Understanding Self-Reflection: How People Reflect on Personal Data through Visual Data Exploration

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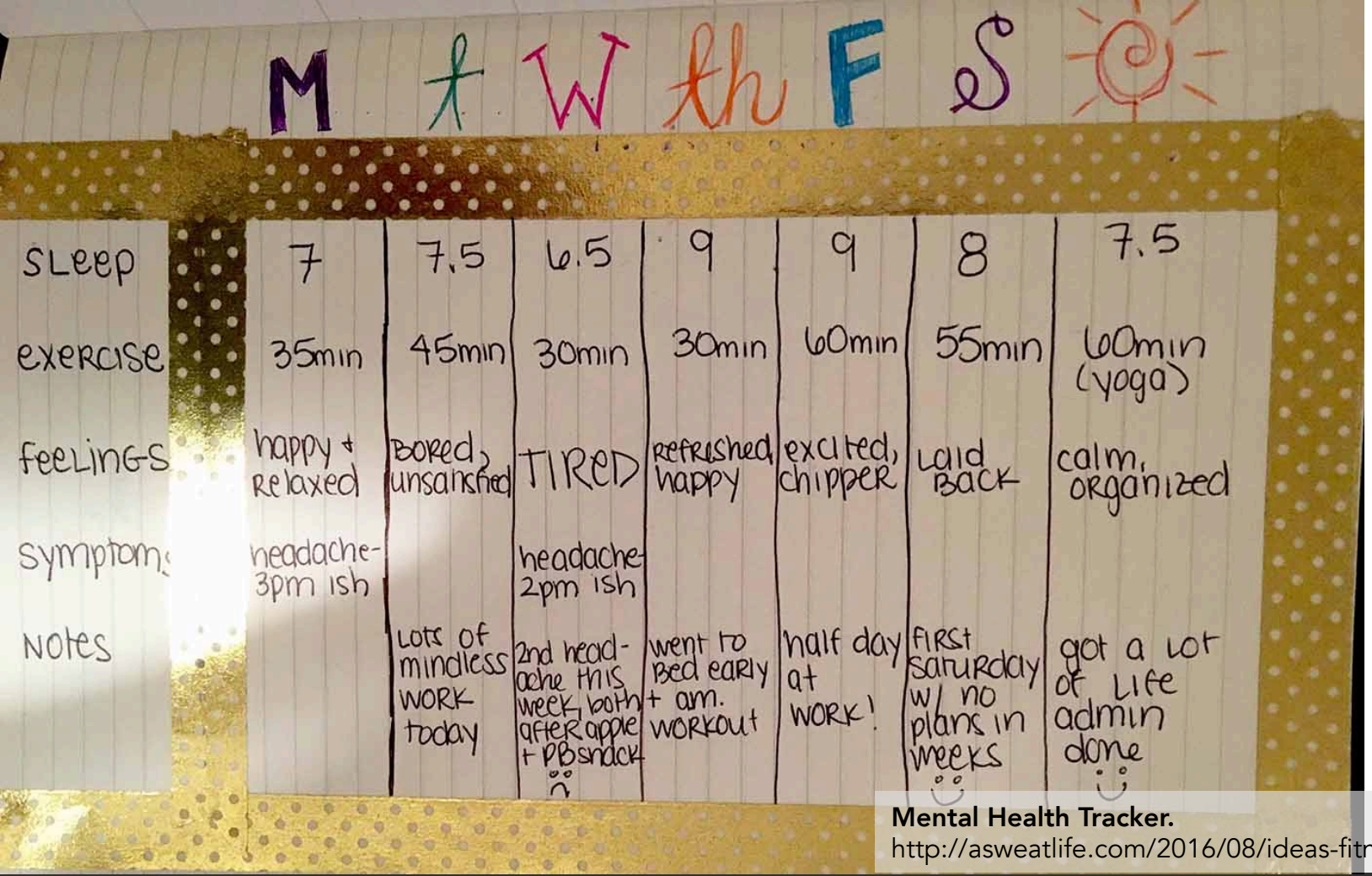
Self-monitoring

An activity of recording one's own behaviors, thoughts, or feelings

[**Kopp, J.** (1988) Self-monitoring: A literature review of research and practice]

Self-monitoring from the 19th century

Public scales from the late 1880s in contemporary Paris (from Crawford 2015)



Mental Health Tracker.
http://asweatlife.com/2016/08/ideas-fitness-bullet-journal/


12:58
NOV 27
86


102
Avg. Resting:
66
GARMIN


08:16


10:09
2:00–3:30PM
Coffee with Nisha
Central garden


LB
164.5
Withings

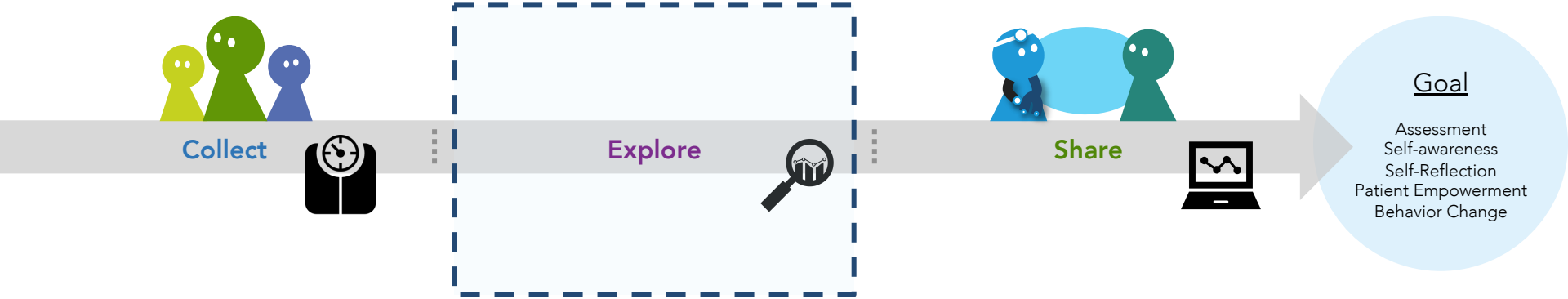

Sleep
Saturday 16.08
DURATION
GOAL
9:07
IN BED
8:35
OF SLEEP
107
%
8 HOURS
BREAKDOWN OF YOUR NIGHT
AWAKE
REM
LIGHT
DEEP

Promises

External measurement to self-knowledge

Self-knowledge to self-improvement?

Human-Data Interaction for Self-Monitoring

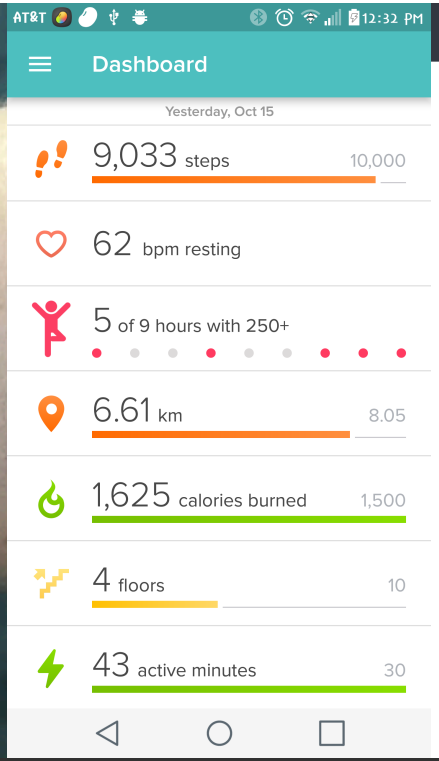


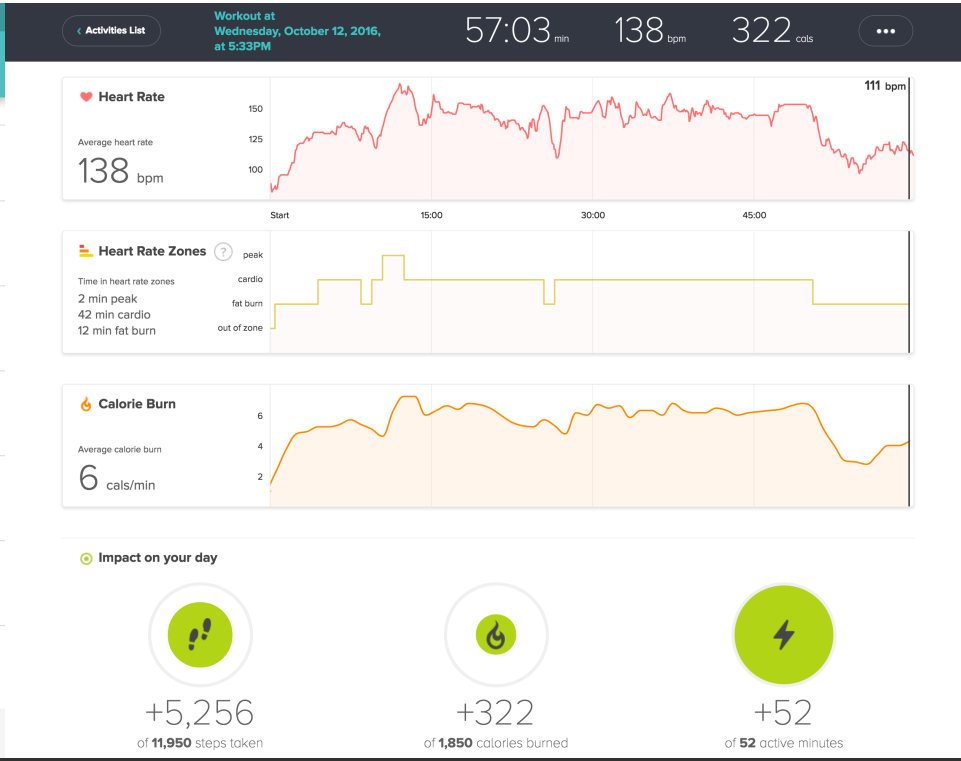
Fawcett (2015)

data exploration and analytics capabilities for personal data analysis **“remain surprisingly primitive, leaving the analytical heavy lifting to the end user”**…

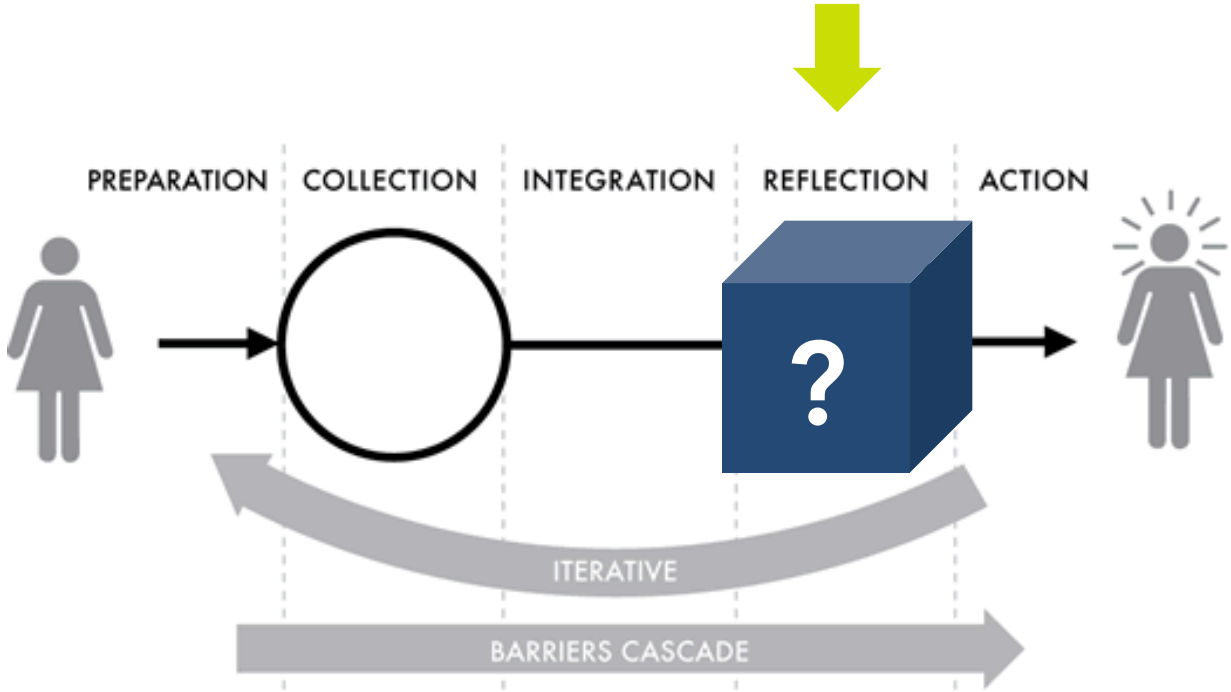
Mining the quantified self: personal knowledge discovery as a challenge for data science. [Big Data 2015]

Personal data visualization





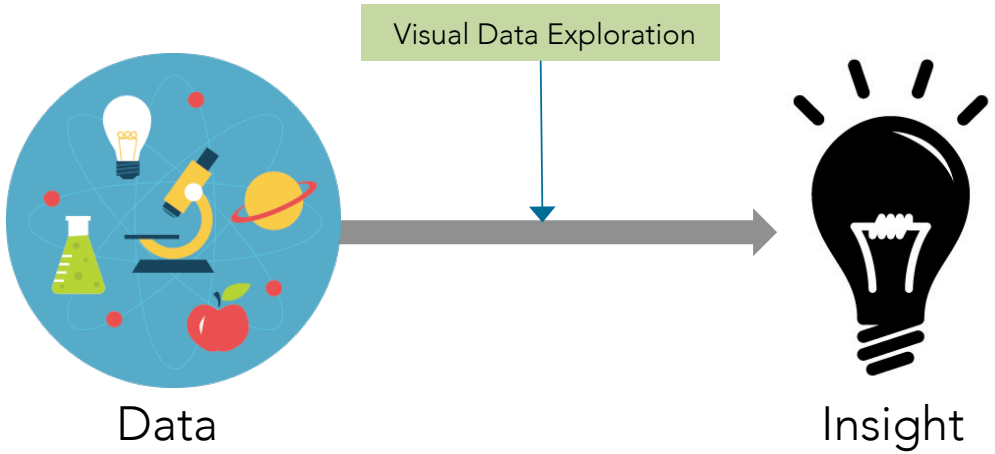
Stage-based model of PI



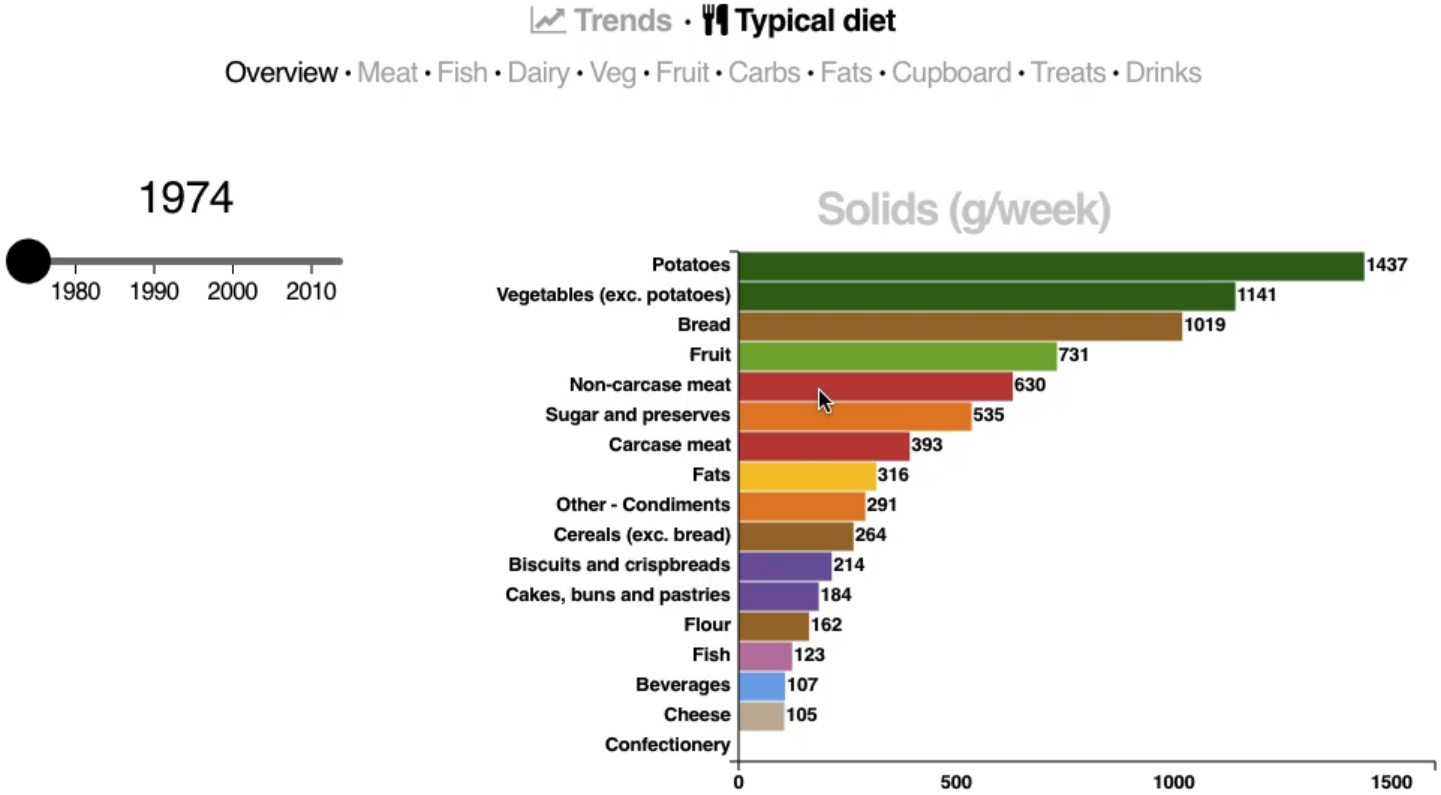
Li, Dey, & Forlizzi. (2010)

Visual data exploration

Powerful way to help people reveal meaningful insights about themselves and to facilitate self-reflection



The British Diet http://britains-diet.labs.theodi.org/

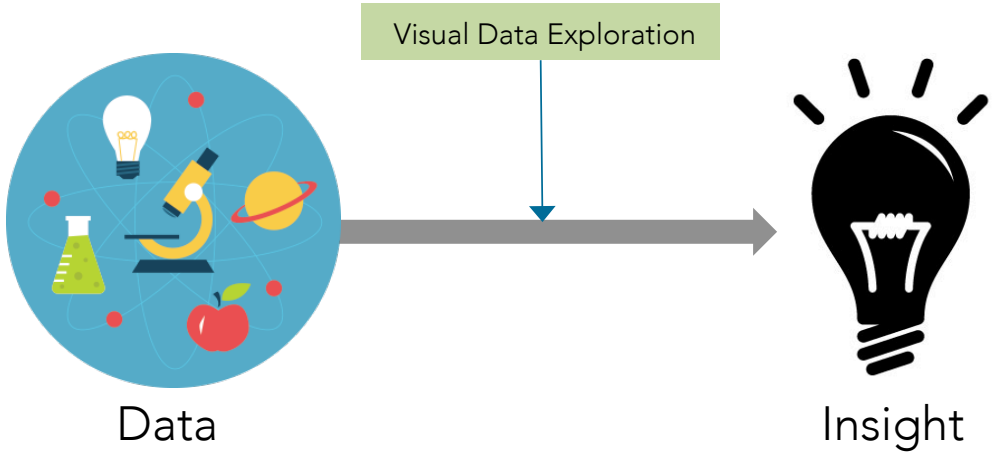


Limited support for data exploration

- Scattered data across multiple platforms (Li et al., 2011; Choe et al., 2014.)
- Don’t know what to do with the data (Choe et al., 2014; Epstein et al., 2015; Lazar et al., 2015.)
- Difficult to translate questions into data attributes (Grammel et al., 2010; Huang et al., 2015.)
- Difficult to construct visualizations (Grammel et al., 2010; Huang et al., 2015.)

Research questions

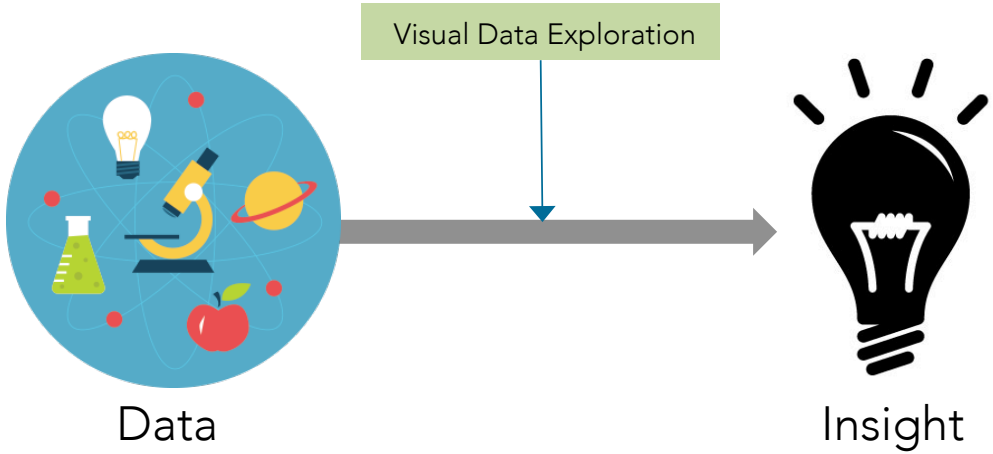
RQ1: How do people reflect on their self-tracking data? (Process)



Research questions

RQ1: How do people reflect on their self-tracking data? (Process)

RQ2: What insights do people gain from visual data exploration? (Outcome)



Insights

A key purpose of visualization Card et al., 2005

"An individual observation about the data by the participant, a unit of analysis" Saraiya et al., 2005

Characteristics of insights North, 2006

Insight gaining process Yi et al., 2008

Types of personal insights

[IEEE CG&A 2015]

Personal Visualization and Personal Visual Analytics

Characterizing Visualization Insights from Quantified Selfers' Personal Data Presentations

Eun Kyoung Choe ▪ *Pennsylvania State University*

Bongshin Lee ▪ *Microsoft Research*

m.c. schraefel ▪ *University of Southampton*

As a result of advances in self-monitoring technology and the prevalence of low-cost

as creating a line chart with two lines to convey a correlation), and they sometimes present insights

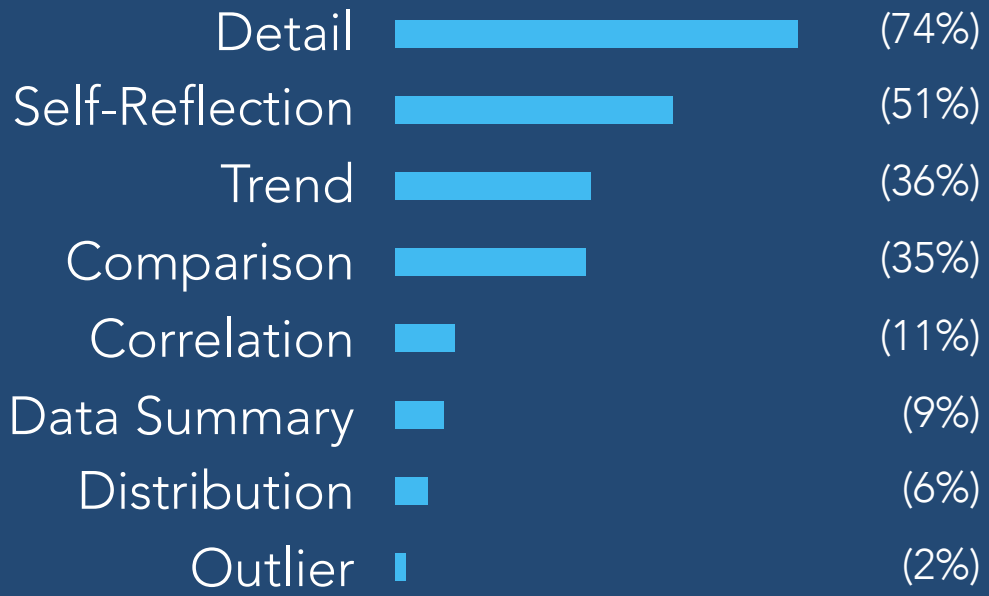
Eun Kyoung Choe

Bongshin Lee

m.c. schraefel

30 video recordings of QS presentations

Visualization Insights

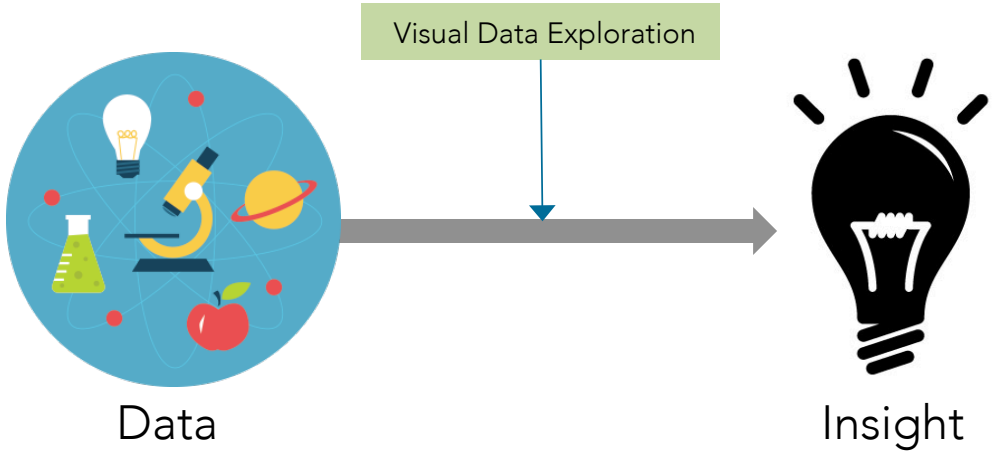


Characterizing Visualization Insights from Quantified Selfers' Personal Data Presentation. [CG&A 2015]

Research questions

RQ1: How do people reflect on their self-tracking data? (Process)

RQ2: What insights do people gain from visual data exploration? (Outcome)



Visualized Self

Data Sources

Calories from: 03/12/10 03/29/16
Heartrate from: 06/25/15 03/29/16
Sleep from: 06/26/15 03/28/16
Steps from: 04/10/15 03/29/16
Weight from: 03/10/10 03/29/16

Data Summary

Overall		Selected		Fitbit		Moves	
Dates:	04/10/2015 - 03/29/2016	Dates:	02/27/2016 - 03/29/2016	Dates:	02/27/2016 - 03/29/2016	Dates:	02/27/2016 - 03/29/2016
Range:	6.0 - 27488.0	Range:	14.0 - 12479.0	Range:	73.0 - 12479.0	Range:	14.0 - 8175.0
Average:	4870.5	Average:	3184.8	Average:	5073.0	Average:	2046.3
Total:	1724140.5	Total:	98729.0	Total:	121752.0	Total:	63436.0

Visualization

Line
1d 1w 1m 6m 1y all
Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016
Steps (steps)
12,479
12,000
10,000
8,000
6,000
4,000
2,000
0
02/28/2016 03/01/2016 03/04/2016 03/06/2016 03/09/2016 03/11/2016 03/14/2016 03/17/2016 03/19/2016 03/22/2016 03/24/2016 03/27/2016 03/29/2016

Design Rationales

1. Support data exploration for the general public

Design Rationales

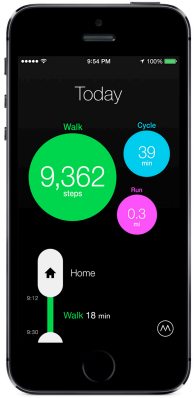
2. Design for a personal data context

Data integration from multiple sources

RescueTime

runkeeper

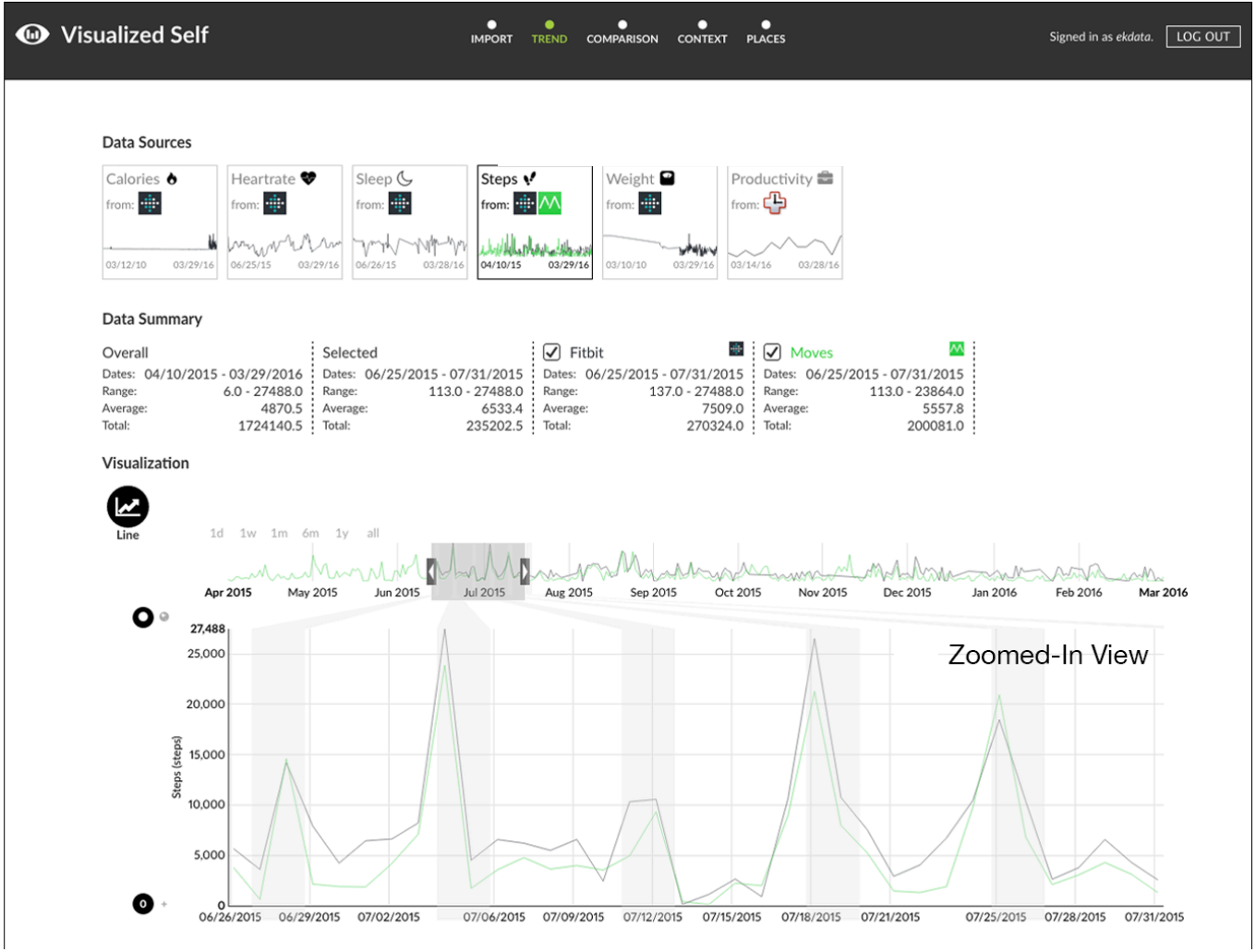
Moves

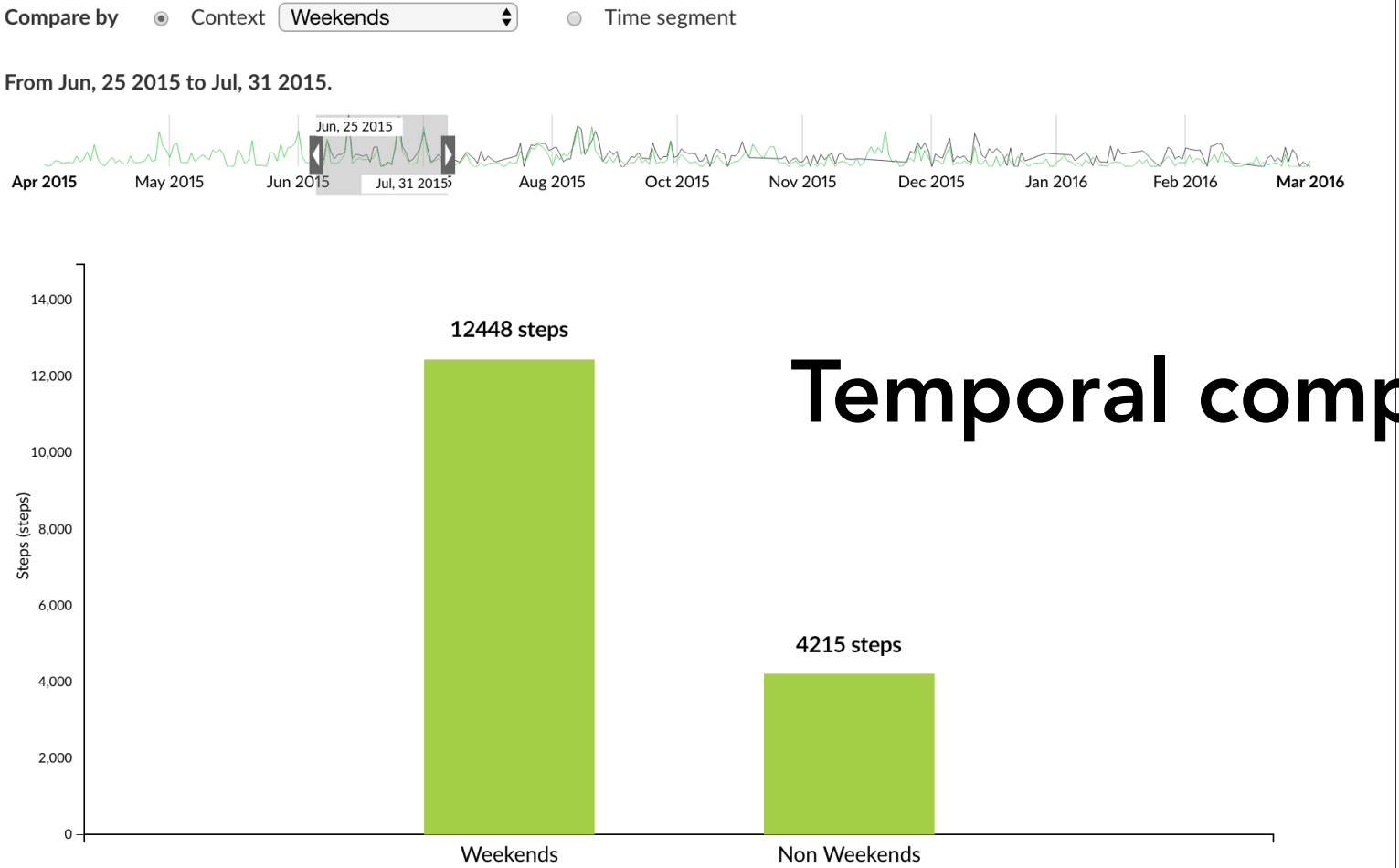


Data import


Fitbit Last sync: 5 hours ago.
Steps (steps)
min 6
max 27488
avg 6522
Collected: 223 days.
Walk
Calories (burn)
min 475
max 2483
avg 1170
Collected: 2210 days.
Sleep
Minutes asleep
min 72
max 595
avg 380
Collected: 86 days.
Heartrate (bpm)
min 57.00
max 72.00
avg 64.3
Collected: 204 days.
Weight
Weight (kgs)
min 43.41
max 49.03
avg 46.4
Collected: 2212 days.
Badges
(undefined)
min 10
max 25000
Collected: 15 days.
Moves Last sync: 5 hours ago.
Steps (steps)
min 14
max 23864
avg 4030
Collected: 354 days.
Walk (meters)
min 475
max 1118
avg 712
Collected: 16 days.
Calories
RescueTime Last sync: 22 seconds ago.
Steps (steps)
min 14
max 23864
avg 4030
Collected: 354 days.
Productivity
(percent)
min 56.00
max 82.00
Collected: 15 days.
Band
Runkeeper
Instagram
Google Map
Facebook
Goodreads
CSV

Data summary


Visualized Self
IMPORT
TREND
COMPARISON
CONTEXT
PLACES
Signed in as ekdata.
LOG OUT
Data Sources
Calories
from:
03/12/10
03/29/16
Heartrate
from:
06/25/15
03/29/16
Sleep
from:
06/26/15
03/28/16
Steps
from:
04/10/15
03/29/16
Weight
from:
03/10/10
03/29/16
Productivity
from:
03/14/16
03/28/16
Data Summary
Overall
Dates: 04/10/2015 - 03/29/2016
Range: 6.0 - 27488.0
Average: 4870.5
Total: 1724140.5
Selected
Dates: 06/25/2015 - 07/31/2015
Range: 113.0 - 27488.0
Average: 6533.4
Total: 235202.5
Fitbit
Dates: 06/25/2015 - 07/31/2015
Range: 137.0 - 27488.0
Average: 7509.0
Total: 270324.0
Moves
Dates: 06/25/2015 - 07/31/2015
Range: 113.0 - 23864.0
Average: 5557.8
Total: 200081.0
Visualization
Line
1d 1w 1m 6m 1y all
Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016
Zoomed-In View
Steps (steps)
27,488
25,000
20,000
15,000
10,000
5,000
0
06/26/2015 06/29/2015 07/02/2015 07/06/2015 07/09/2015 07/12/2015 07/15/2015 07/18/2015 07/21/2015 07/25/2015 07/28/2015 07/31/2015



Temporal comparison

Data Sources

Calories from: 03/12/10 03/29/16

Heartrate from: 06/25/15 03/29/16

Sleep from: 06/26/15 03/28/16

Steps from: 04/10/15 03/29/16

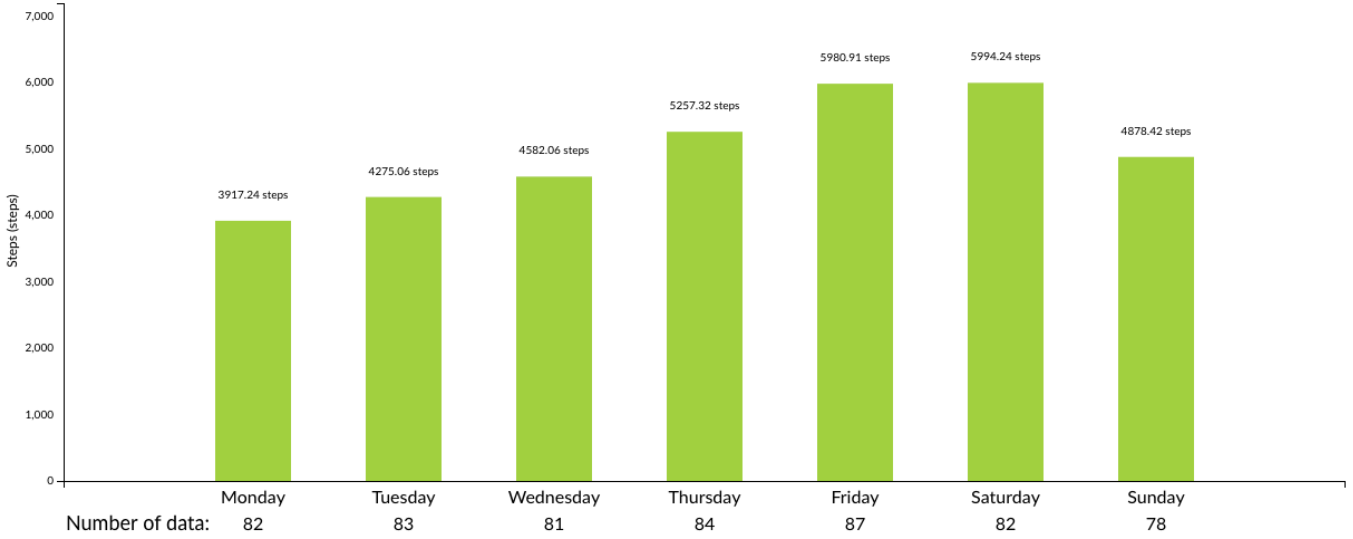
Weight from: 03/10/10 03/29/16

Compare by ○ Context ◉ Time segment Days of the week

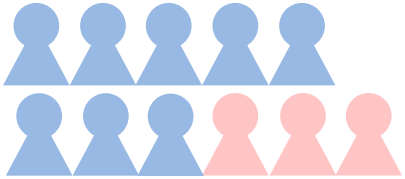
- Before/After
- ✓ Days of the week
- Months of the year
- Two Timespans

From Apr, 10 2015 to Mar, 29 2016.

Apr 2015 May 2015 Jun 2015 Jul 2015 Aug 2015 Sep 2015 Oct 2015 Nov 2015 Dec 2015 Dec 2015 Jan 2016 Feb 2016 Mar 2016



Study Session



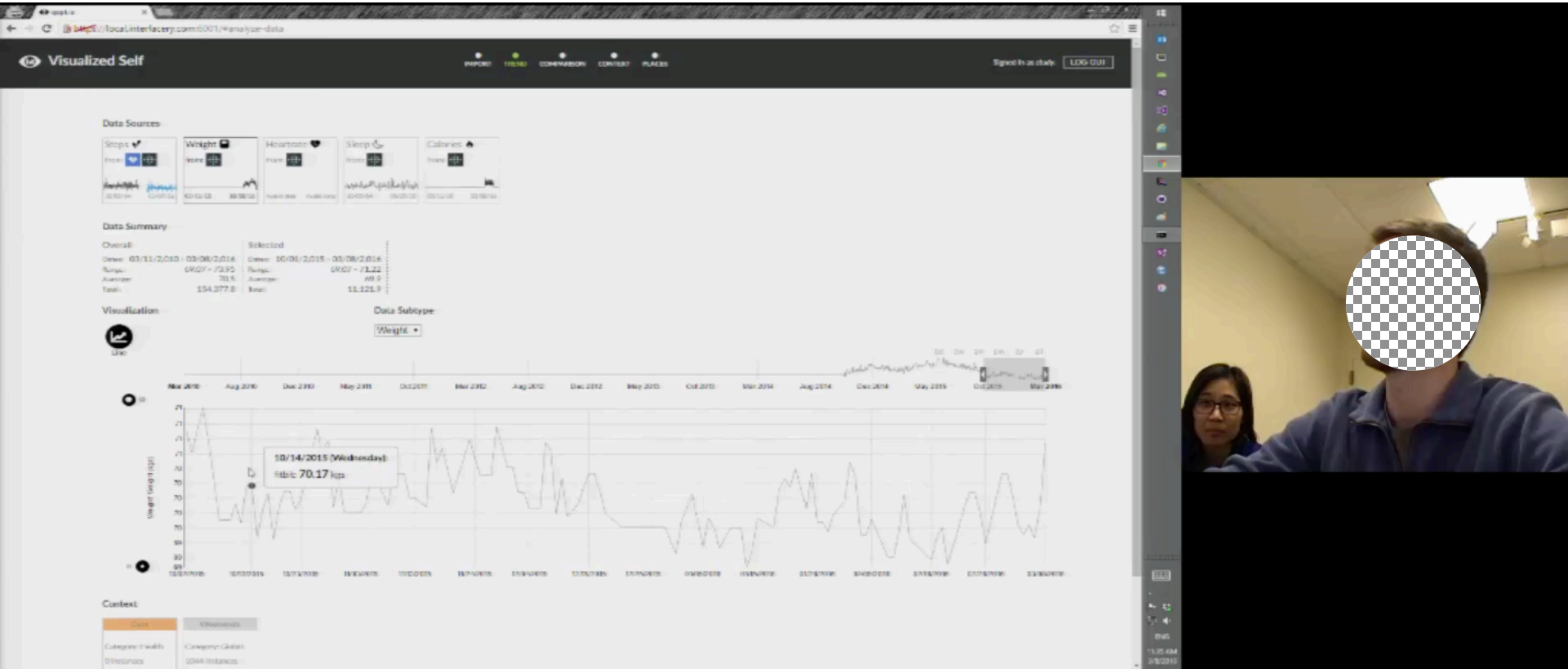
Invited 11 self-trackers to the lab

- Have been regularly tracking personal data for two months or longer
- Have been using two or more of the following devices or apps: Fitbit, Aria, MS Band, Moves, RunKeeper, RescueTime
- Age range: 24–60 (mean = 35.8)

Study session (1.5–2 hours total)

- Demographic / tracking experience survey
- Tutorial and demonstration of the tool
- **Think-aloud session with observation**
- De-briefing interview

What a session looks like



Data Analysis

- Transcribed the think-aloud session & debriefing interview
- Open coding, axial coding on the process of self-reflection (RQ1)

Data Analysis

- Transcribed the think-aloud session & debriefing interview
- Open coding, axial coding on the process of self-reflection (RQ1)
- Directed contents analysis for the types of insights (RQ2)

Levels of Reflection

R0—description

R1—description with justification

R2—exploring relationships

R3—asking of fundamental questions

R4—considering social and ethical issues

Fleck, R., & Fitzpatrick, G. (2010). Reflection on reflection: framing a design landscape.

Findings

Personal insight types

Table 2. Types of visualization insights. We adopted from [8], and then revised and expanded adding new insight categories.

Type (total frequency)	Subtype (frequency)	Description	Example Quotes
Recall (327)	External context (171)	Uncaptured data provided by the self-tracker to understand and explain a phenomenon shown in the data	"I think that was soon after my surgery and that maybe would make sense cause I'd have to get up to take medicine and maybe being restless or something." [P8]
	Confirmation (80)	Collected data confirms existing knowledge	"So for the most part…I mean, this graph is informative in that it doesn't usually take me long to fall asleep. So this is confirming what I already know about." [P9]
	Contradiction (76)	Collected data contradicts existing knowledge	"That was the opposite of what I was expecting. I would've expected that as I ate healthier I would've been burning more calories." [P9]
Detail (257)	Identify value (105)	Explicitly specify the measured value, its range for one or more clearly identified data points, or the difference between two measured values	"And it looks like my highest since I've started using it is 7,958. I wonder what date that was." [P7]
	Identify extreme (87)	Explicitly state the identities of the data points possessing extreme values of the measure variable	"Yeah, look at this peak. 11/2014 that was a trip to San Francisco." [P2]
	Identify references (65)	Explicitly state the values of categorical variables, labels from the axes, or legends	"It says I'm taking a lot of weekend steps. That's quite surprising." [P1]
Comparison (168)	By time segmentation (111)	Compare measured values segmented by time	"I could see every month this year I'm improving." [P11]
	Multiple services* (26)	Compare the same data type from two or more services	"Yeah, so the—yeah, definitely interesting to see that the two devices gave very different trends." [P6]
	Against external data (14)	Bringing in external data for comparison	"I have data for the same period for my HDL and my LDL and my triglycerides. My weight is important but those are just as important as well as to how those values are changing." [P10]
	By factor (12)	Compare measured values by a factor (other than time)	"What was happening in February 2015? [Laughter] I bet I can tell you what those are. That's one of my son's sleep regressions." [P1]
	Instances (5)	Compare two specific instances	"The plan says no exercise after 7:30. And these two data points is basically validating that you've got to stick by it." [P3]
Trend (119)		Describe changes over time	"Then there's also a time when I had surgery actually both holidays. In 2013 I had shoulder surgery in December. Everything went down." [P8]
Value judgment* (118)		Convey positive or negative connotations about the data	"It's pretty irregular. I really wish I woke up at the same time. This is really bad." [P6]
Distribution (41)	Variability (41)	Explicitly state the variability of measured values	"This is around—around here is when my son was born. Second kid. So, you know, some of this stuff—you can see trending up as you're not taking care of yourself. Son gets a little older, things go back to normal." [P1]
	By category (0)	Explicitly describe the variation of measured values across all or most of the values of a categorical variable	By category (0)
Correlation (34)		Specify the direct relationship between two variables (but not as comparison)	"So the Calorie data matches the Steps data." [P9]
Outlier (28)		Explicitly point out outliers or state the effect of outliers	"The min and max are interesting. But from a global perspective, they're probably outliers on asleep." [P11]
Data summary (27)		Summary of collected data (such as number of data points, duration of tracking, and averages)	"So about two years, and averaging over ten [10,000 steps]. My goal is set at ten [10,000 steps], so that makes me happy." [P4]
Prediction (14)		Predict the future based on the collected data	"Yeah, Martin Luther King. So if I go to comparison of weekend I think my weekends tend to be sluggish. Weekdays are okay." [P3]
Total (1133)			

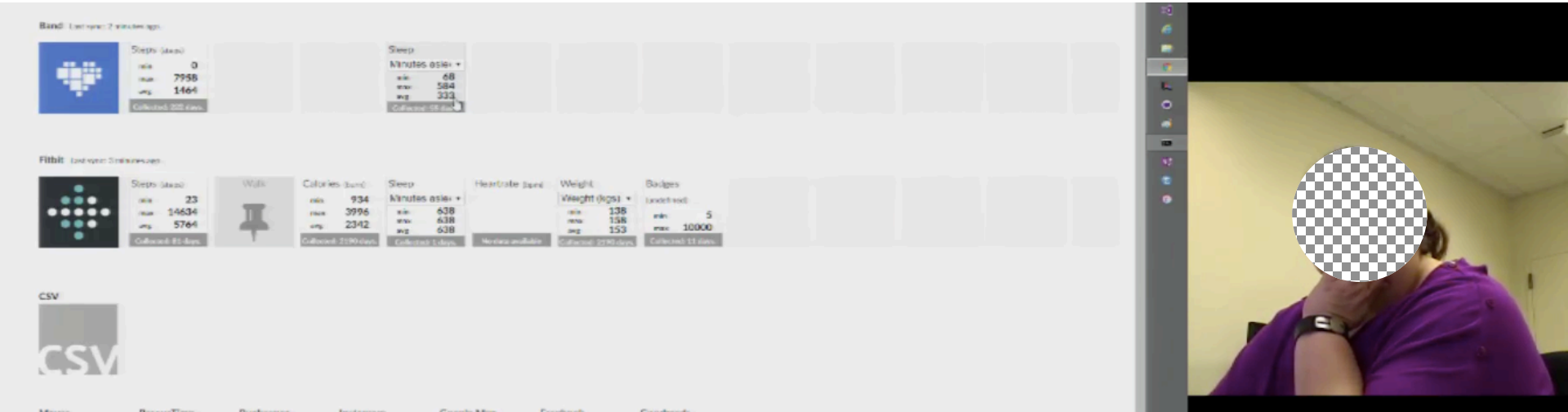
* New insight types identified in this study in comparison to Choe, Lee, and schraefel [8].

From a lower-level reflection to a higher-level reflection

Data summary; Comparing multiple services; "R0" reflection

"Band has 222 days of collected data and it's saying my average is 1,464, but Fitbit has 81 days and it's saying I have 5,764 as my average. So it leads me to wonder which one is more accurate?" [P7]

Question; "R2" reflection



Insight gaining pattern #1

Visual data exploration

Recall previous contexts that could explain the captured behavior

"R1" reflection

Revisiting with explanation, descriptive reflection

External context

"I think that was soon after my surgery and that maybe would make sense cause I'd have to get up to take medicine and maybe being restless or something." [P8]

Insight gaining pattern #2

Recall previous contexts that could explain the captured behavior

Create an interesting question / hypothesis

Visually explore the data to look for an answer

"R2" reflection

Questioning; exploring relationships

Temporal comparison

P1: (entering Sept 15, 2015 to compare his weight before and after this date)

Researcher: Why Sept 15?

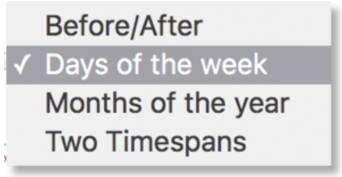
P1: *"That's kind of around the time I changed jobs. I was wondering if there was anything interesting there."*

External context; Comparison by time segmentation

Using External Context in Data Exploration

External Context: Uncaptured data provided by the presenter to understand and explain a phenomenon shown in the data

Calendar events, location semantics, major life events, key dates, vacation, workout types, seasons, weather…



Value judgment:

"Saturday is pretty bad" [in terms of step count]

"R3" reflection

alters or transforms the reflector's original point of view

Making a resolution:

"So I need to take action to probably monitor myself to ensure that I'm at least at 2,000 [steps] or more." [P10]

Reflection on the levels of reflection

Many R0, R1, and R2 types of reflections due to Visualized Self's data summary and temporal comparison pages

Drawing higher-level reflections (i.e., R3) was less common

R3 might be an important reflection type that can potentially lead to short-term, or even long-term behavior change

Did not observe R4

Summary

Supporting self-reflection with VDE

Flexible data selection, filtering, and comparison features

Help people create interesting questions and hypotheses

Help people capture/use various contextual information

Combine system-driven and human-driven insights

Thank you!

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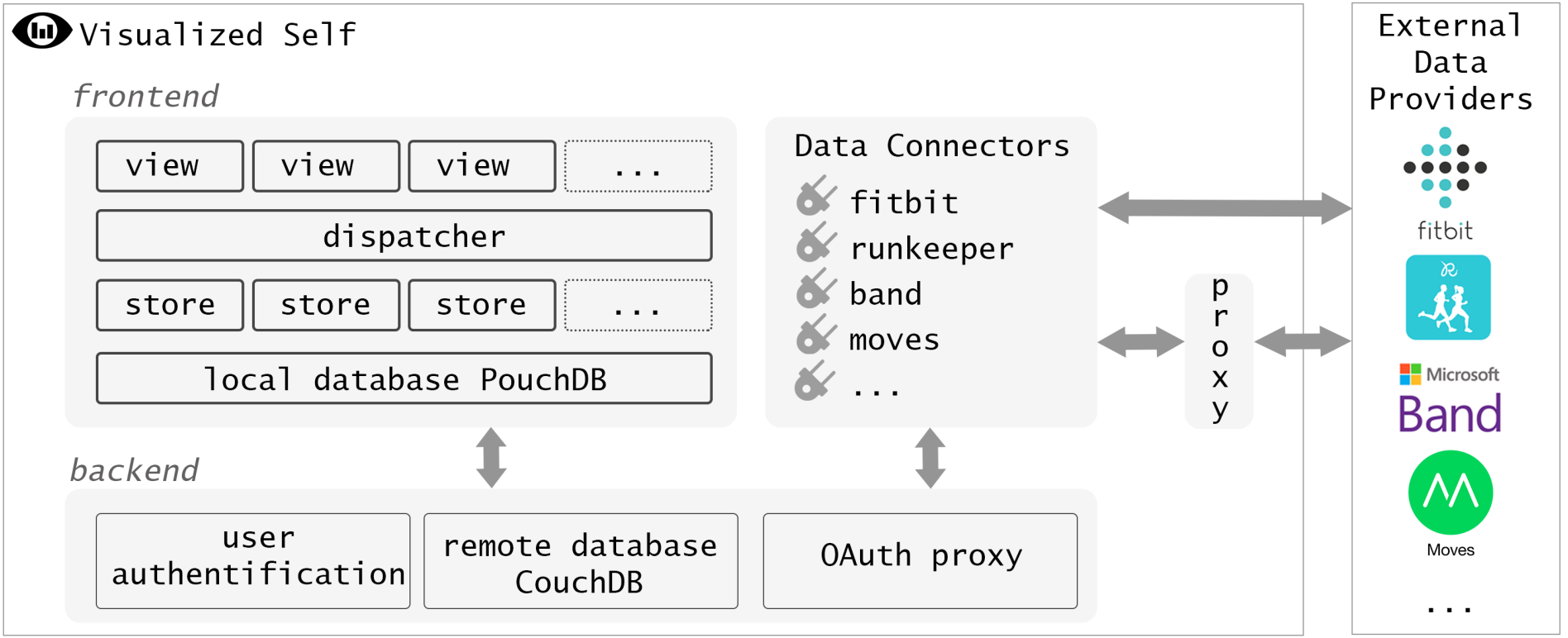
Microsoft Research


Visualized Self
frontend
view
view
view
...
dispatcher
store
store
store
...
local database PouchDB
backend
user authentification
remote database CouchDB
OAuth proxy
Data Connectors
fitbit
runkeeper
band
moves
...
proxy
External Data Providers
fitbit
Microsoft Band
Moves
...

Data ingegration from multiple sources