

IN4MATX 241: Ubiquitous Computing

Class 6:
Behavior Change

Daniel Epstein

Learning goals

- Develop some high- and low-level understanding of behavior change theories
- Identify how classic research and commercial technologies incorporated these theories

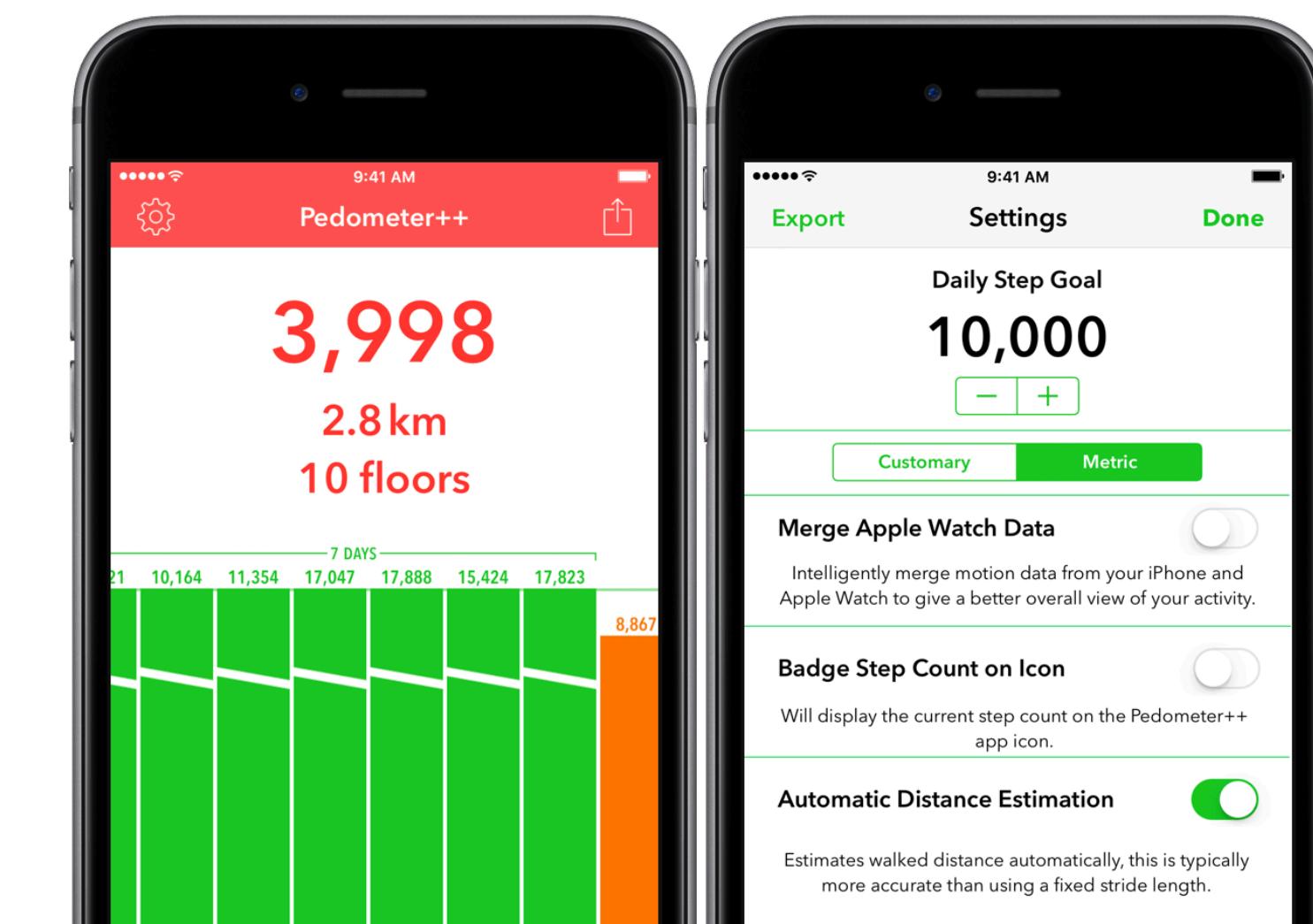
Consumer Health Technology

- Apps, devices, etc. which aim to promote health or wellbeing
- Often where behavior change has been applied
in the Ubiquitous Computing space
- This is really an intro to the history and foundations of the space,
we'll dive more into this topic on Wednesday

Consumer Health Technology



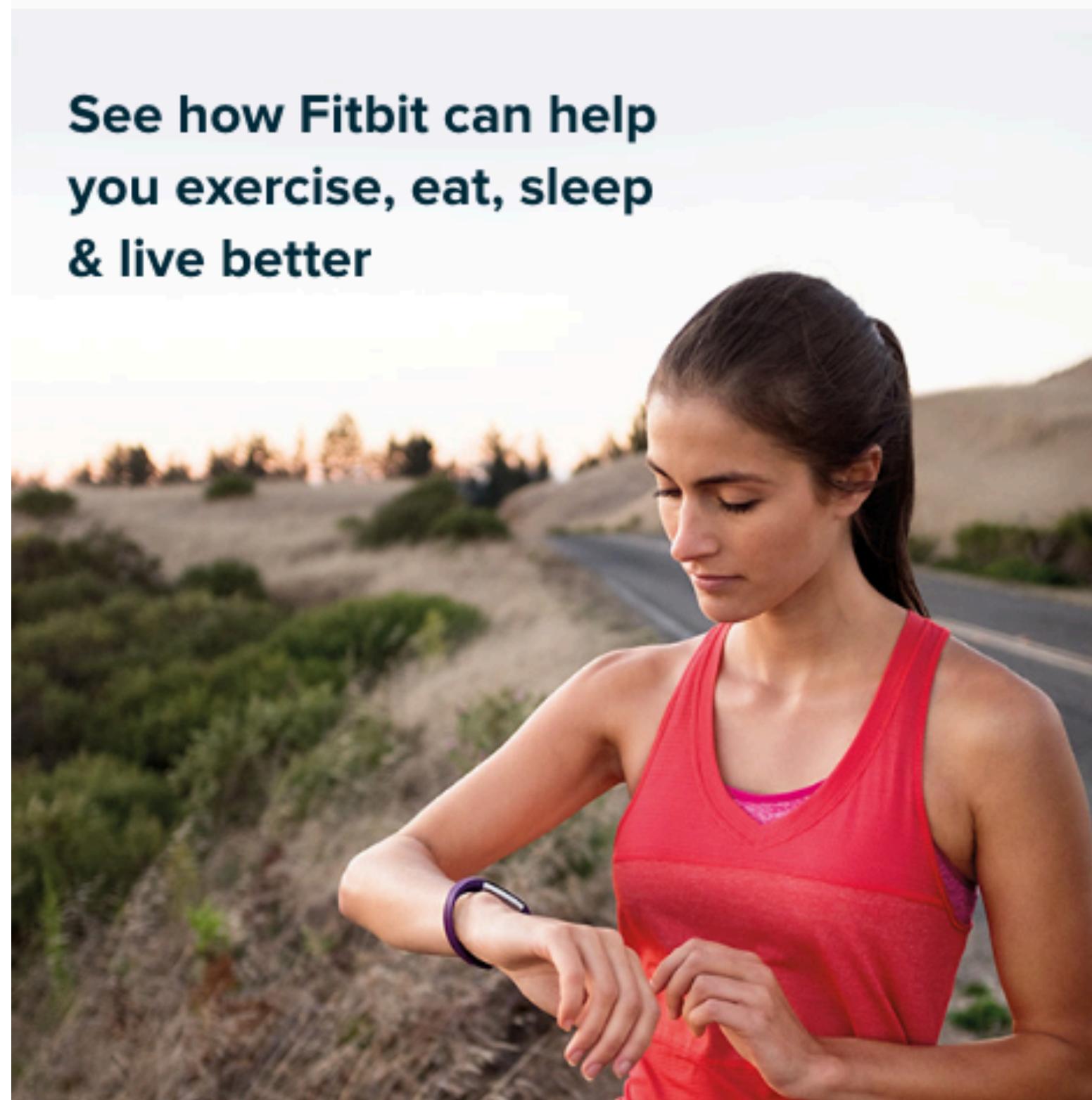
21% of the US



81% of the US
and 45% worldwide

Pew Research Center, 2018 & 2020

Consumer Health Technology



See how Fitbit can help
you exercise, eat, sleep
& live better

The landing page for MyFitnessPal. At the top, there is a large image of a white bowl filled with various fruits like strawberries, blueberries, and pineapple, next to a glass of orange juice. Below the image, the text "Lose Weight with MyFitnessPal" is displayed in large, white, sans-serif font. Underneath that, it says "The fastest, easiest to use calorie counter app." There are two sign-up buttons: one blue button with "Sign up with Facebook" and a white button with "Sign up with Email". At the bottom, there is a link "Already have an account? Log In".

Lose Weight with
MyFitnessPal

The fastest, easiest to use calorie counter app.

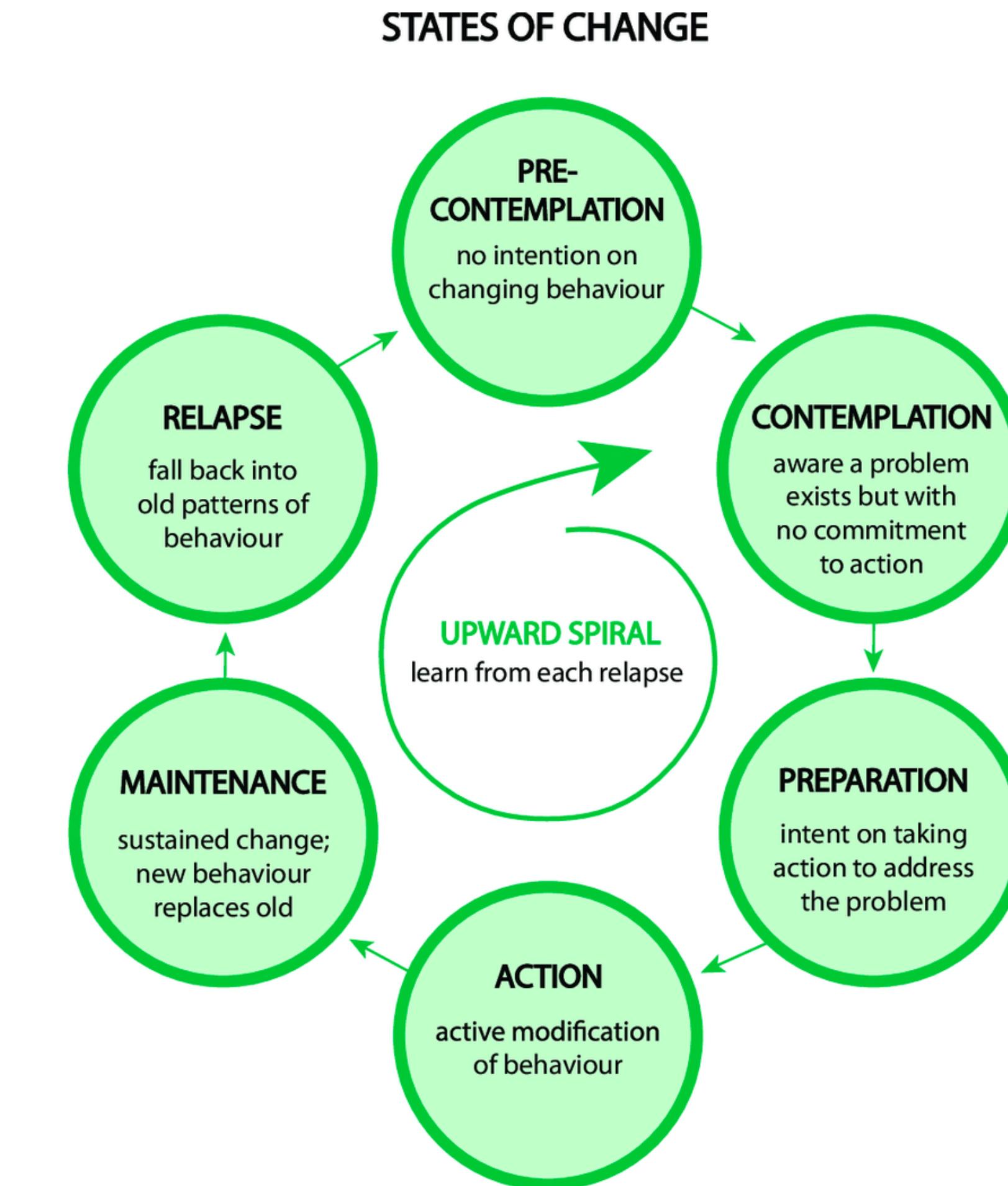
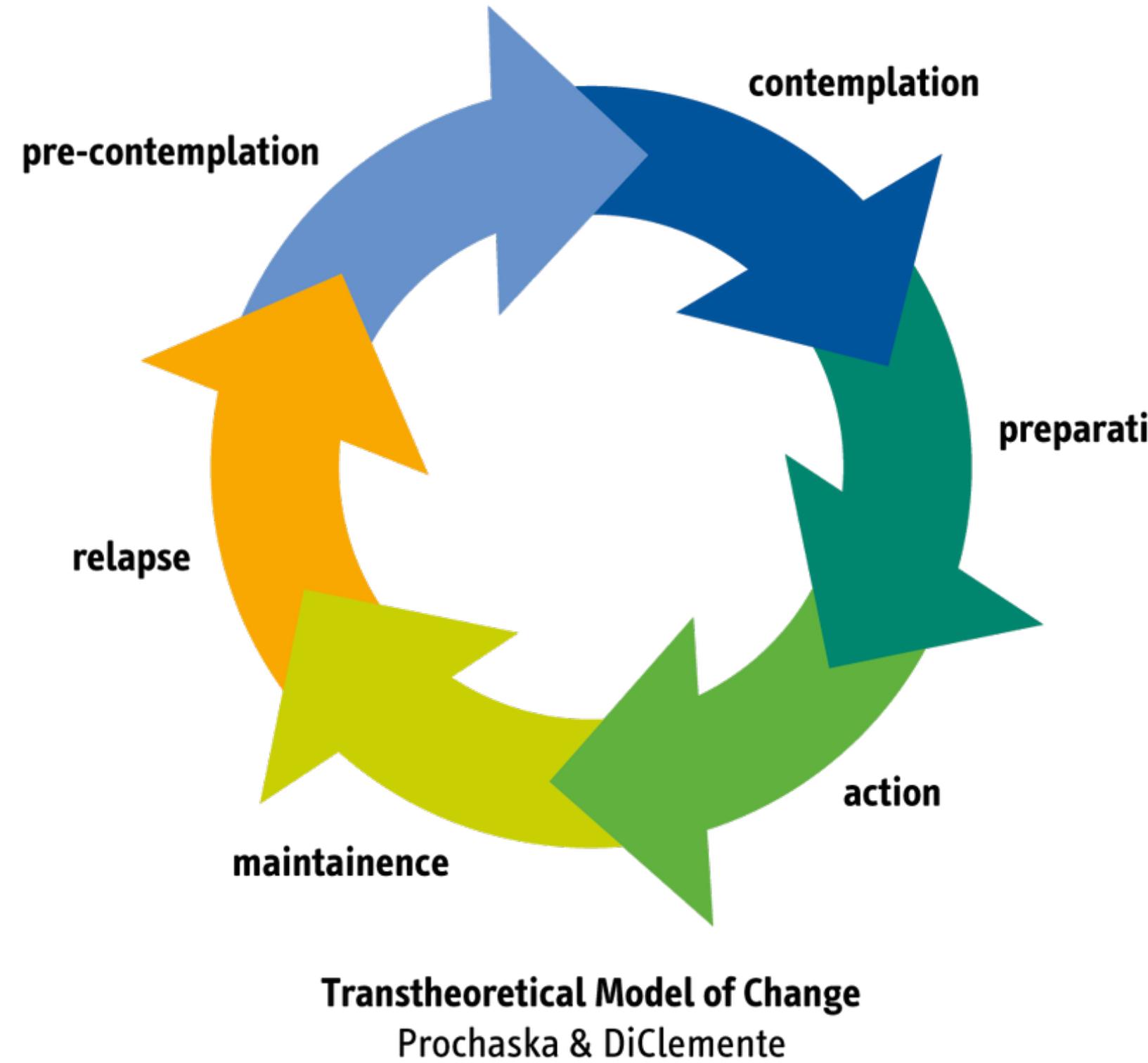
Sign up with Facebook Sign up with Email

Already have an account? [Log In](#)

Outline

- Motivating theory
- Classic examples
- Theory-research gap

Motivating theory



Prochaska & DiClemente. Toward a comprehensive model of change. Treating Addictive Behaviors, 1986

Motivating theory

Health Psychology
2008, Vol. 27, No. 3, 379–387

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0278-6133/08/\$12.00 DOI: 10.1037/0278-6133.27.3.379

A Taxonomy of Behavior Change Techniques Used in Interventions

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University of Sussex

Susan Michie
University College London

Objective: Without standardized definitions of the techniques included in behavior change interventions, it is difficult to faithfully replicate effective interventions and challenging to identify techniques contributing to effectiveness across interventions. This research aimed to develop and test a theory-linked taxonomy of generally applicable behavior change techniques (BCTs). **Design:** Twenty-six BCTs were defined. Two psychologists used a 5-page coding manual to independently judge the presence or absence of each technique in published intervention descriptions and in intervention manuals. **Results:** Three systematic reviews yielded 195 published descriptions. Across 78 reliability tests (i.e., 26 techniques applied to 3 reviews), the average kappa per technique was 0.79, with 93% of judgments being agreements. Interventions were found to vary widely in the range and type of techniques used, even when targeting the same behavior among similar participants. The average agreement for intervention manuals was 85%, and a comparison of BCTs identified in 13 manuals and 13 published articles describing the same interventions generated a technique correspondence rate of 74%, with most mismatches (73%) arising from identification of a technique in the manual but not in the article. **Conclusions:** These findings demonstrate the feasibility of developing standardized definitions of BCTs included in behavioral interventions and highlight problematic variability in the reporting of intervention content.

Keywords: behavior change, intervention, content, techniques, taxonomy, CONSORT

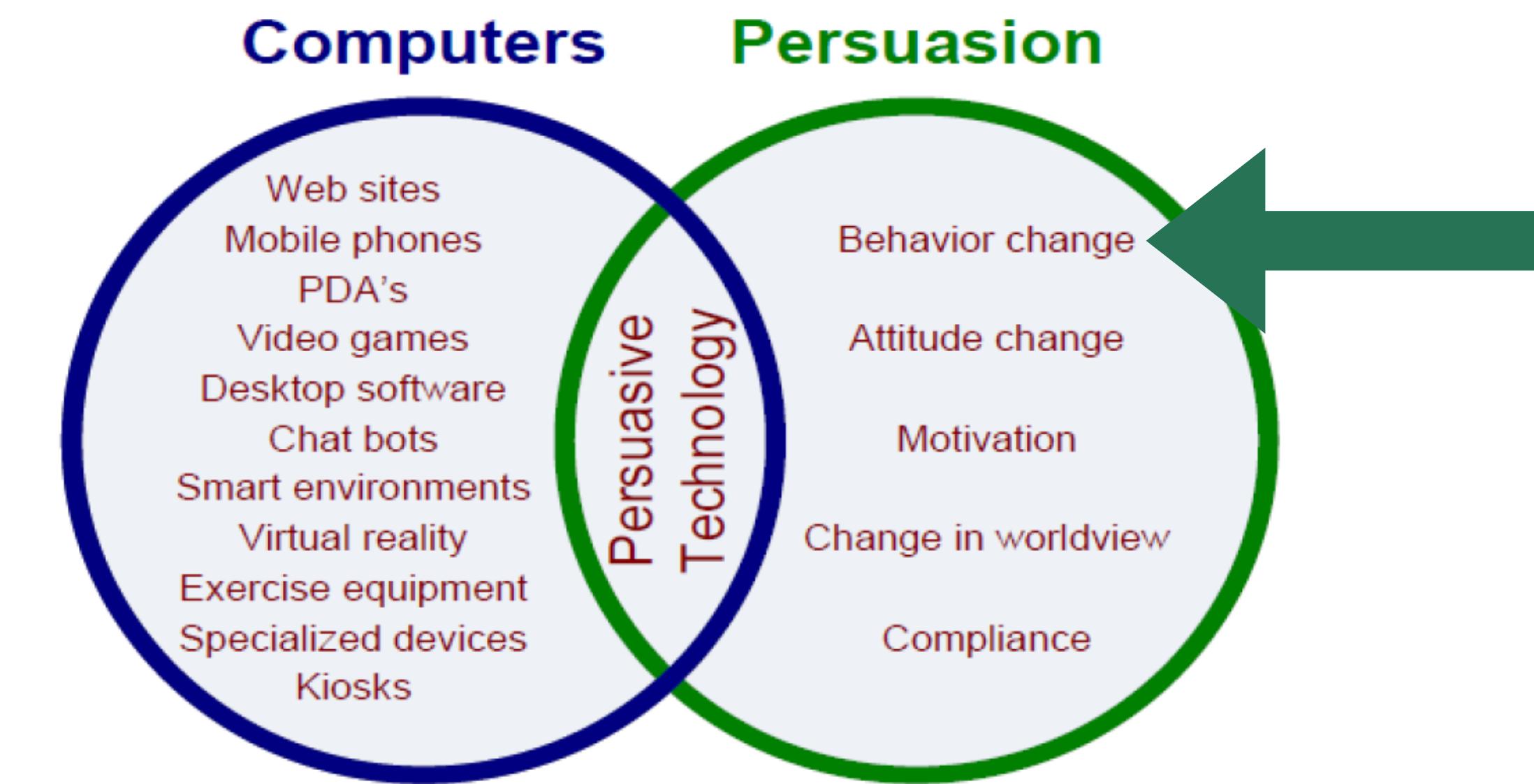
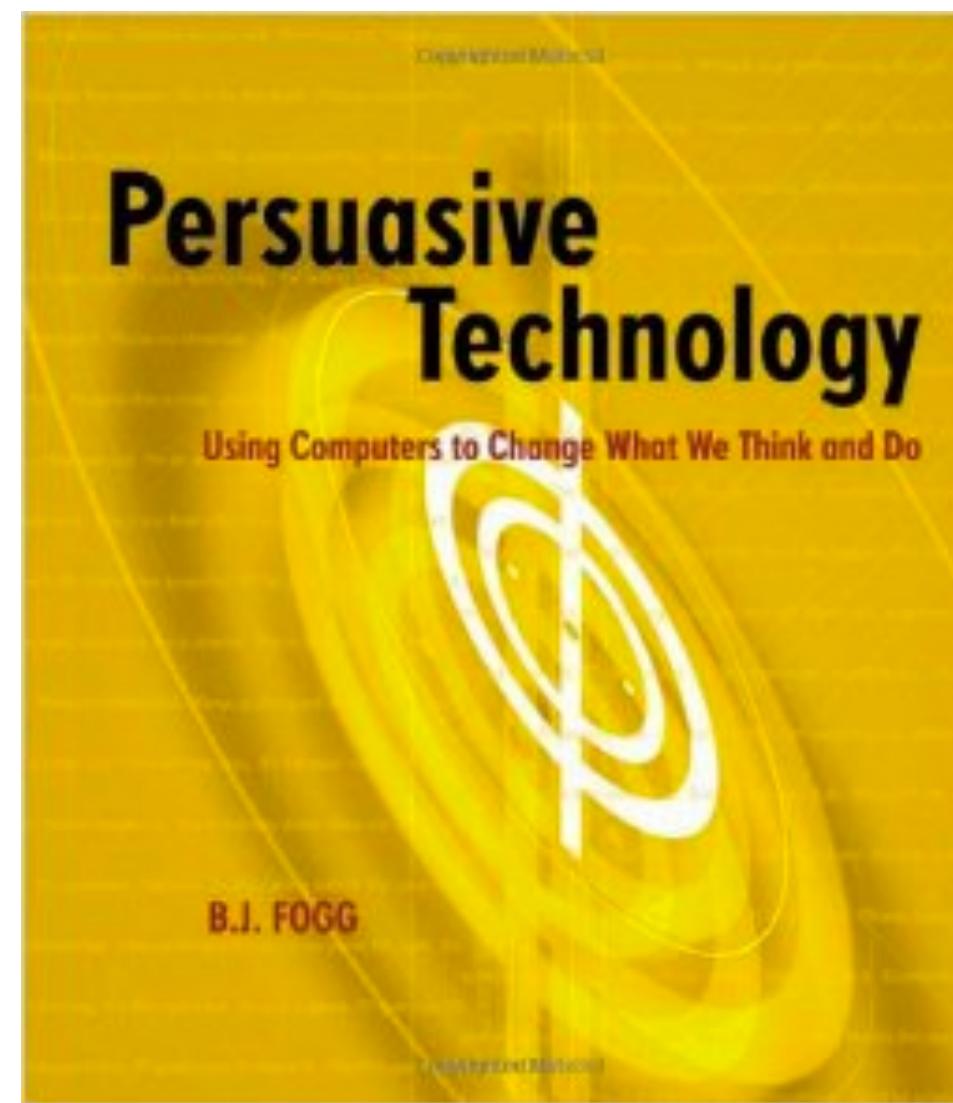
Abraham & Michie. A Taxonomy of Behavior Change Techniques Used in Interventions. Health Psychology, 2008

Motivating theory

Table 1
Definitions of 26 Behavior Change Techniques and Illustrative Theoretical Frameworks

Technique (theoretical framework)	Definition
1. Provide information about behavior-health link. (IMB)	General information about behavioral risk, for example, susceptibility to poor health outcomes or mortality risk in relation to the behavior
2. Provide information on consequences. (TRA, TPB, SCogT, IMB)	Information about the benefits and costs of action or inaction, focusing on what will happen if the person does or does not perform the behavior
3. Provide information about others' approval. (TRA, TPB, IMB)	Information about what others think about the person's behavior and whether others will approve or disapprove of any proposed behavior change
4. Prompt intention formation. (TRA, TPB, SCogT, IMB)	Encouraging the person to decide to act or set a general goal, for example, to make a behavioral resolution such as "I will take more exercise next week"
5. Prompt barrier identification. (SCogT)	Identify barriers to performing the behavior and plan ways of overcoming them
6. Provide general encouragement. (SCogT)	Encouraging the person for effort or performance without this being contingent on specified behaviors or standards of performance
7. Set graded tasks. (SCogT)	Set easy tasks, and increase difficulty until target behavior is performed.
8. Provide instruction. (SCogT)	Telling the person how to perform a behavior and/or preparatory behaviors
9. Model or demonstrate the behavior. (SCogT)	An expert shows the person how to correctly perform a behavior, for example, in class or on video
10. Prompt specific goal setting. (CT)	Specified planning of what the person will do, including a definition of the behavior specifying frequency, intensity, or duration and specification of at least one context, that is, where, when, how, or with whom

Motivating theory

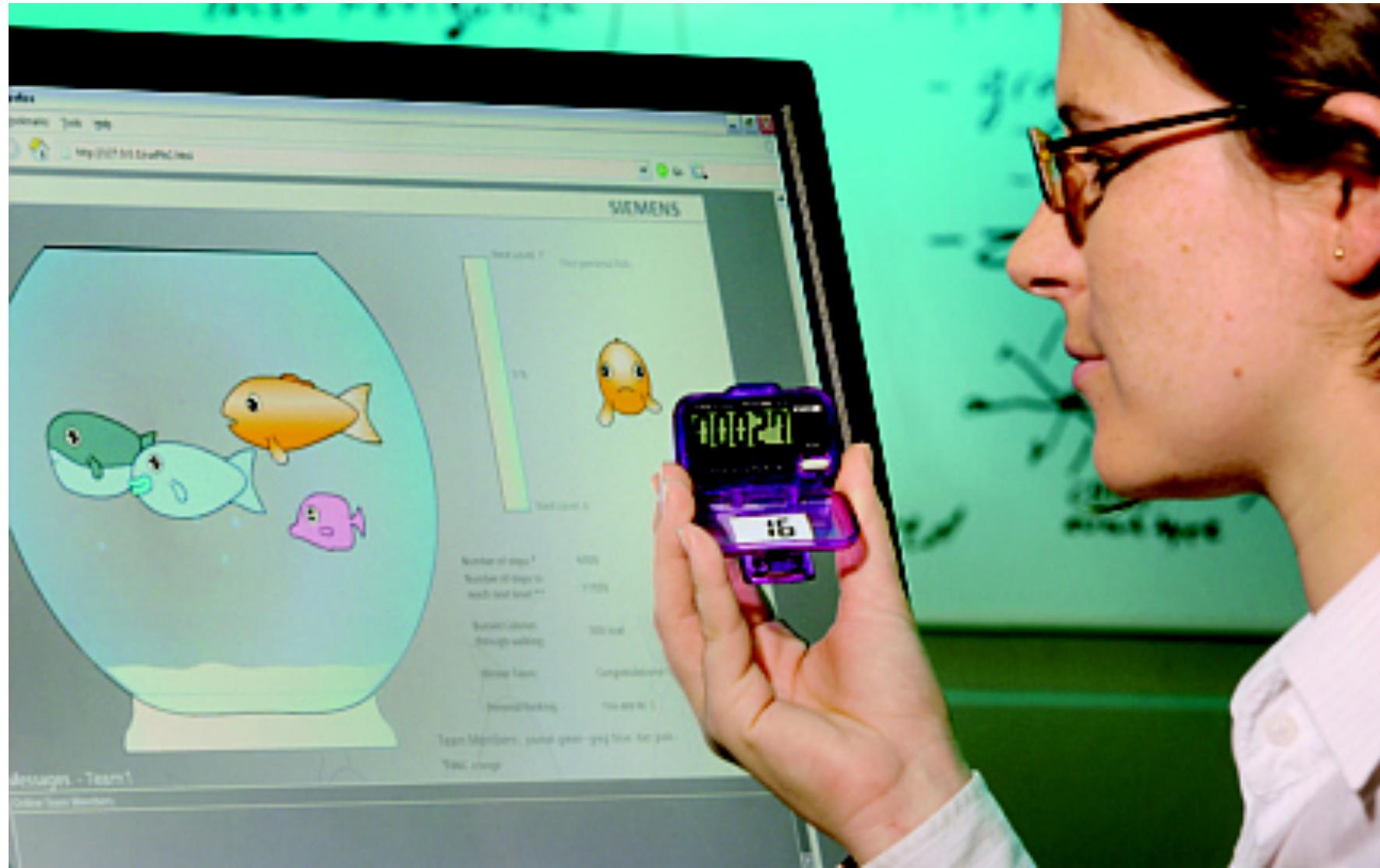


Fogg. Persuasive Computers: Perspectives and Research Directions. CHI 1998

Outline

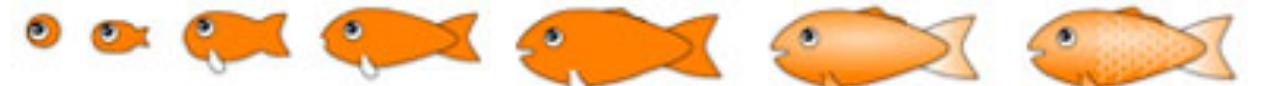
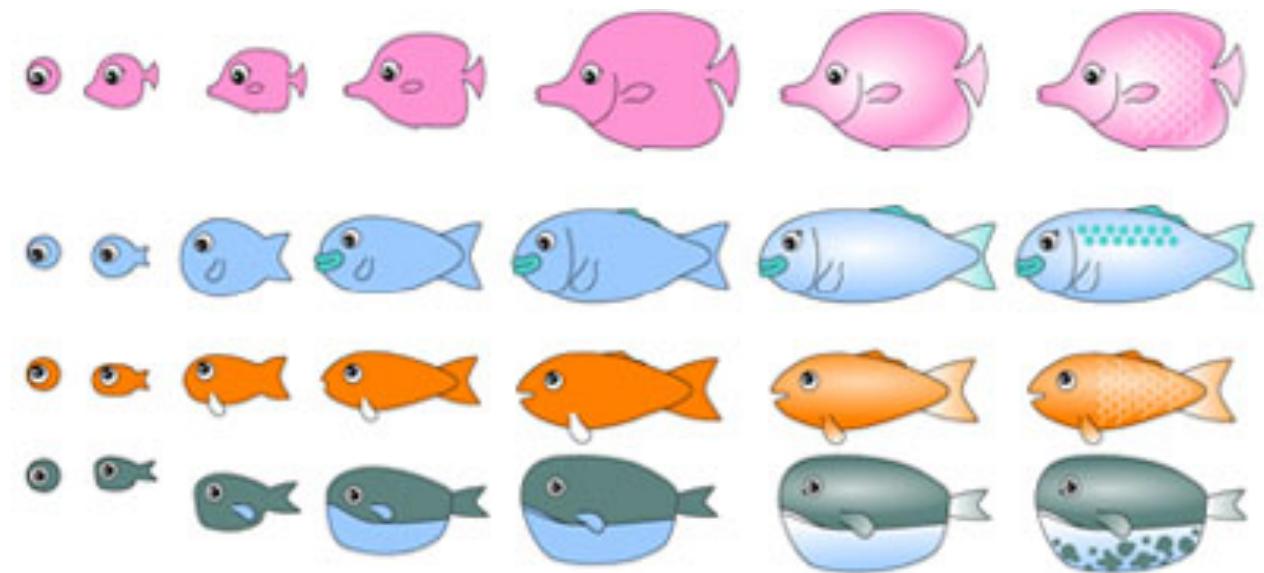
- Motivating theory
- Classic examples
- Theory-research gap

Fish'N'Steps

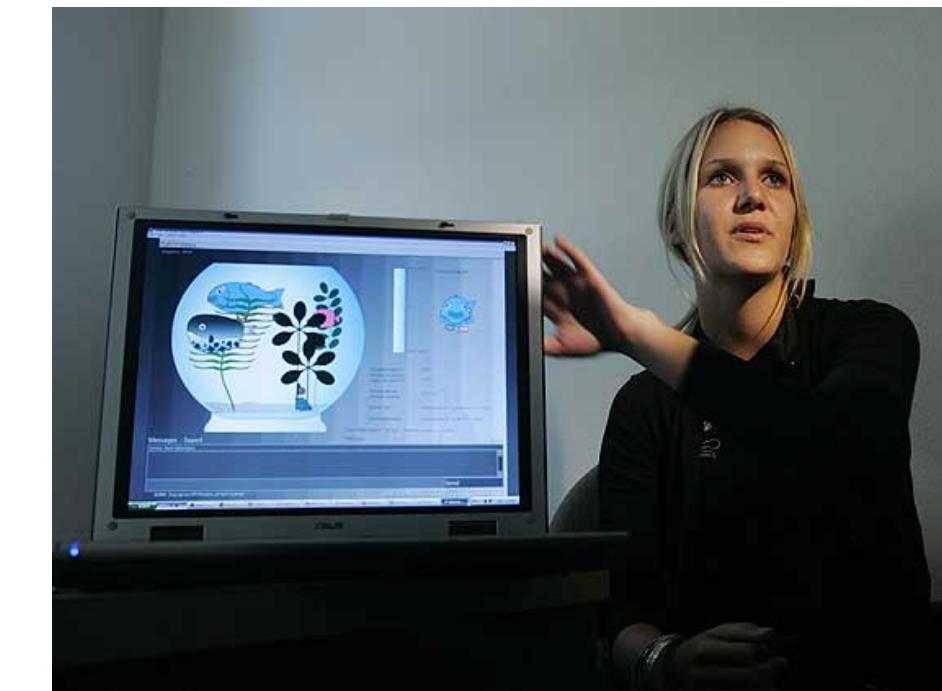


Lin, Mamykina, Lindtner, Delajoux, Strub. *Fish'n'Steps: Encouraging Physical Activity with an Interactive Computer Game.* UbiComp 2006.

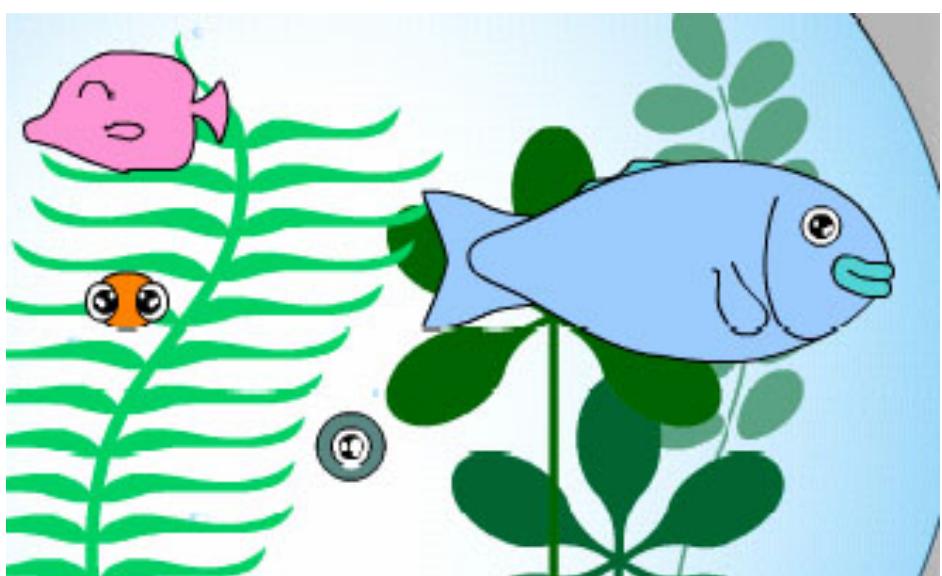
Fish'N'Steps



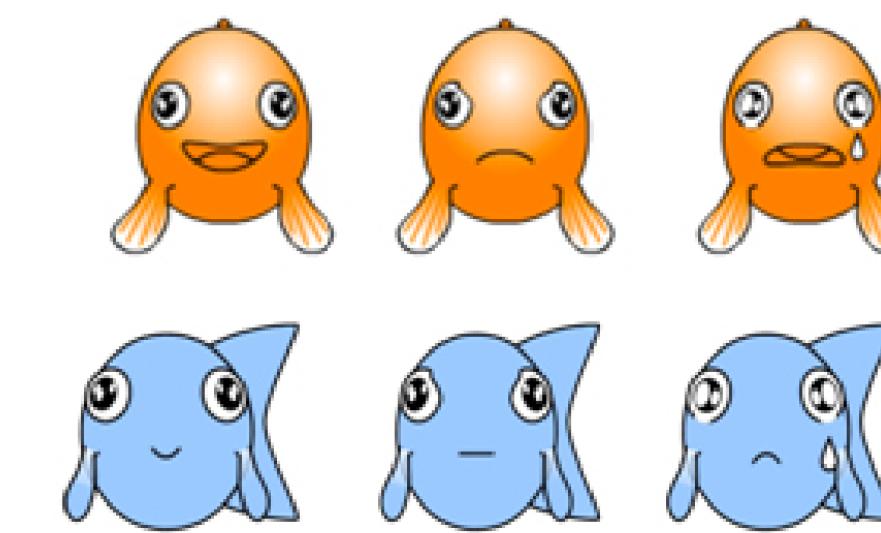
Achievement



Public Display



Teams



Punishment

Lin, Mamykina, Lindtner, Delajoux, Strub. *Fish'n'Steps: Encouraging Physical Activity with an Interactive Computer Game.* UbiComp 2006.

Fish'N'Steps

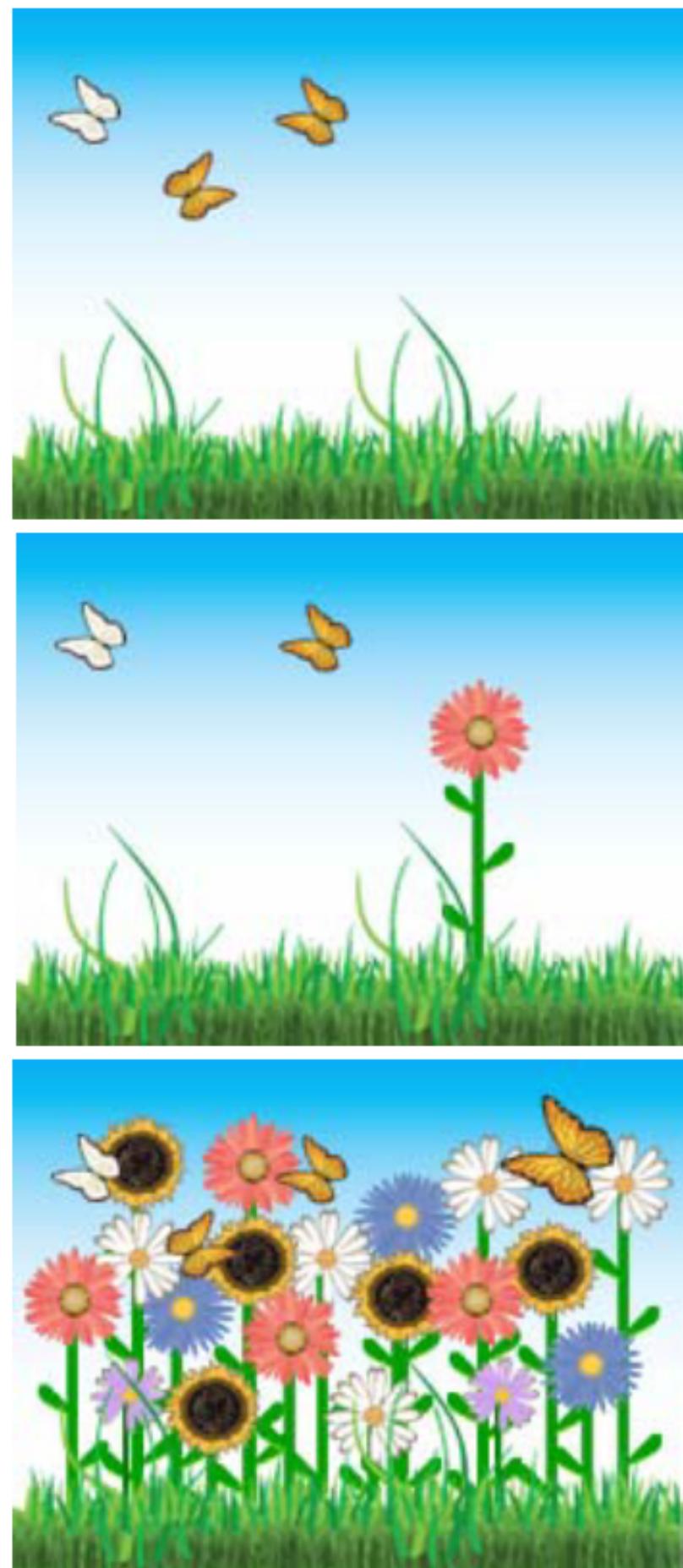
Table 1. TTM assessment results – pre-study

Level	Definition	Example evidence
1	No intention to take action in the next 6 months	"I had a membership at a gym last year, but dropped out. I don't have time anymore because of the baby." "I don't have an exercise routine or goal. I am not member of a gym. Doctor suggested me to do more exercising, but I didn't follow that advice."
2	Intention to take action within the next 6 months	"I am member of a gym, but I have never been there. I am thinking about going there."
3	Intention to take action within the next 30 days and some initial steps towards that action	"I don't have an exercise routine. But I want to develop one now and hope that this study helps me. I have never been in a gym. My exercise goal is to start exercising now."
4-5	Change in behavior occurred at some point in the past, but have not developed into habit	"I have a routine: 3 days a week squash and weights, 45 min total. I am member of a gym and usually exercise there."
6	Overt behavior will never return, and there is complete confidence in coping without fear of relapse.	"I have had the same morning routine for 11 years now; it includes a jog and an hour of yoga and then my coffee and a newspaper"

Table 2. Cumulative TTM assessment results – pre-study and post-study. Gray rows indicate participants who achieved positive change in their daily steps.

#	Pre-study level	Pre-study steps	Post-study level	Post-study steps	Change
1	1	5,175	4	7,000	1,825
2	1	6,214	4	4,572	-1,642
3	1	7,140	2	6,676	-464
4	1	5,880	2	1,800	-4,080
5	2	4,904	2	3,742	-1,162
6	3	3,868	4	7,596	3,728
7	3	7,610	3	6,880	-730
8	3	5,849	4	8,832	2,983
9	3	1,884	3	1,920	36
10	3	5,104	4	9,494	4,390
11	3	6,546	4	11,725	5,179
12	4-5	3,705	4-5	6,016	2,311
13	4-5	7,756	5	10,616	2,860
14	4-5	11,667	5	15,012	3,345
15	4-5	6,666	4-5	7,026	360
16	6	9,378	6	9,187	-191
17	6	10,284	6	16,496	6,212
18	6	11,639	6	10,021	-1,618
19	6	7,171	6	8,123	952

Ubifit



Consolvo, Klasnja, McDonald, Avrahami, Froehlich, LeGrand, Libby, Mosher, Landay. *Flowers or a Robot Army? Encouraging Awareness & Activity with Personal, Mobile Displays.* UbiComp 2008.

UbiFit

-  cardio
-  strength training
-  flexibility training
-  walk
-  “other”
-  primary goal met
-  alternate goal met



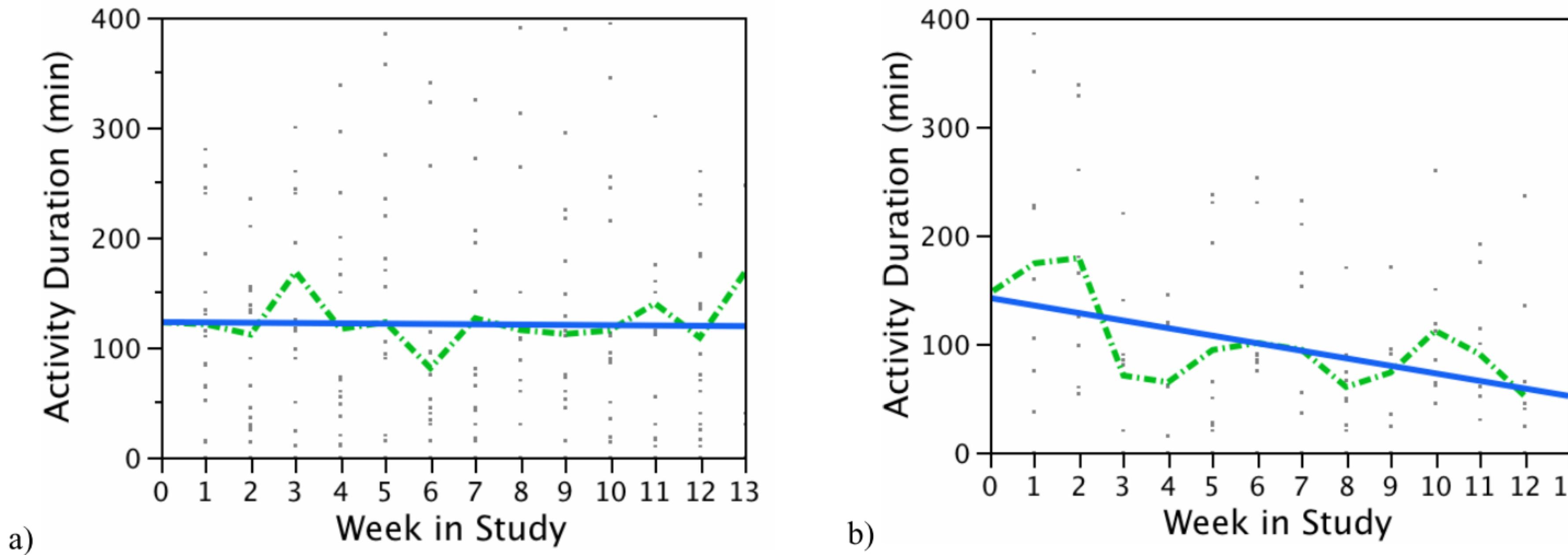
Consolvo, Klasnja, McDonald, Avrahami, Froehlich, LeGrand, Libby, Mosher, Landay. *Flowers or a Robot Army? Encouraging Awareness & Activity with Personal, Mobile Displays.* UbiComp 2008.

UbiFit



Consolvo, Klasnja, McDonald, Avrahami, Froehlich, LeGrand, Libby, Mosher, Landay. *Flowers or a Robot Army? Encouraging Awareness & Activity with Personal, Mobile Displays.* UbiComp 2008.

Ubifit



**Figure 4. Activity Duration (in minutes per week) over the course of the study for
a) participants with the Glanceable Display, and b) participants without the Glanceable Display.** The dashed lines
are best fit lines, and the solid lines are linear trend lines.

Consolvo, Klasnja, McDonald, Avrahami, Froehlich, LeGrand, Libby, Mosher, Landay. *Flowers or a Robot Army? Encouraging Awareness & Activity with Personal, Mobile Displays*. UbiComp 2008.

Fitbit

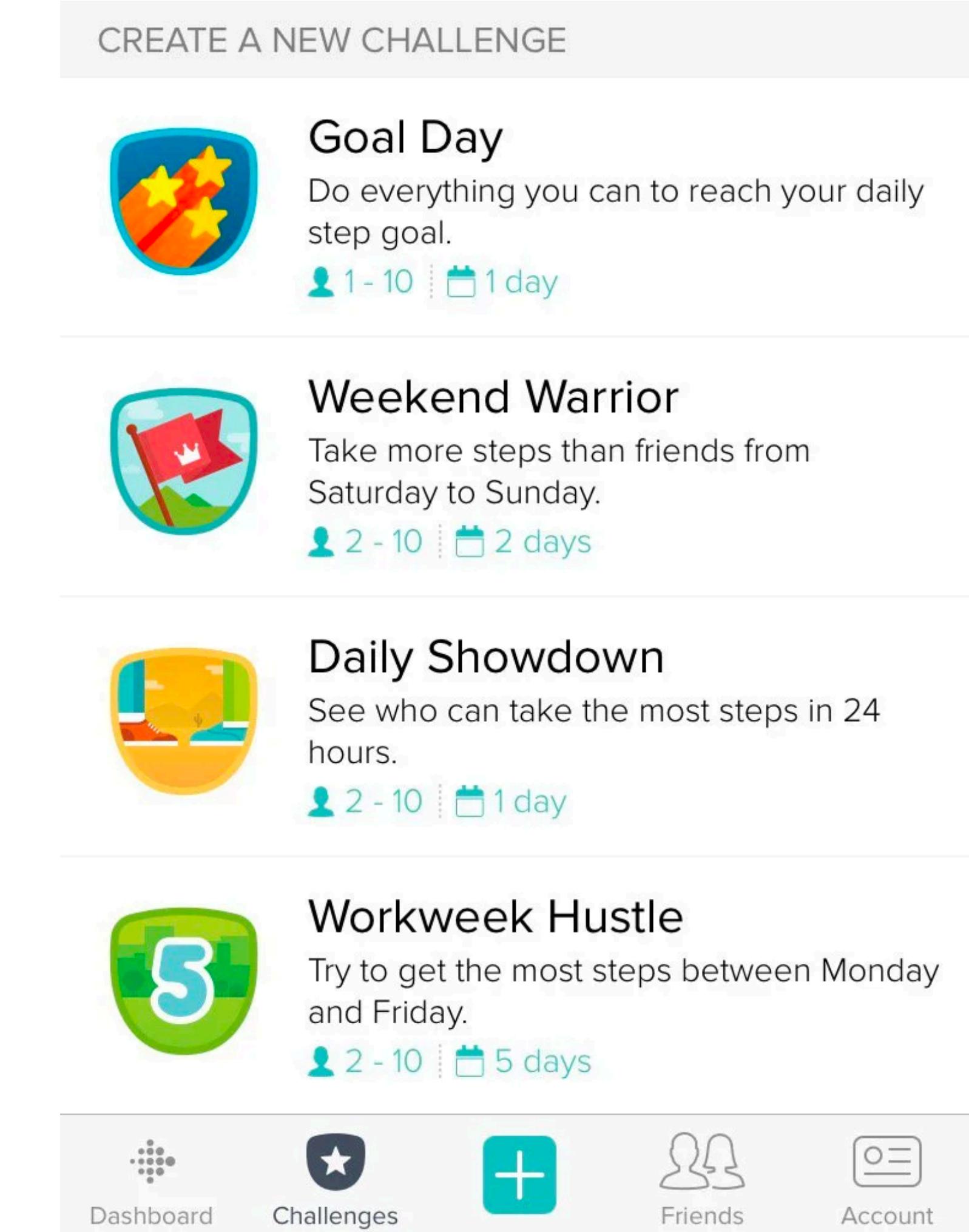


Fitbit

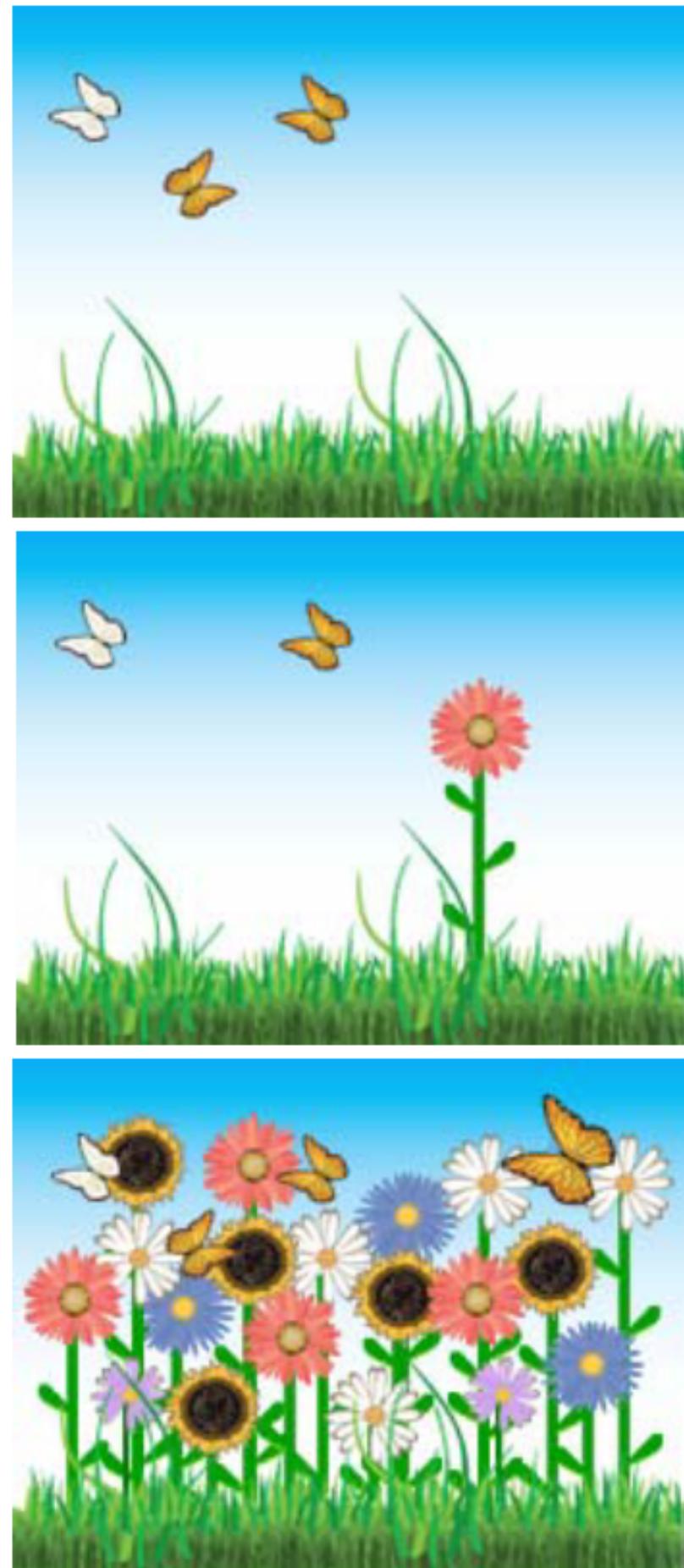


Leaderboard		
TOP	FRIENDS	LOCAL
#31	Lloyd 95 104 steps	
#32	Joann 95 002 steps	
#33	Rashell 94 341 steps	
#34	Leanne 93 324 steps	
#35	Becky 93 270 steps	
#36	Jay 93 217 steps	
#37	Christoph	

Bottom navigation: Dashboard, Challenges, Friends, Account.

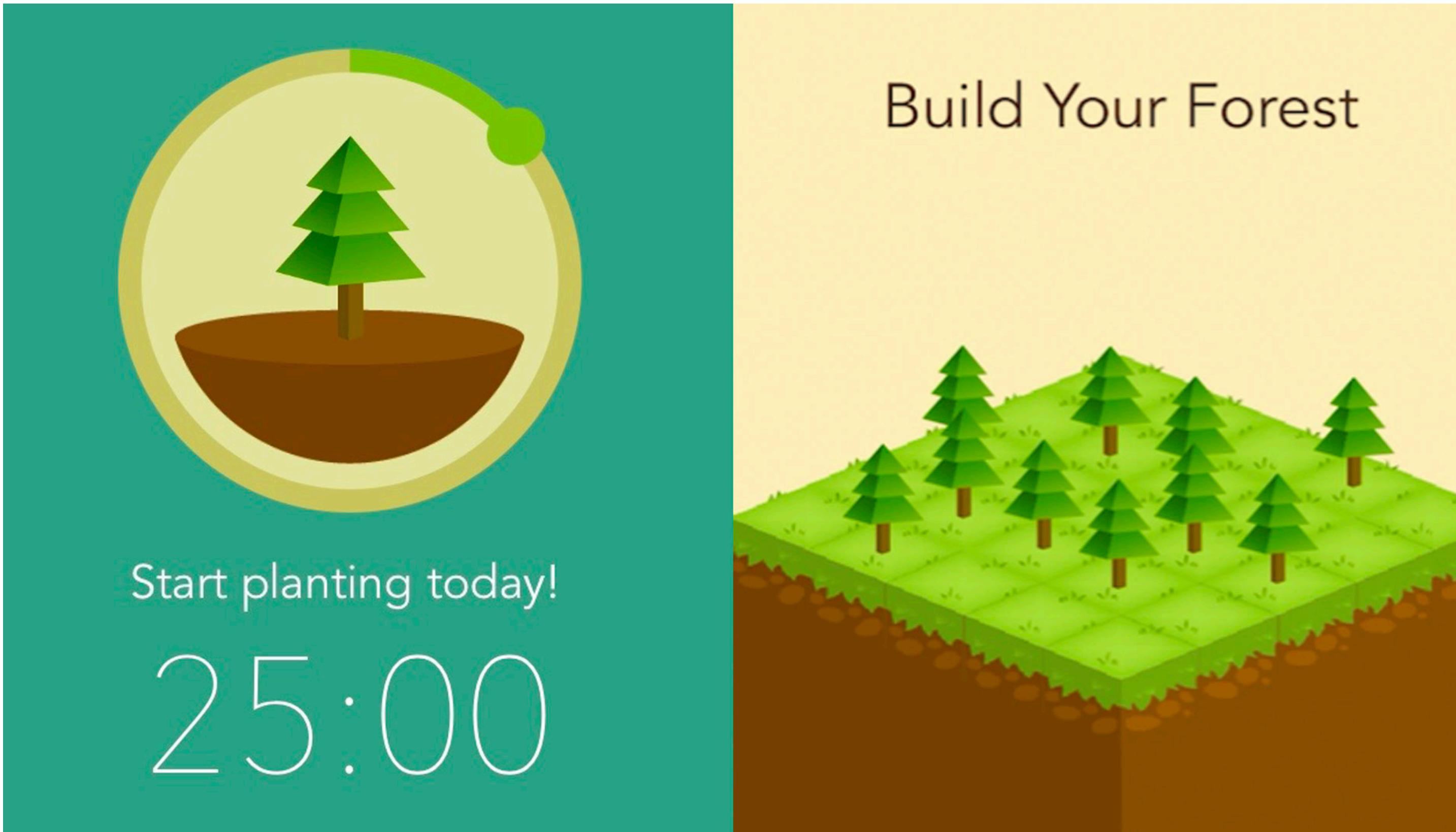


Fitbit



<https://bits.blogs.nytimes.com/2009/12/10/fitbits-motivator-a-virtual-flower/>

Forest



<https://www.forestapp.cc/>

Outline

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- Classic examples
- Theory-research gap

Theory-research gap

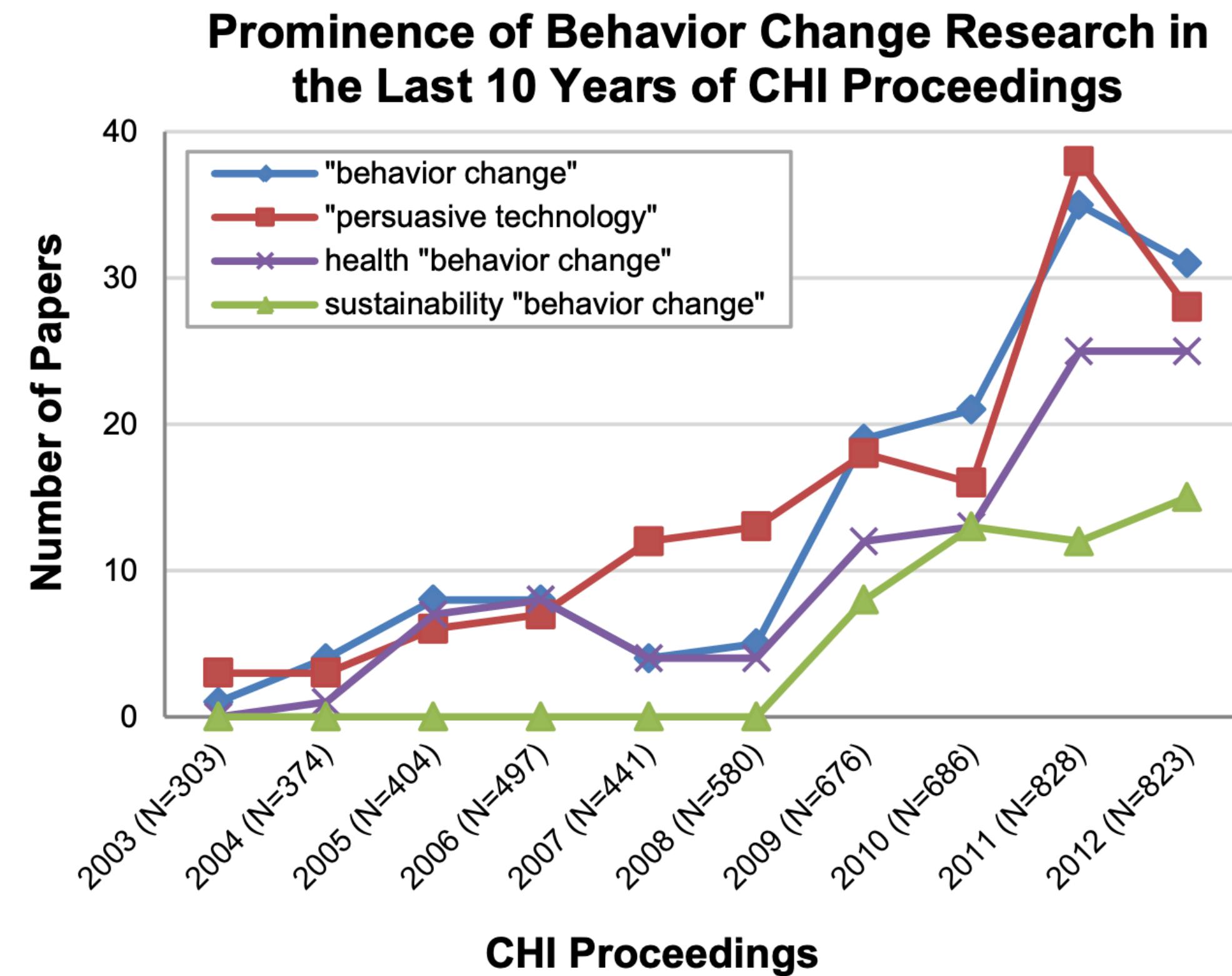


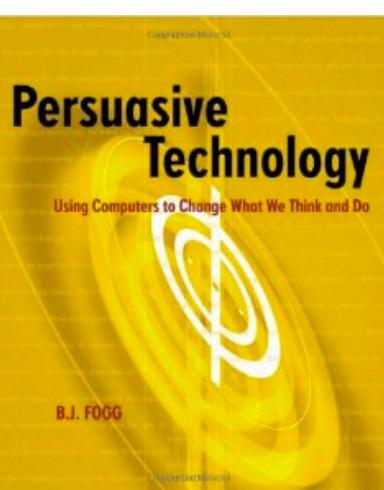
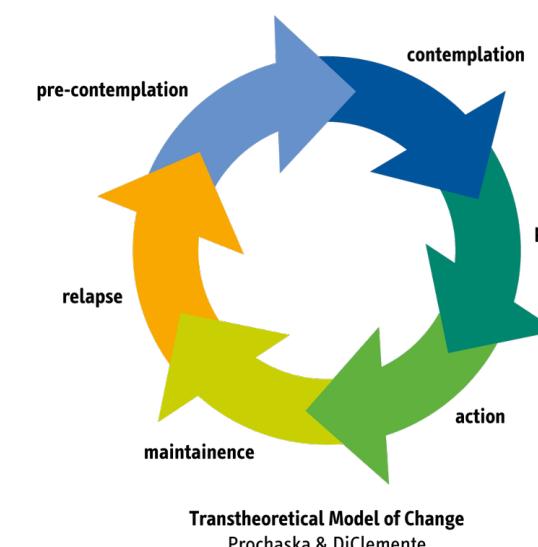
Figure 1: The prominence of behavior change related research in the last 10 years of CHI proceedings. Specific search terms (including quotes) are shown in the legend.

Hekler, Klasnja, Froehlich, Bauman. *Mind the Theoretical Gap: Interpreting, Using, and Developing Behavioral Theory in HCI research*. CHI 2013.

Theory-research gap

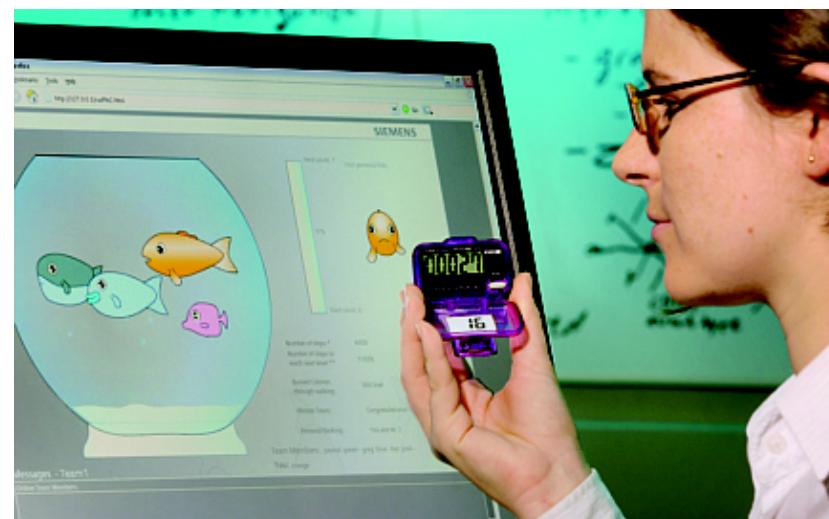
Low Specificity,
High Generalizability

Meta-models



High Specificity
Low Generalizability

Constructs



Hekler, Klasnja, Froehlich, Bauman. *Mind the Theoretical Gap: Interpreting, Using, and Developing Behavioral Theory in HCI research*. CHI 2013.

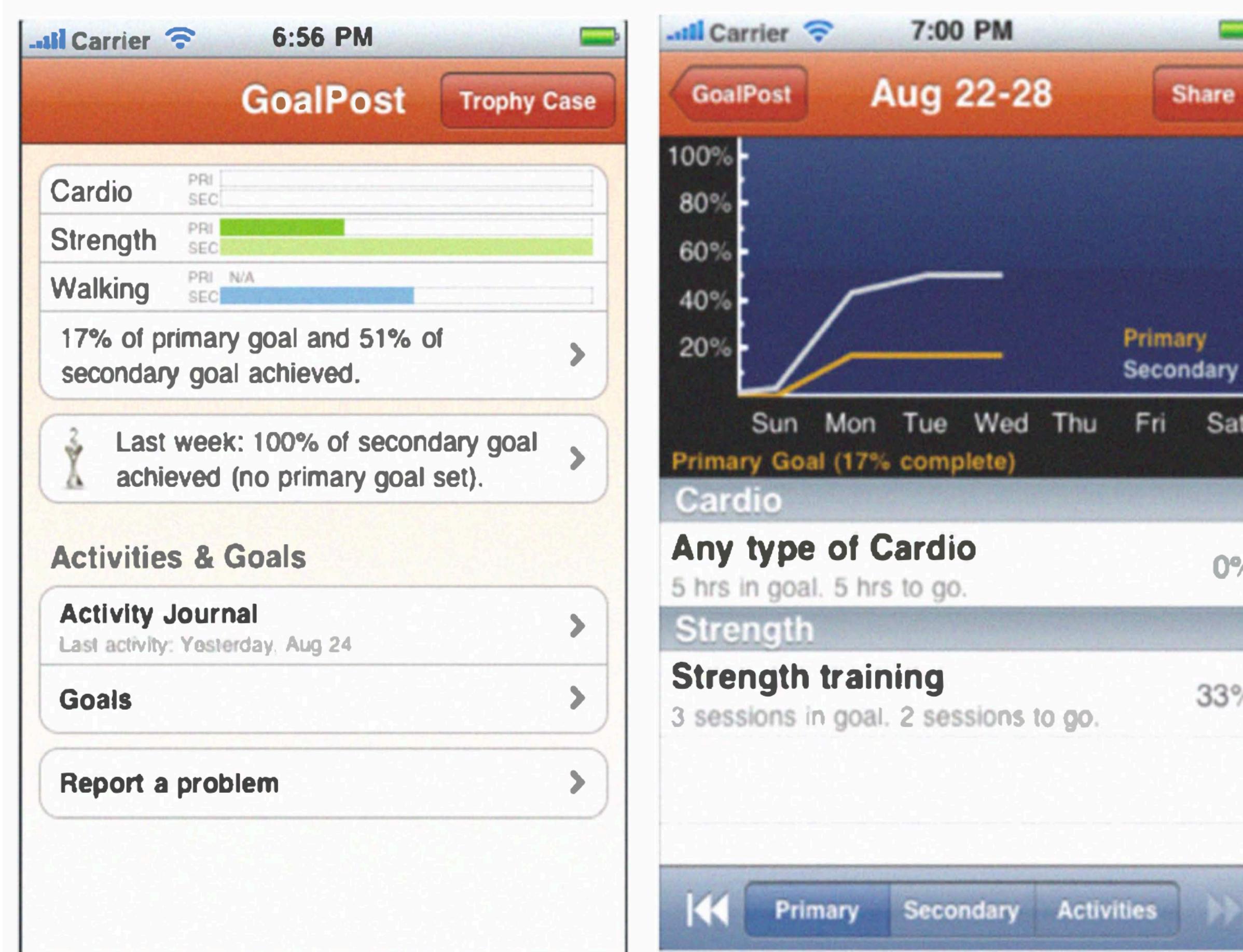
Theory-research gap

- There is often no “guidebook” for how to apply theoretical principles into technology
- We should empirically “try out” different approaches to implementing strategies
 - Design, develop, & evaluate systems

Hekler, Klasnja, Froehlich, Bauman. *Mind the Theoretical Gap: Interpreting, Using, and Developing Behavioral Theory in HCI research.* CHI 2013.

**10 design ideas:
“Prompt specific goal-setting” in an app/
device for promoting physical activity**

Theory-research gap



Primary & secondary goals

Munson, Consolvo. *Exploring Goal-setting, Rewards, Self-monitoring, and Sharing to Motivate Physical Activity*. PervasiveHealth 2012.

Theory-research gap

- There is often no “guidebook” for how to apply theoretical principles into technology
- We should empirically “try out” different strategies
 - Design, implement, & evaluate design approaches
- This empirical work can inform guidelines, which can be further tested
 - Vary the domains in which they’re tested (physical activity, diet, sustainability)
 - Vary the populations (age, education, socioeconomic, race, gender)

Hekler, Klasnja, Froehlich, Bauman. *Mind the Theoretical Gap: Interpreting, Using, and Developing Behavioral Theory in HCI research.* CHI 2013.

Theory-research gap

- One would typically use a Randomized Control Trial (RCT) to evaluate a behavior change technique
 - Randomly assign people to receive a treatment (change technique) or a control
 - Give them the treatment for long enough to evaluate persistent change versus a novelty effect
 - Measure the desired “outcome” (weight loss, increased exercise, improved diet, etc.)

Theory-research gap

- In the HCI/Ubicomp space, we're "rewarded" for design novelty
- Longitudinal evaluation is typically not expected
 - Would stifle creativity & slow down the research process
 - Would be premature; we have little evidence of the effectiveness of most of our designs

Theory-research gap

- Alternative approaches to longitudinal evaluation:
 - Evaluate efficacy (quantitative scales indicating readiness to change behavior)
 - Qualitatively assess validity and elaborate on what worked & what didn't
 - More clever experimental designs for varying within-subjects (ABAB)
 - Qualitatively/Quantitatively assess “mediators” like demographics

Discussion topics (as time allows)

- Which behavior change strategies are most useful in technology?
 - Arthur, Lika, Neeraj, Jason
- How does the theory relate to persuasive technology that's not intended for behavior change? Is there a such thing as “too much” intervention?
 - Jo, Myles, Dennis
- Could technology better leverage other theories that haven't been mentioned?
 - Colby

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