

# Passive Monitoring for Significant Health Events

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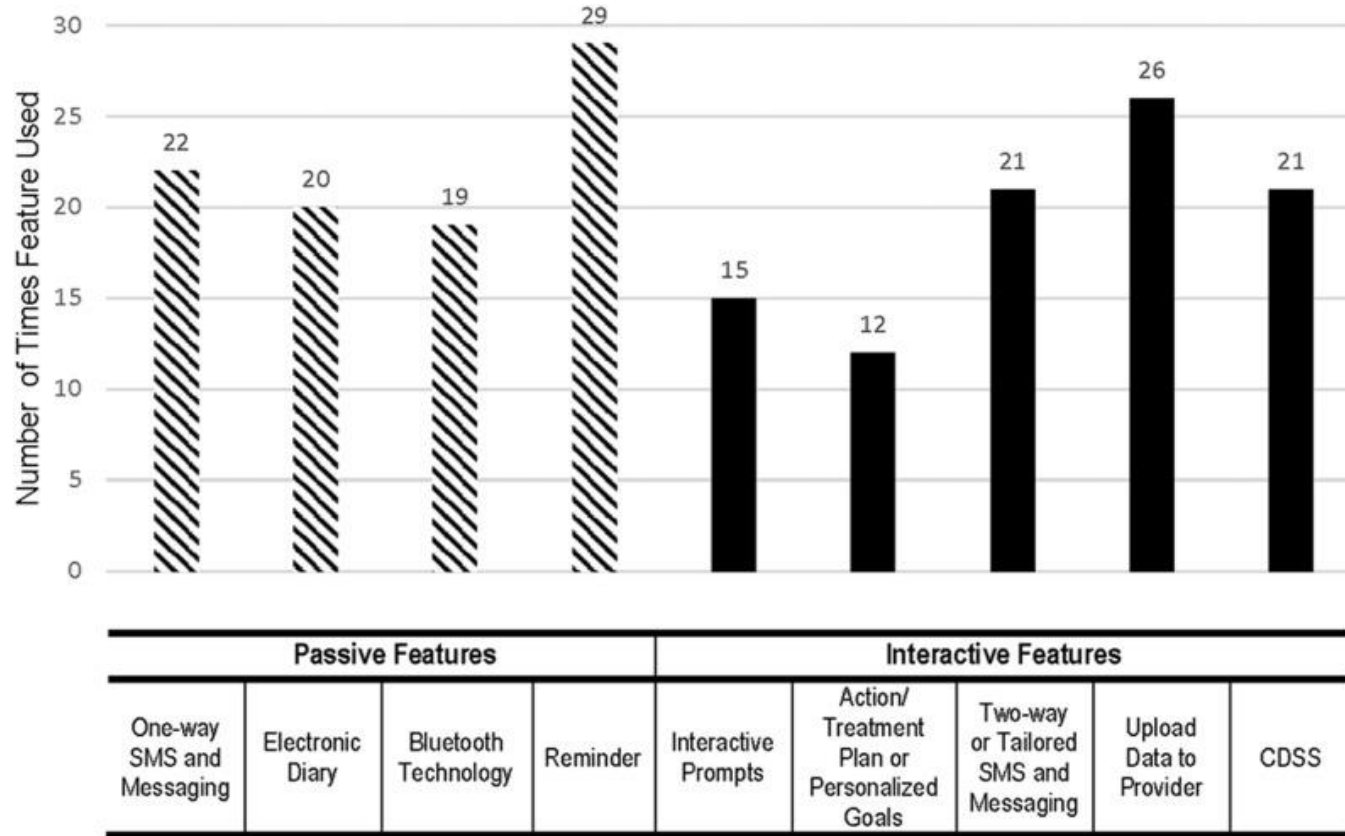
ORCATECH - Oregon Center for Aging & Technology



# What is "Passive" Monitoring? - There is no such thing as

Differing conceptions of what is "passive"

(entirely) passive sensing



*...do not require any additional response or action from the patient within the mHealth app*

*... require patients to provide a response or modify the content in real time*

Donevant SB, et al. Exploring app features with outcomes in mHealth studies involving chronic respiratory diseases, diabetes, and hypertension: a targeted exploration of the literature. Journal of the American Medical Informatics Association : JAMIA. 2018 Oct;25(10):1407-1418.



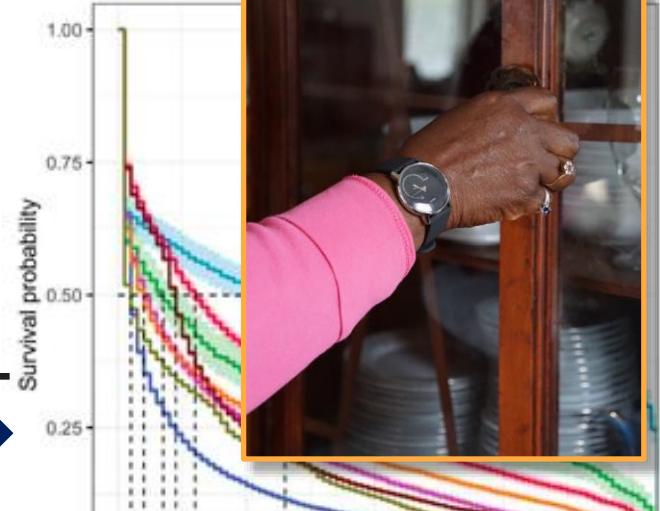
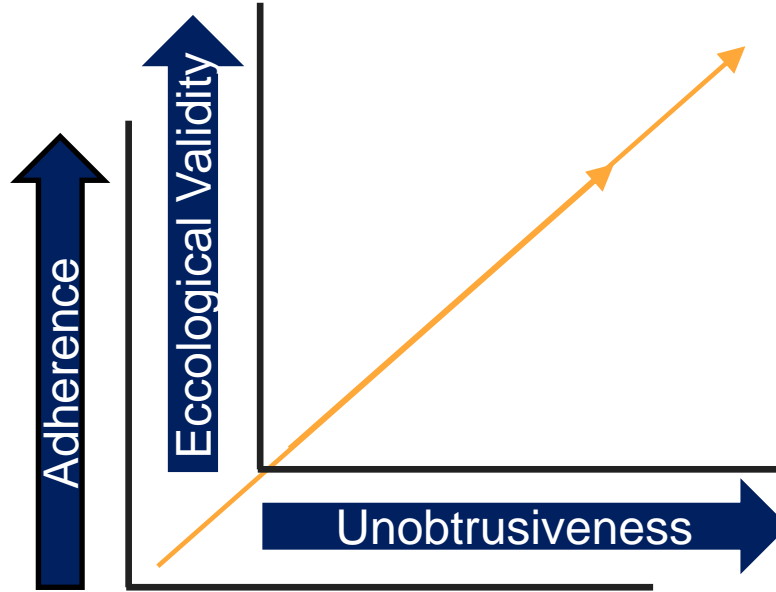
More Passive

A CONTINUUM



More Active

# Value of More Passive, Inobtrusive Monitoring



PORTS

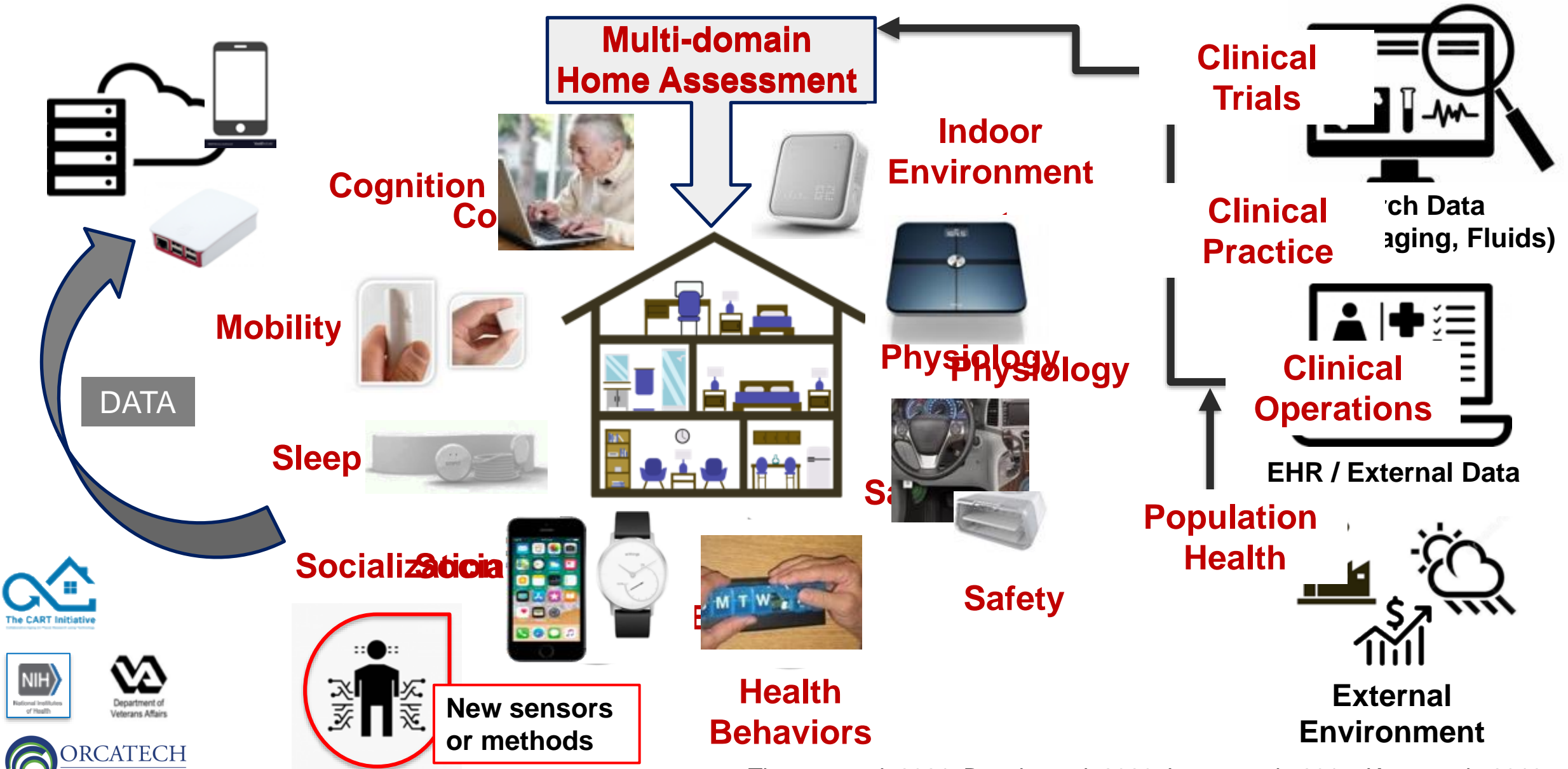


12

ention  
0 part

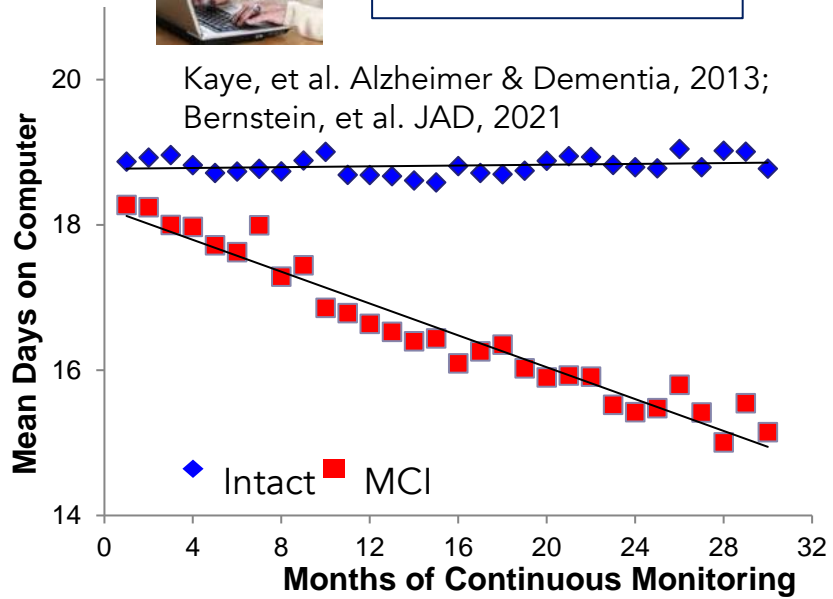


# Use Case Dictates Assessment Approach – ORCATECH/CART platform





# EVERYDAY COGNITION



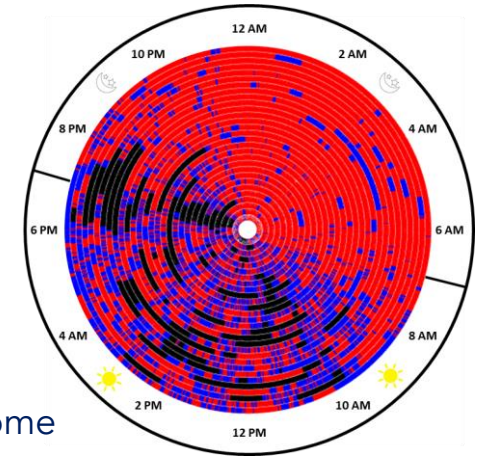
# Passive, Multi-Domain, Remotely & Longitudinally Acquired, Digital Biomarkers

## SOCIAL ENGAGEMENT

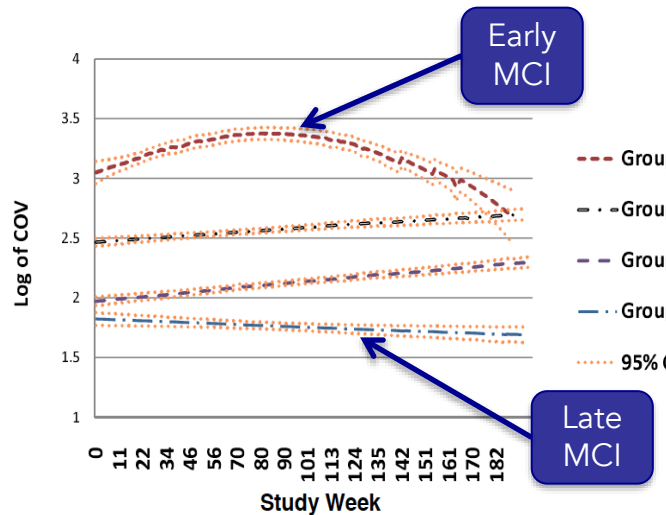


Peterson, et al. PloS One, 2015; Thomas, et al. AAN, 2018

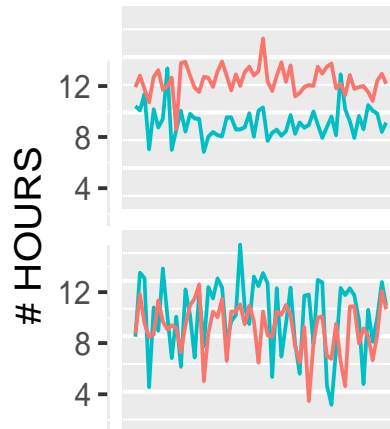
- Time together
- Time apart
- Time out of home



## MOBILITY



Kaye, et al. Gait & Posture, 2011 Dodge, et al. Neurology, 2012



Miller et al. GSA, 2019; Hayes et al. ADAD, 2014

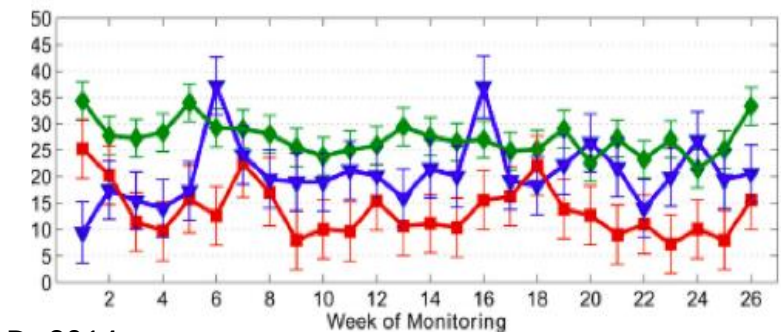
## SLEEP



- Normal
- NA-MCI
- A-MCI

variable

- Female Sleep
- Male Sleep



# Passive Sensing Requires CONTEXT

Aging Well Study -  
Adriana Hughes, PI

## Web-based Weekly Questionnaire

In the past week, is someone *newly* assisting you with medication management, bathing, dressing or grooming?

Yes

No

Have you felt downhearted or blue for three or more days in the past week?

Yes

No

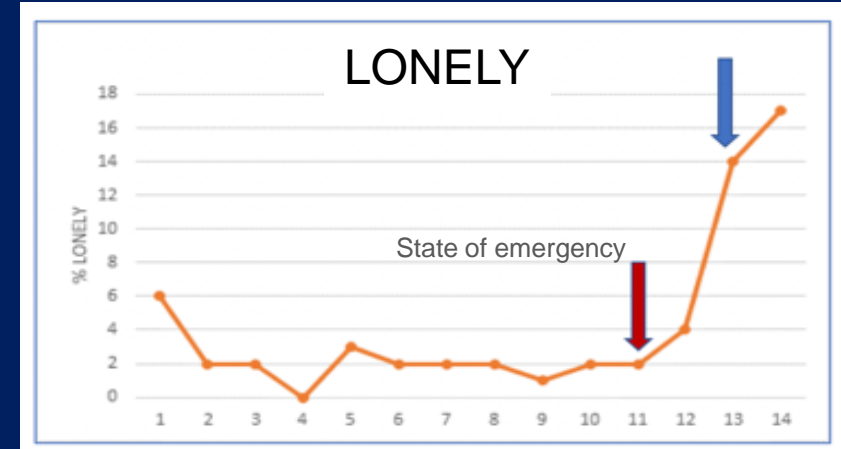
In the past week I felt lonely.

Yes

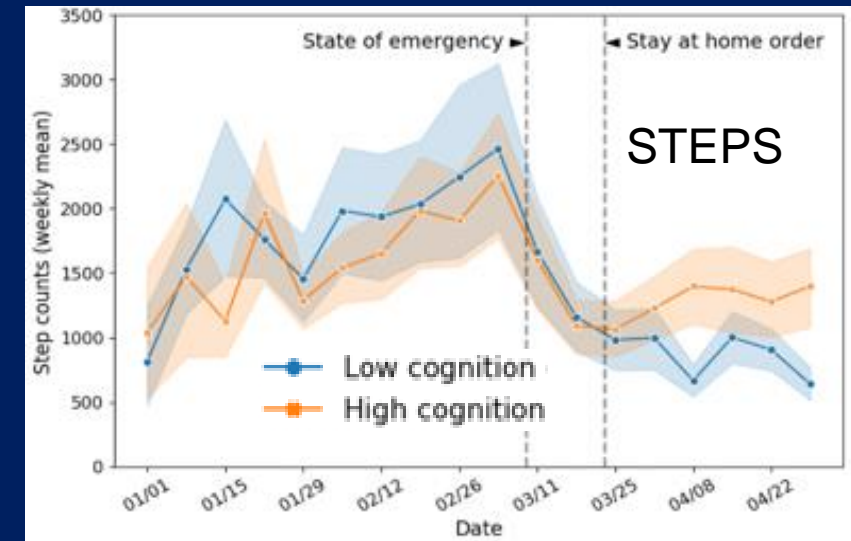
|    |                       |
|----|-----------------------|
| 1  | AWAY FROM HOME        |
| 2  | VISITORS              |
| 3  | MEDICATION CHANGE     |
| 4  | FALLS                 |
| 5  | ACCIDENTS/INJURIES    |
| 6  | HOSPITALIZATION/ER    |
| 7  | HEALTH CHANGE/ILLNESS |
| 8  | LIFE SPACE CHANGE     |
| 9  | ASSISTANCE            |
| 10 | MOOD - BLUE           |
| 11 | MOOD - LONELY         |
| 12 | PAIN LEVEL (1-10)     |
| 13 | PAIN INTERFERENCE     |

Timely Self-Report Data is Necessary

### Portland Section 202 Low Income Housing Cohort



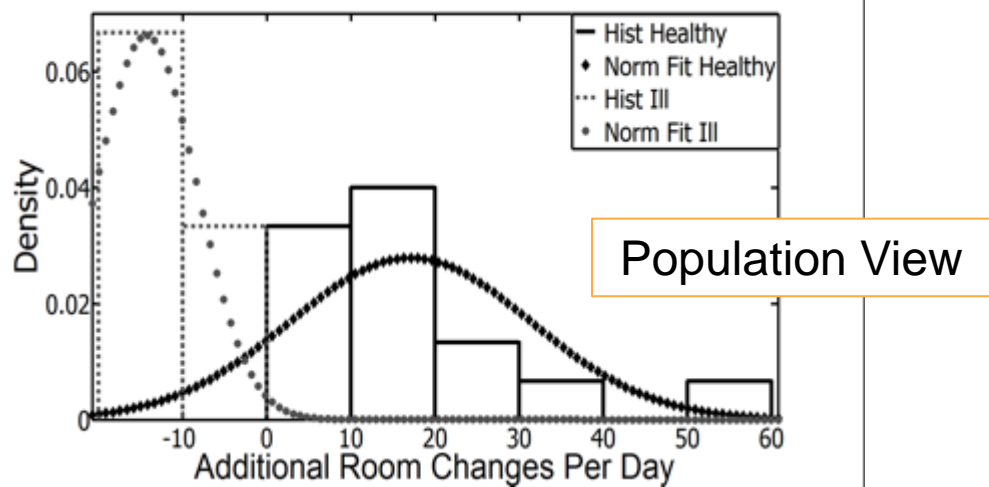
### Chicago African American MARS Cohort



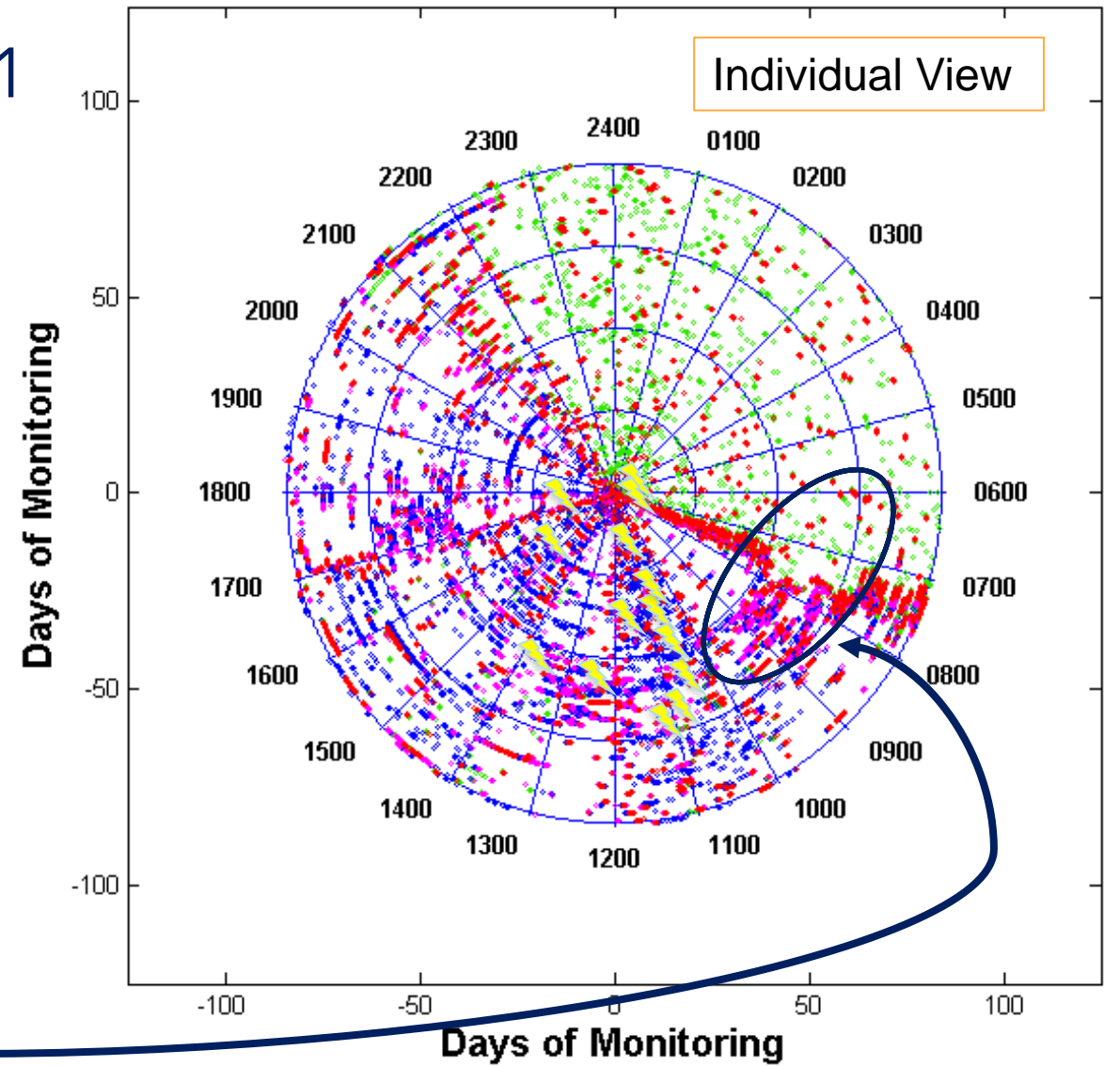
Leese MI, et al. Older Adults' Daily Activity and Mood Changes Detected During the COVID-19 Pandemic Using Remote Unobtrusive Monitoring Technologies, *Innovation in Aging*, Volume 5, Issue 4, 2021

# Life Space & Event Monitoring During a Norovirus Epidemic - 2011

Fig. 1. An examination of median room-transition values during and before the quarantine shows that activity levels changed differently between the healthy and unhealthy groups ( $p < 0.001$ ).



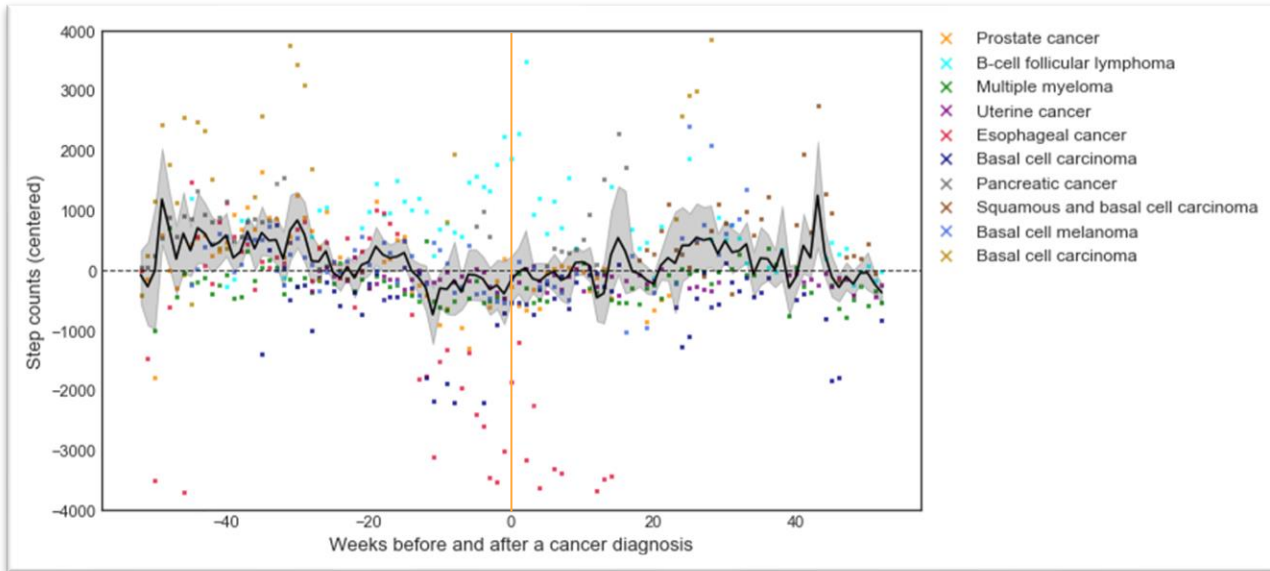
Note the 2 weeks when the resident stayed mostly in their apartment weathering the norovirus quarantine that was going on in their community and how this changed their usual pattern – sleeping in and starting computer session later.



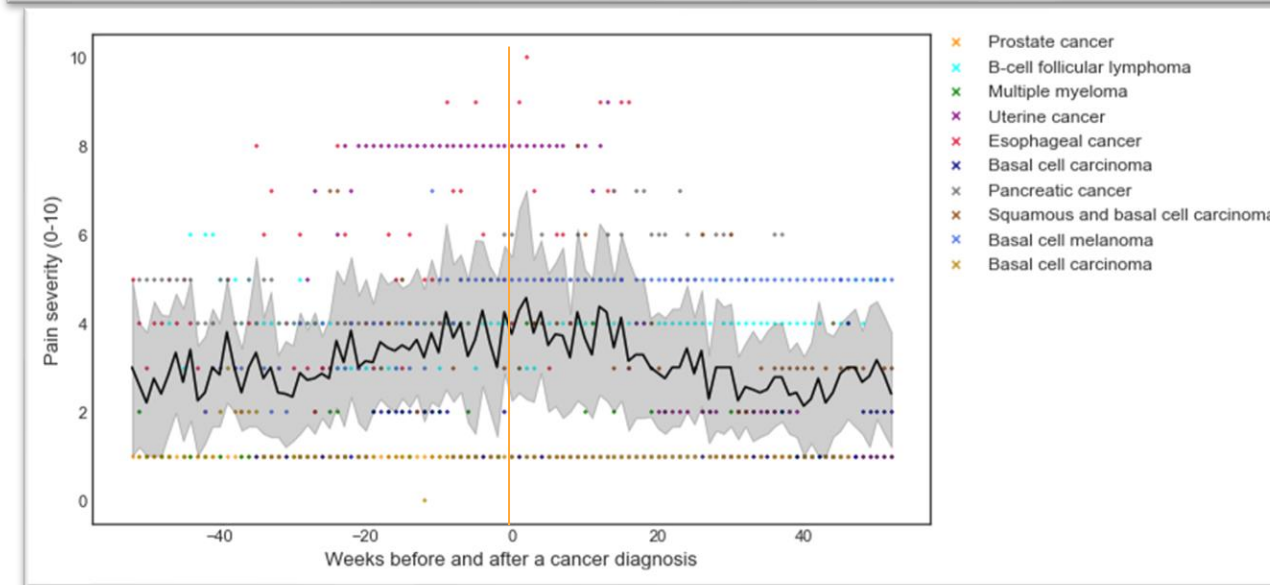
- Kitchen
- Bath
- Bedroom
- Living room
- ⚡ Computer Session

Wu et al. *Journal of Clinical Oncology* 39, no. 15\_suppl (May 20, 2021) 1569.

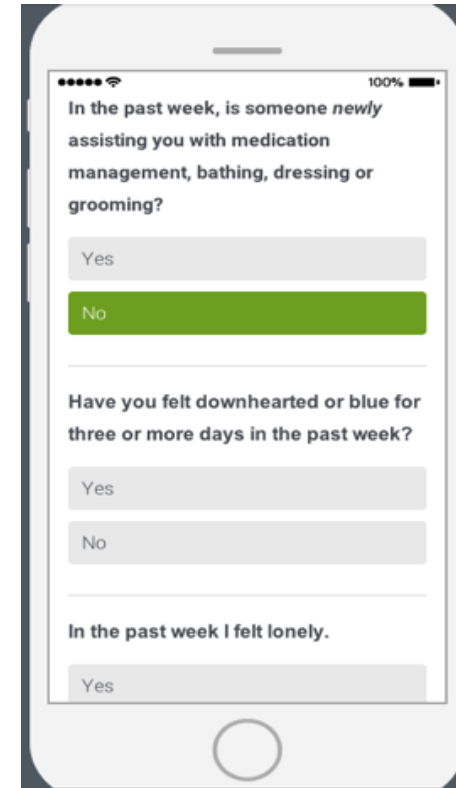
MOBILITY - STEPS



PAIN SEVERITY



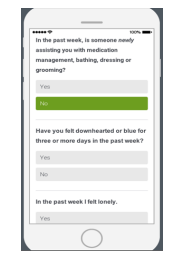
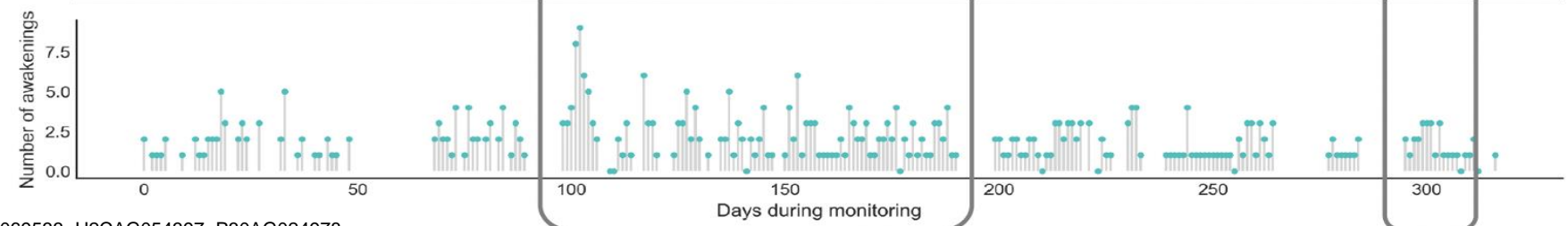
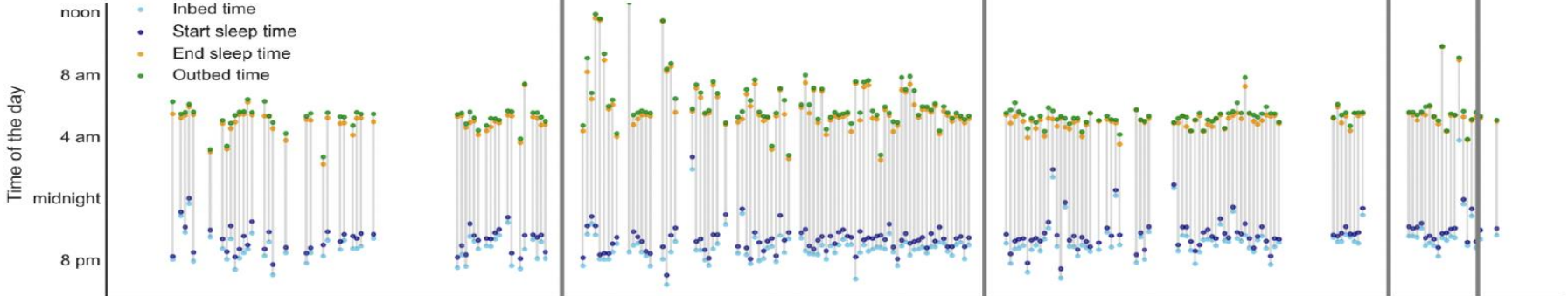
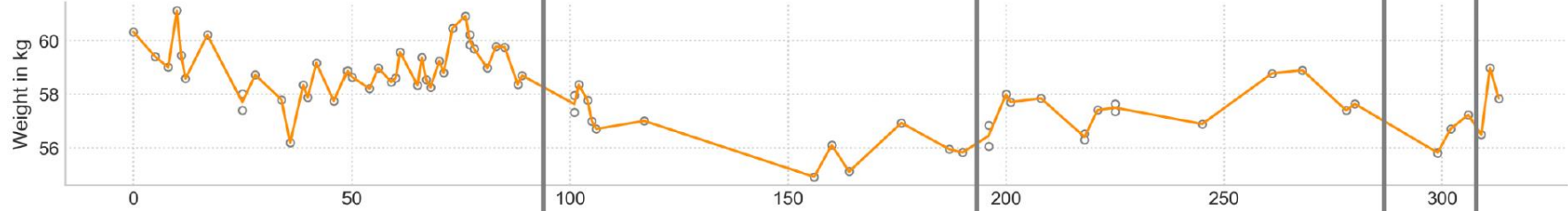
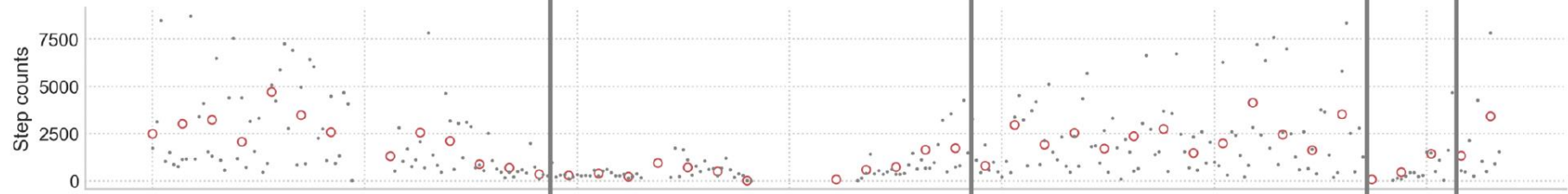
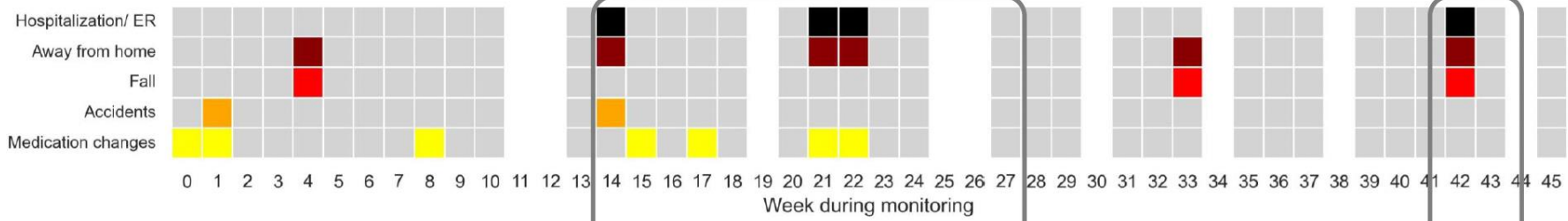
A remote-monitoring sensing platform deployed in homes detects population-based changes 1-year *before* and *after* a cancer diagnosis.



Pacific Aging & Cancer Study Collaborative - PACS collaborative



Funding sources: NCI P30CA069533, U2CAG054397, P30AG024978, P30AG008017, P30AG066518



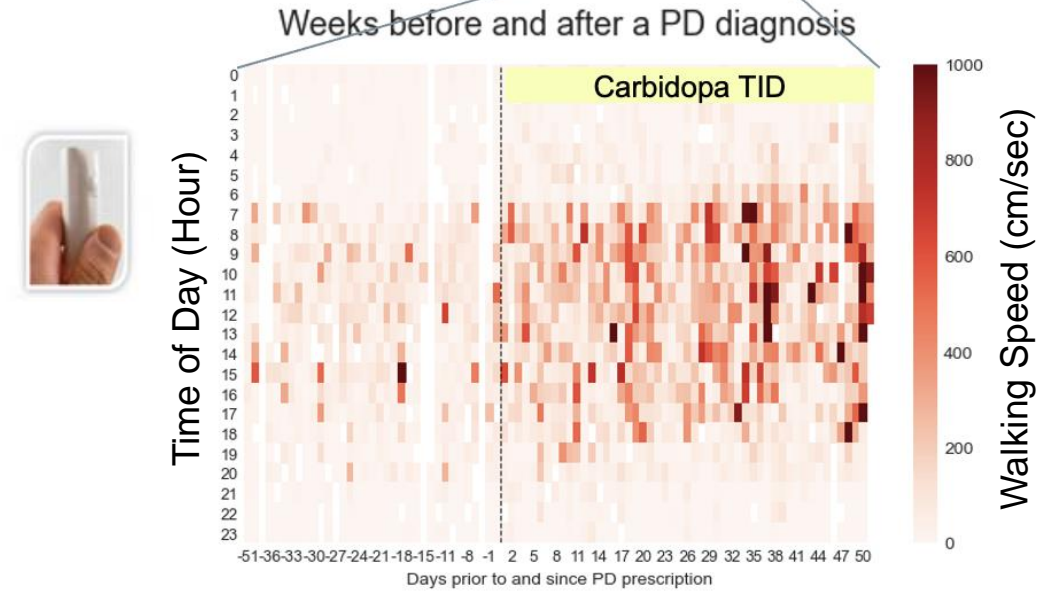
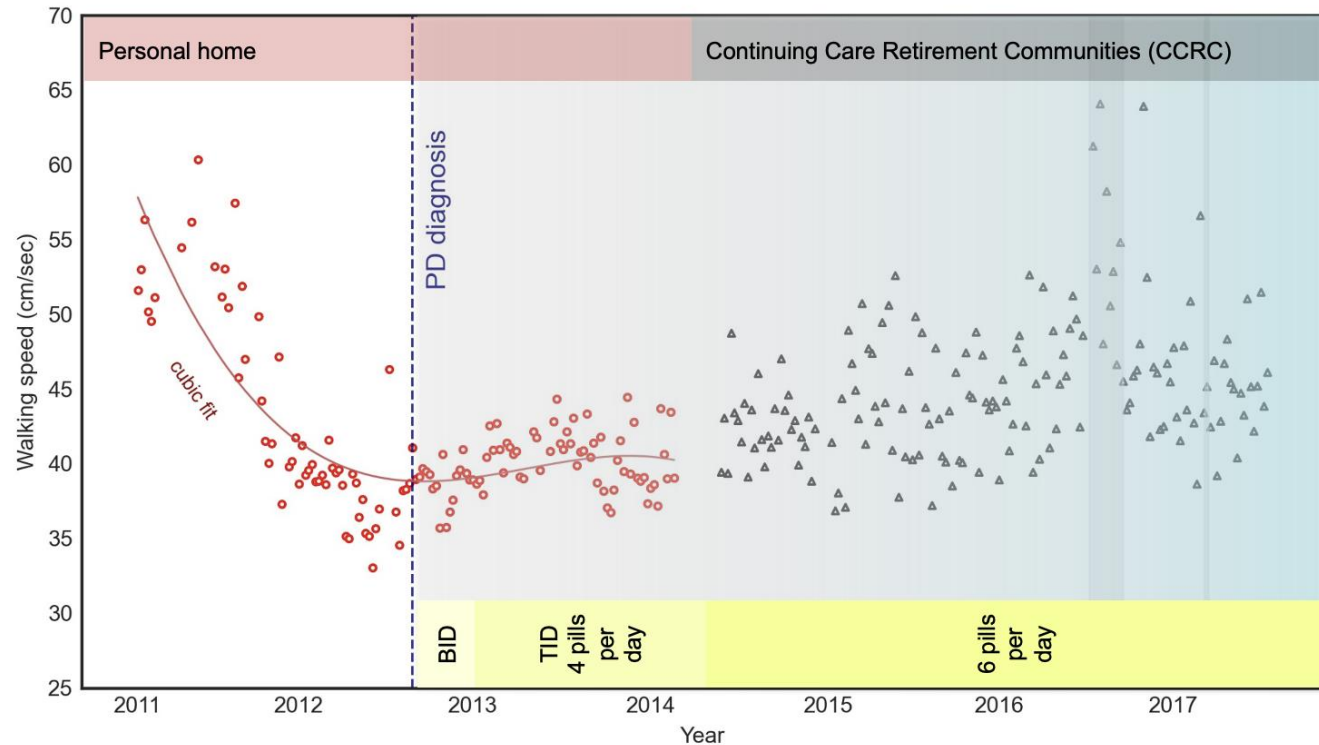
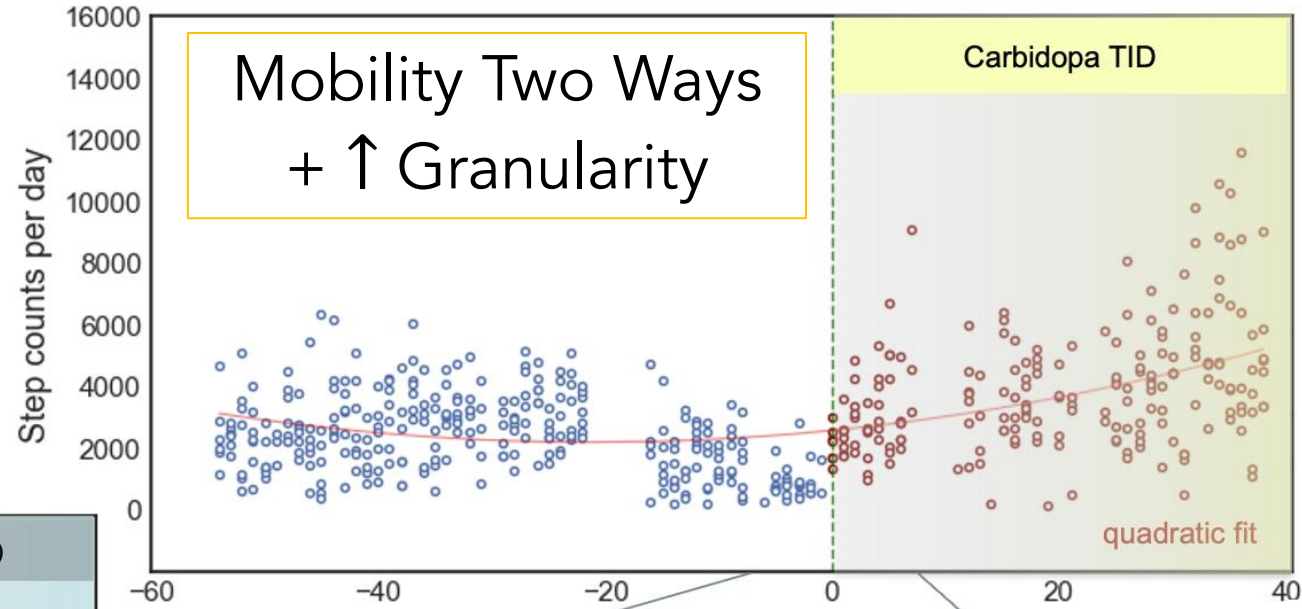
Pacific Aging & Cancer Study Collaborative - PACS Collaborative



P30CA069533, U2CAG054397, P30AG024978, P30AG008017, P30AG066518

# Mobility changes before and after PD diagnosis –Tx Effects

Long-term Change + Venue Change





# A Culturally Relevant Multi-modal Brain Health Program - SHARP

## *Sharing History through Active Reminiscence and Photo-imagery*

| M                                               | T                                      | W                                          | Th                           | F                                          |
|-------------------------------------------------|----------------------------------------|--------------------------------------------|------------------------------|--------------------------------------------|
|                                                 |                                        |                                            |                              |                                            |
|                                                 |                                        |                                            |                              |                                            |
| Group Walking + Reminiscence<br>45 minutes      | Health Education Session<br>30 minutes | Group Walking + Reminiscence<br>45 minutes | Memory Session<br>30 minutes | Group Walking + Reminiscence<br>45 minutes |
| In-home technology to monitor social engagement |                                        |                                            |                              |                                            |

PI: Raina Croff

NIA: P30AG008017, P30AG024978, Alzheimer's Association

Croff R, et al. The Gerontologist, 2018.



# The Future – Bridging Gaps with Opportunities for Research

*More evidence is needed across the board...*

## SPECIAL TOPICS

- Understanding effects of context on unsupervised data
- Improving outcome measures: (Re-)defining 'gold' standards to be ecologically valid and more meaningful (e.g., sleep lab vs home; cognitive test vs everyday cognition; room transitions vs timed walks)
- Multi-domain digital outcomes (efficient, confirmatory, mechanism validating)
- Taking advantage of high-dimensional data (valid N-of-one analyses)



## OVERARCHING AREAS

- User issues (diversity, clinicians, researchers, lawyers)
- Technical issues (hardware, software, data): device/sensor churn, acceptable error/precision of measures, algorithms, etc.
- Privacy / Agency / Autonomy
- Infrastructure, Infrastructure, Infrastructure
- Collaboration, Collaboration, Collaboration



**Not everything  
that can be counted counts,  
and not everything that counts  
can be counted.**

**- William Bruce Cameron (1963) -**



In 1963: "It would be nice if all of the data which sociologists require could be enumerated because then we could run them through IBM machines and draw charts as the economists do. However, not everything that can be counted counts, and not everything that counts can be counted.

(Cameron 1963, "Informal Sociology: A Casual Introduction to Sociological Thinking", p. 13)

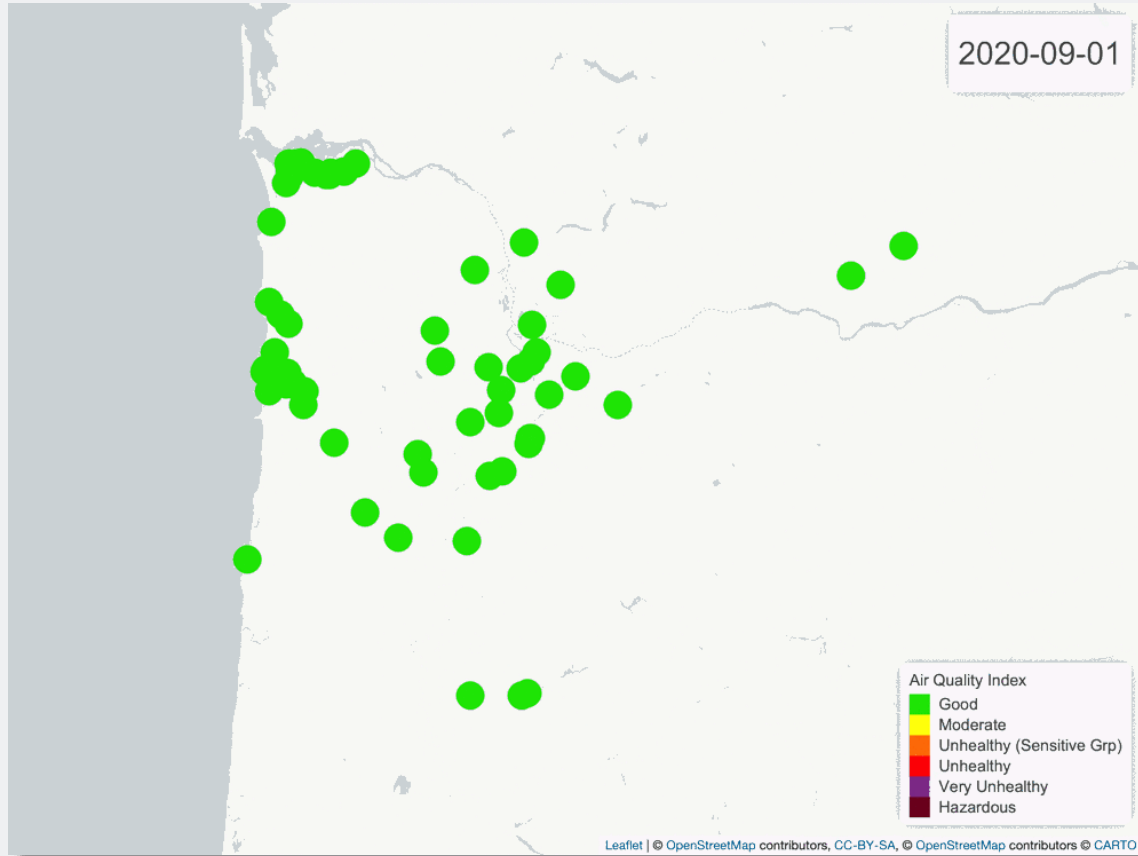
Thank you!



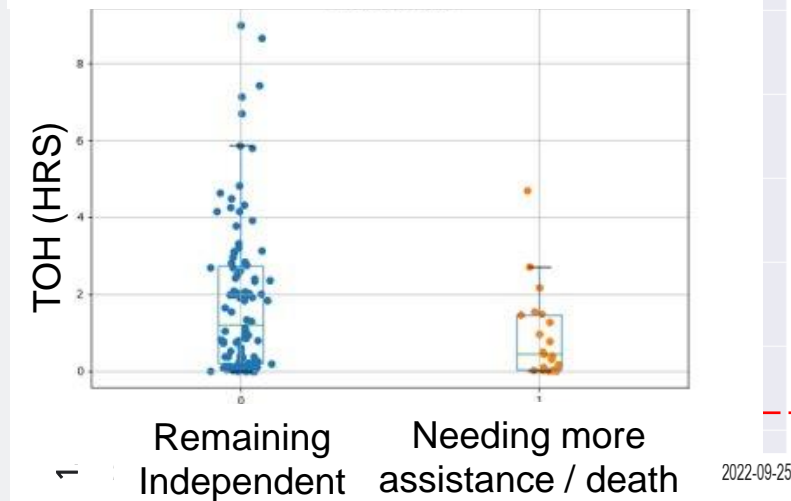
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# Making Sense of Environment Sensing Over Time: Air Quality



Time Out of Home as Predictor of Functional Decline / Death



Correlation Index of air monitors and the estimates of air quality at closest outdoor locations = 0.418 (range= 0.0610-0.585)