



# **Oregon Center for Aging & Technology: New Approaches to Assessing Health**

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*Oregon Center for Aging & Technology*



**ORCATECH**

SUCCESSFUL AGING  
WITH TECHNOLOGY

# How do we age successfully?



- How can we better understand changes associated with aging?
- Can we predict memory impairment?
- How can we help seniors live independently as long as possible?
- How will technology play a role?

# Memory and Movement



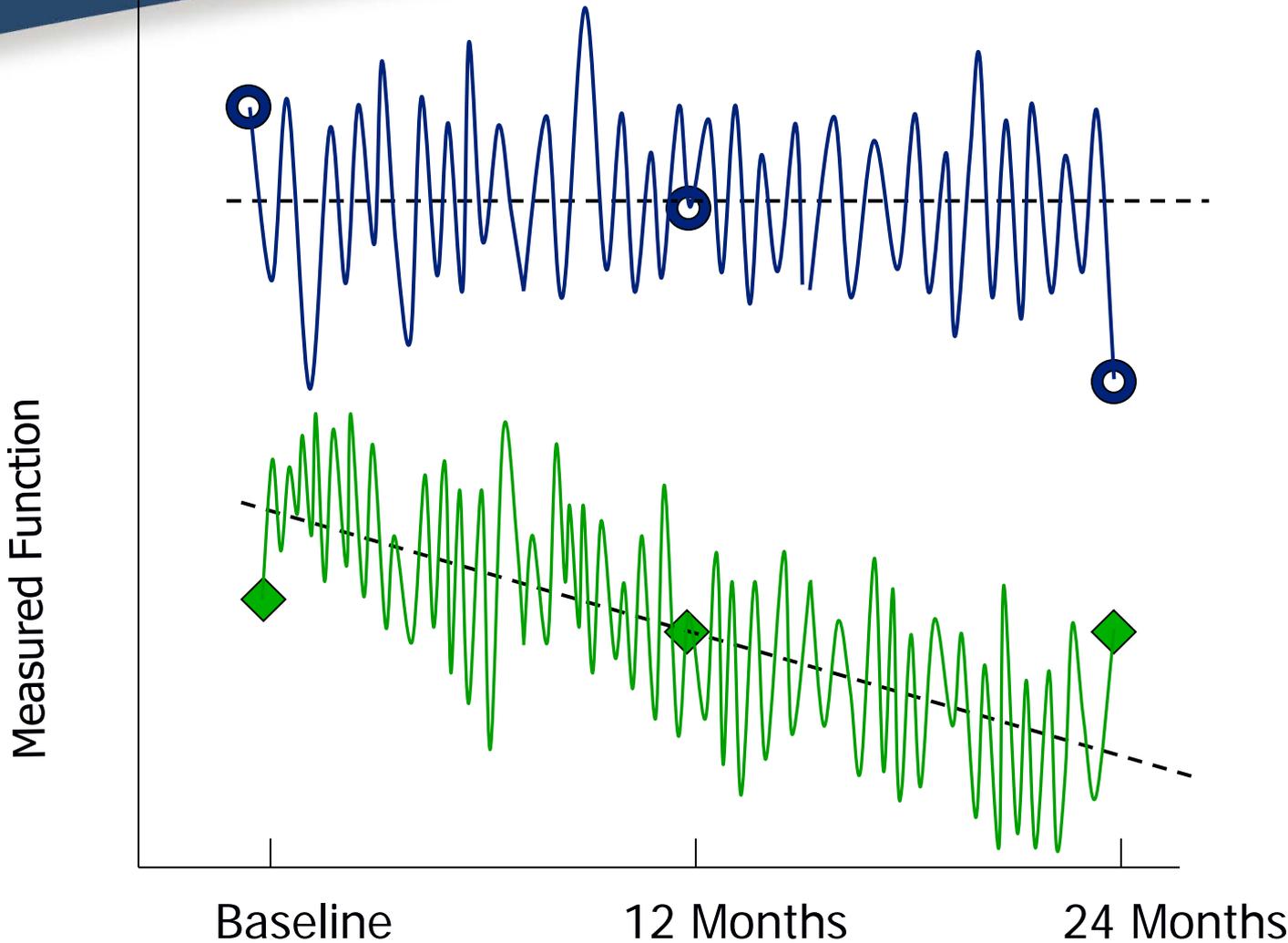
- Key factors in ability to live independently
- Research indicates a relationship
  - Faster walkers live longer without dementia
  - Increase in variability BEFORE memory problems start
- Current assessment limits what we can understand

# Current practice is limited

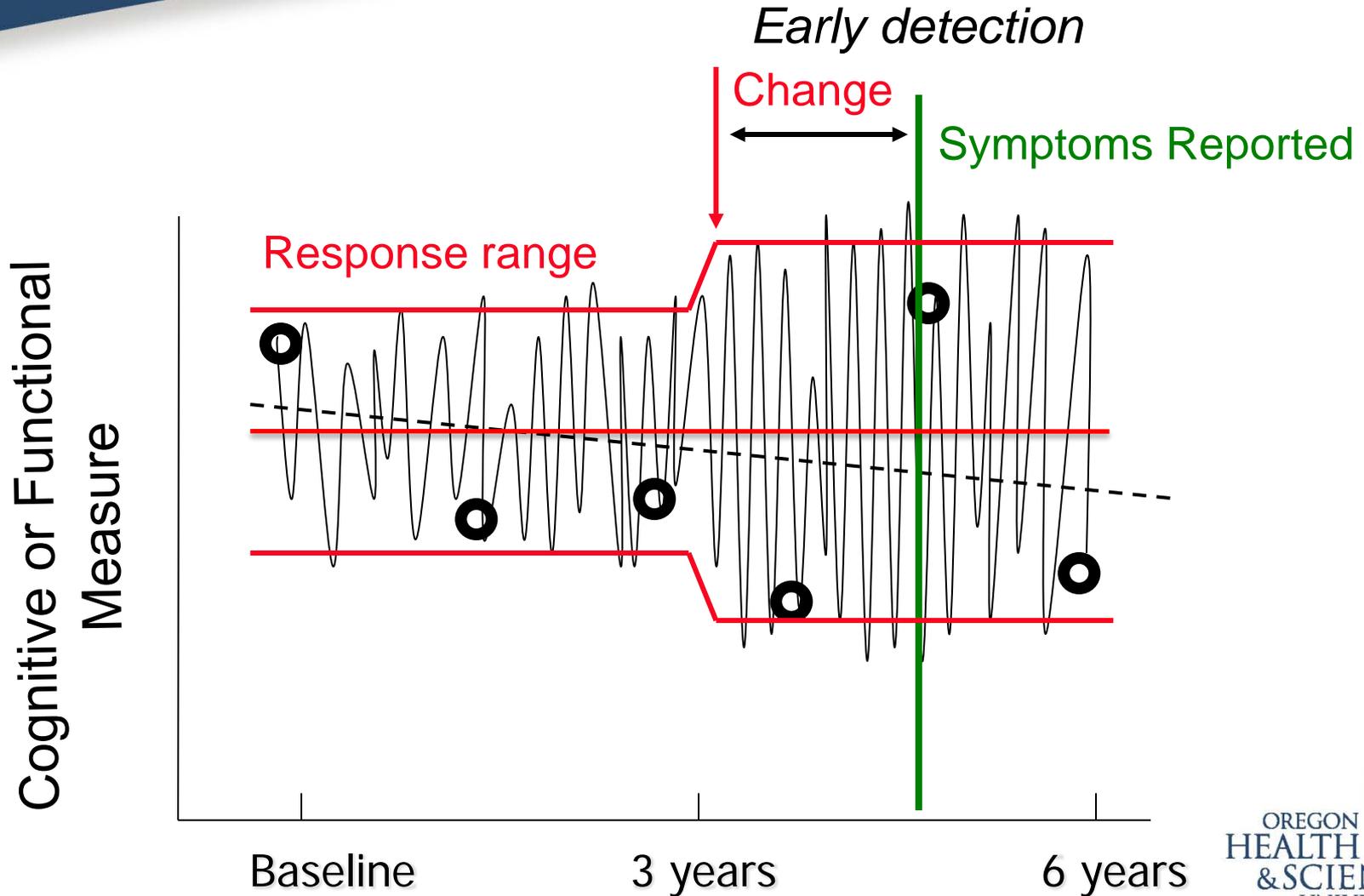


- Infrequent assessments
- Depends on self-report
- Conducted at a clinic on provider's schedule
- Assumes exam indicates typical function
- Hard to track across the course of illness
- Limited knowledge of life context (e.g., sleep, socialization, physical activity)

# The Greatest Challenge: Detecting *Meaningful* Change



# The Greatest Challenge: Detecting *Meaningful* Change





*Expand how we assess people!*

Brief, episodic,  
clinic-based,  
obtrusive &  
inconvenient  
assessment



Real-time,  
continuous,  
home-based &  
unobtrusive  
assessment

# Continuous Assessment Platform Elements

Actigraphy  
devices



Bed Sensors



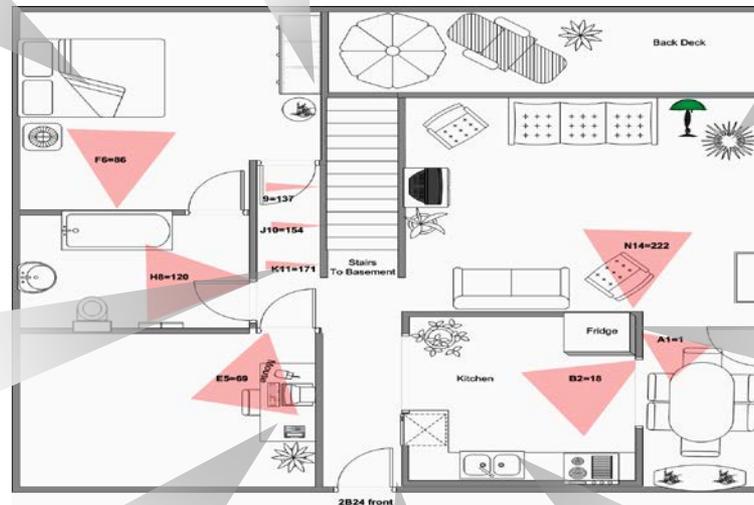
Physiological  
sensors



Phone  
sensors



Localization  
sensors



Walking  
sensors



Activity  
sensors



Cell phone as  
prompting  
device and for  
location  
tracking



PC/Kiosk/Etc.:  
Experience sampling;  
cognitive testing; social  
engagement; coaching



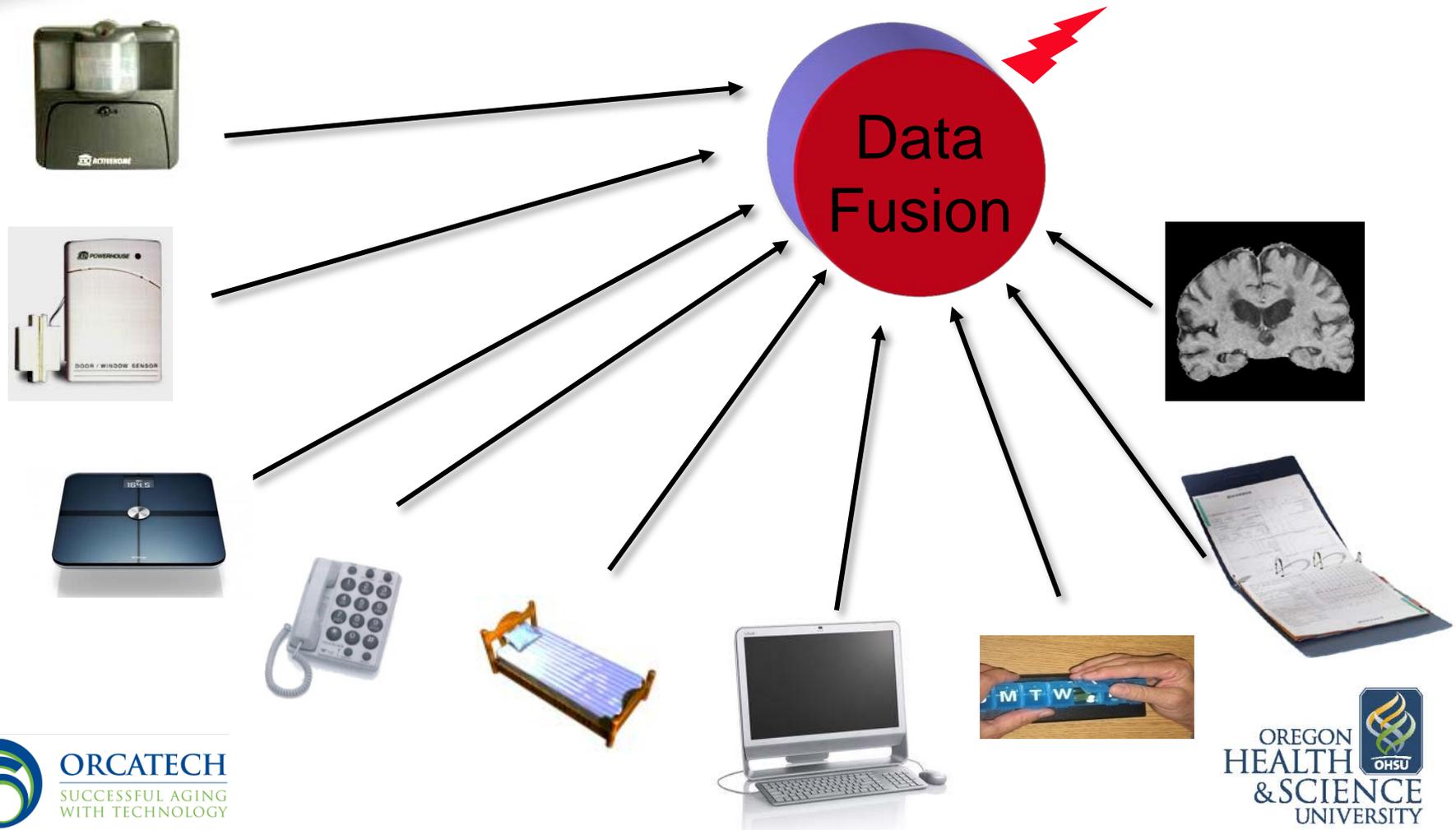
Door  
sensors



Medication  
tracking device

# Data Fusion: strength in combining data streams

Improved Dementia Assessment & Health Outcomes

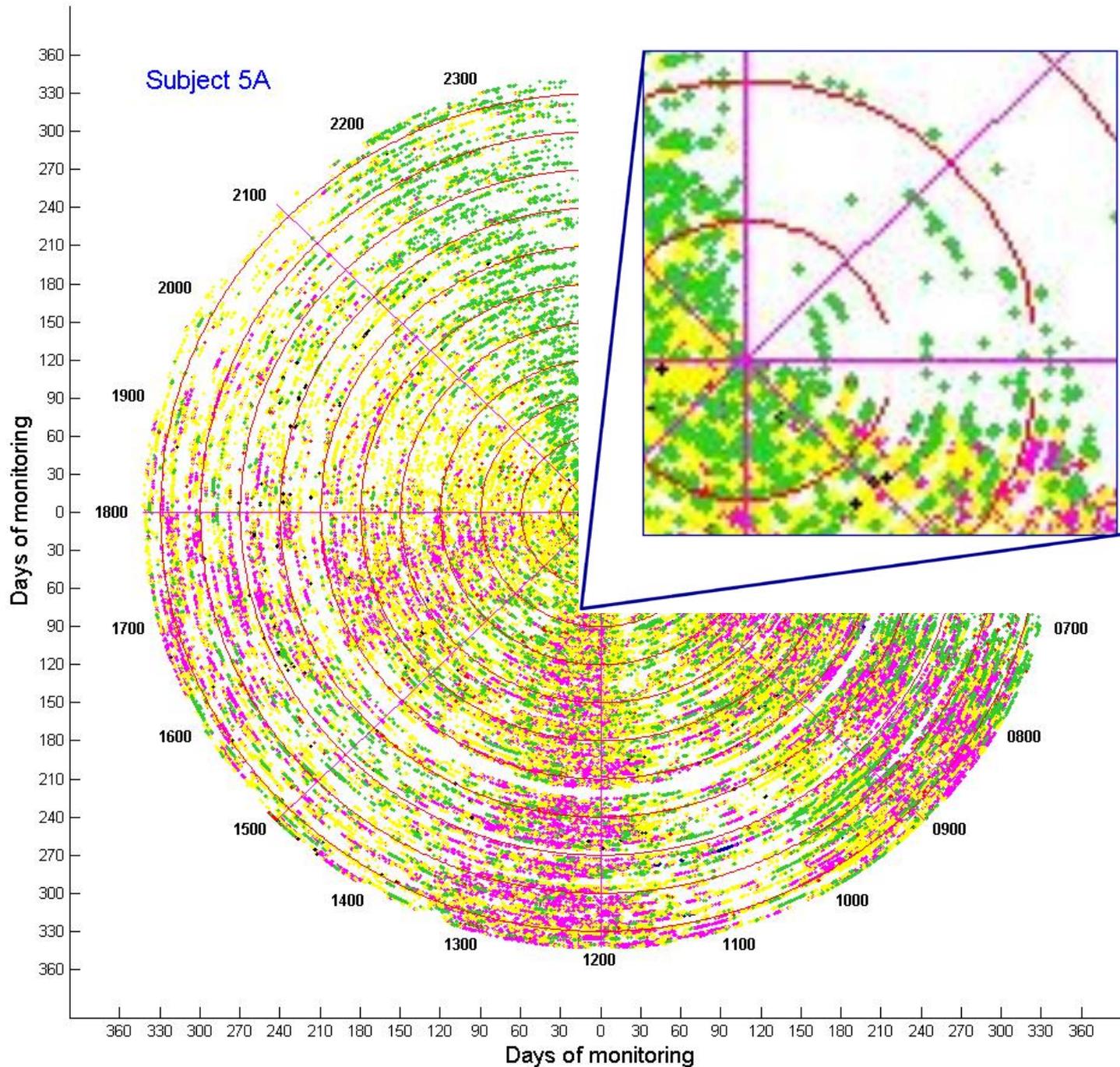


# Goals of continuous assessment

- Be unobtrusive
- Identify highest risk individuals
- Early detection of onset
- Start early treatment
- Prevent acute events & hospitalizations
- Maintain independence
- Efficiently use resources & labor
- Save money
- Faster clinical trials



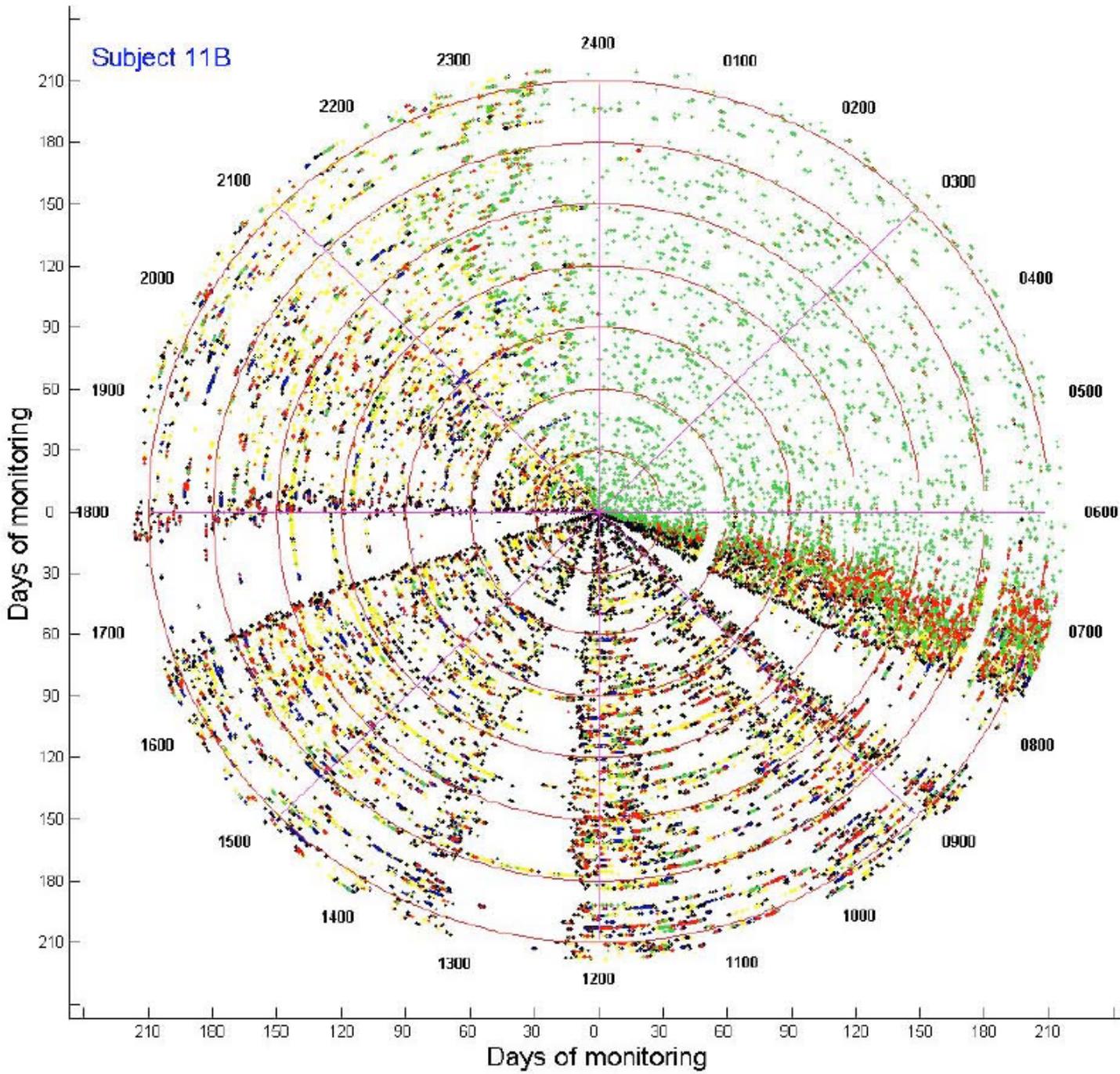
Subject 5A



## Spiral plot:

motion activity for 330 consecutive days. Each circle represents the beginning of a month proceeding in time from the center outward. Points are plotted on a 24:00 clock. Colors represent location of activity sensor firing (green = bedroom; red = bathroom; black = front door; pink = kitchen; yellow = living room).

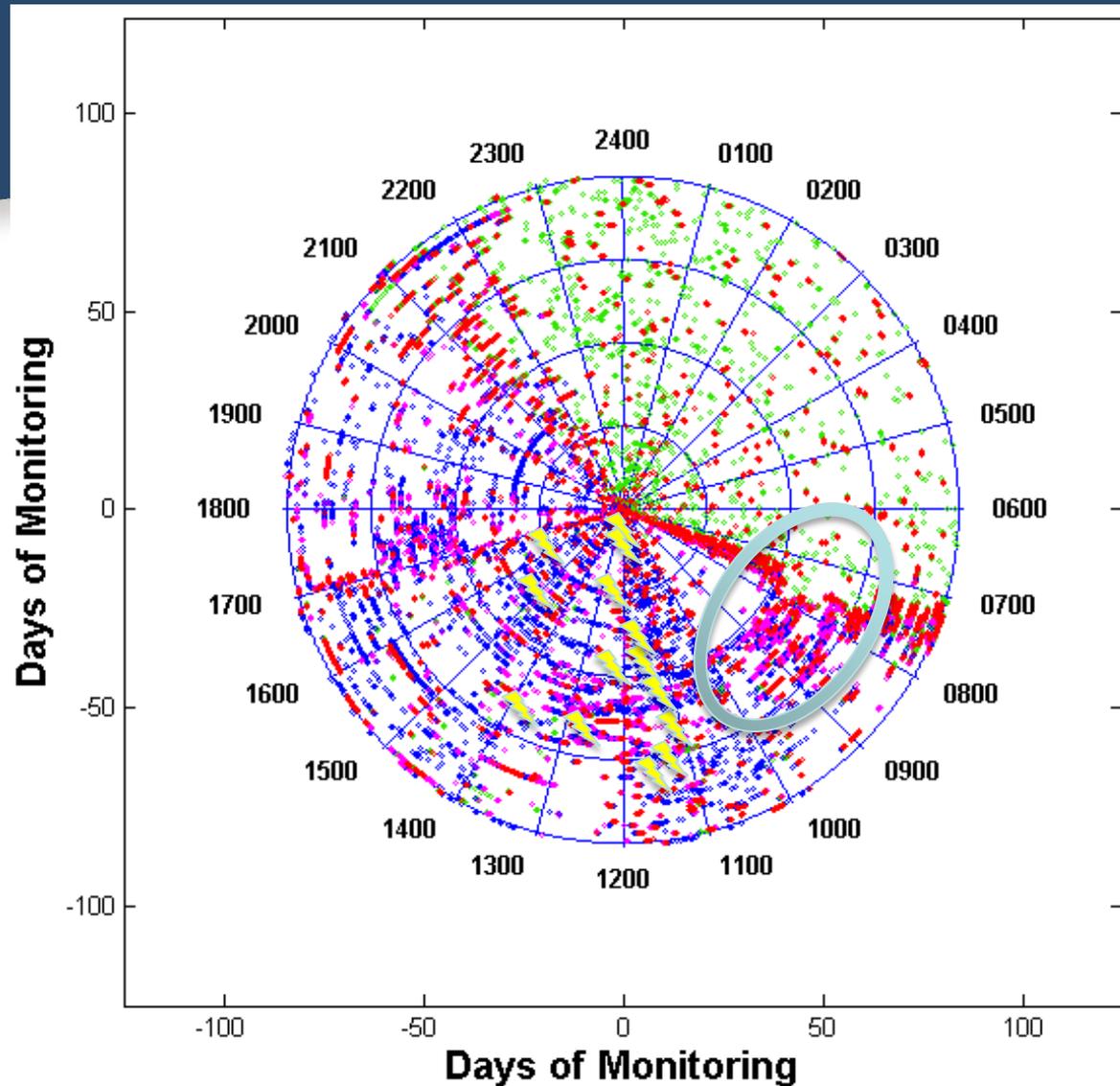
Subject 11B



**Spiral plot 2:** motion activity over 210 days of a participant who lives in a **continuing care retirement community**. Notice he/she leaves at mealtimes to go to the dining room. Also notice that there are many other exits/entries (in black), likely indicating more social interactions.

# Life Events Life Space Analysis

**Spiral plot:** The plot is a 24 hour clock representing here 8 weeks of continuous data. At the top of the clock is midnight; at the bottom is noon. Each concentric blue circle outward represents 2 weeks of time. The colors of the dots represent firings of sensors by location



Kitchen



Bath



Bedroom

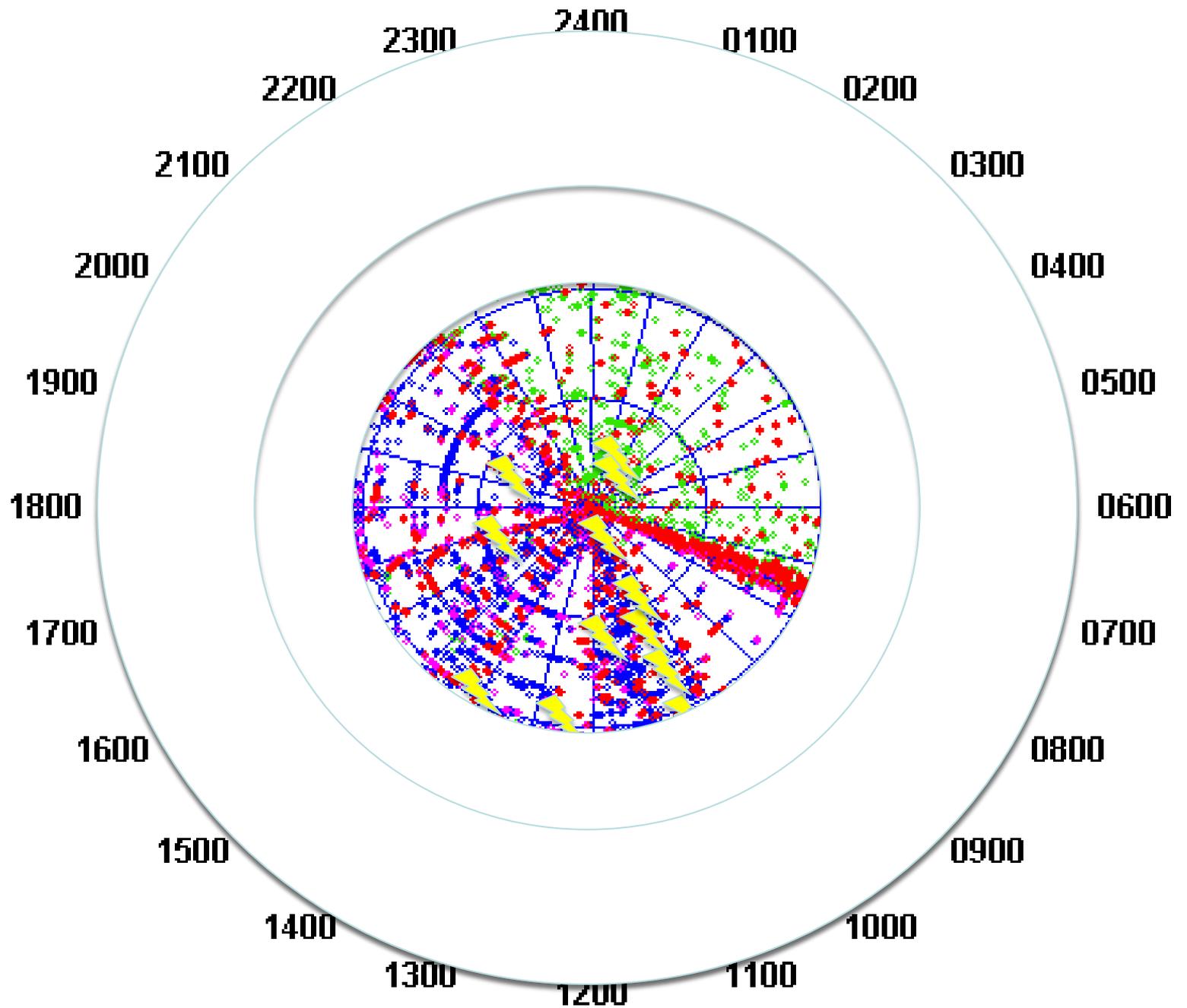


Living room



Computer  
Session





# Weekly Health Survey: online



## Oregon Technology and Aging Study

### Health and Activity Questionnaire

Please note that we have made changes to this weekly questionnaire to make it easier to complete. If you have any questions about how to fill this out, please call your Research Assistant for assistance. Again, we thank you for your valuable contribution.

Please use your mouse to click on YES or NO to indicate if there have been any changes in your health or activities in the past week. If you answer yes to any of these questions, please explain them briefly in the spaces designated. All of your responses will be confidential.

In the past week have you:

1:  Yes  No Been away from home overnight? If so, what dates?

Start Date:  End Date:

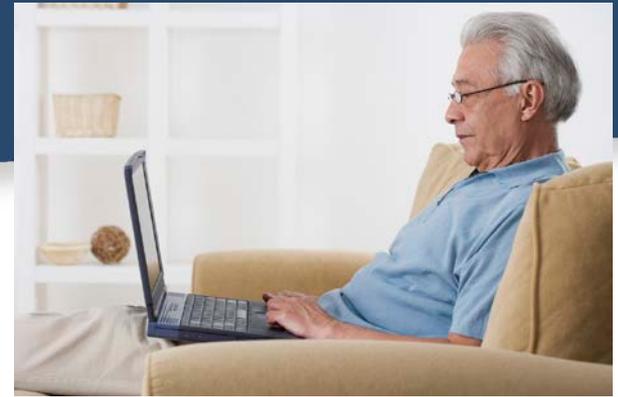
Please provide details here:

2:  Yes  No Had visitors that have stayed for more than one day in your home? If so, what dates?

Start Date:  End Date:

Please provide details here:

# Weekly Health Survey



- Away overnight
- Visitor overnight
- Medication change
- Falls
- Injuries
- Hospitalization or Emergency Room
- Physical health
- Space changes like moved furniture
- Downhearted or blue
- Lonely
- Pain level
- Limited due to pain

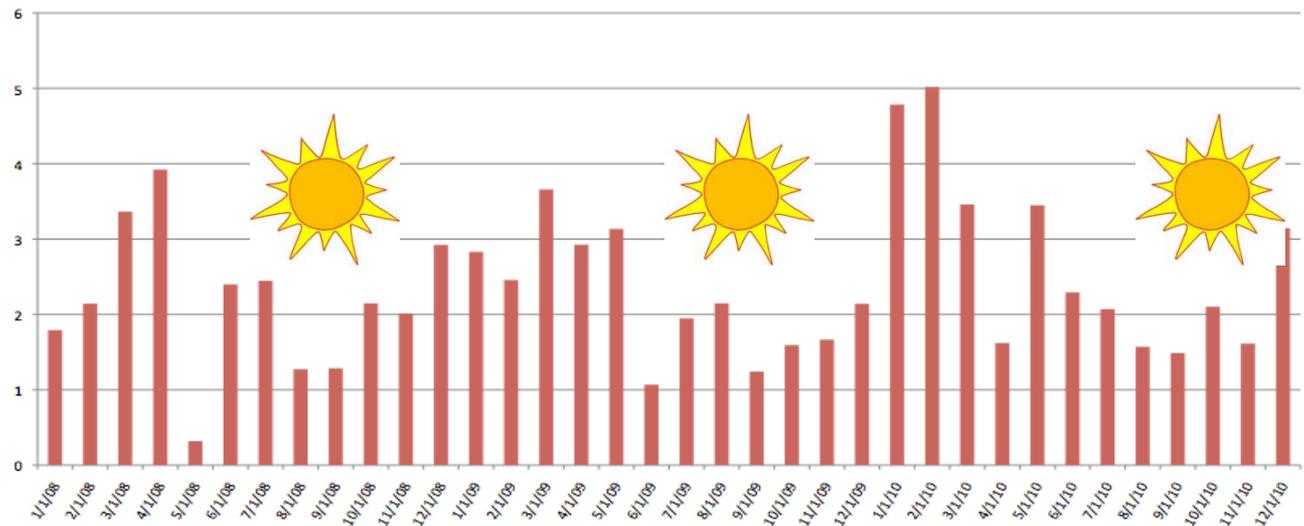
# Weekly on-line reports provides unique insights into function: patterns of low mood

“During the last week, have you felt downhearted or blue for more than three days?”

N = 122; 14,566 reports

(2008-2010)

## Seasonal Pattern of Low Mood Reports



“During the last week, have you felt downhearted or blue for more than three days?”



### Example responses:

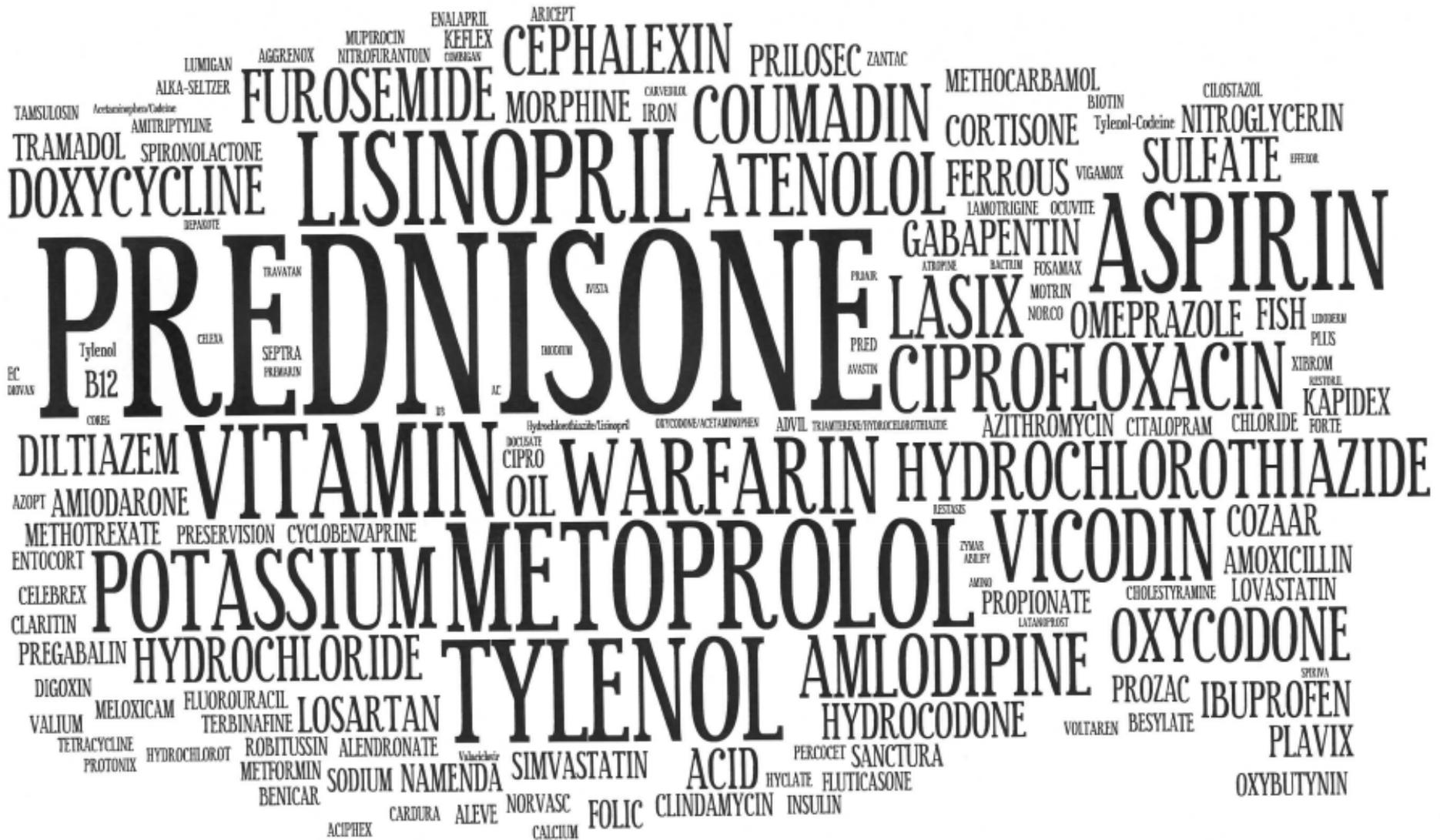
- “My youngest daughter has been diagnosed with cancer.”
- “December is not my favorite month, especially when it is foggy and dreary”
- “almost constant pain is beginning to wear on my nerves”
- “I feel a little low as i'm giving up my car. Decided as I'm going to be 92 next month it was about time. and my insurance came due this month and my license for the car next month, so figured this was the time. My reactions are slower than they used to be also.”
- “3rd anniversary of husband's death and the death a close friend.”





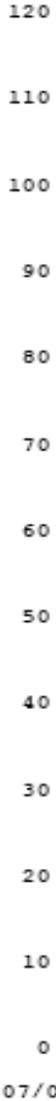
“During the last week, have you had a change in your medications?”

Medication changes



# Walks: From 2 to 7000 per year

Walking Speed cm/s



07/01/2007 01/01/2008 07/0

Date

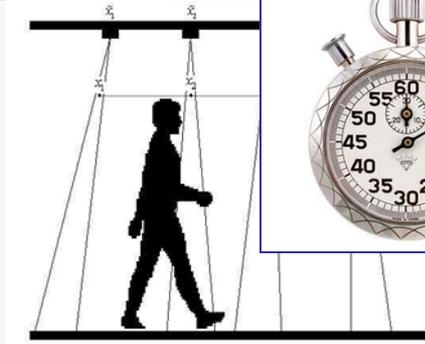
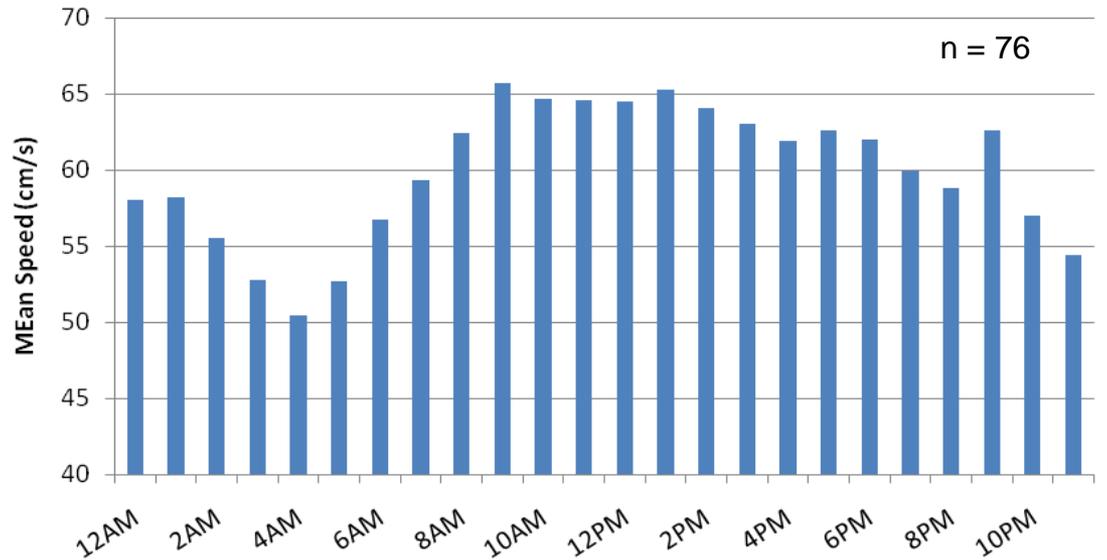


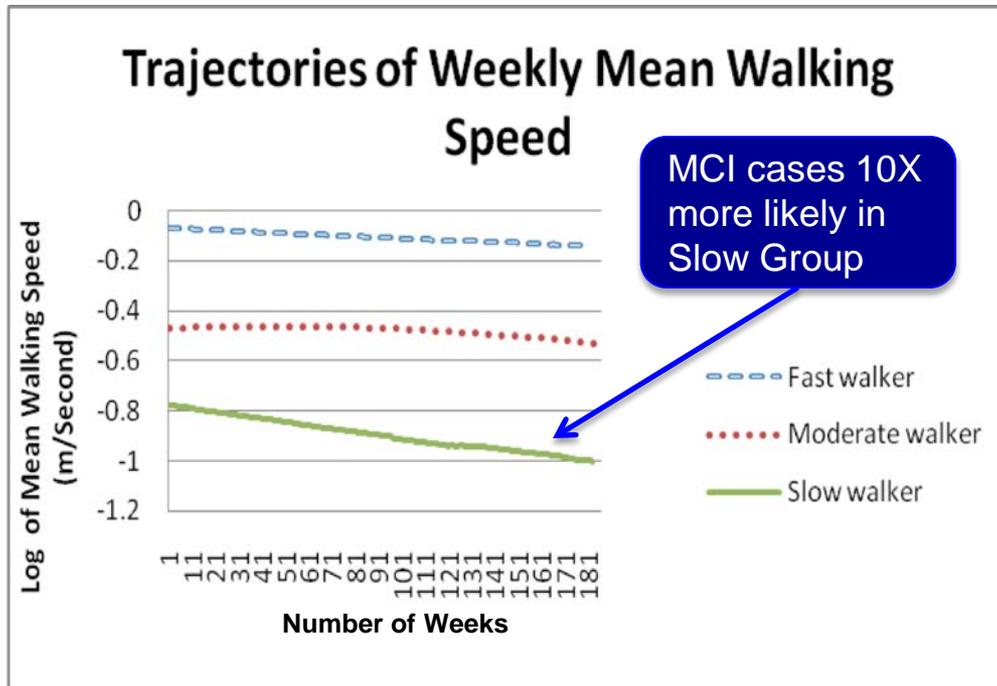
Photo: NYT, 2009



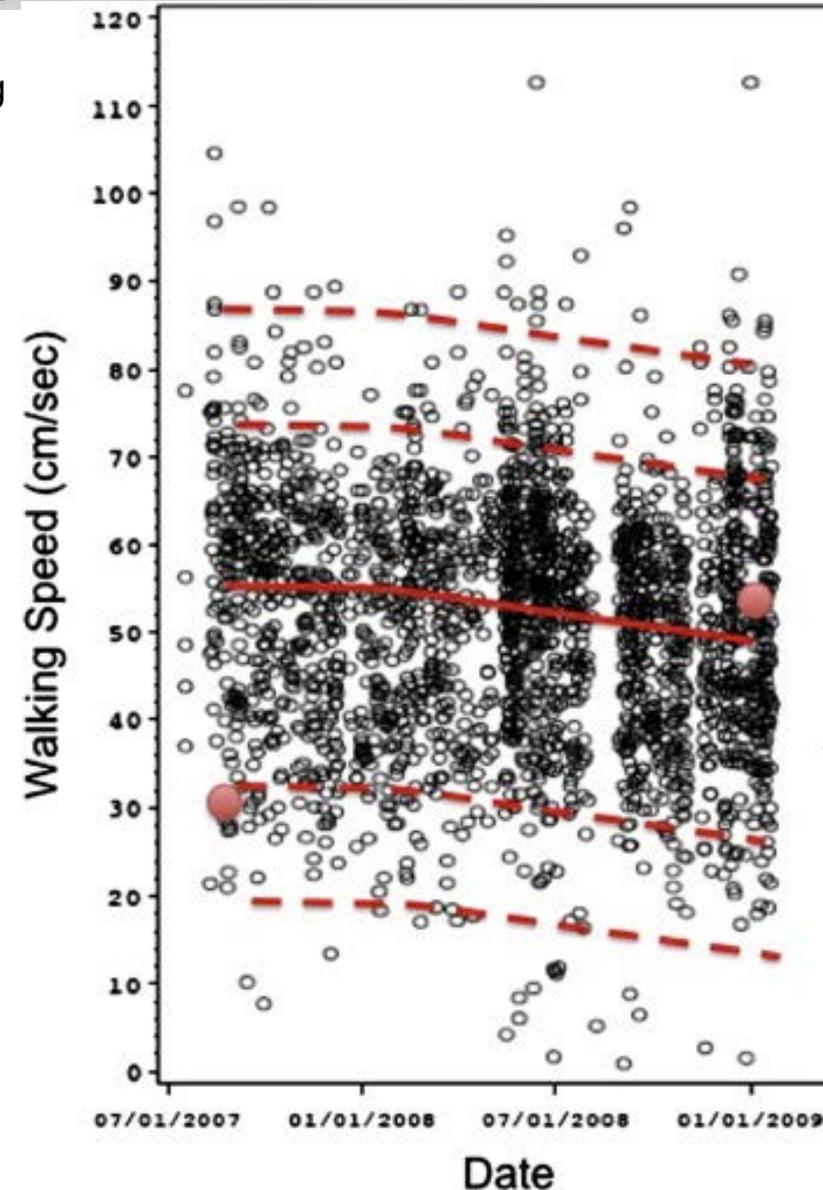
# Walking in MCI is slow and declining faster over time

**Right Panel** - Automated daily walking speed measurements for an individual derived from an in-home sensor line operating over a period of 16 months showing the normal variability and range in this metric. Red dots: conventional single in-person stop-watch measurements. Kaye et al. Gait & Posture, 2011.

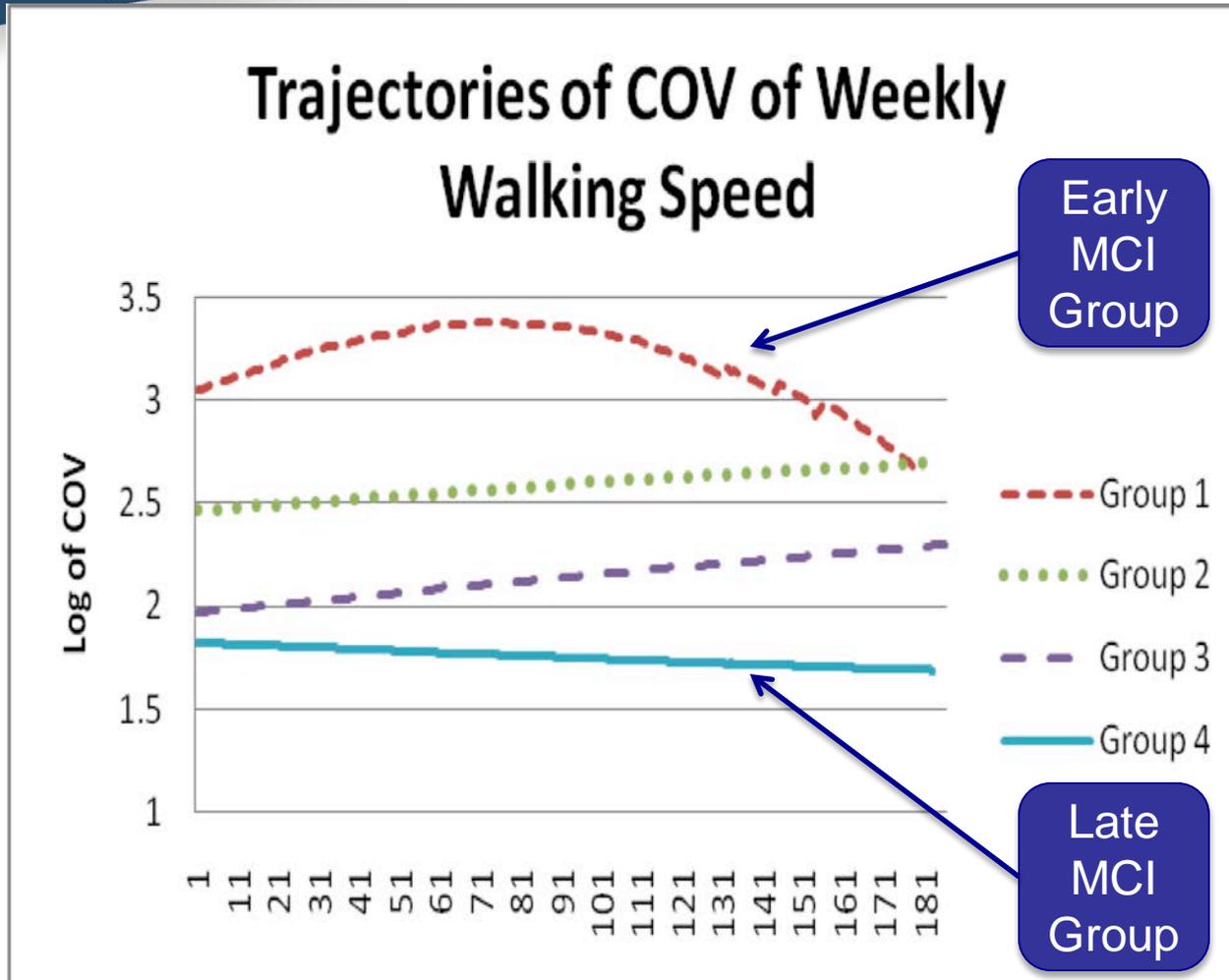
**Lower Panel** – Walking speed trajectories over time are characteristic of MCI. Dodge et al. Neurology, 2012



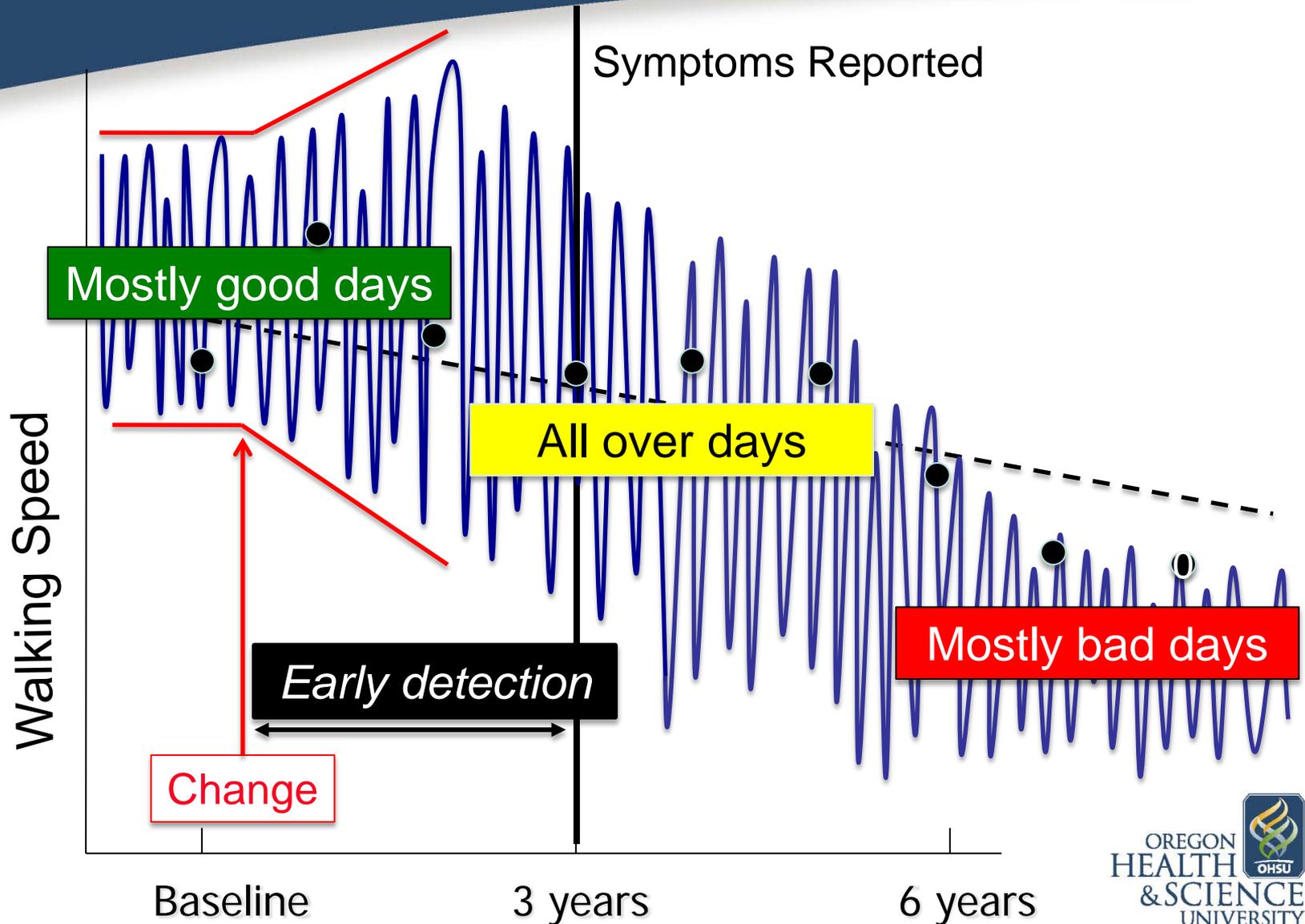
Controlled for Tinetti Balance in addition to age (at baseline), sex, yrs of education



Walking in MCI is more VARIABLE (becomes less so over time)



# Walking Speed and Memory: a simplified hypothesis



# Direct Assessment of *Everyday* Cognition

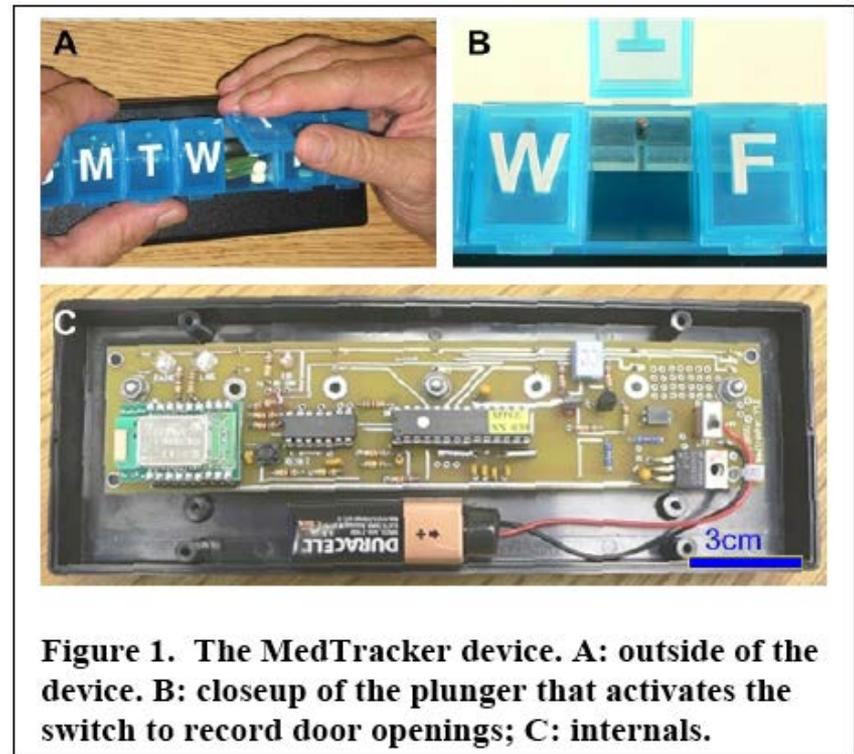
## PROSPECTIVE MEMORY

*Prospective memory task* – probability of remembering to take medications as desired tracked using a familiar plastic pill box.

VS

*Conventional memory task* – recall a list of unrelated words.

## ORCATECH MedTracker

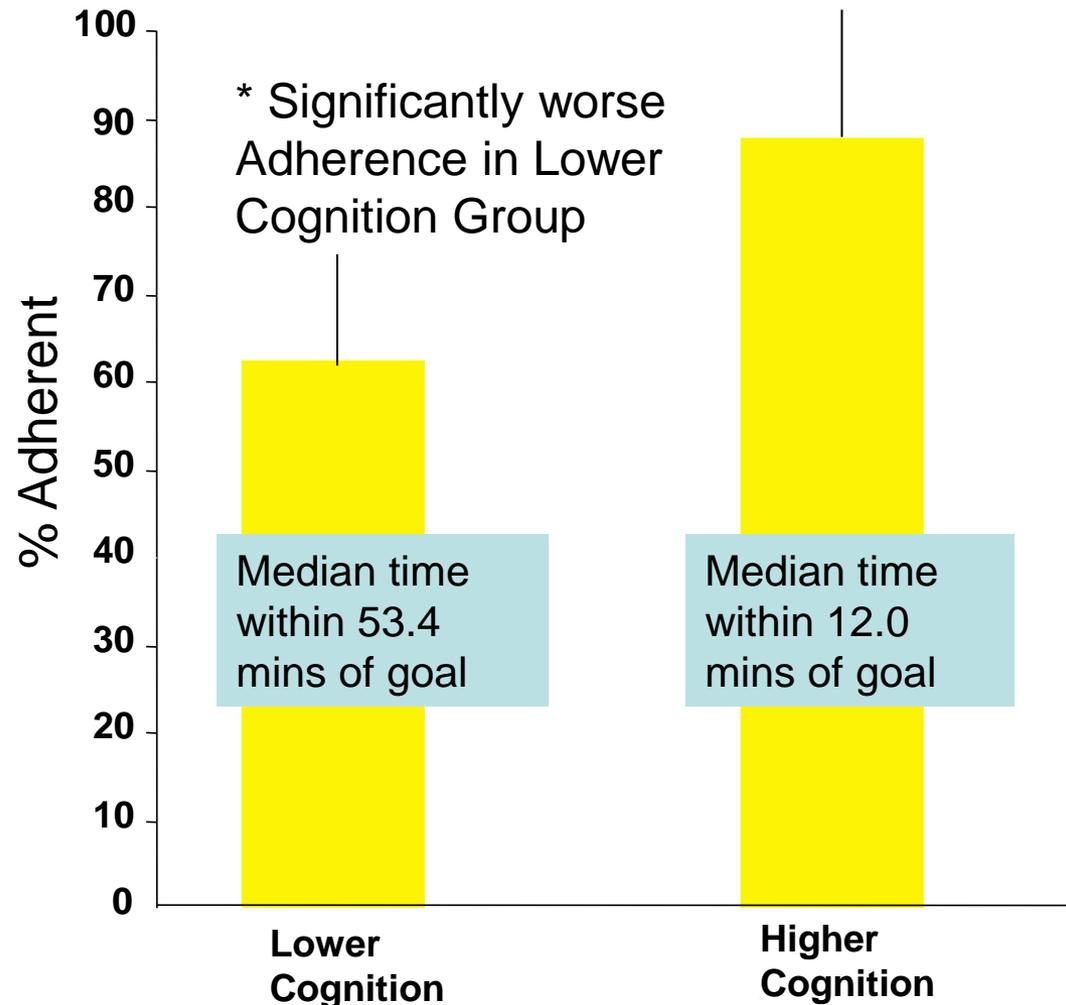


**Figure 1.** The MedTracker device. **A:** outside of the device. **B:** closeup of the plunger that activates the switch to record door openings; **C:** internals.

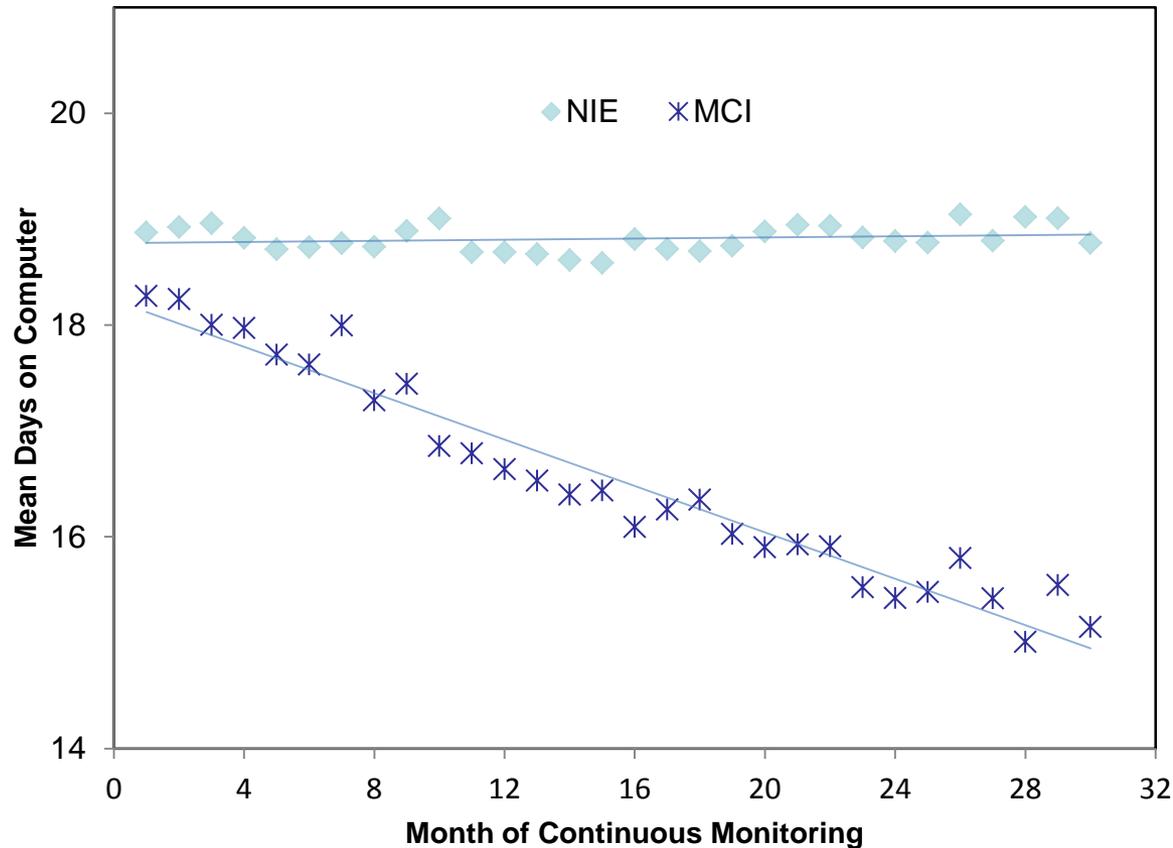
# Medication Adherence: A Sensitive Measure of Cognitive Function



- Adherence assessed with MedTracker taking a vitamin BID; target times set by seniors
- Mean Age - 83 yrs
- Assessed continuously x 5 wks
- Based on ADAScog: Lower Cognition Group (n = 18) vs Higher Cognition Group (n = 20)
- Very mild cognitive change in independent elderly is associated with medication adherence
- Medication adherence can be a very early marker of cognitive and functional impairment.



# Computer use and memory impairment

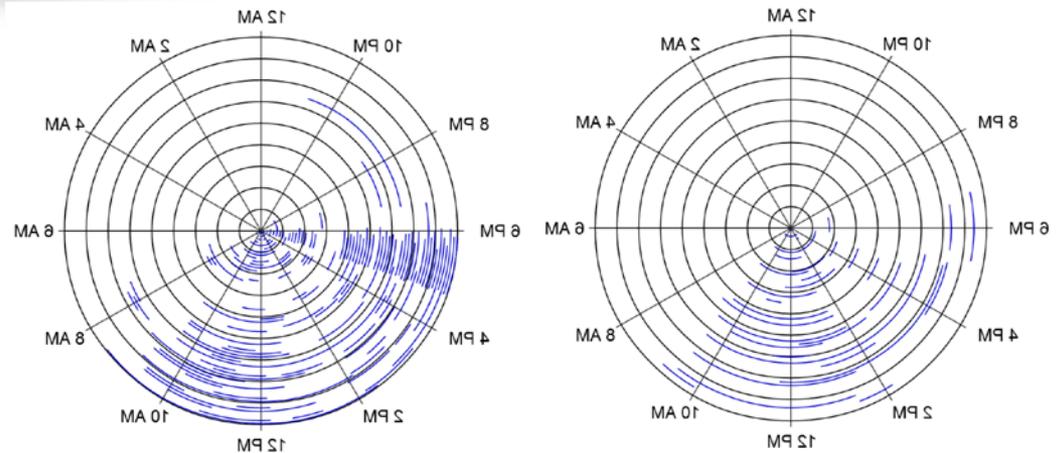


- Mean 1.5 hours on computer/per day at baseline month
- Over time:
  - *Less use days per month*
  - *Less use time when in session*
  - *More variable in use pattern over time*

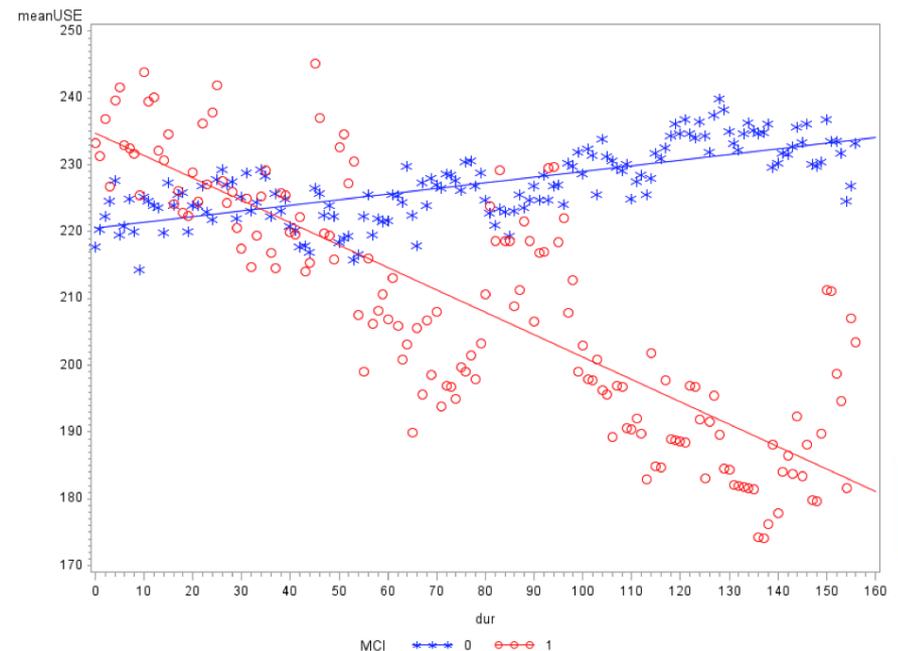
# Time Out of Residence (TOR)

## Sensitive to memory change

Spiral plots: Time of individual outings per day for a 9 week period in two participants. Left - Cognitively intact, mean TOR = 6.3 hrs; Right - MCI, mean TOR = 2.4 hrs



Independent of chronic disease burden, depression, or season of enrollment, MCI participants had a significantly greater decline in time out of home over time compared to cognitively intact participants

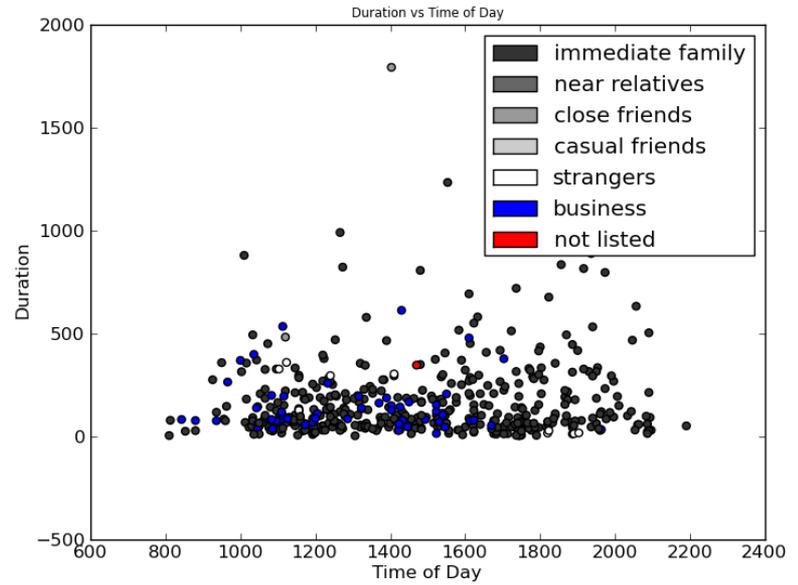


# Technology as intervention: social engagement



# Channels of Engagement

## Telephone



**Table 1. Duration and frequency of voluntary Skype calls to family members and friends**

ID	Mean	Median	Number of Skype Calls
1	16.16	8.00	19.00
2	21.30	17.50	32.00
3	19.44	17.50	34.00
4	35.19	35.00	16.00
5	28.67	22.00	15.00
6	32.67	33.90	15.00
7	31.22	23.00	38.00
8	10.17	10.00	9.00



## Internet email/VOIP

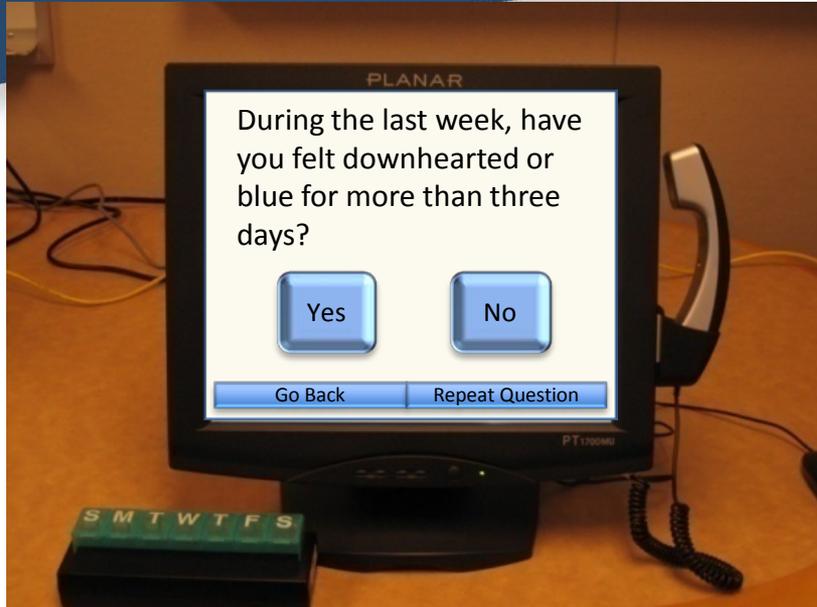
## Face-to-Face



**Table 3. MAR Feasibility Study Results**

ID	Age	Sex	Yrs. of Education	MMSE	Day 1 Total time in talking (in minutes)	Day 2 Total time in talking (in minutes)
012420	79	F	16	26	85.5	-
014387	79	M	Missing	27	120.0	25.1
006923	92	F	18	30	271.3	70.2
013881	76	F	14	20	110.3	85.3
014235	85	F	12	26	65.1	-
010024	78	F	10	26	20.3	40.3

# Deciding on Collection Device

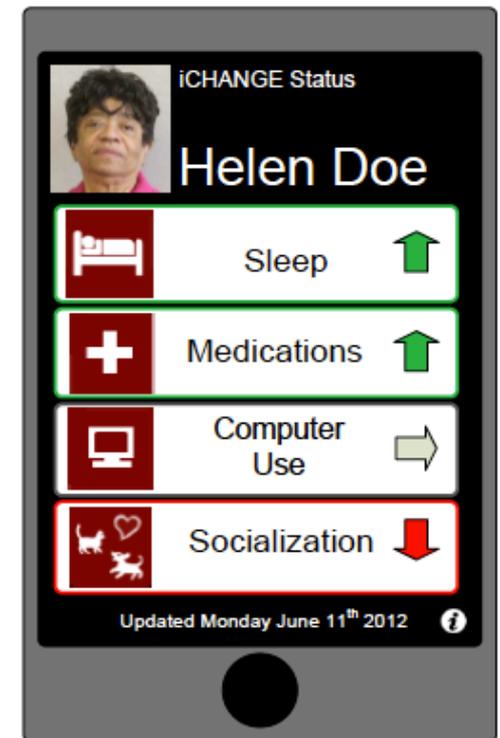


# Who uses the data?

I'm OK



Mom's OK



# Who uses the data?

My patient is OK

Production - Hyperspace - Oregon Health & Science University - NEU AGING/ALZ CHH

Epic Schedule Patient Lists Patient Station In Basket Chart Tel Enc Refill Enc Meds List Support Desk Print Log Out

**Doe, Mary**

Doe, Mary MRN:000000 Language: English Adv. Dir: YES  
84yrs, Female, 01/27/1928 PCP: Dr. Spock Primary Ins: Medicare POLST: YES

6/7/2012 visit with Jeffrey Kaye, MD for NEU OFFICE VISIT - Follow up. Rescheduled for May to coordinate appts, pt doing very well per

Reason for Visit: None

Date of Onset: DOCUMENT FOR PRIMARY DX Total Questions: 5

iCHANGE Dementia Assessment

**Medication Adherence** Details

Adherence 5 Day 0% 60 80

Medication	Adherence Status
Donepezil	Yellow
HCTZ	Yellow
Aspirin	Yellow
Trazodone	Red

Smoking Status: Former Smoker

Type	Noted	Valid Until	Updated
		3/19/2009	

Past Updates...



## AIMs Grant

- Ambient Independence Measures for Guiding Care Transitions
  - Develop new metrics that predict health decline (AIMs)
  - Work with care transition teams to identify
  - Create tool for continuous reporting of AIMs
  - Evaluate use of AIMs in making transition decisions
- \$2.5m, 5-year project, funded by NIH NIA



## ORCATECH Expansion & Development

- Judith Kornfeld, MBA - Chief Business Officer
- Extraordinary research resources
  - Unique expertise
  - Longitudinal Data
  - Living Laboratory of volunteers
- Develop industry collaborations
  - Consulting
  - Device testing and clinical trials



## ORCATECH Living Laboratory

- Maintain 150 installed homes (recruit!)
  - Annual memory and clinical assessments
  - Sensor platform installed in home
  - Weekly health questionnaire
- Create “ready to go” cohort
  - Recruitment source for new studies
  - Remote follow up (online or telephone)
  - Participate in periodic surveys and assessments

# Grateful Acknowledgements

**Faculty:** Drs. Jeff Kaye, Tamara Hayes, Kathy Wild, Linda Boise, Hiroko Dodge, Pete Jacobs, Misha Pavel, Holly Jimison and many faculty collaborators

**Tamara Hayes, PhD**  
August 2, 1959 – July 28, 2013

**Staff:** many research assistants, technicians, programmers, analysts

**Volunteers:** who invite us into their homes and lives

**Communities:** Willamette View, Mirabella Portland, Holladay Park Plaza, Rose Villa, Terwilliger Plaza, Mary's Woods

**Collaborators:**

National Institute  
on Aging ■ ◆ ★ ✨



alzheimer's association

NLST

Enterprise



National Heart  
Lung and Blood Institute

Robert Wood Johnson Foundation



OREGON  
HEALTH  
& SCIENCE  
UNIVERSITY





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