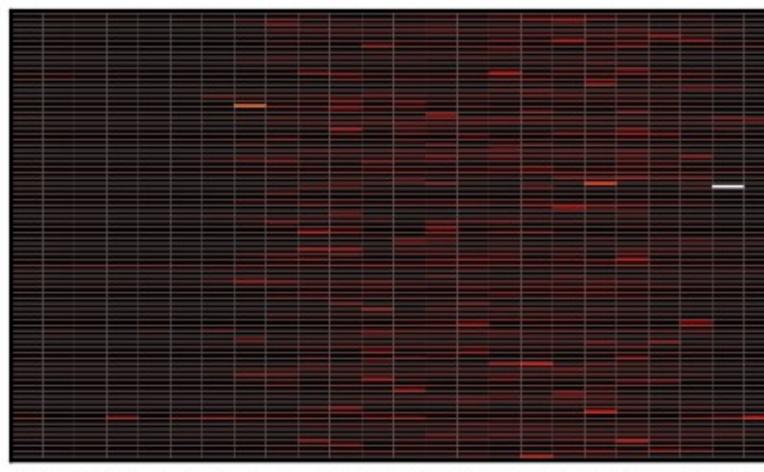
Weekend Sample



High Activity



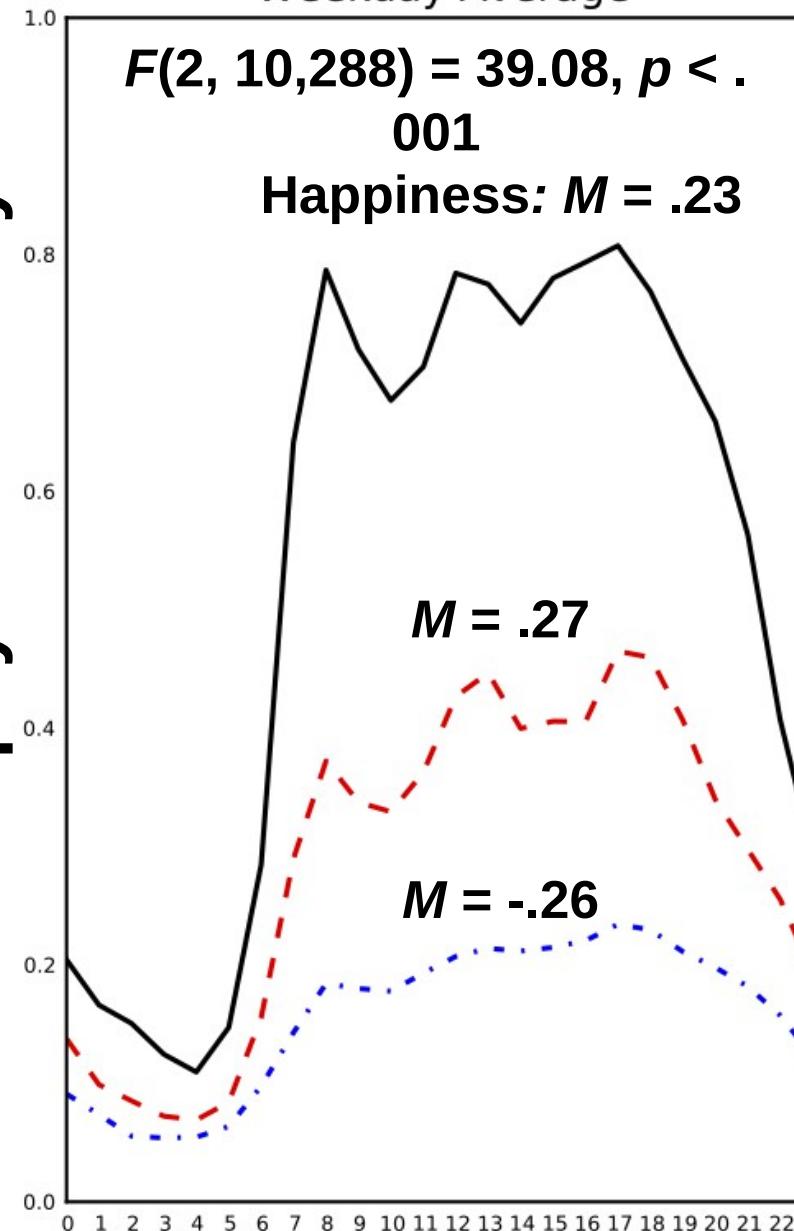
Low Activity



0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

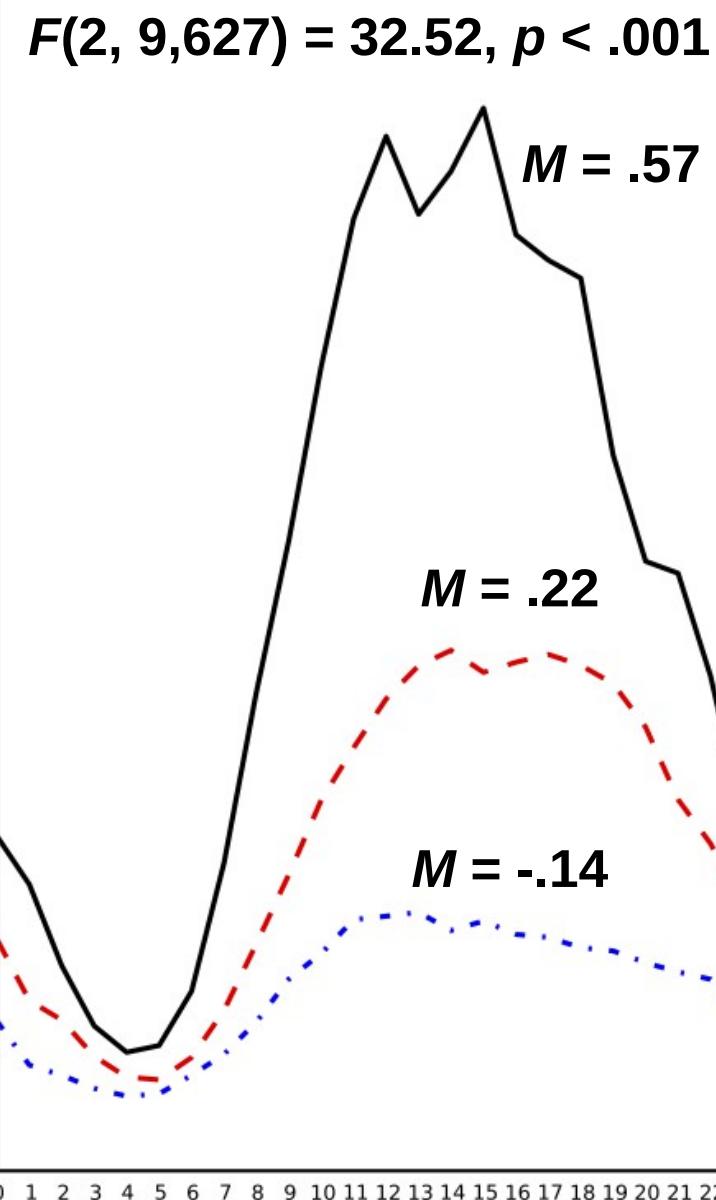
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Weekday Average



Hour of the Day

Weekend Average



Hour of the Day



*Jump to a Month*



# Health Experts Recommend Standing Up At Desk, Leaving Office, Never Coming Back

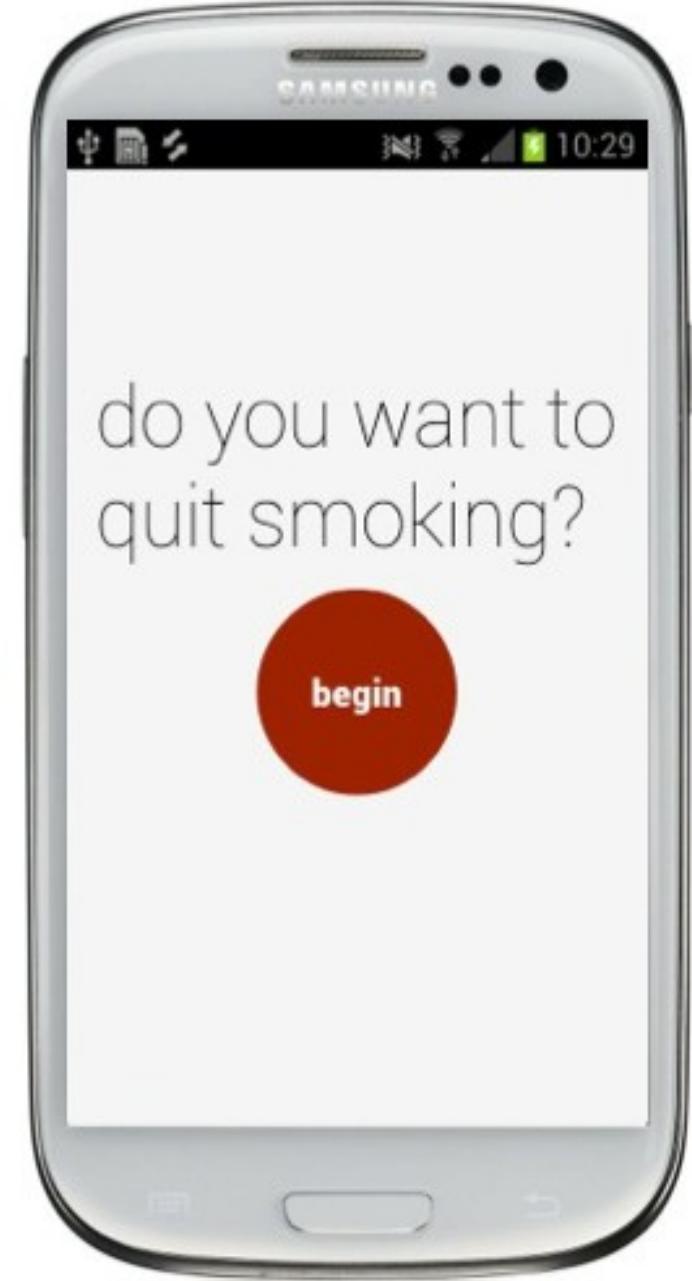
*February 6, 2015*



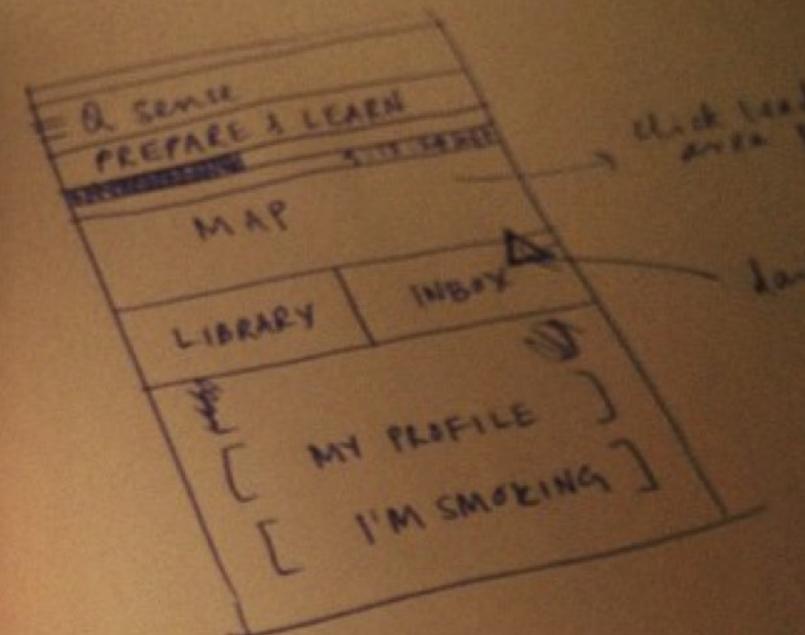
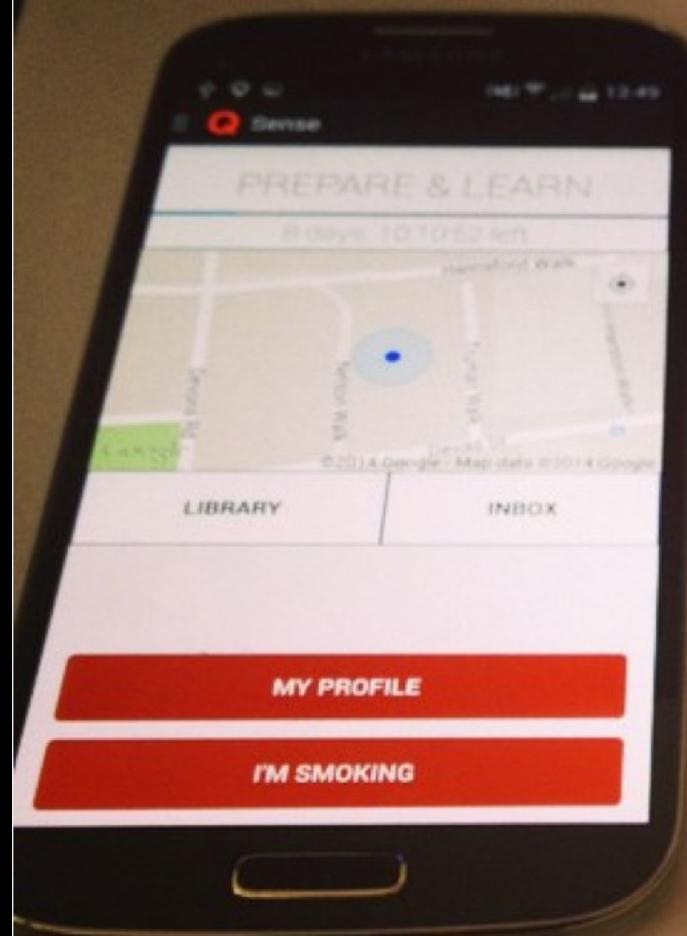
## Case 2: Smoking Cessation

Naughton et al. (in prep). *The feasibility of a context aware smoking cessation app (Q Sense): A mixed methods study.* 2015.

“cue-induced cravings: intense, episodic cravings typically provoked by situational cues associated with drug use [...] smokers exposed to smoking-related cues demonstrate increased craving [...]”



Ferguson, Shiffman. *The relevance and treatment of cue-induced cravings in tobacco dependence*. In J Subst Abuse Treat. April 2009.



16:54 21:01 11:07

Hello, neal.

PREPARE & LEARN  
20 days, 23:58:44 left.

My Profile I'm Smoking

Ok, Neal! The first stage is "Prepare & Learn."

Next

2/4: Cravings and Urges.

How strong was the urge to smoke just before you lit up?

Very Strong  
Slight Extremely Strong

Submit

22:00 MONDAY 15 SEPTEMBER, 2014 |   
Wi-Fi GPS Vibrate Screen rotation Bluetooth  
Notifications Clear  
Q Sense 22:00 How was your day today?  
EE

Nelson Walk Truman Walk Google

You have 40 reports in this area. Click below to explore your data.

Stress Levels Mood Levels Craving Levels Smoking Situations

08:51 08:57 08:56

Emotion Sense

EMOTIONSENSE

Click on 'Profile' to complete a Demographics survey!

Profile Emotions

How do you feel?

My Emotions ?

Time Of Day

Location SMS Patterns Accelerometer Phone Screen Microphone Call Patterns Personality Sociability

Survey Stats

Page 1/10 To what extent do you feel:

1. Calm? Very much  
2. Anxious? Somewhat

Submit

21:18 MONDAY 15 SEPTEMBER, 2014 |   
Wi-Fi GPS Vibrate Screen rotation Bluetooth  
Ongoing  
Connected as a media devi.. Touch for other USB options.  
Notifications Clear  
e Emotion Sense 21:11 How do you feel?  
vodafone UK

Time Of Day

Alert Stress Excitement

Negative Positive

Depression Sleepy Relaxation

Data: Last 30 days.

Colours

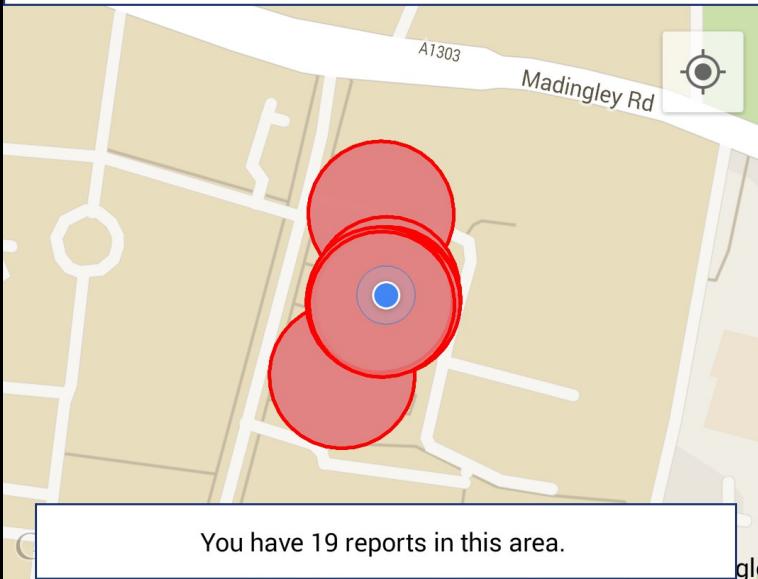


16:35

☰ Q Sense

## PREPARE & LEARN

5 days, 7:24:23 left.



LIBRARY

INBOX

MY PROFILE

I'M SMOKING

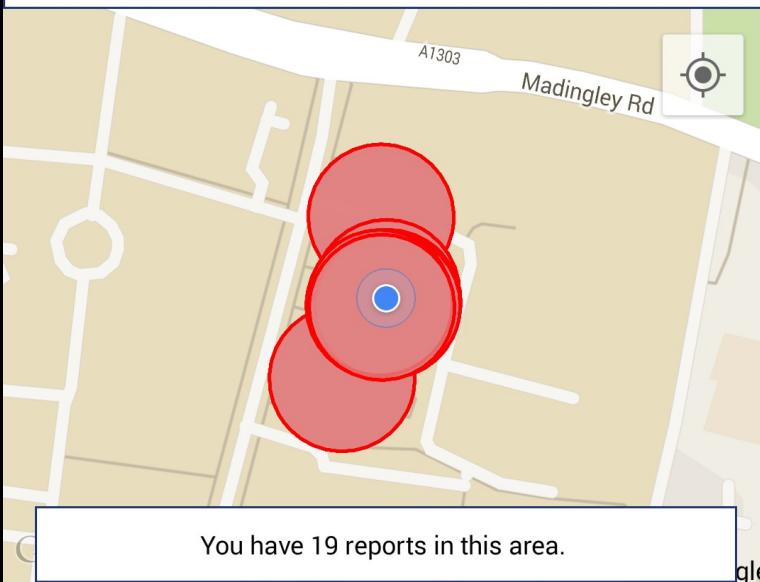


16:35

☰ Q Sense

## PREPARE & LEARN

5 days, 7:24:23 left.

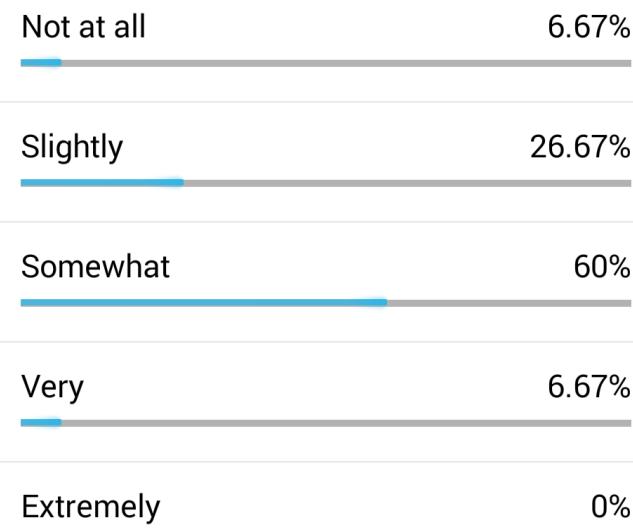
[LIBRARY](#)[INBOX](#)[MY PROFILE](#)[I'M SMOKING](#)

16:36

## Stress Levels

Your ratings for how stressed you felt just before smoking.

Based on your reports, stress seems to be part of why you smoke.



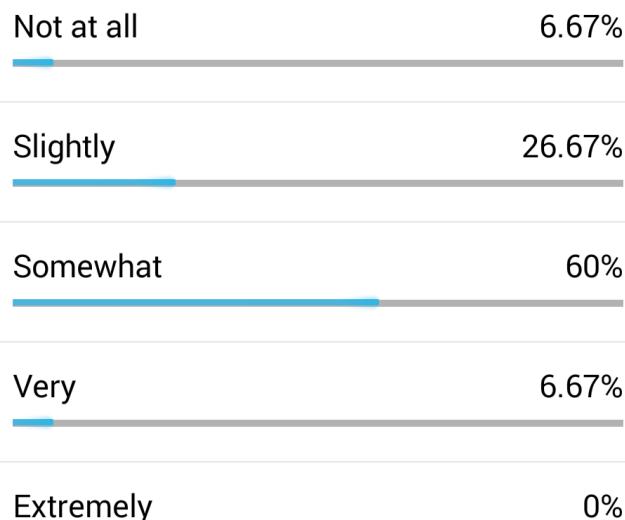


16:36

## Stress Levels

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Based on your reports, stress seems to be part of why you smoke.



# Stress, Depression, Urges, Situation, Social (Other Smokers).

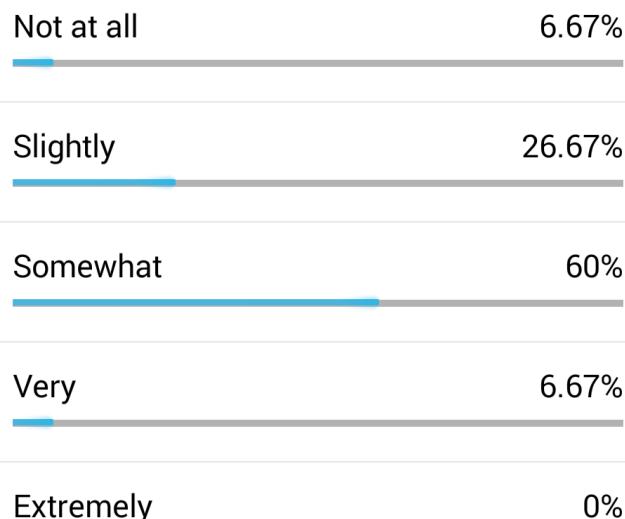


16:36

## Stress Levels

Your ratings for how stressed you felt just before smoking.

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## Stress, Depression, Urges, Situation, Social (Other Smokers).

### MAKE LIFE EASIER

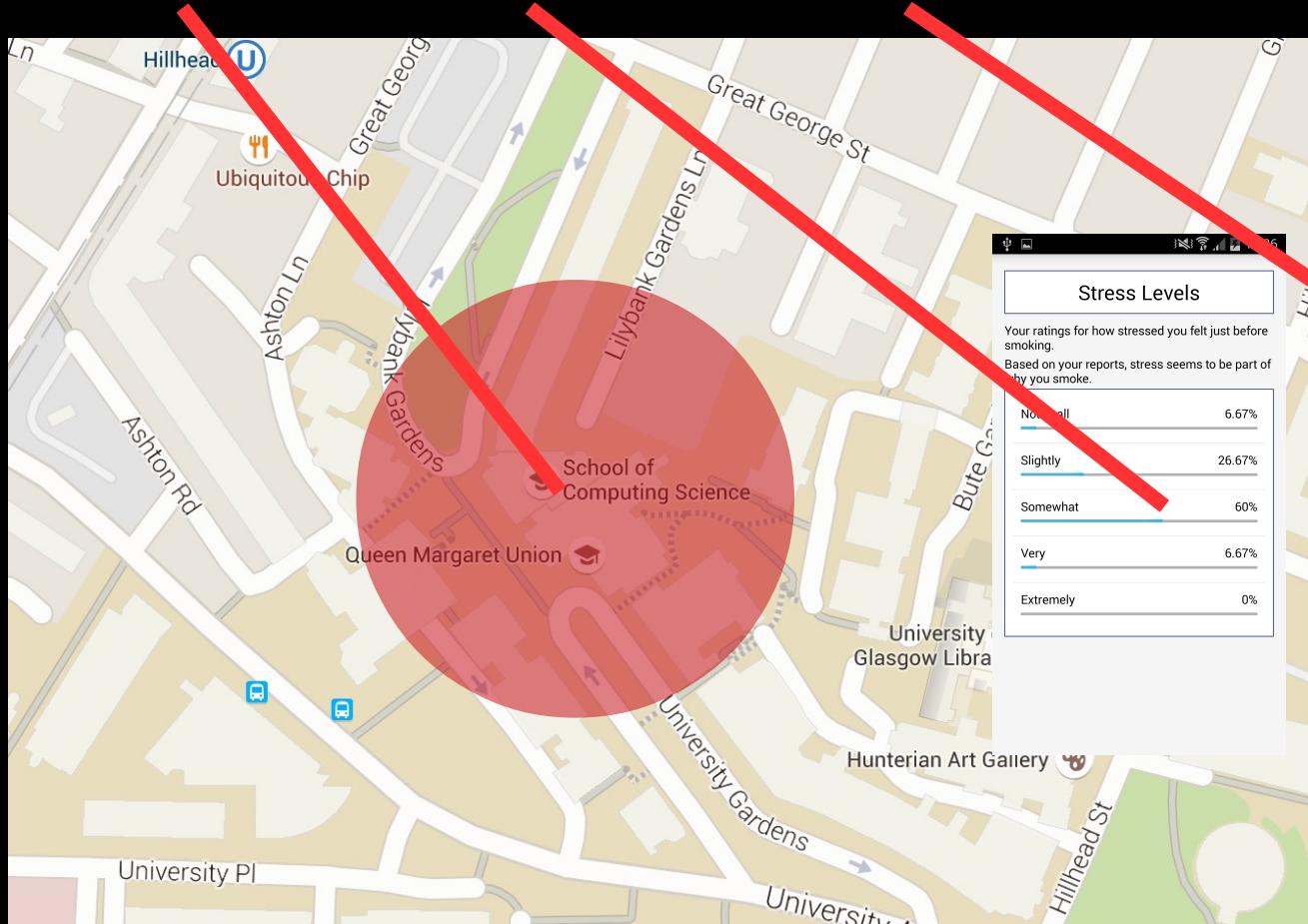
Quit tip - when you start your quit attempt make life easier by replacing your smoking routines e.g. try chewing gum or mints instead of smoking when socialising.

18 Dec 2014 16:30:28



# EXAMPLE

Your location + your profile = tailored support



16:36

Inbox

BODY CHANGES

What research has found: After you stop smoking, your body will retain more caffeine after you drink tea, coffee etc. due to changes in your metabolism. So go easy on the caffeinated drinks at first, especially at night!

19 Jan 2015 15:44:40

★★★★★

YOU REPORTED SMOKING

You reported feeling "somewhat" stressed.

19 Jan 2015 15:43:33

DID YOU KNOW?

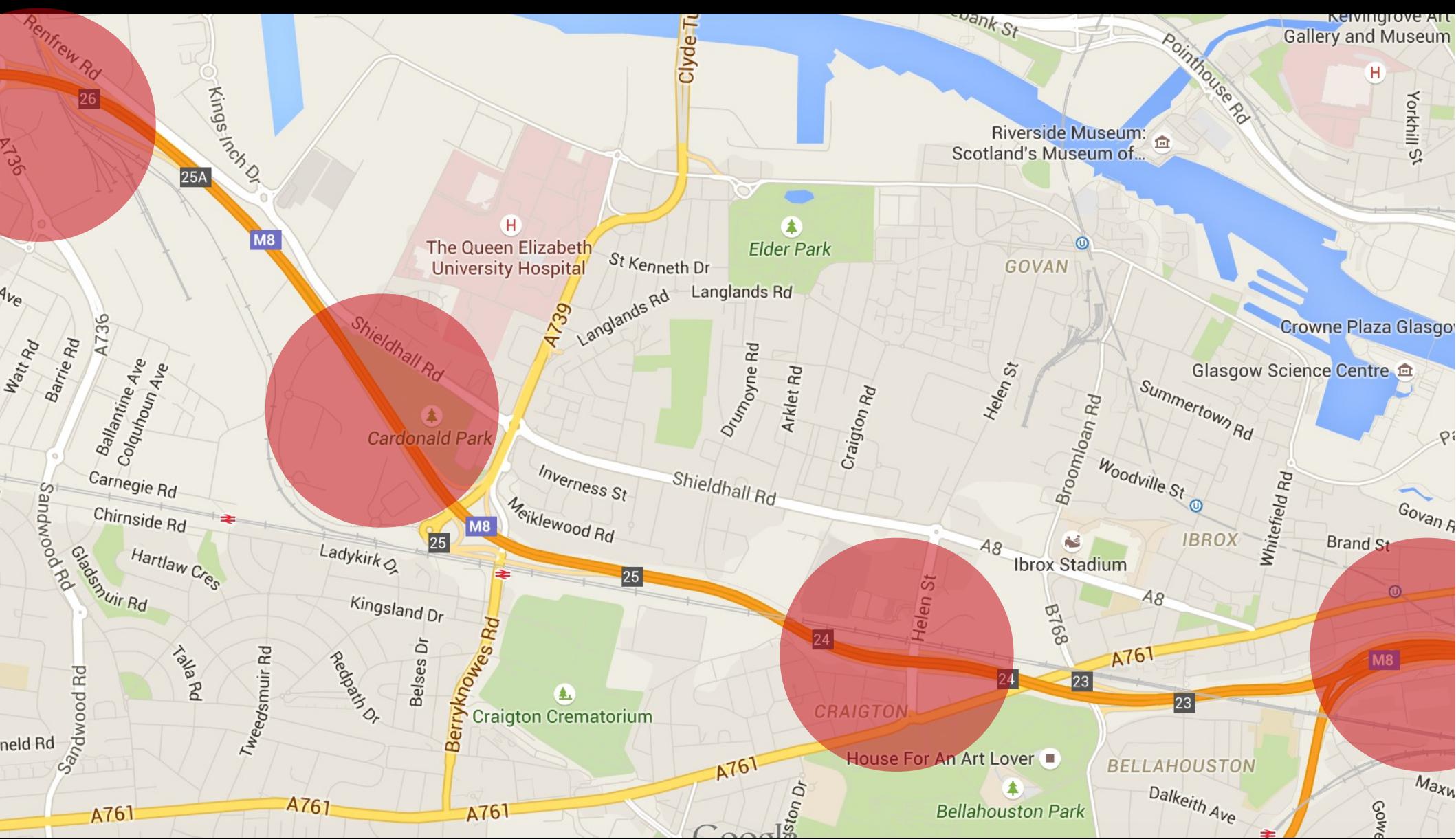
13.0% of your 78 reports are after 6:00pm.

19 Jan 2015 15:32:52

★★★★★

**SCIENCE**

STEAM





08:57



16:36

## My Emotions ?

View

### Time Of Day

Location

SMS Patterns

Accelerometer

Phone Screen

Microphone

Call Patterns

Personality

Sociability

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Survey Stats

## Inbox

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19 Jan 2015 15:44:40



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19 Jan 2015 15:43:33

### DID YOU KNOW?

13.0% of your 78 reports are after 6:00pm.

19 Jan 2015 15:32:52





08:57



16:36

## My Emotions ?

View

### Time Of Day

Location

SMS Patterns

Accelerometer

Phone Screen

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### YOU REPORTED SMOKING

You reported feeling "somewhat" stressed.

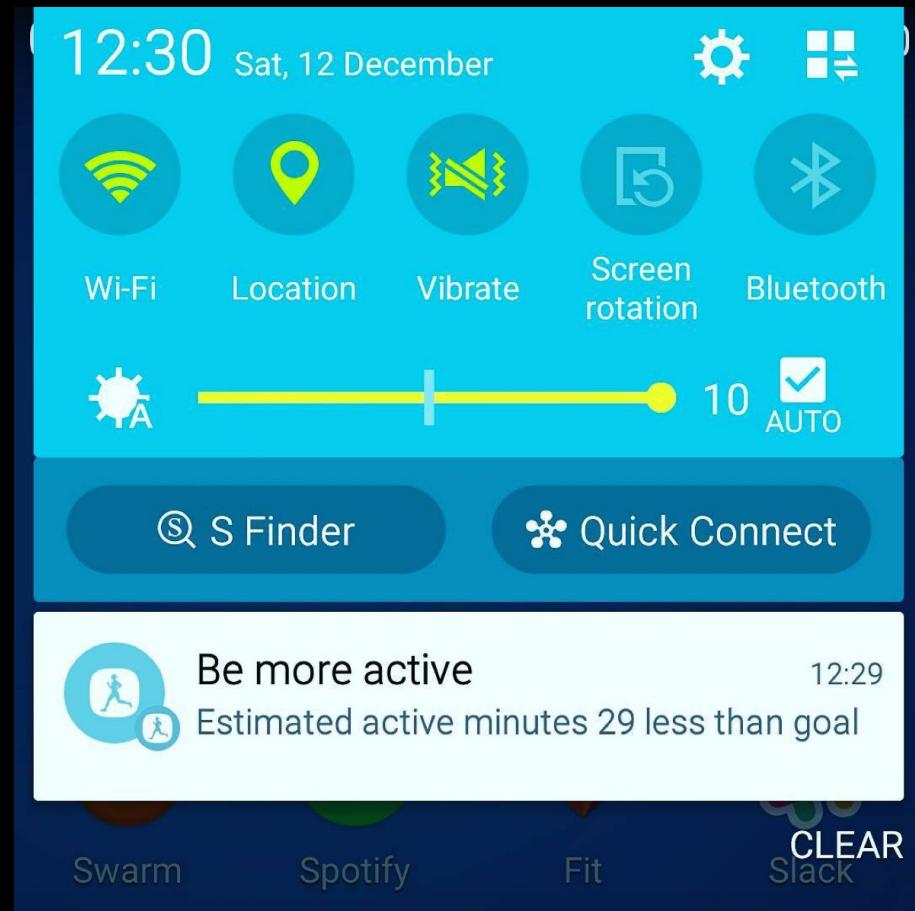
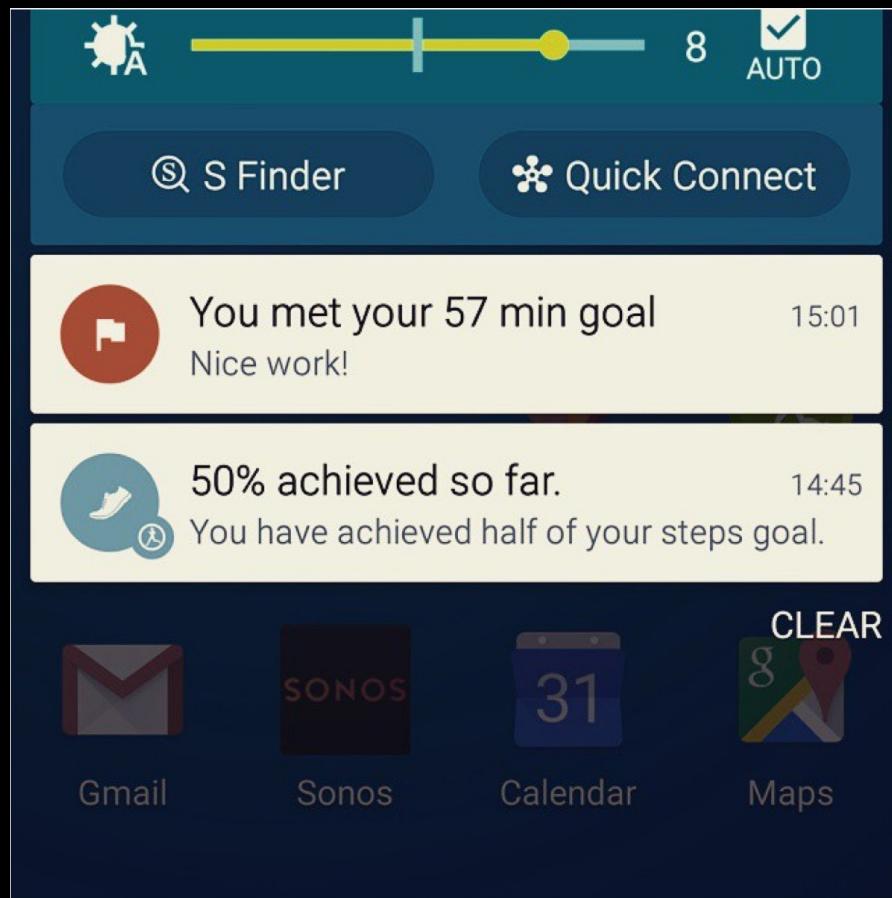
19 Jan 2015 15:43:33

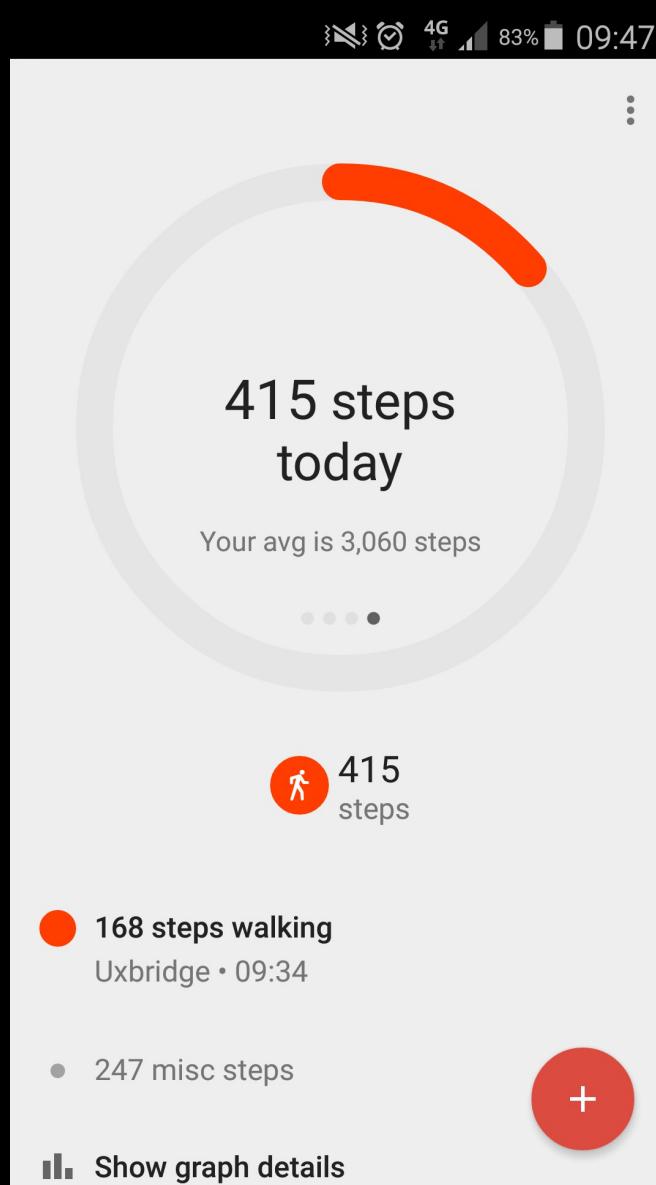
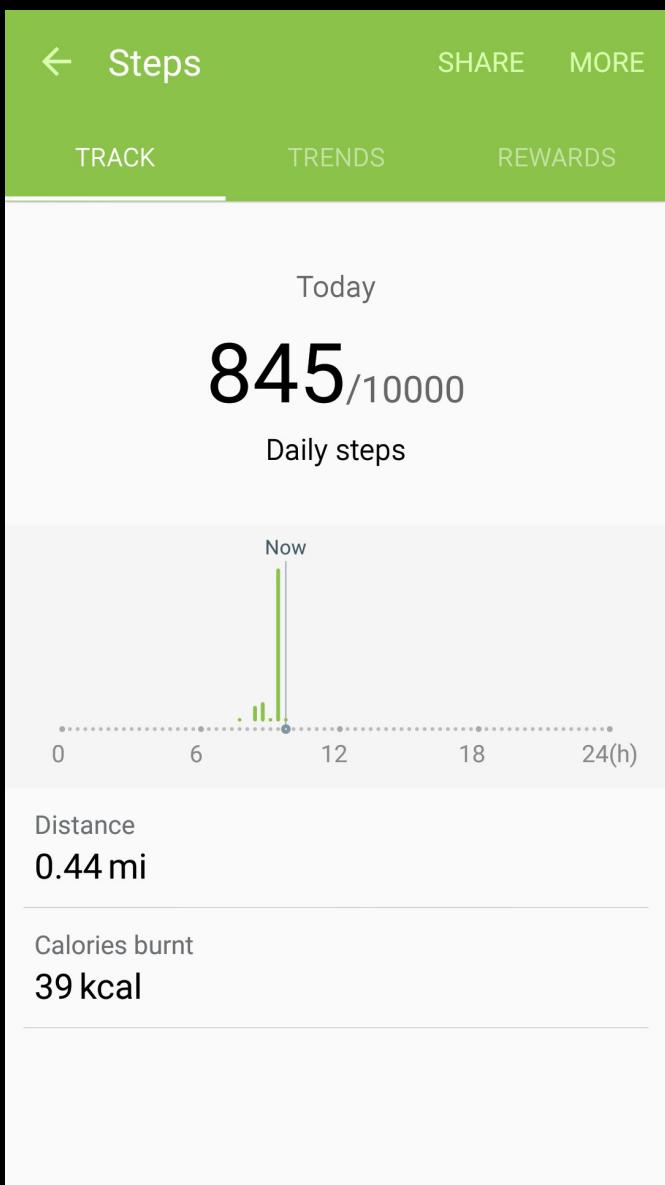
### DID YOU KNOW?

13.0% of your 78 reports are after 6:00pm.

19 Jan 2015 15:32:52



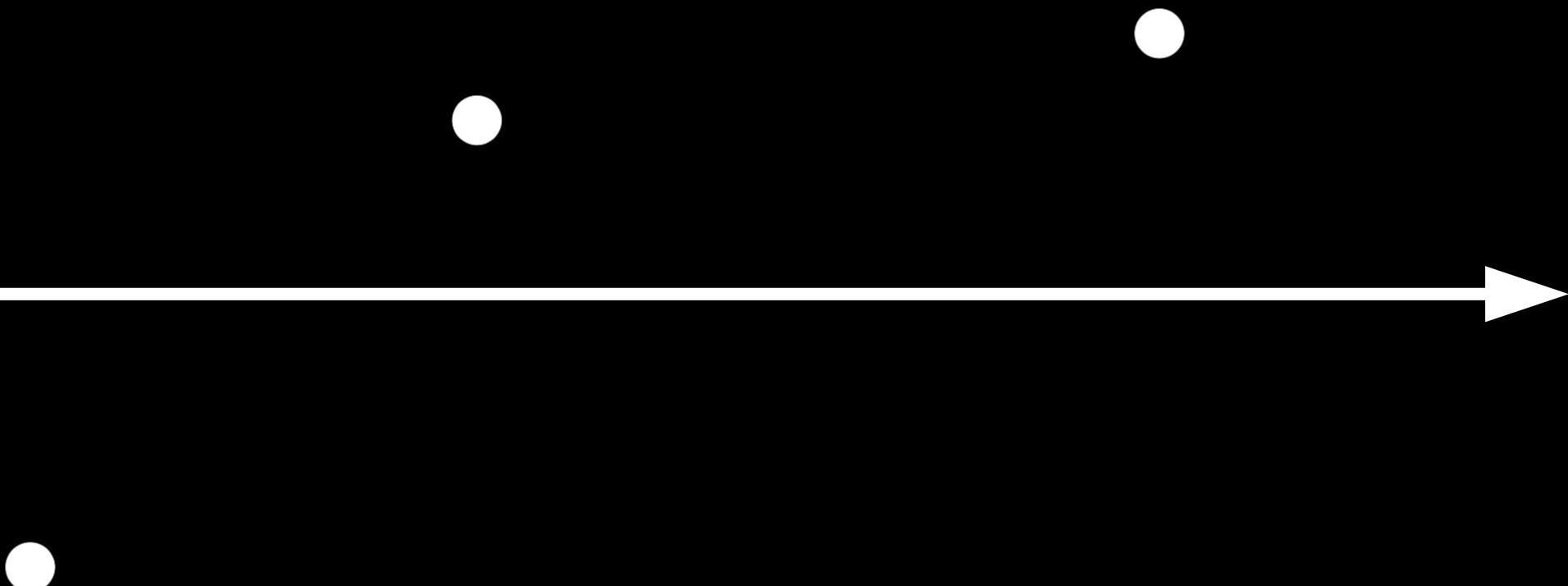




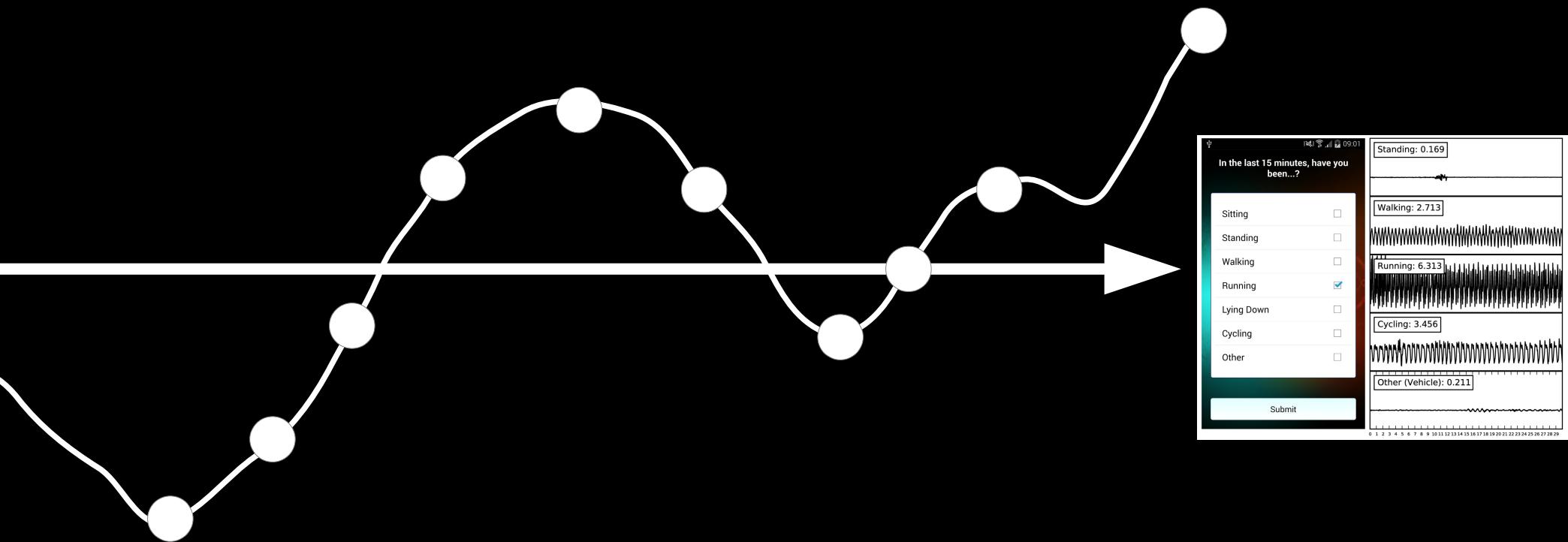
Day view Steps

Sat 14 Nov	10,216 steps
	10,216 steps
● Cycling	20:38
● 535 steps walking	Puerto Vallarta • 20:00
● 379 steps walking	Puerto Vallarta • 19:26
● 277 steps walking	Puerto Vallarta • 18:20
● 726 steps walking	Puerto Vallarta • 17:17
● 546 steps walking	Puerto Vallarta • 08:43

## Current health monitoring methods:



# Smartphones



# Happier and Healthier.. with Smartphone Data

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Cambridge Science Festival

