



Wearable Technologies for Changing Nutrition Behavior

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Disclosure & Acknowledgements

- Actigraph Scientific Advisory Board



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C. Pellegrini

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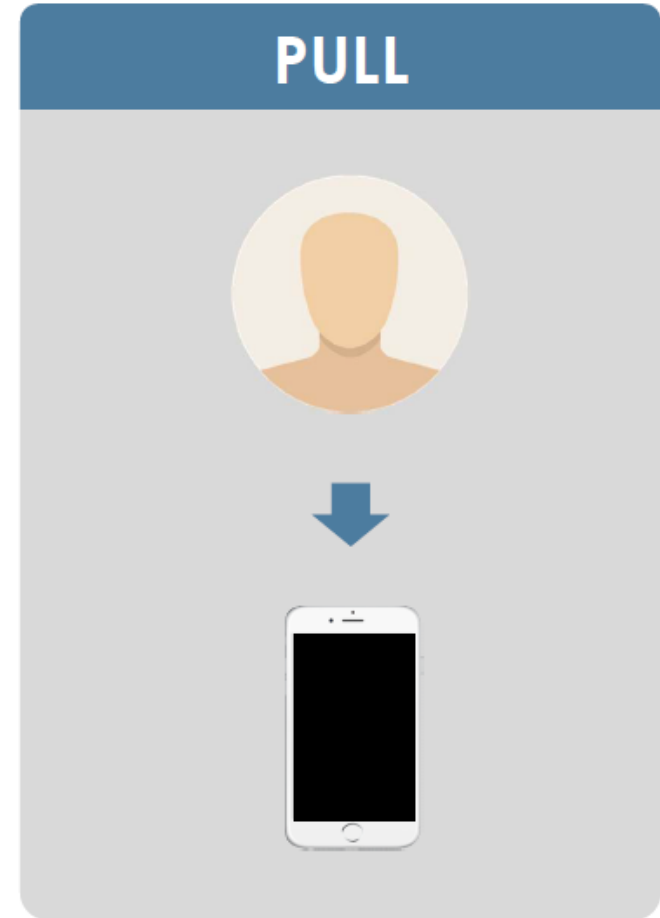
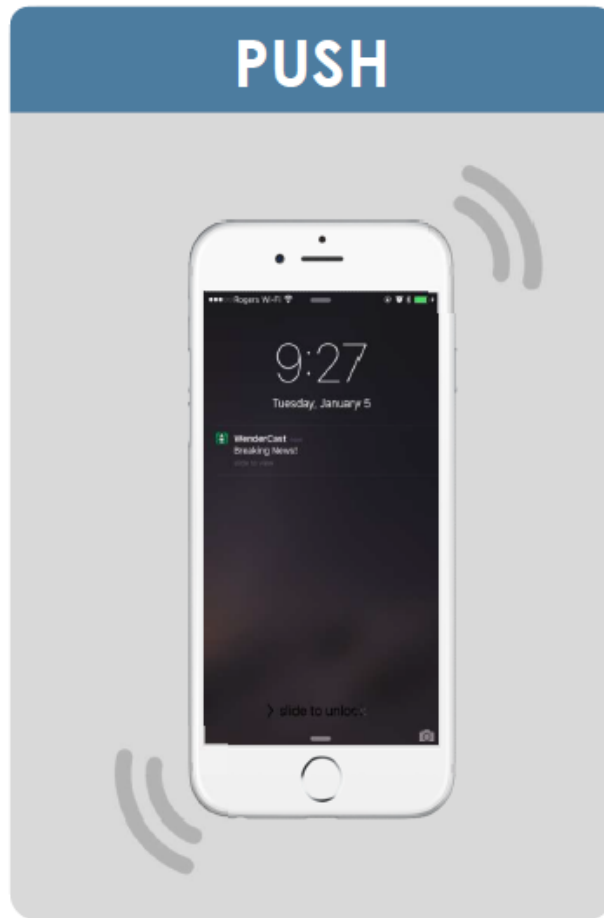


Back row (L to R): Angela Pfammatter, PhD; Alexa Mitsos; Philip Rak, MBA; Sean Arca; Gene McFadden; Bonnie Spring, PhD, ABPP; Laura Martindale; Shirlene Wang; Ekaterina Klyachko, PhD; Gleb Iakovlev; Susan Hood, PhD
Front row (L to R): Sara Hoffman, MS; Alejandra Povedano; Elyse Daly; Sasha Cukier; Margaret DeZelar; Hannah Rumsey; Tammy Stump, PhD; JC Subida

Three Questions

- What mobile technologies work to change nutrition behavior?
- Are there any wearable technologies that change eating behavior?
- The potential of wearables for eating behavior change

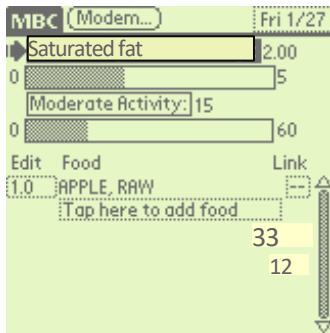
Mobile Intervention Treatments



What technologies work to change nutrition behavior?

Validation criteria: *intermediate endpoints, proximal outcomes:* weight loss; fruit & vegetable grocery receipts

Technology-Assisted Weight Loss



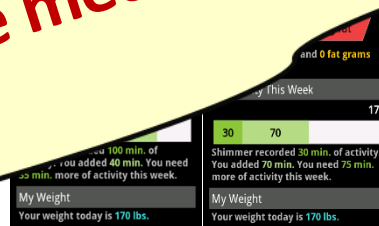
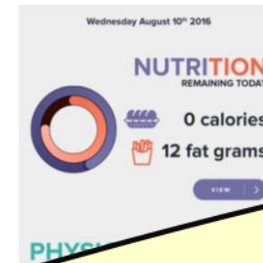
HL075451

Behavior Change
Techniques



The widget does nothing on its own. It engages behavior change mechanisms. PULL interventions

Support/
Accountability



DK087126
DK097364



Multiple diet &
activity change

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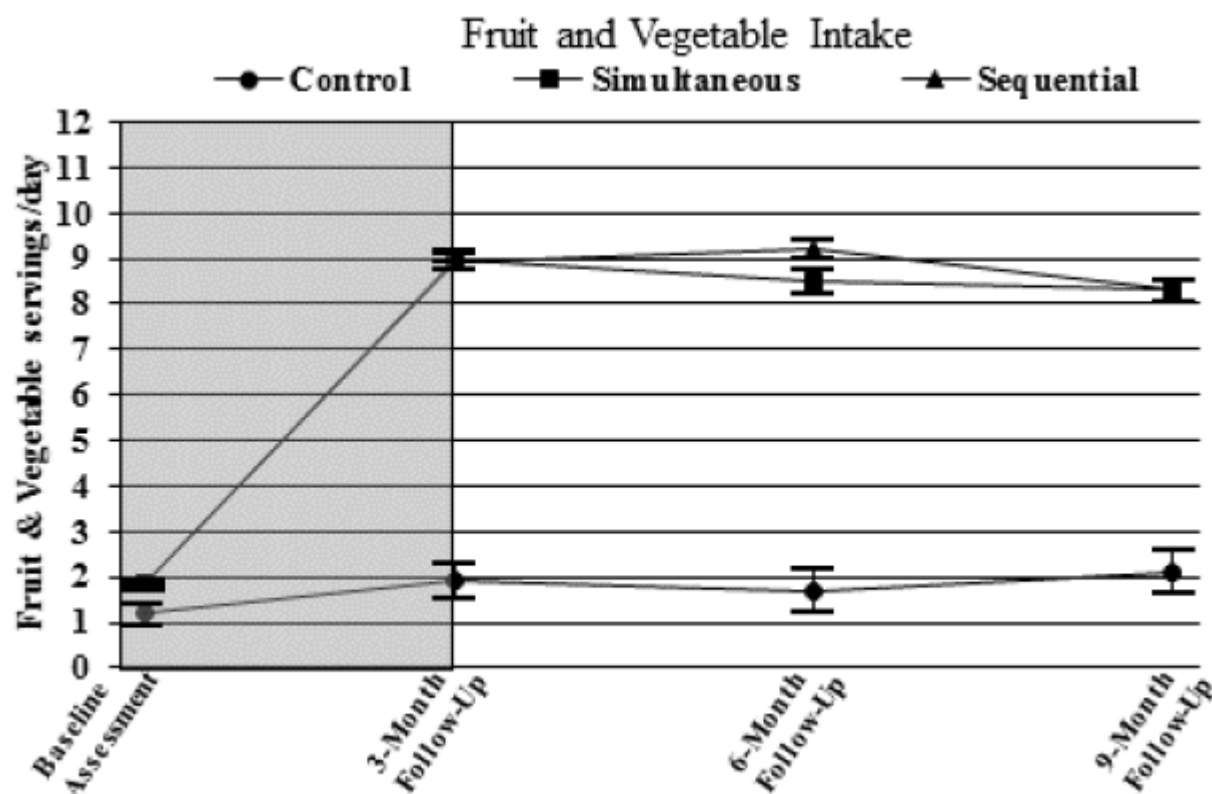
Original Paper

Multicomponent mHealth Intervention for Large, Sustained Change in Multiple Diet and Activity Risk Behaviors: The Make Better Choices 2 Randomized Controlled Trial

(J Med Internet Res 2018;20(6):e10528)

Bonnie Spring¹, PhD; Christine Pellegrini¹, PhD; H G McFadden¹, BS; Angela Fidler Pfammatter¹, PhD; Tammy K Stump¹, PhD; Juned Siddique¹, DrPH; Abby C King², PhD; Donald Hedeker³, PhD

¹University of Illinois at Chicago, Chicago, IL, USA; ²University of Illinois at Chicago, Chicago, IL, USA; ³University of Illinois at Chicago, Chicago, IL, USA



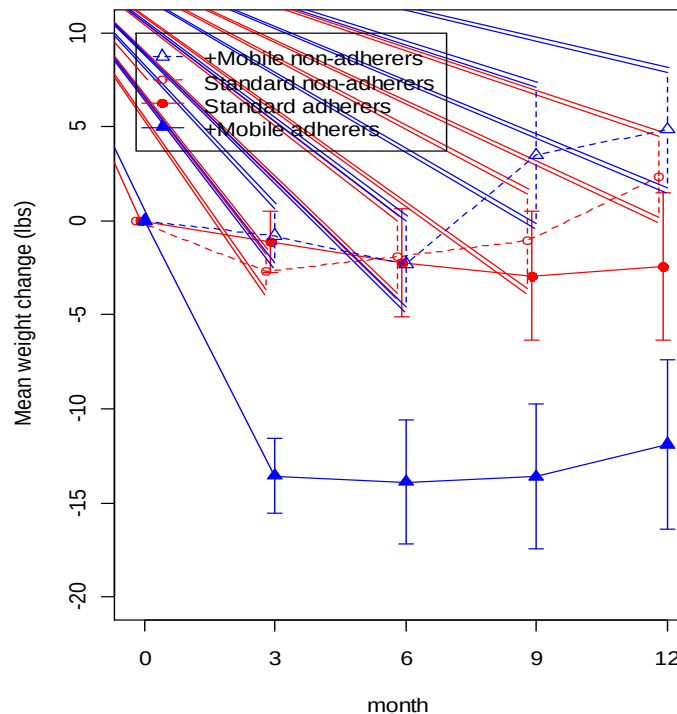
Integrating Technology Into Standard Weight Loss Treatment

A Randomized Controlled Trial

JAMA Intern Med. 2013;173(2):105-111.

Bonnie Spring, PhD; Jennifer M. Duncan, PsyD; E. Amy Janke, PhD; Andrea T. Kozak, PhD;
H. Gene McFadden, BA; Andrew DeMott, BA; Alex Pictor, BA; Leonard H. Epstein, PhD;
Juned Siddique, PhD; Christine A. Pellegrini, PhD; Joanna Buscemi, PhD; Donald Hedeker, PhD

*Adherent =
Attended
≥80% of
treatment
sessions.



Tech alone doesn't do magic

Tech gives the engaged participant a leg up

Weight loss over time as a function of mHealth technology access and treatment attendance

N=70; m = 58 years

A Factorial Experiment to Optimize Remotely Delivered Behavioral Treatment for Obesity: Results of the Opt-IN Study

Bonnie Spring ¹, Angela F. Pfammatter¹, Sara H. Marchese ¹, Tammy Stump¹, Christine Pellegrini ², H. Gene McFadden¹, Donald Hedeker³, Juned Siddique¹, Neil Jordan^{1,4,5}, and Linda M. Collins^{6,7}

Obesity | VOLUME 28 | NUMBER 9 | SEPTEMBER 2020

Combination	Calls	Meal Replacement	Text Message	PCP Report	Buddy Training	Y-hat (6-mo weight change)(kg)	Y-hat (percent achieving 5% weight loss)	Y-hat (percent achieving 7% weight loss)	Cost	
21	12	No	No	Yes	Yes	-6.11	57.13	51.77	\$427.00	\$74.9 / kg
1	12	No	No	Yes	No	-3.40	34.48	25.86	\$337.00	
5	12	No	No	No	Yes	-5.05	46.56	31.02	\$414.00	
17	12	No	No	No	No	-5.24	52.95	41.17	\$324.00	\$67.1 / kg

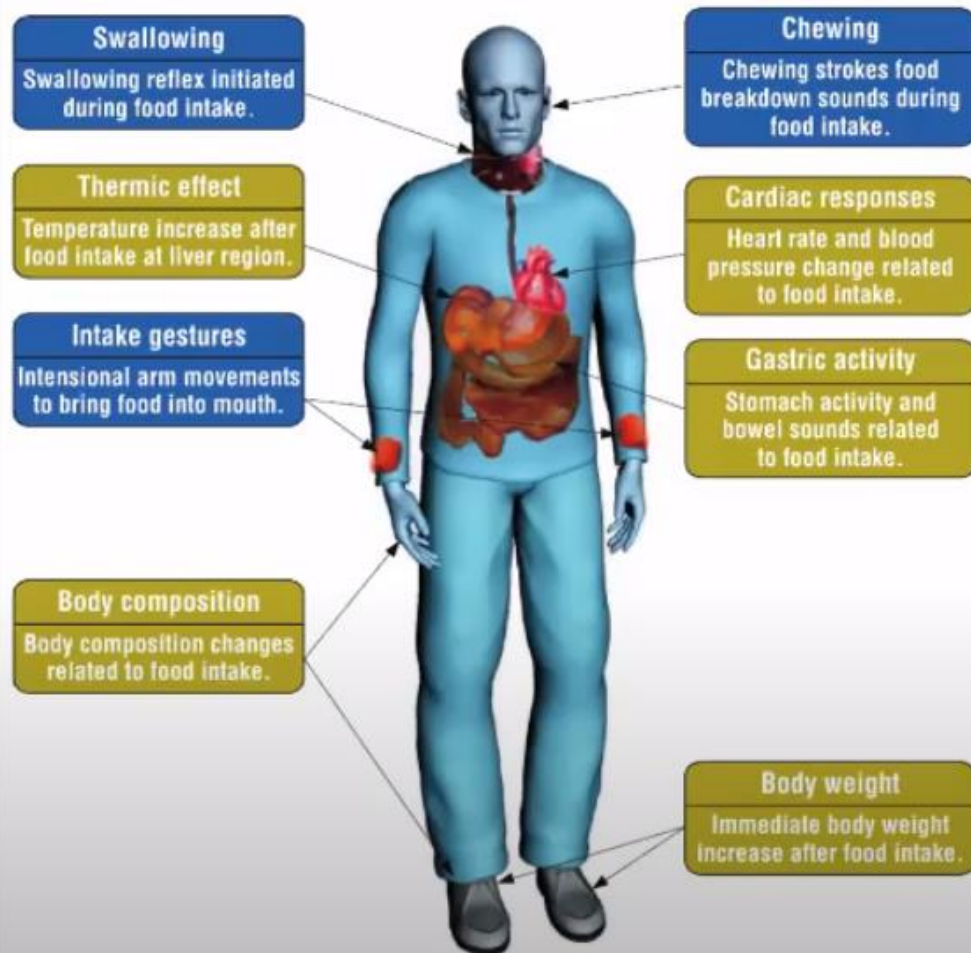
App + treatment packages that maximize
6-month weight loss for <\$500

Motivation: burden, recall bias, inaccuracy →



Do wearable technologies change eating behavior?

PASSIVE SENSING: potential for PUSH intervention



Oliver Amft - Friedrich Alexander University Erlangen-Nürnberg (FAU)

Technology for Automated Capture of Diet, Nutrition, and Eating Behaviors in Context, NSF Workshop, November 2020

Counting Bites With Bits: Expert Workshop Addressing Calorie and Macronutrient Intake Monitoring

Nabil Alshurafa^{1,2,3}, PhD; Annie Wen Lin¹, PhD; Fengqing Zhu⁴, PhD; Roozbeh Ghaffari⁵, PhD; Josiah Hester^{2,3}, PhD; Edward Delp⁴, PhD; John Rogers^{5,6}, PhD; Bonnie Spring¹, PhD J Med Internet Res 2019 | vol. 21 | iss. 12 | e14904 |



Image-based sensing

Challenges:

- No food image dataset with comprehensive ground truth
- Inaccurate in-image food segmentation
- Nonrobust in-image food recognition
- Inaccurate food portion size estimation in image



Biochemical sensing

Challenges:

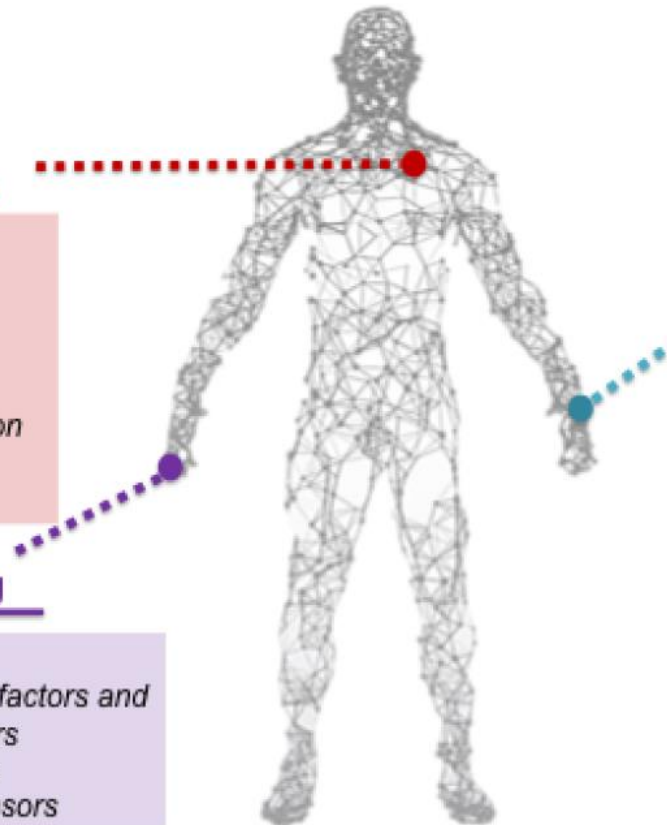
- Adaptation to environmental factors and mechanical impact on sensors
- Stability of wearable sensors
- Inefficiency of single-use sensors



Eating action units

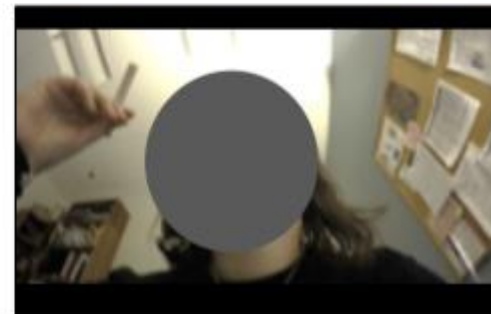
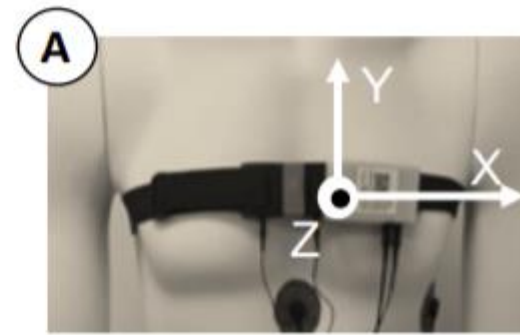
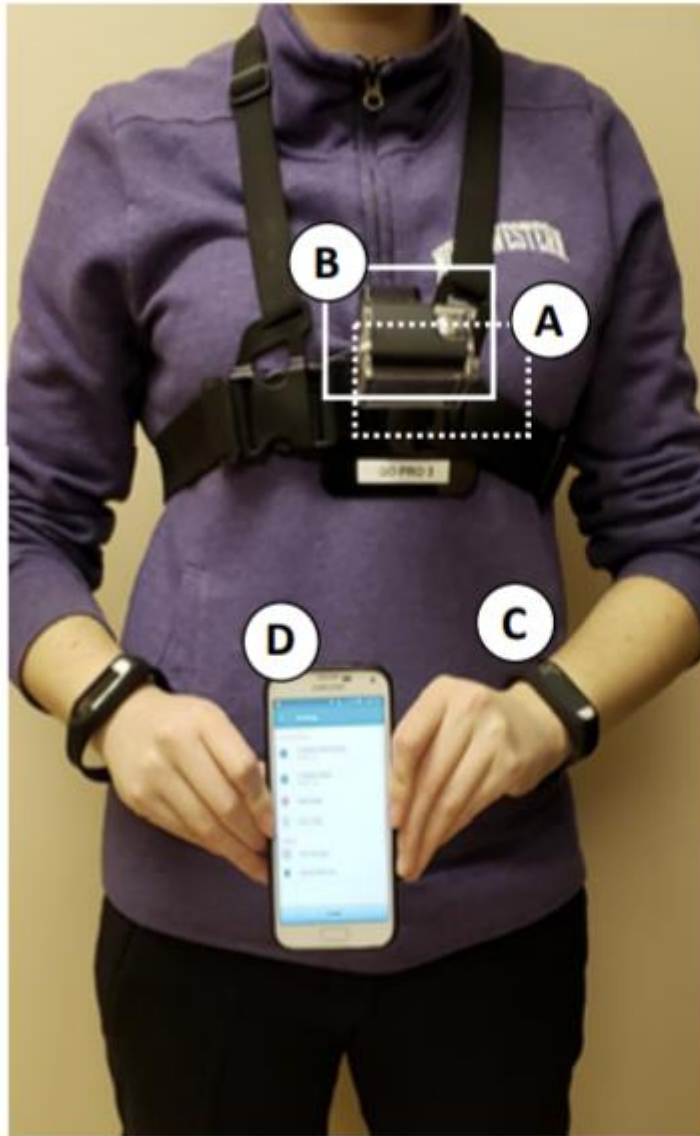
Challenges:

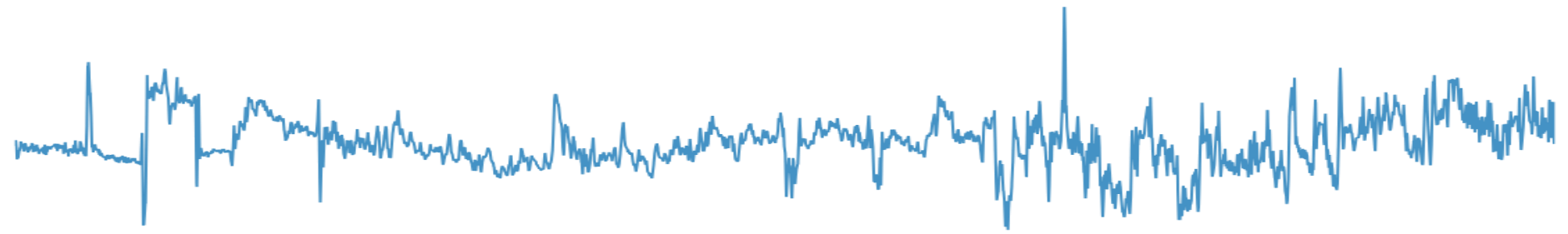
- Limited understanding of system success and failures
- No privacy protection
- Uncertainty in food categorization



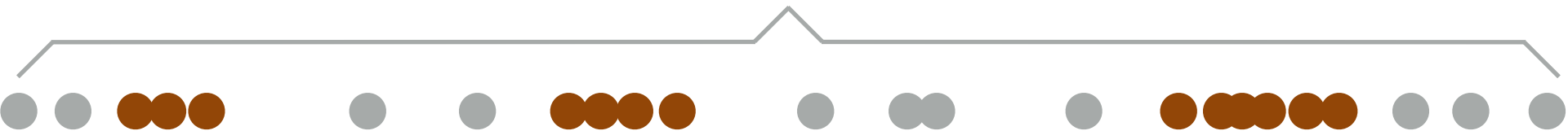
Challenges for all Domains

- Burden of multimodal systems
- Time asynchronization across systems
 - Automated data labeling
 - Uncertainty of system acceptability
- Short battery lifetime
- Nonrigorous system testing





Machine Learning: Food Intake Gesture Classifier



Breakfast



Lunch

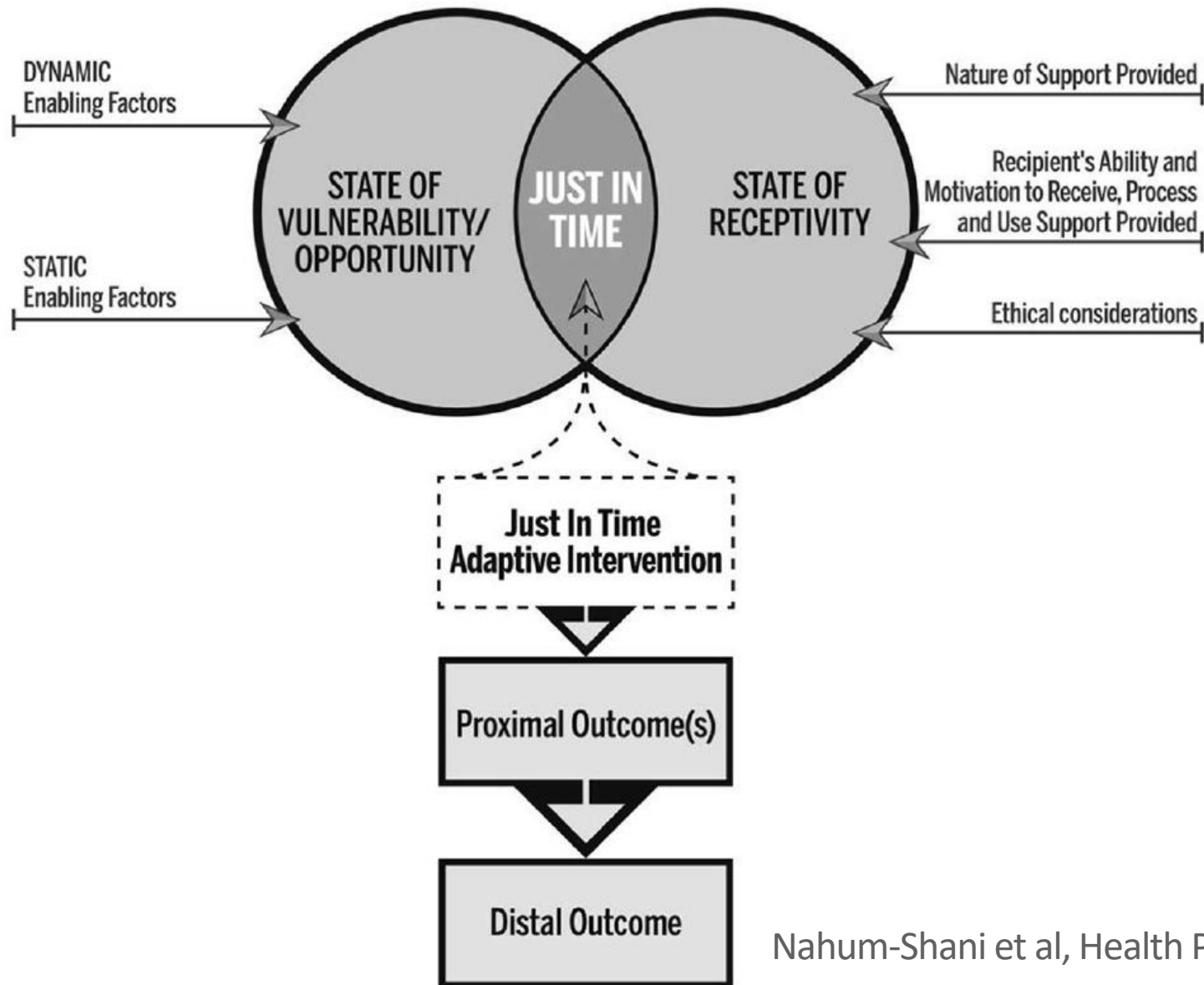


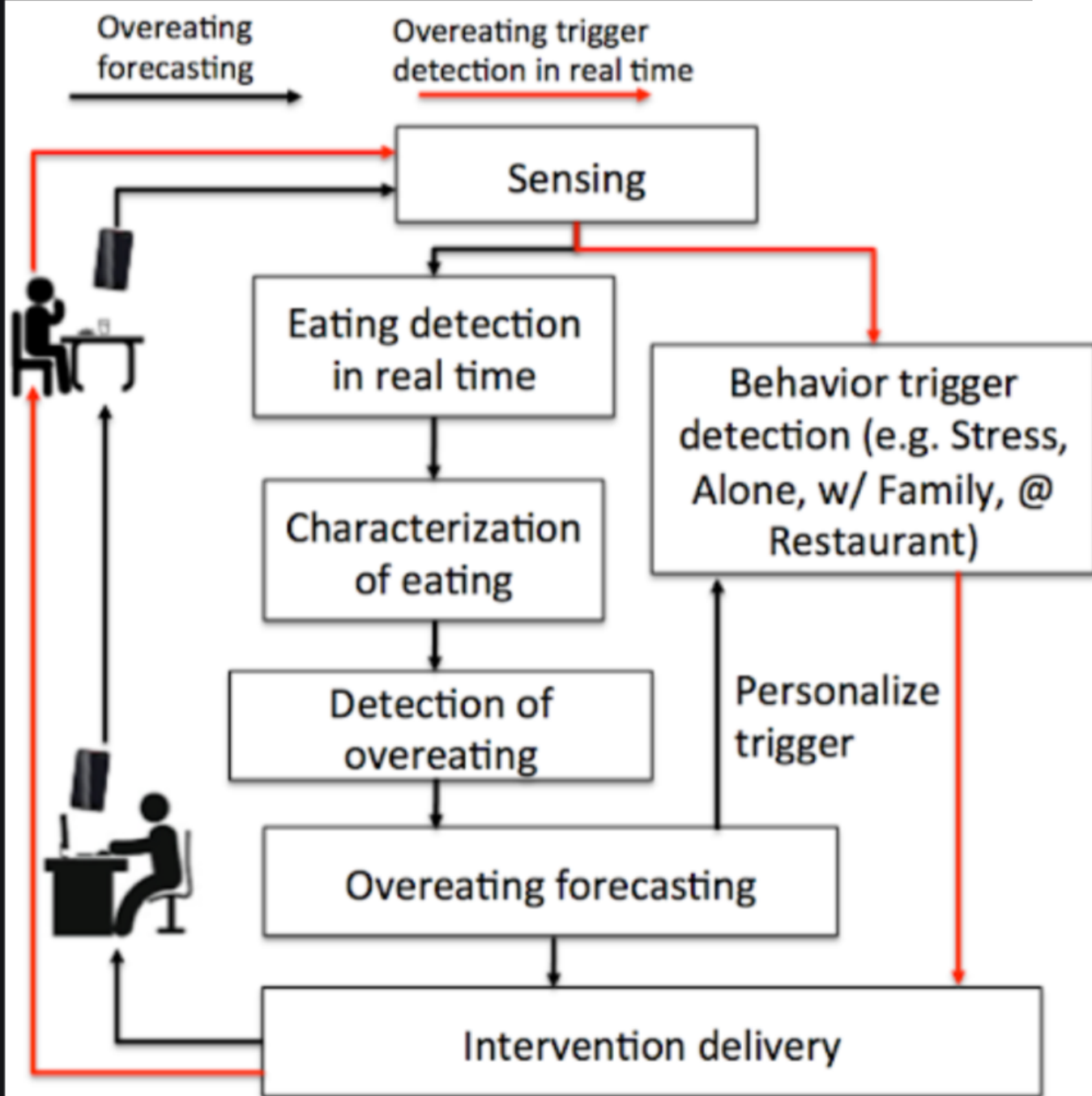
Dinner



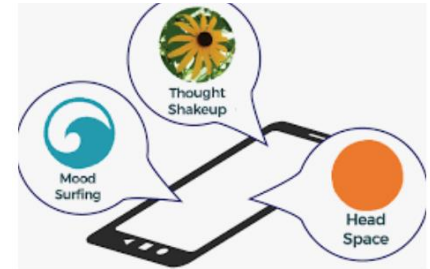
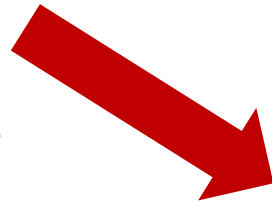
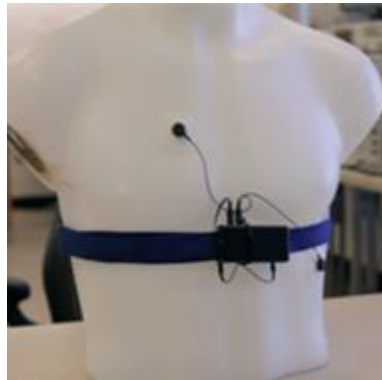
Future of Wearable-Assisted Eating Behavior Change

Just-In-Time Adaptive Intervention (JITAI)





Just-In-Time Adaptive Intervention (JITAI) for Stress-Induced Eating

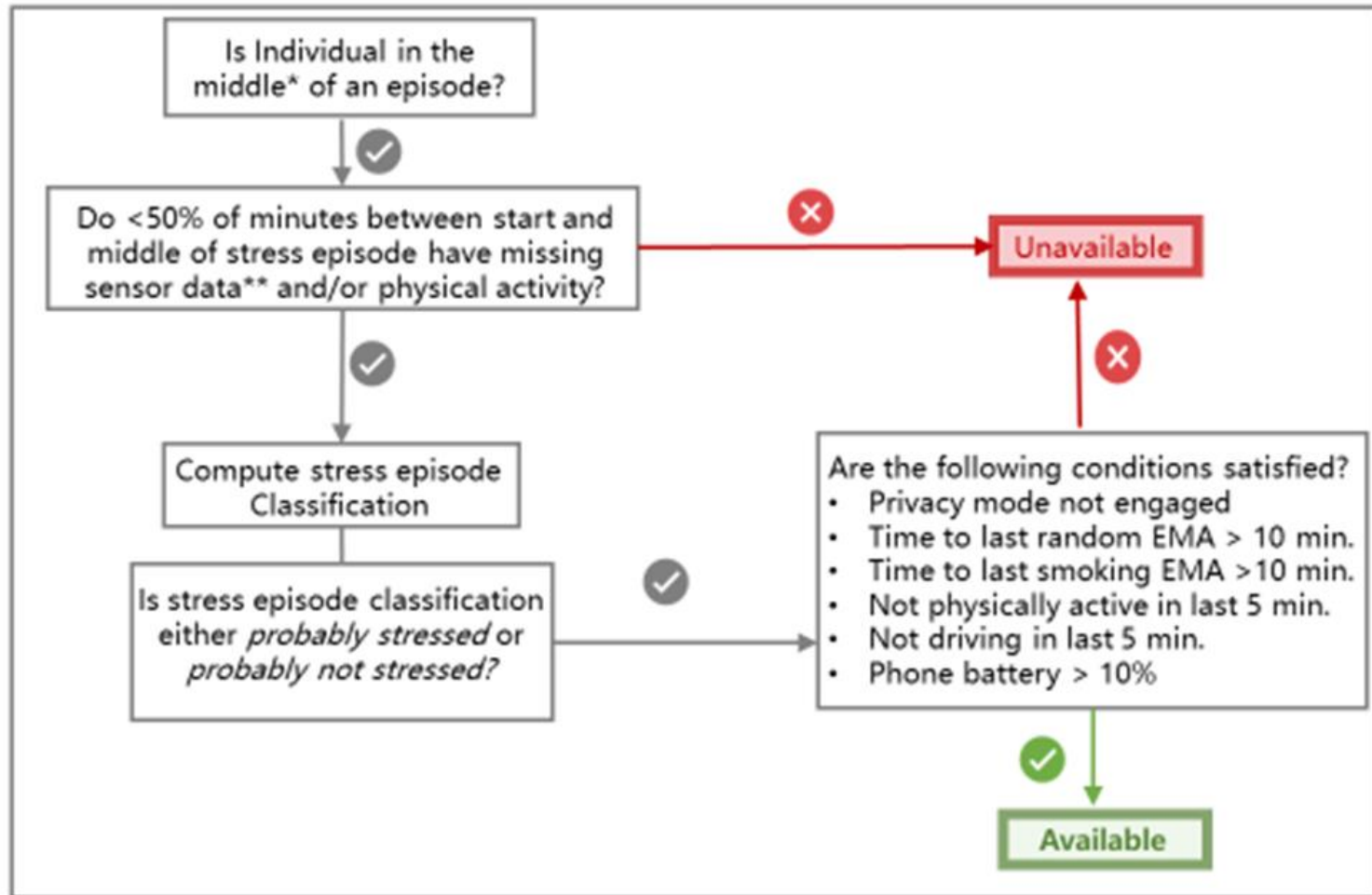


JITAI



Stressed?

Availability for Intervention



Conclusions

- Mobile phone-based apps can change nutrition behavior, esp. if they engage behavior change techniques and include coaching. (PULL)
- Passive diet sensing using image and biochemical analysis is work in progress.
- Much interest in sensing eating action units (chew, swallow, gestures) to pave the way toward real-time, preventive intervention in context – JITAI (PUSH)