

sensing opportunities for mobile health persuasion

jonfroehlich@gmail.com
phd candidate in computer science
university of washington

mobile health conference
stanford university, 05.24.2010

sensing opportunities for mobile health persuasion



sensing opportunities for mobile health persuasion



sensing opportunities for mobile health persuasion



Kairos

technology that suggests
a behavior at the most
opportune moment

-fogg, 2003

two things you need

1. a method to **passively monitor** human activity
2. a method to provide **feedback** about behavior



self-report

- useful for measuring
 - beliefs, feelings, goals
 - simple
 - low cost
- burdensome
 - people are not good at monitoring their own behaviors:
 - eating [champagne, 2002]
 - exercise [lichtman, 1992]
 - routine activities [klasnja, 2008]
 - coughing [liu et al., in submission]

activity inference

a very brief history

want, pers com



gavrila et al, c. vision



bao et al., pervasive



lester et al., ijcai



miluzzo et al., sensys



1990

2000

2010

instrumenting the
environment

instrumenting the
person/clothing

instrumenting
the cell phone

not just sensor hardware progressions

- also, advances in machine learning
- ability to store lots of information
- constant connectivity / the cloud

just as location aware computing has ushered in
a new era of mobile phone software

so to will activity inference for
future mobile phone generations

running



lester et al., ijcai 2005
choudury et al., ieee pervasive 2008



walking

lester et al., ijcai 2005
choudury et al., ieee pervasive 2008

A man with dark hair, wearing a dark brown t-shirt and blue jeans, is sitting on a light-colored stone sidewalk. He is seen from behind, looking down a city street. The street is paved with dark asphalt and has white crosswalk markings. On the right side of the street, there is a red brick sidewalk, a green fire hydrant, and a blue sign that says "PUBLIC PARKING" with an arrow pointing left. Several cars are parked along the right side of the street, including a red pickup truck and a gold sedan. In the background, there are buildings and more cars. The word "sitting" is overlaid in white text on a dark grey arrow pointing right.

sitting

lester et al., ijcai 2005
choudury et al., ieee pervasive 2008

transit modes



patterson et al., ubicomp 2003
zheng et al., ubicomp 2008
reddy et al., sensor networks 2009

A close-up photograph of a man with curly brown hair and black-rimmed glasses, wearing a blue shirt. He is holding a sandwich with both hands and taking a bite. The background is slightly out of focus, showing an outdoor setting with greenery and a wooden fence. A dark grey banner with the word 'eating' is in the top left corner. A speech bubble on the right contains text about a microphone in the ear. A dark grey box in the bottom right corner contains citation information.

eating

microphone in ear
detects **when** a
person is eating
with **99%** accuracy

amft et al., ubicomp 2007
cheng et al., pervasive 2010

identifying fluids

A close-up photograph of a woman's face, partially visible, looking down at a glass of red juice. She is holding a celery stalk with green leaves in the glass, and a straw is also in the drink. The background is blurred.

instrumented cup

79% classification accuracy

68 different fluids including
sodas, juices, beers, wines

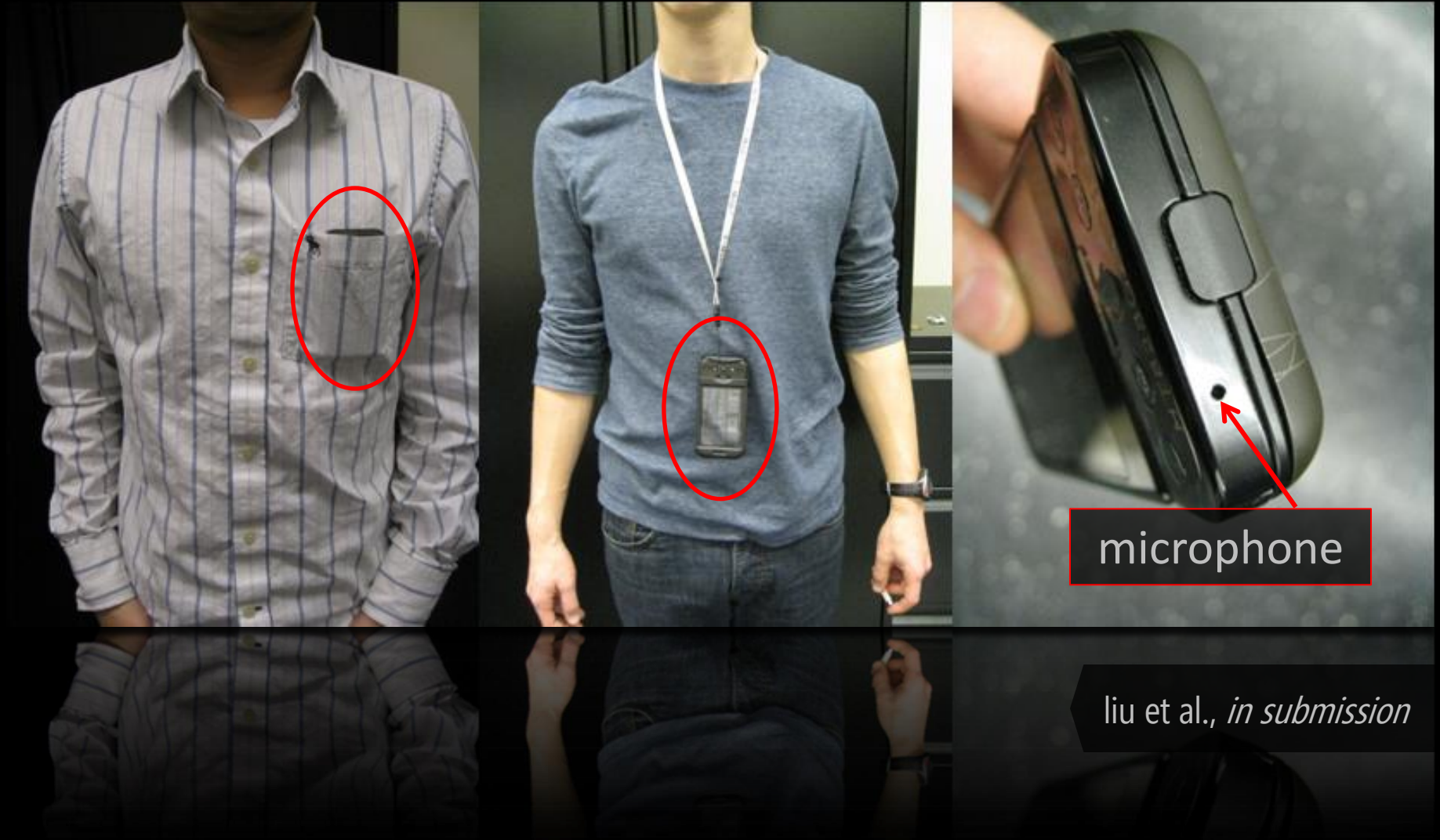
lester et al., pervasive health 2010

coughing



liu et al., *in submission*

automatically detecting coughs with a commodity mobile phone



liu et al., *in submission*

collecting and analyzing the cough dataset



17 participants

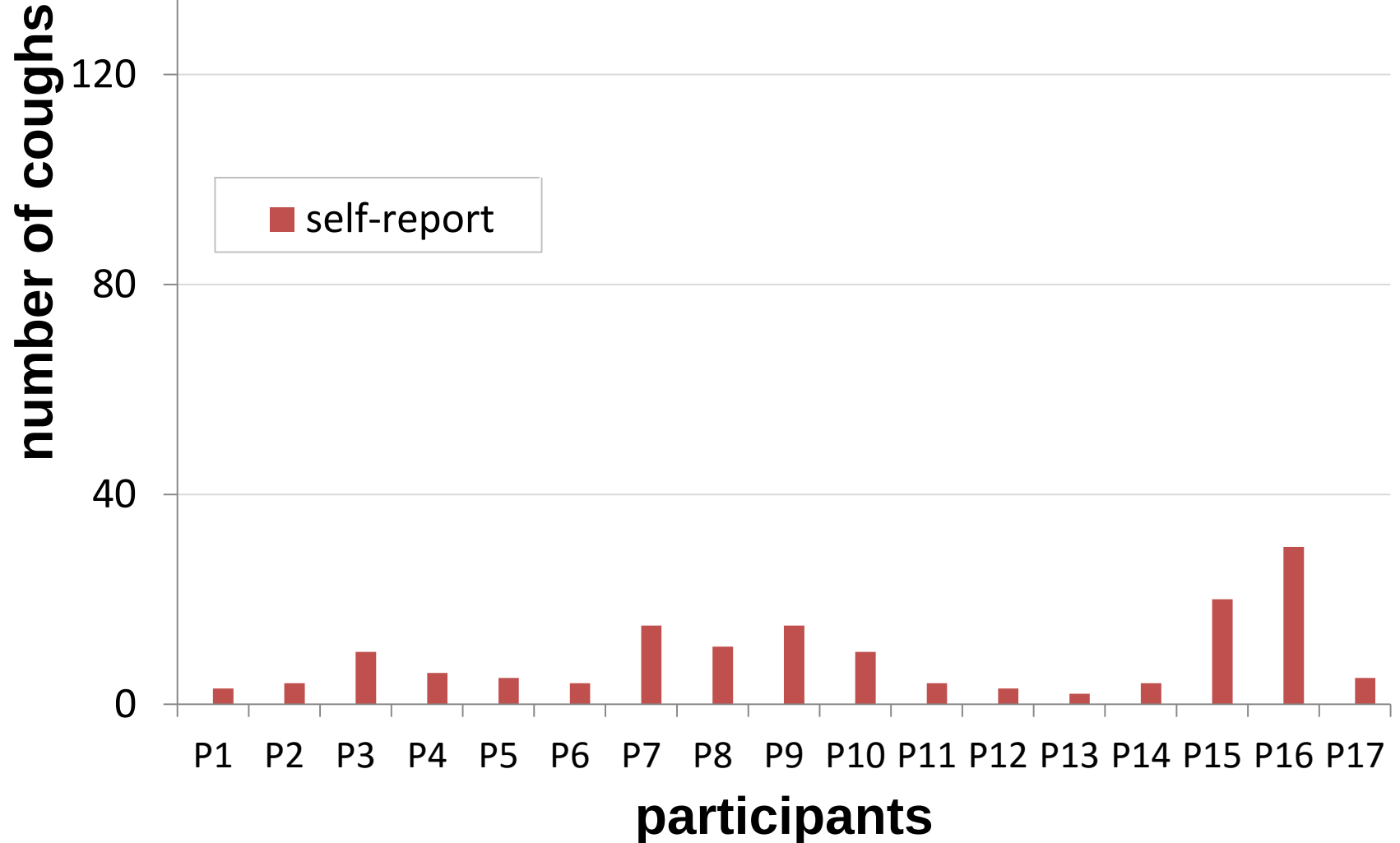
72 hours of naturalistic audio recording

6 graduate students annotated recordings

2542 coughs labeled by annotators

84.4% of coughs were correctly classified
0.7% false positive rate (3.3/hr)

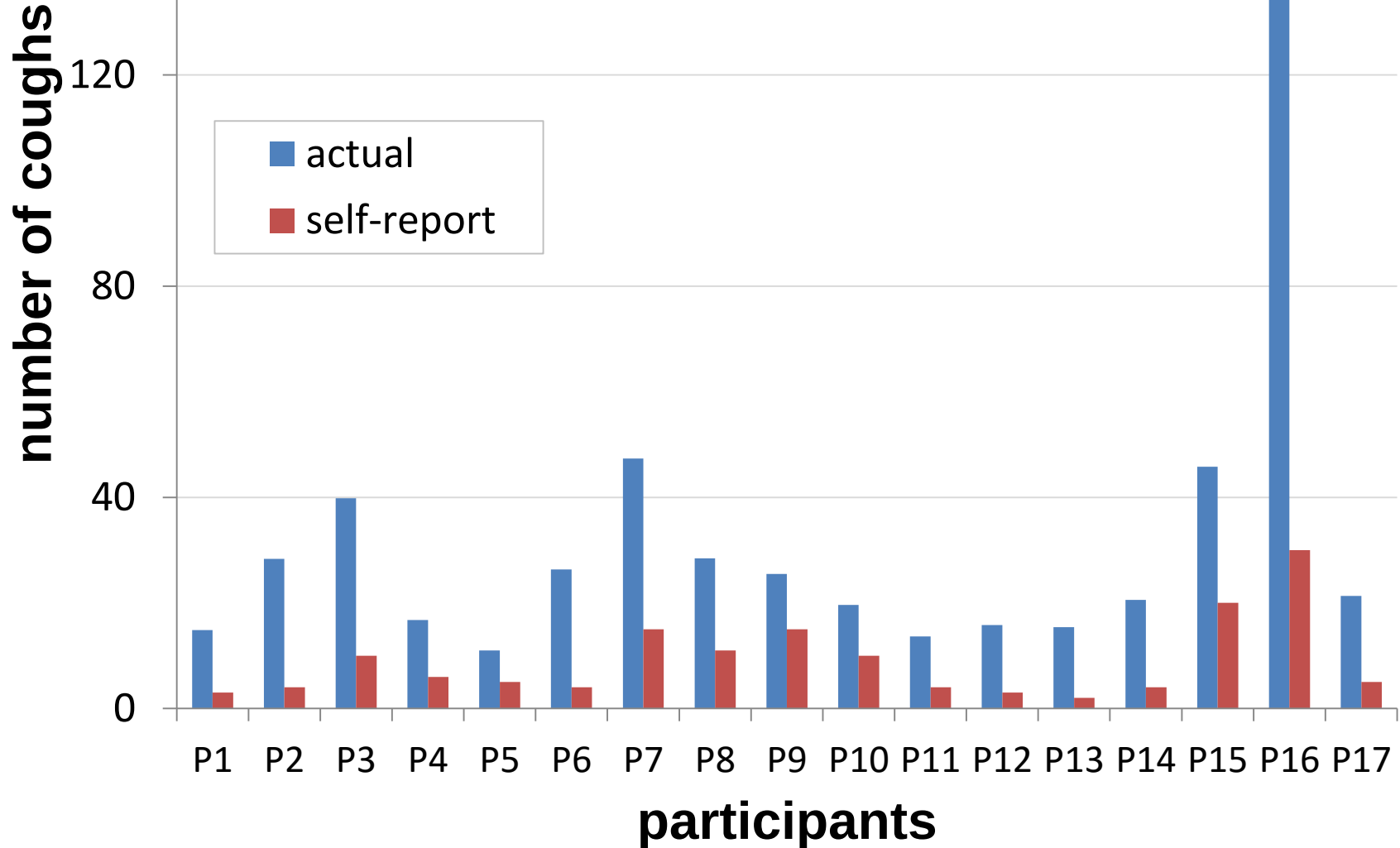
number of coughs



number of coughs

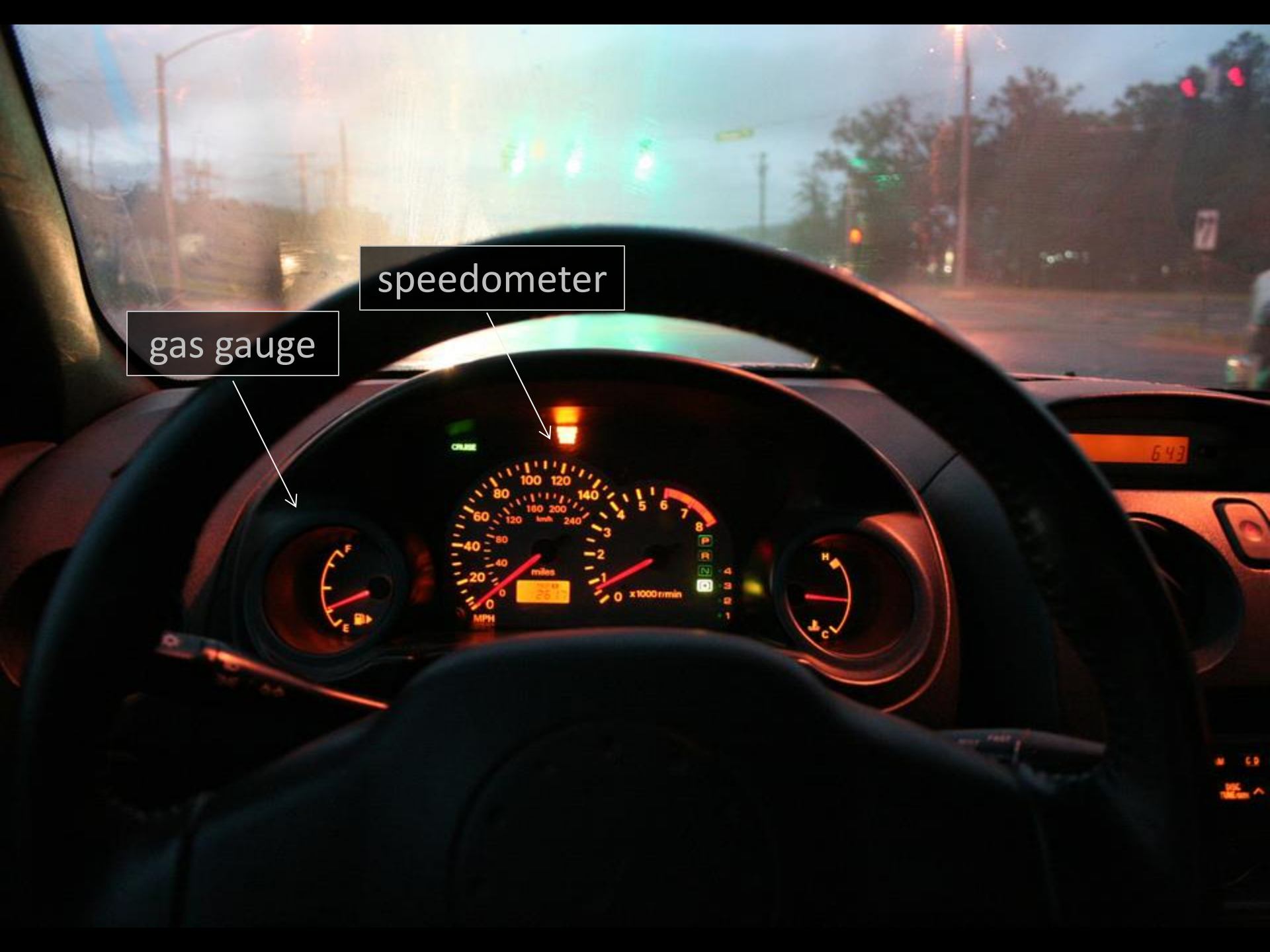
measured vs. self-report

diff: mean (**22.8/hr**), std (**33/hr**)



two things you need

1. a method to **passively monitor** human activity
2. a method to provide **feedback** about behavior



speedometer

gas gauge



zero effort applications for behavior change

goal: minimize interaction costs

approach: passive sensing + passive display

basically, do the activities that you
normally do and the mobile phone
will **automatically** respond

two examples:



ubifit

encouraging *fitness*
behaviors through passive
sensing and feedback

consolvo et al., chi 2008
consolvo et al., ubicomp2008



ubigreen

encouraging *proenvironmental*
behaviors through passive
sensing and feedback

froehlich et al., chi 2009

ubisystem components

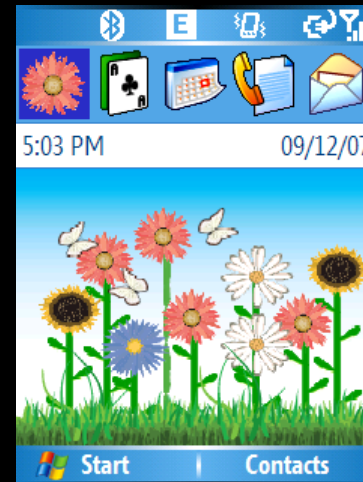
collects data about physical activities

activity recognition device



+

glanceable display



phone wallpaper!



communicates data about physical activities

ubisystem components

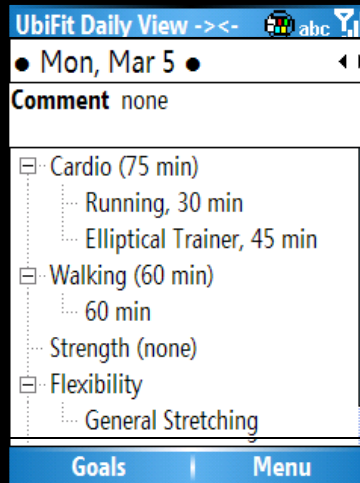
towards zero effort applications

collects data about physical activities

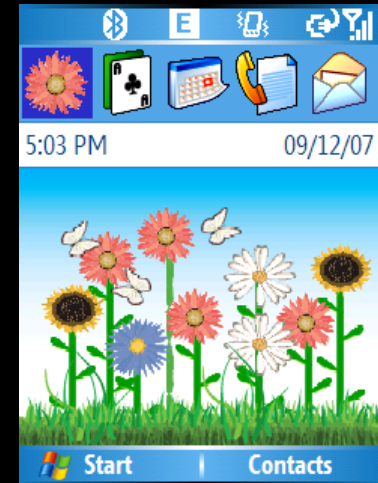
activity recognition device



interactive application



glanceable display



communicates data about physical activities

ubifit

personal ambient display



walk



cardio



strength



flexibility



primary goal met



alternate goal met

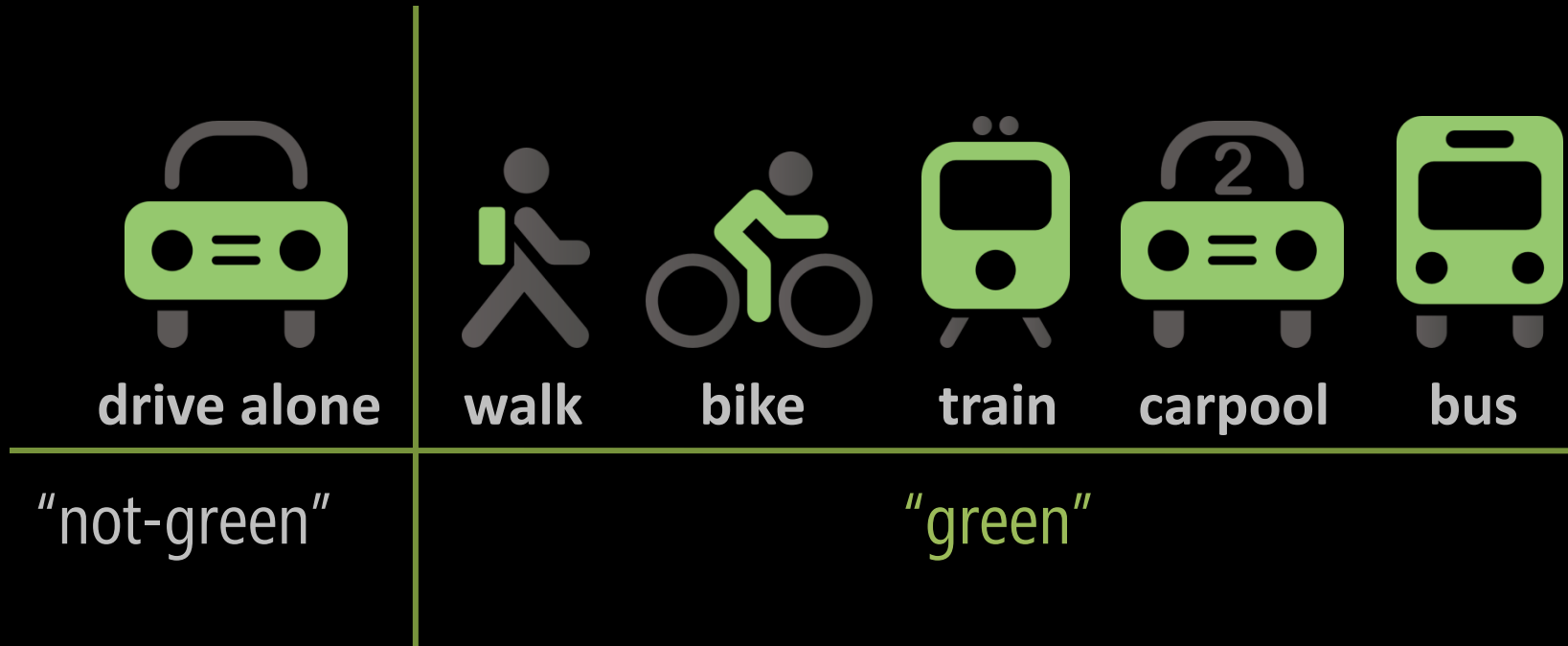


recent goal met



ubigreen

tracked 6 transit activities



minimum activity duration: 7 minutes

ubigreen

personal ambient display

current
activity

value
icon bar

phone
background
(wallpaper)

evolving
image





sense of anticipation for how story would unfold

ubigreen
personal ambient display



tree
design:

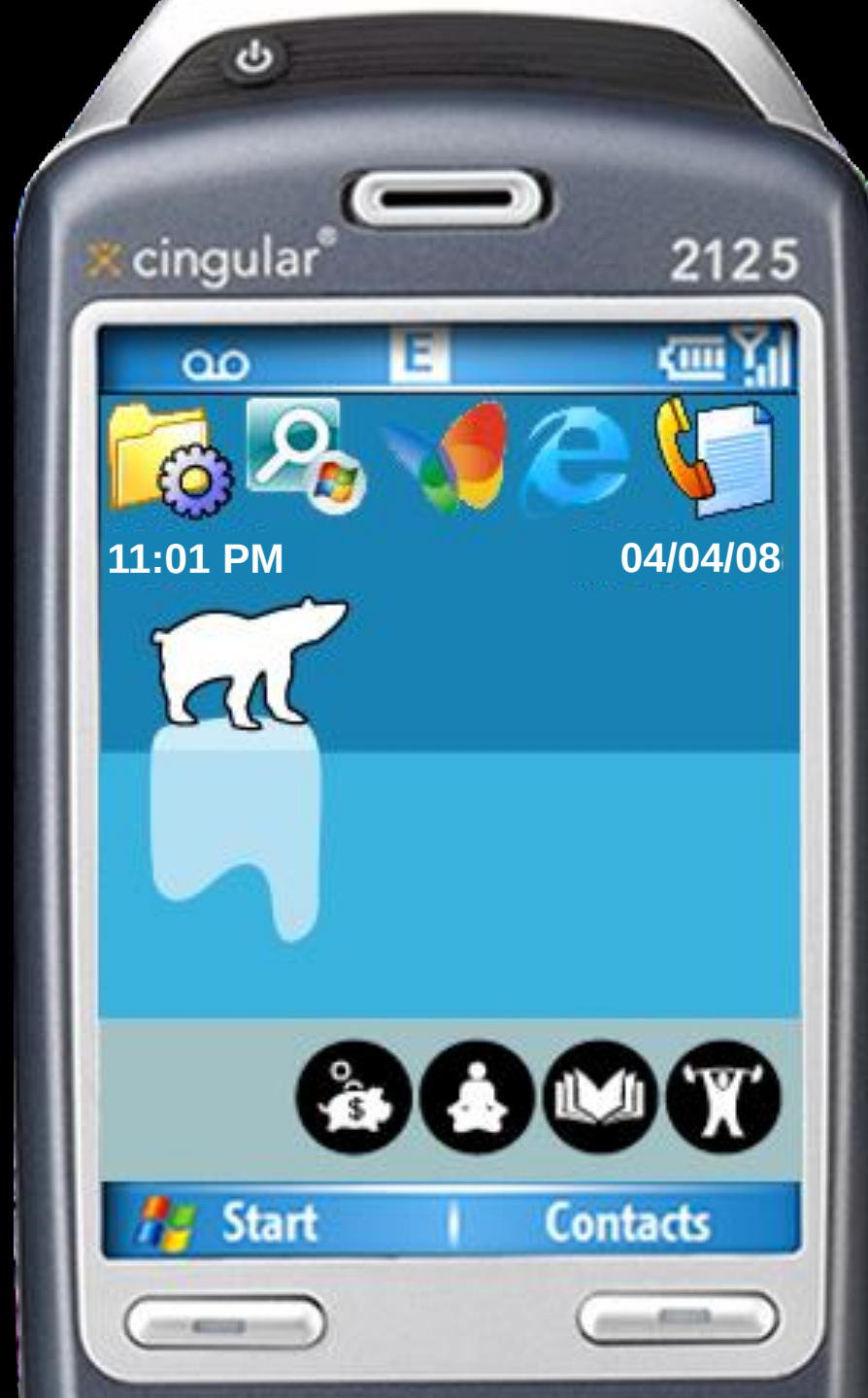


everything
resets
on sunday

ubigreen
personal ambient display



polar bear
design:



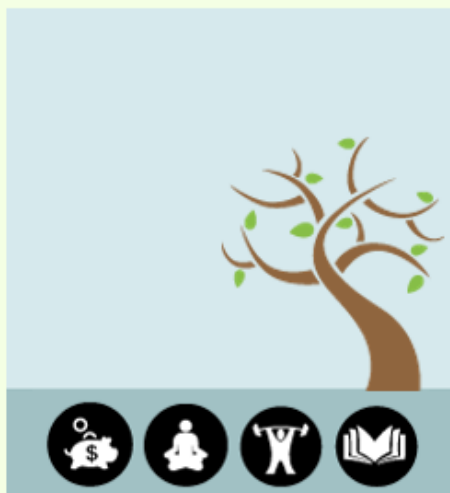


Saturday

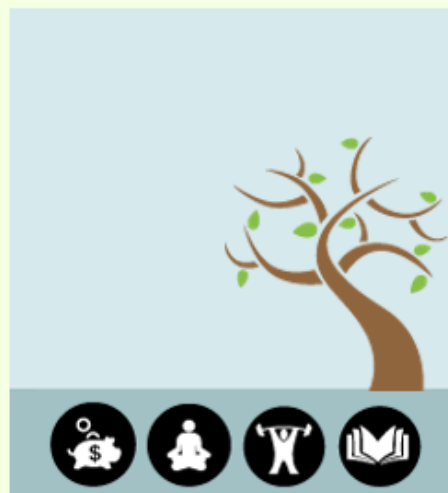
RESEARCH PARTICIPANTS



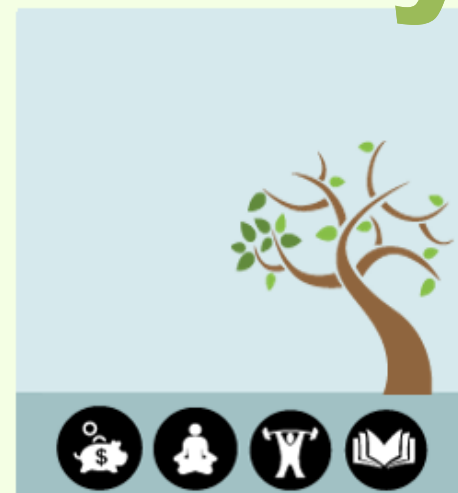
ubigreen1



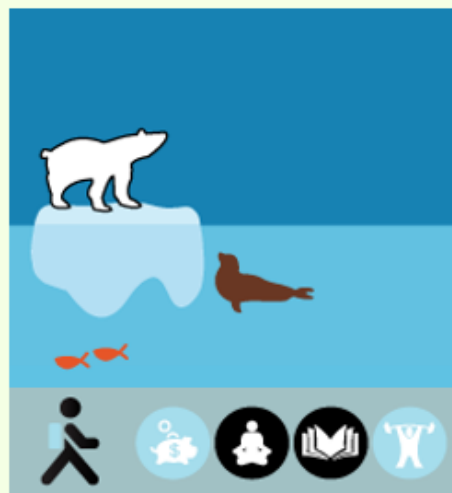
ubigreen2



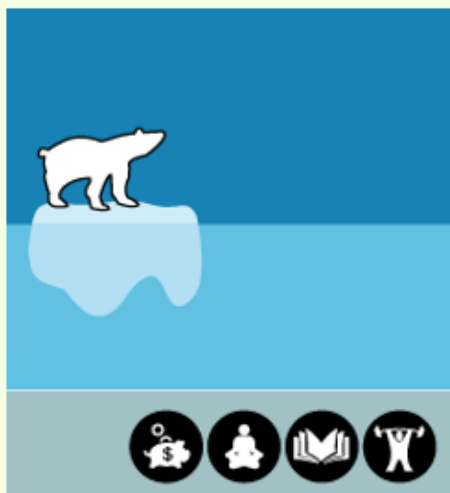
ubigreen3



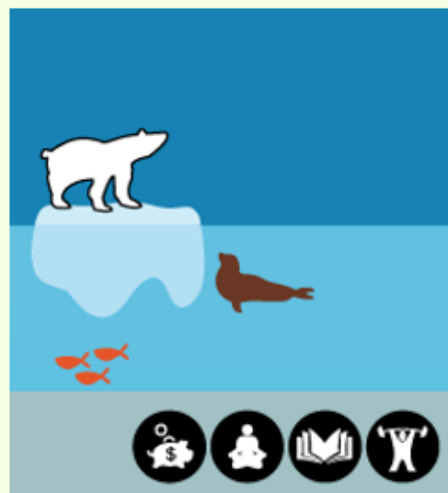
ubigreen4



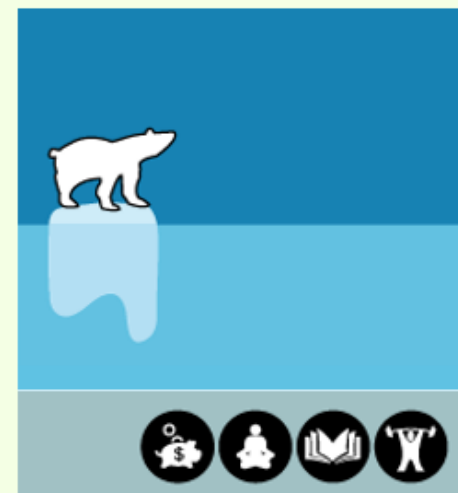
ubigreen5



ubigreen6



ubigreen7



ubigreen8

personal ambient display

impressions of ubifit



If you didn't have a screen [display], I wouldn't think about it [physical activity] as much... I **think about it** maybe subconsciously **every time I look at my phone.**

- P5_{UF}

With a **website**, it's so easy to ignore... it's just out of sight, out of mind. But **on the phone**, you can't really ignore it...

- P9_{UF}

MARIO
000000

0x00

WORLD
1-1

TIME

SUPER MARIO BROS.

©1985 NINTENDO



1 PLAYER GAME

2 PLAYER GAME

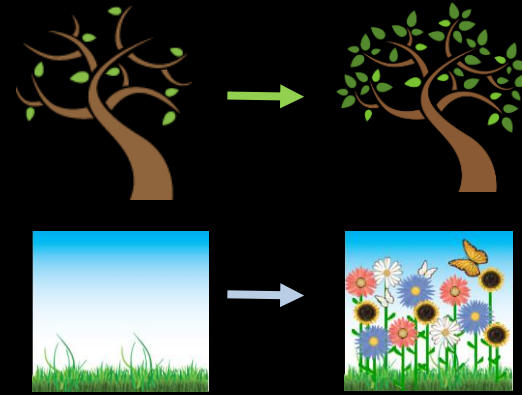
TOP- 000000



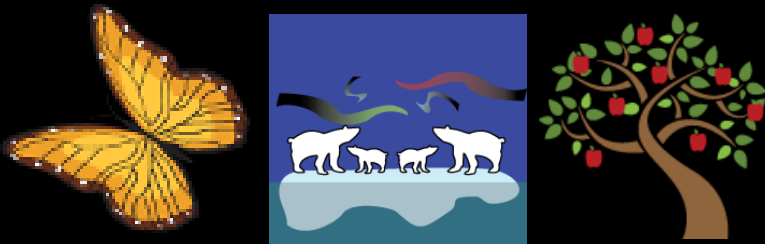
game mechanics



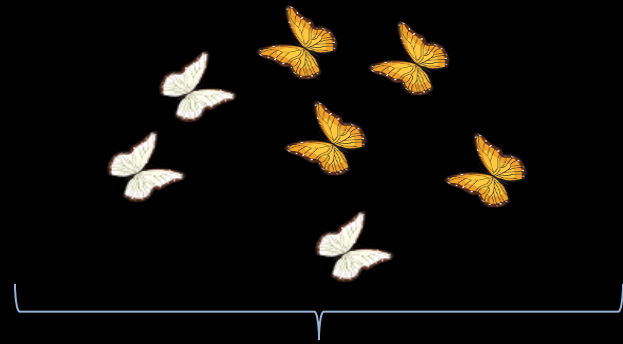
playful



measured progress



virtual achievements



collections

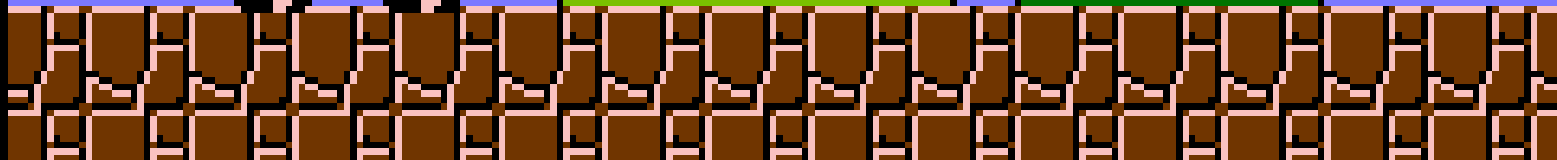
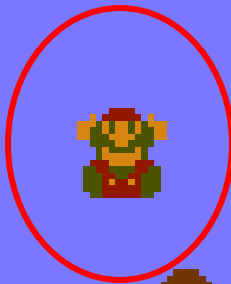
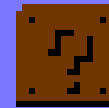
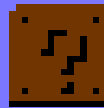
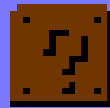
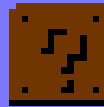
MARIO
002100

×03

WORLD
1-1

TIME
323

loss aversion

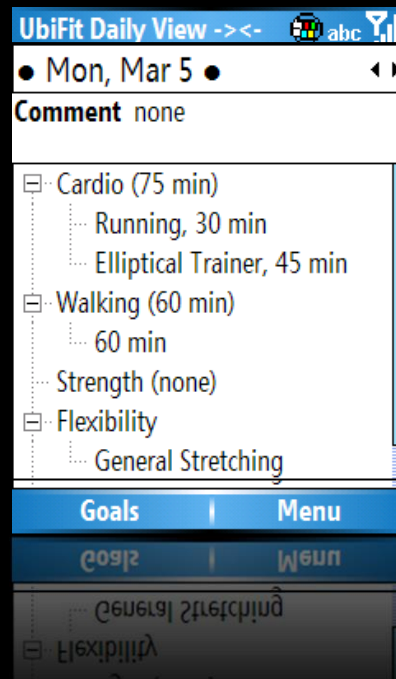


need for quantitative data



I would **like to see some graph** or raw data.

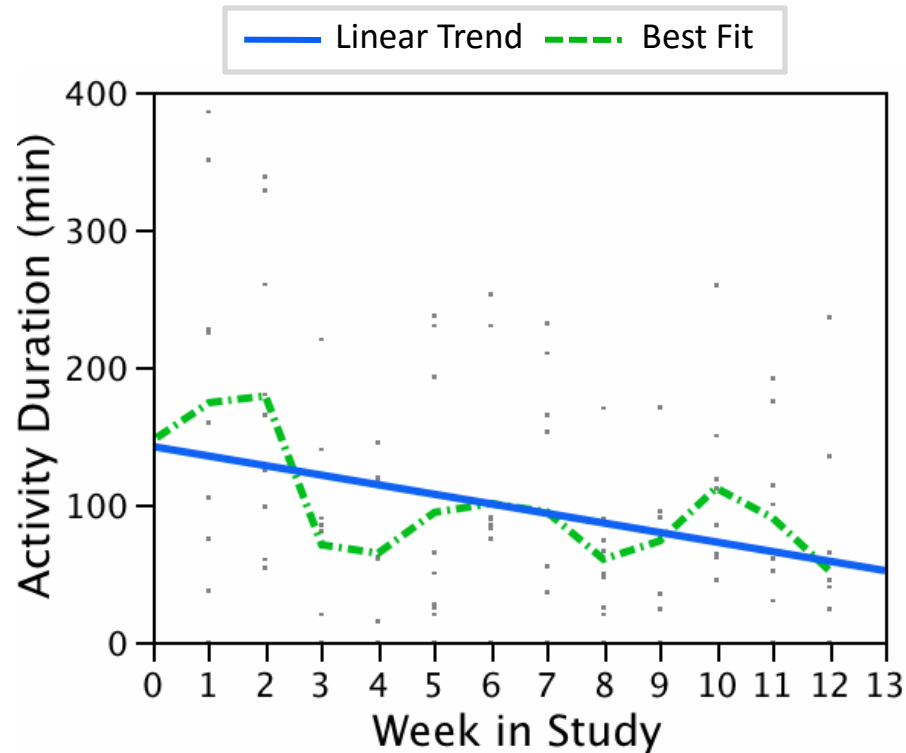
- P13_{UG}



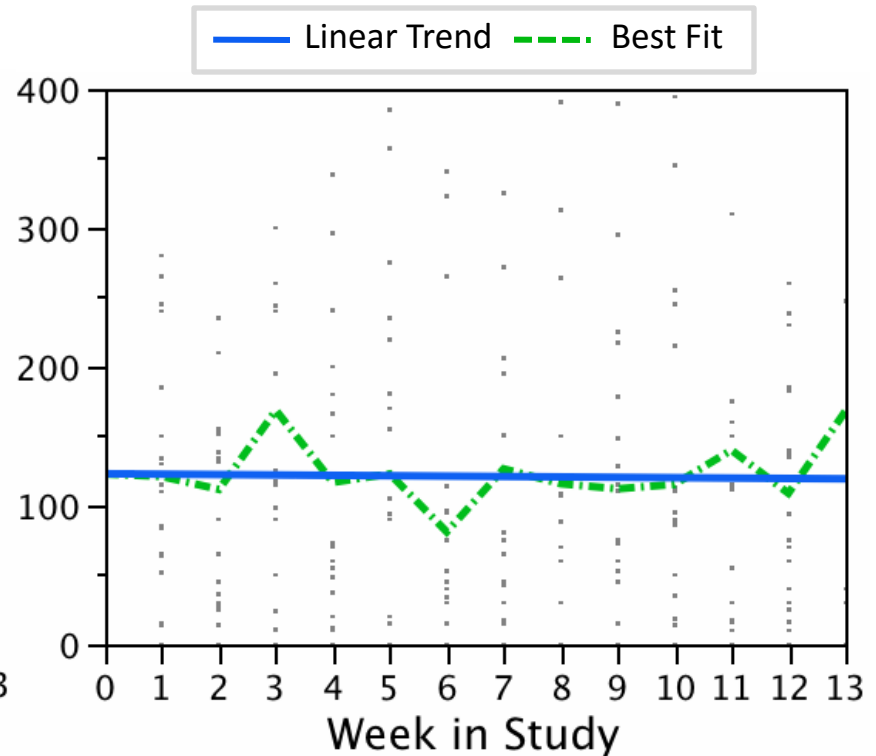
quantitative data

- builds trust system is working
- allows for self-comparison
- some people like it better

effectiveness of the ubifit glanceable display



no glanceable display



glanceable display

study occurred over thanksgiving, christmas, and new years.

in conclusion

imagine that you can sense....

running



lester et al., ijcai 2005
choudury et al., ieee pervasive 2008



walking

lester et al., ijcai 2005
choudury et al., ieee pervasive 2008

A man with dark hair, wearing a dark grey t-shirt and blue jeans, is sitting on a light-colored concrete sidewalk. He is seen from behind, looking down a city street. The street is paved with dark asphalt and has white crosswalk markings. On the right side of the street, there is a red brick sidewalk, a green fire hydrant, and a blue sign that says "PUBLIC PARKING" with an arrow pointing left. Several cars are parked along the right side of the street, including a red pickup truck and a gold sedan. In the background, there are buildings and more cars. The word "sitting" is written in white text on a dark grey arrow-shaped background in the top left corner.

sitting

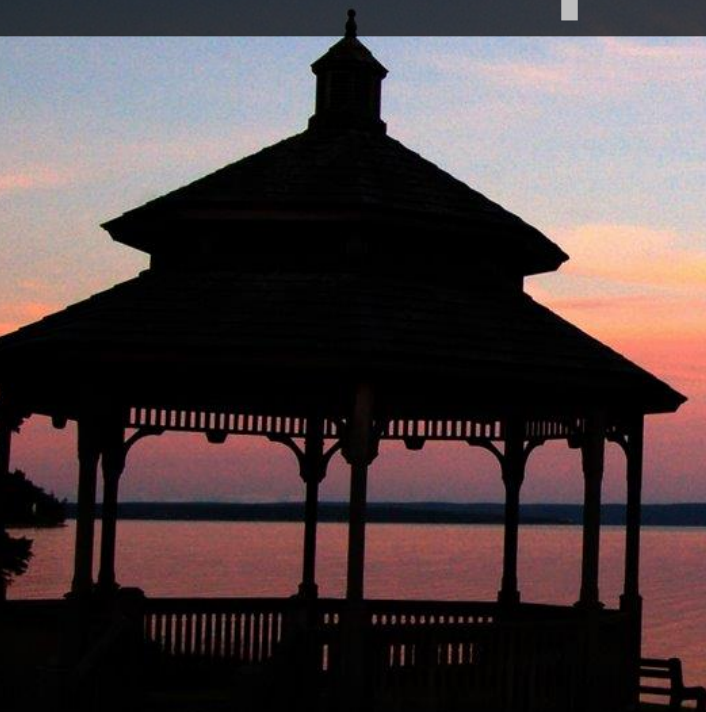
lester et al., ijcai 2005
choudury et al., ieee pervasive 2008

A close-up photograph of a man with brown hair and black-rimmed glasses, smiling and eating a sandwich. He is holding the sandwich with his right hand. The background is slightly out of focus, showing a wooden fence and greenery, suggesting an outdoor setting like a park or sports field. A dark grey banner with the word 'eating' in white is in the top left corner. In the bottom right corner, there is a dark grey box containing white text about research papers.

eating

amft et al., ubicomp 2007
cheng et al., pervasive 2010

lakefront property



lakefront property

phone home/lock screen:
most valuable real estate in all
of technology



thank you

@jonfroehlich

thanks to:
sunny consolvo
pedja klasnja
james landay
eric larson
sean liu
shwetak patel



extra slides

sink usage

A photograph of a kitchen sink with a person's hands being washed under running water. The faucet is a chrome single-lever design. On the countertop to the right of the faucet are a yellow pump bottle of dish soap, a blue-handled brush, a red and white toothbrush, and a clear glass. To the left of the faucet is a pink plastic cup and a colorful fish-shaped container. The background wall has a light-colored patterned wallpaper.

froehlich et al., ubicomp 2009
larson et al., pervasive & mobile computing 2010

ubigreen sensing transit



Drive Alone



Walk



Bike



Train



Carpool



Bus

minimum activity duration: 7 minutes

precursor to ubifit

pedometer cell phone fitness study



Figure 1. a) The Omron HJ-112 pedometer, b) the pedometer in use, and c) the Nokia 6600 mobile phone running Houston.

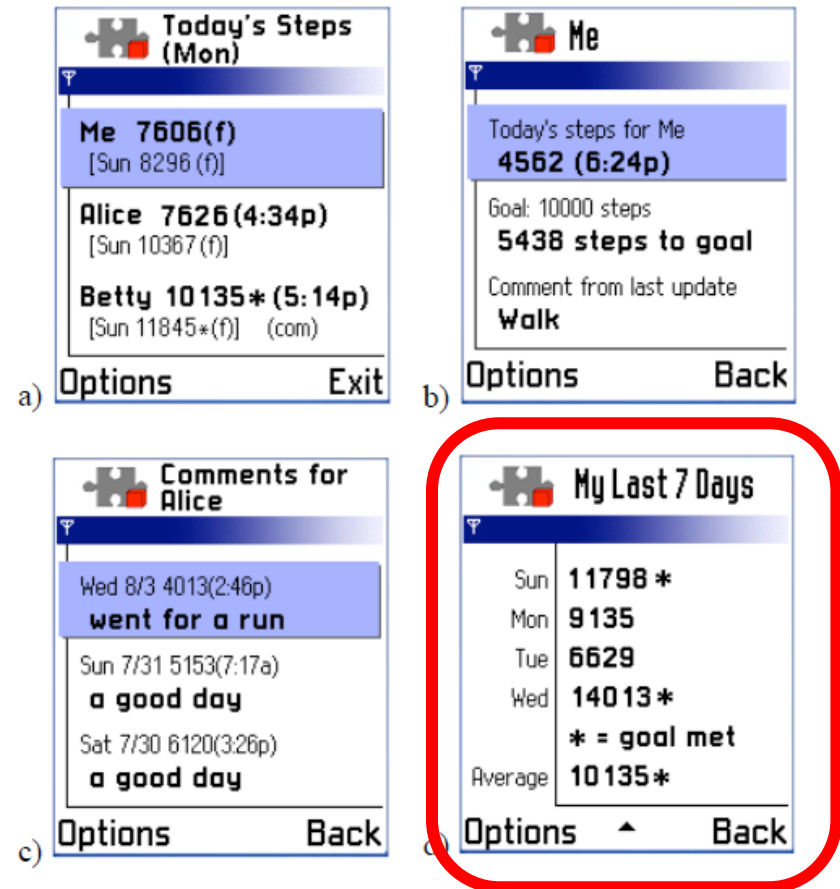
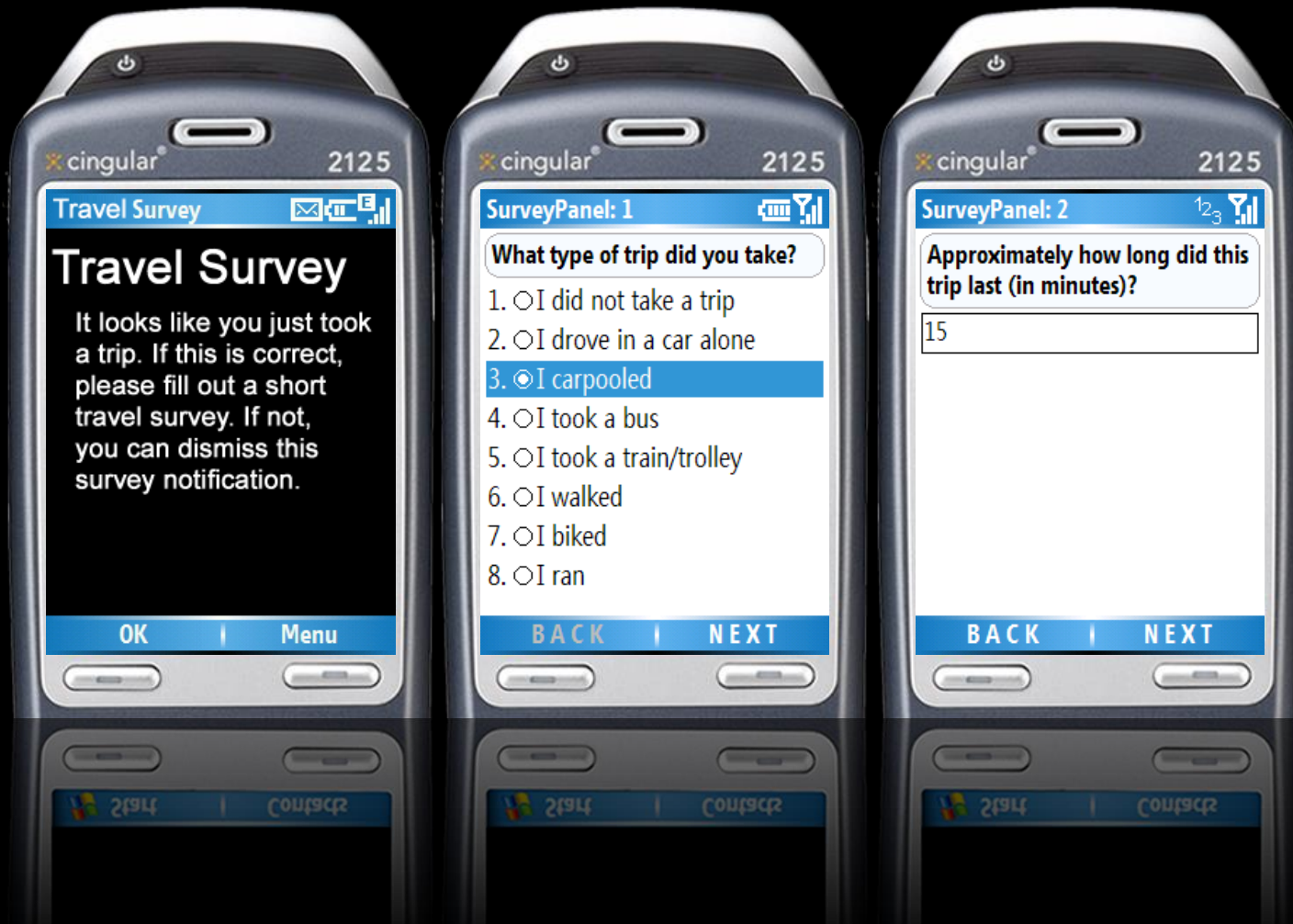


Figure 2: Houston screen shots. (a) Main screen, (b) detail screen, (c) recent comments, and (d) trending information.

ubigreen context-triggered survey

using the *myexperience toolkit*
froehlich et al., mobisys 2007
<http://myexperience.sourceforge.net>



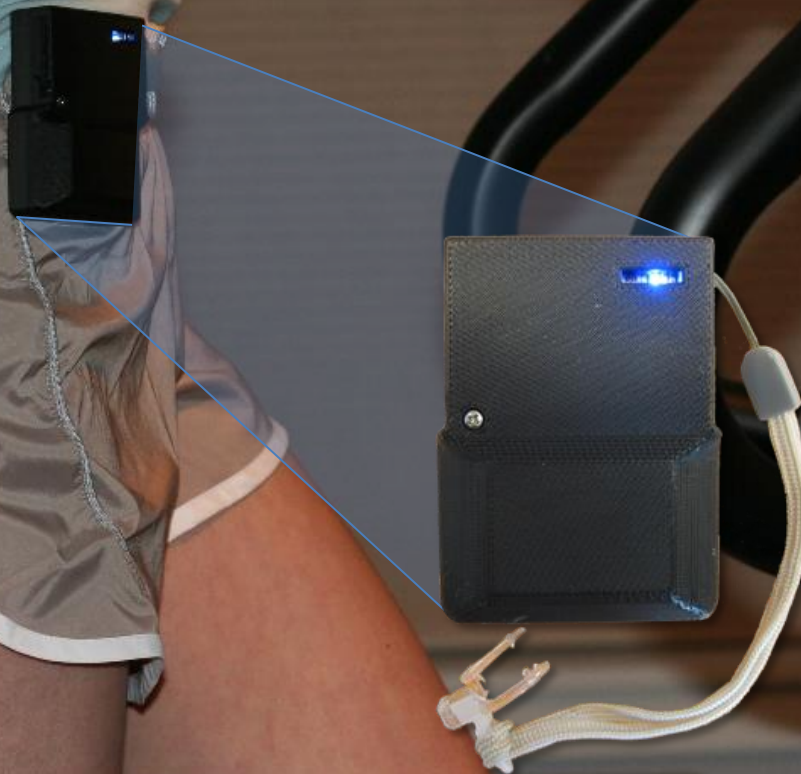
limitations of sensing

can't infer **thoughts, feelings, intentions**
can be **expensive**
sensing **may not yet exist** for behavior

froehlich et al., mobisys 2007
<http://myexperience.sourceforget.net>



intel msp



lester et al., ijcai 2005

personal ambient display impressions of ubi**green**



It's **omnipresent**

- P9_{UG}

It definitely **keeps you more aware** of it
[personal transportation]. **You use your
phone every single day** so you know.

- P6_{UG}