

USING TECHNOLOGY TO PROMOTE HEALTHY COGNITIVE AGING

Applications for the 24-hour Activity Cycle

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OUTLINE



Aging and technology

Aging and cognitive health

What is the 24-hour activity cycle?

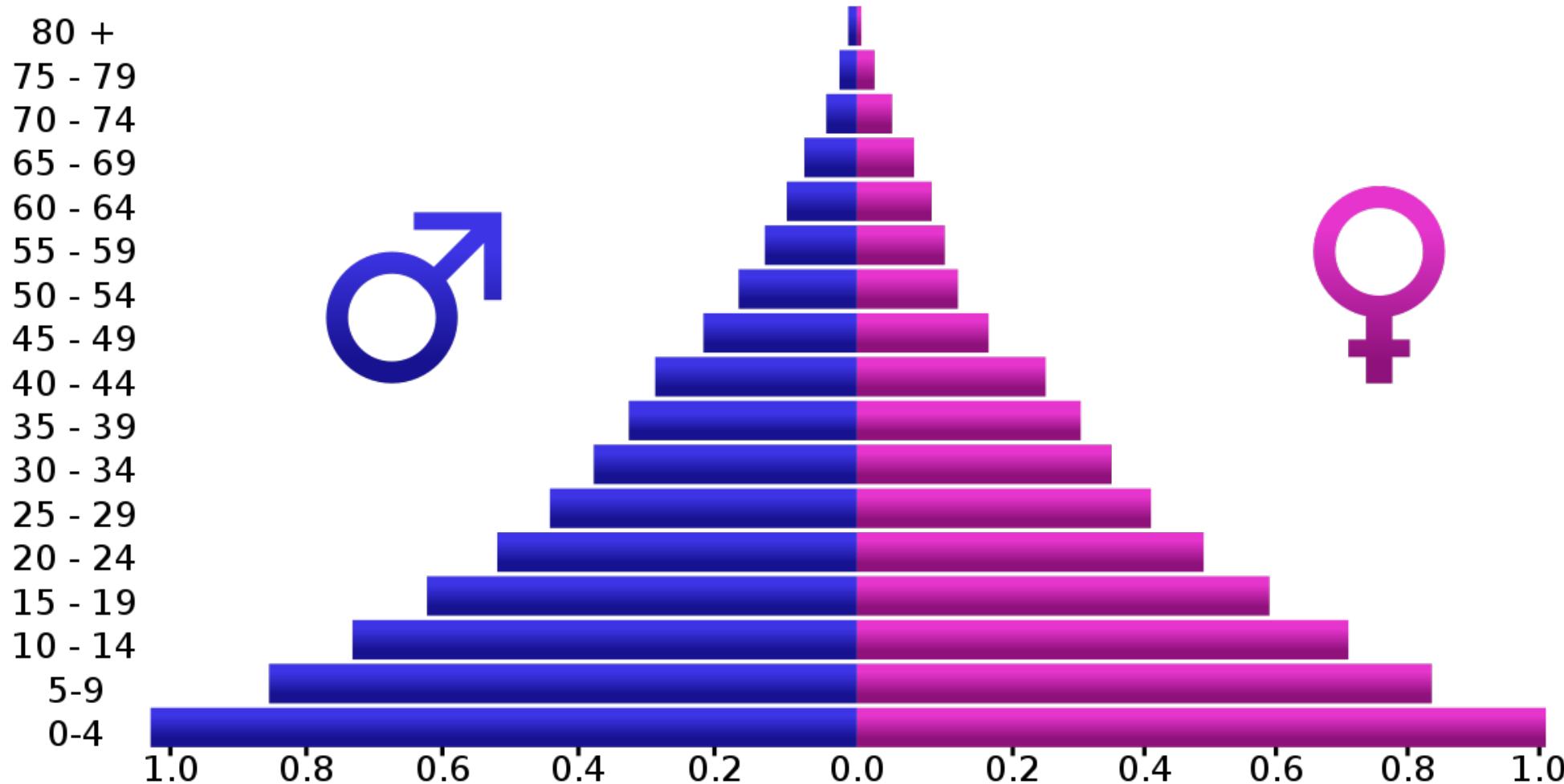
Can we use technology to promote the 24-hour activity cycle?

Future opportunities

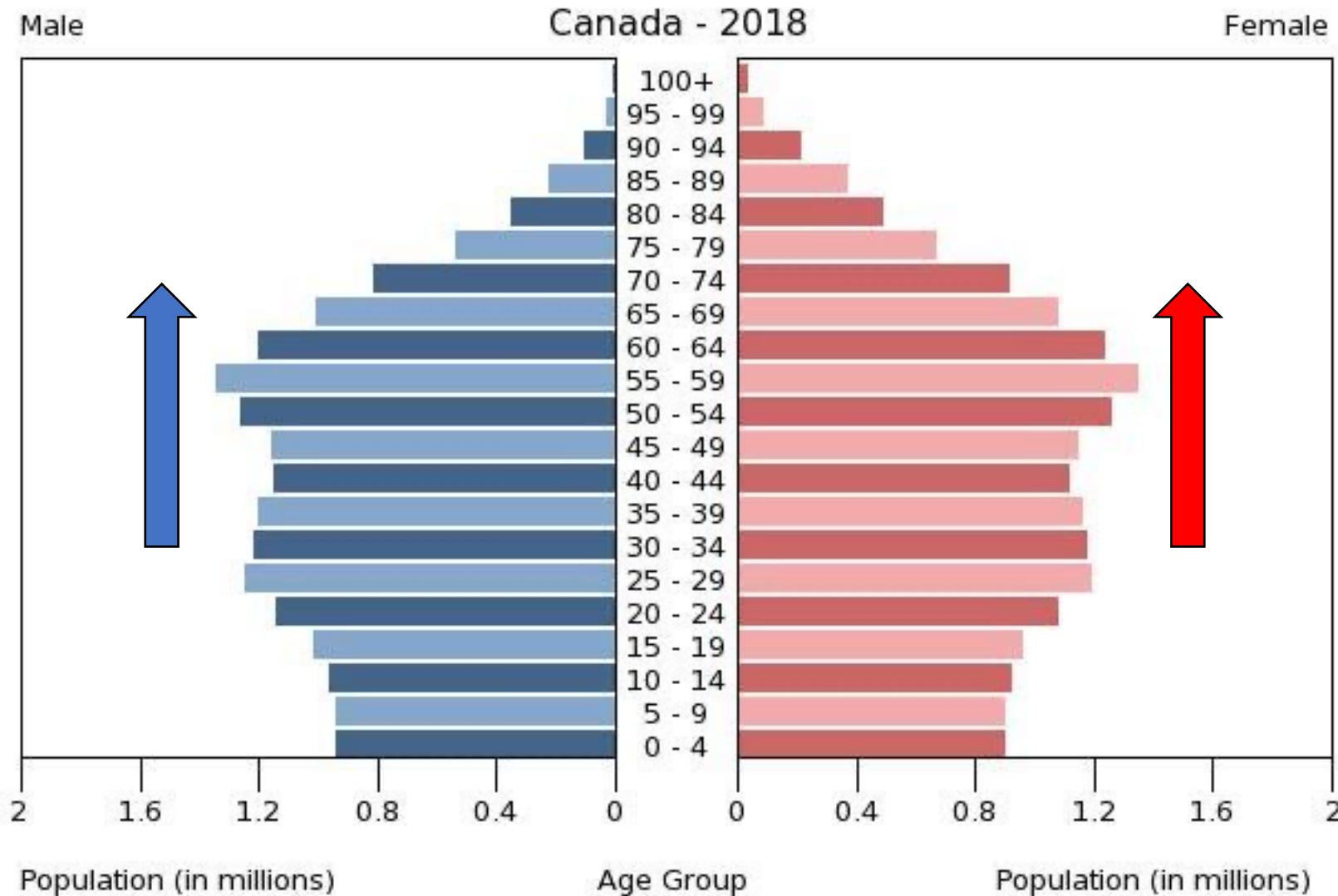


AGING AND TECHNOLOGY

THE IDEAL POPULATION PYRAMID



THE REALITY: OLDER ADULTS ARE THE FASTING GROWING DEMOGRAPHIC





One in five households provides care to an elderly or disabled individual who requires assistance. The number is expected to grow to **one in two** by 2030

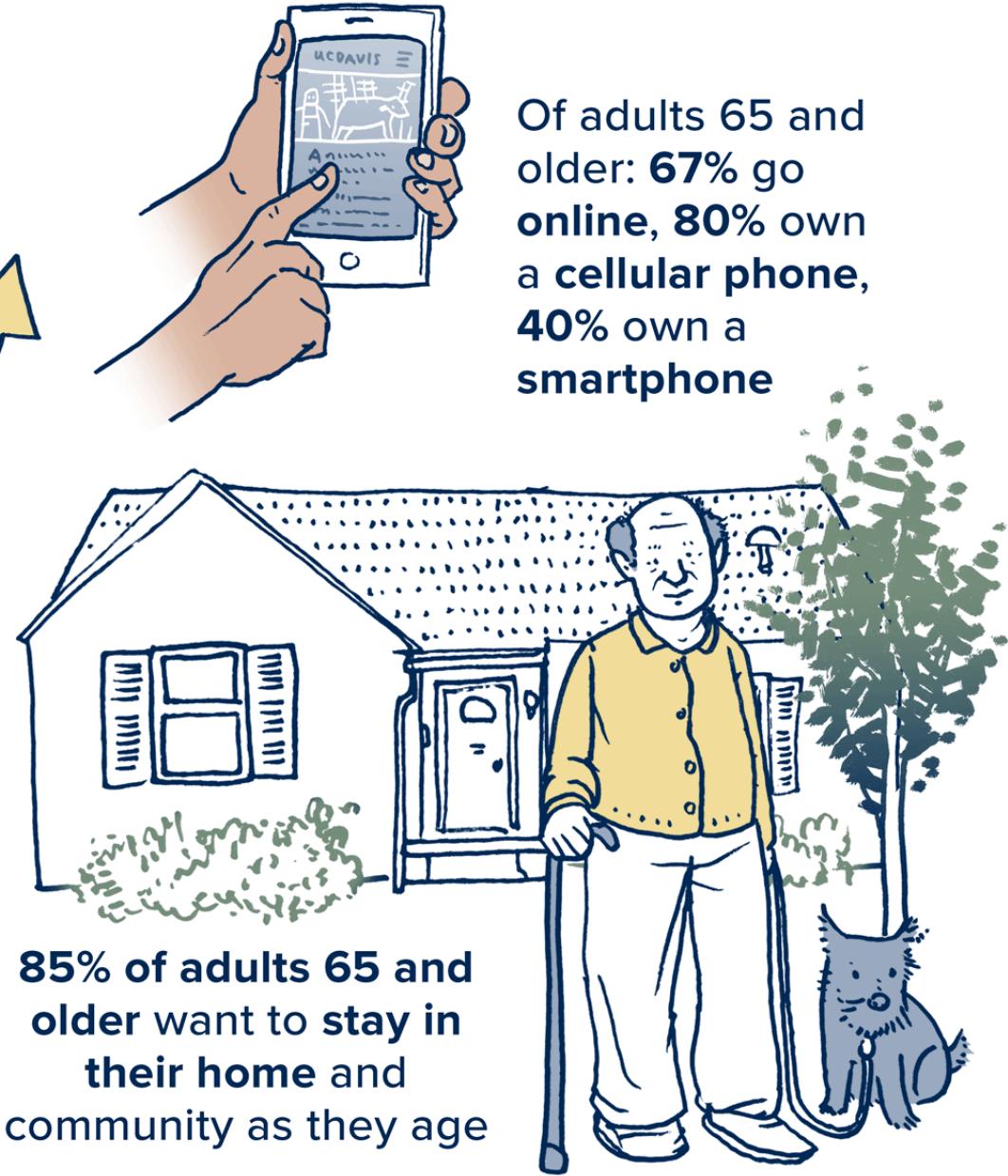


2015



2030

Health care spending is on the rise, with **75% of spending** due to chronic disease



Of adults 65 and older: **67%** go online, **80%** own a cellular phone, **40%** own a smartphone



Canada's technology and aging network

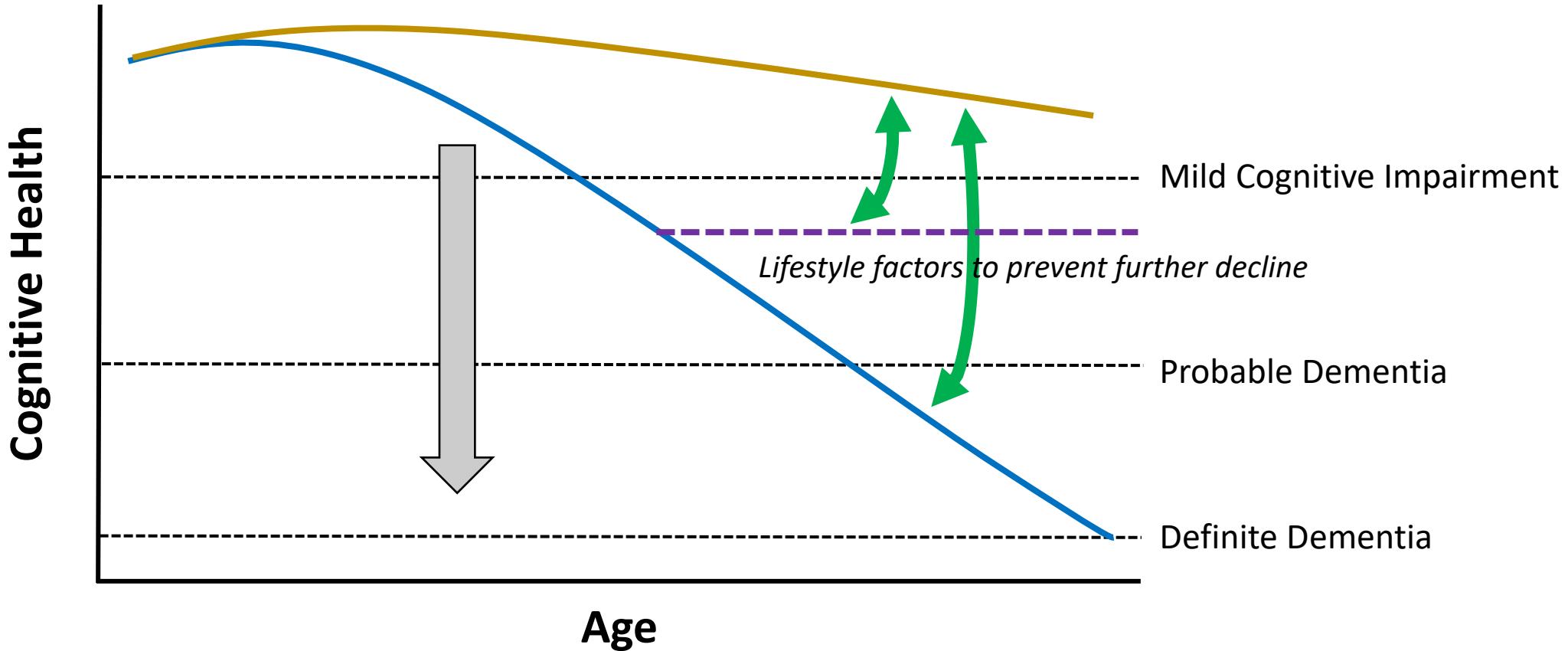
<https://agewell-nce.ca>



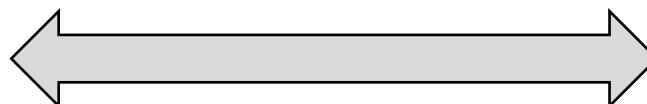
AGING AND COGNITIVE HEALTH

AGE-RELATED COGNITIVE CHANGES

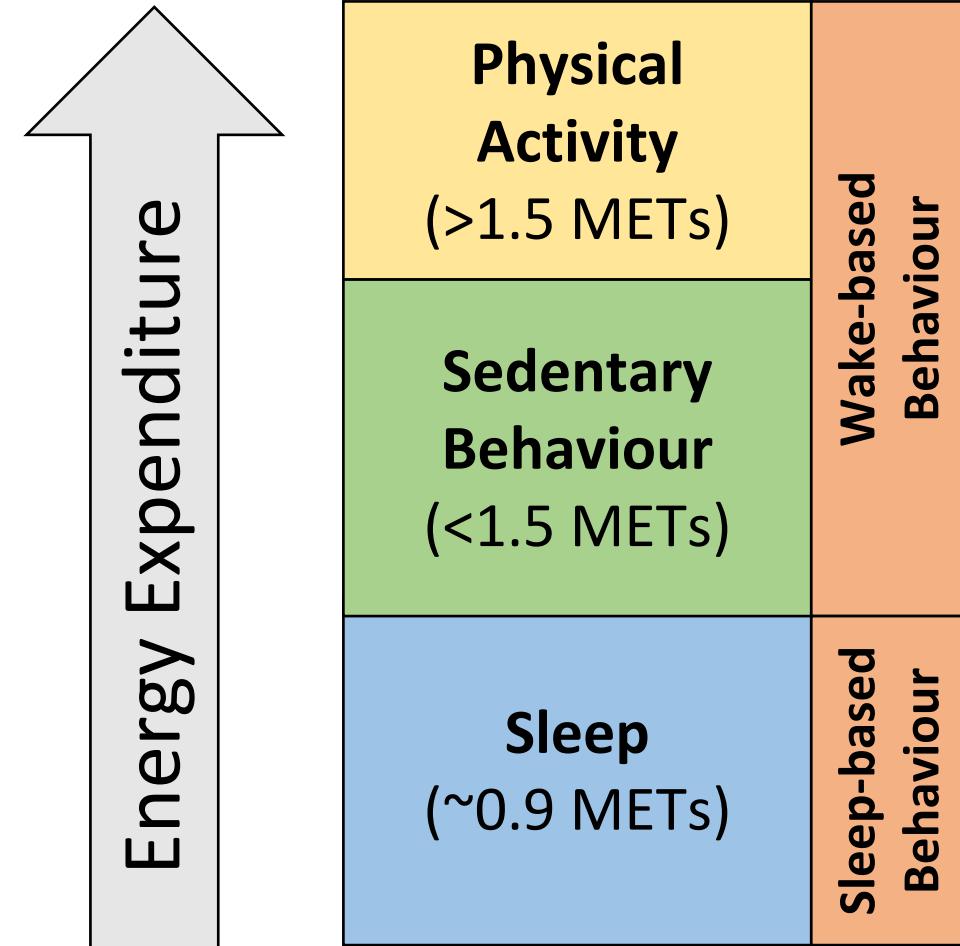
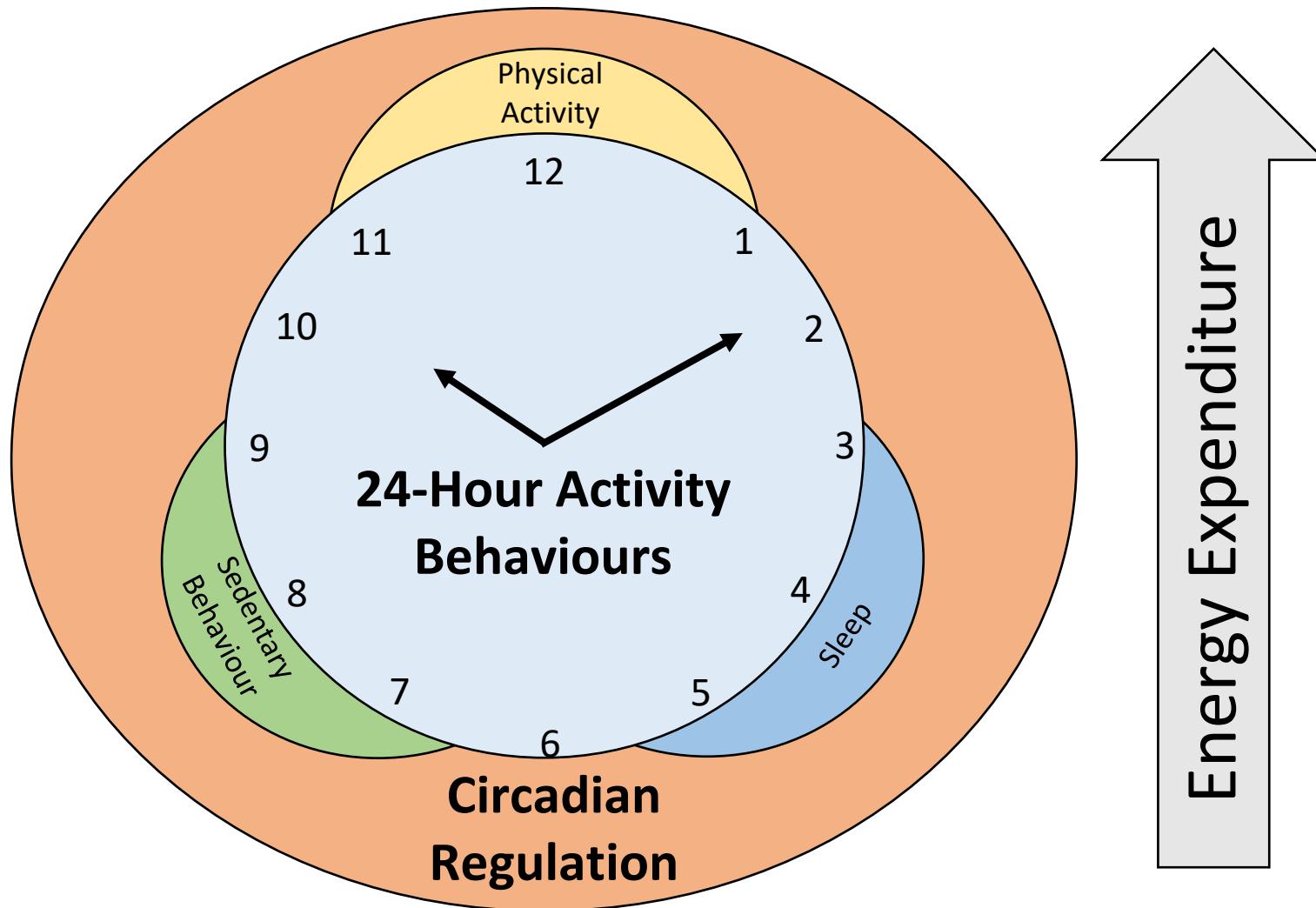
Individual Variability in Cognitive Trajectory



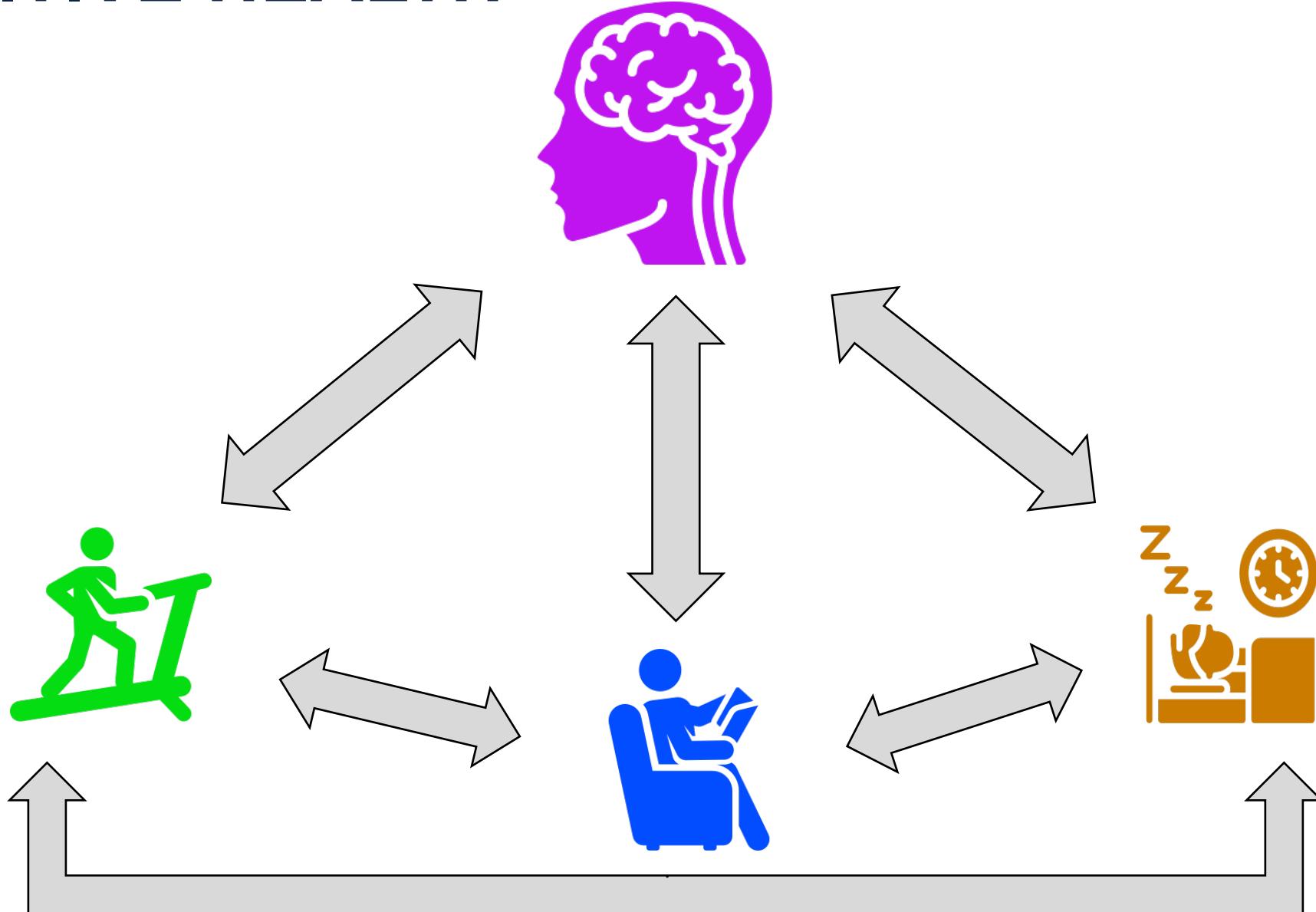
THE 24-HOUR ACTIVITY CYCLE AND COGNITIVE HEALTH



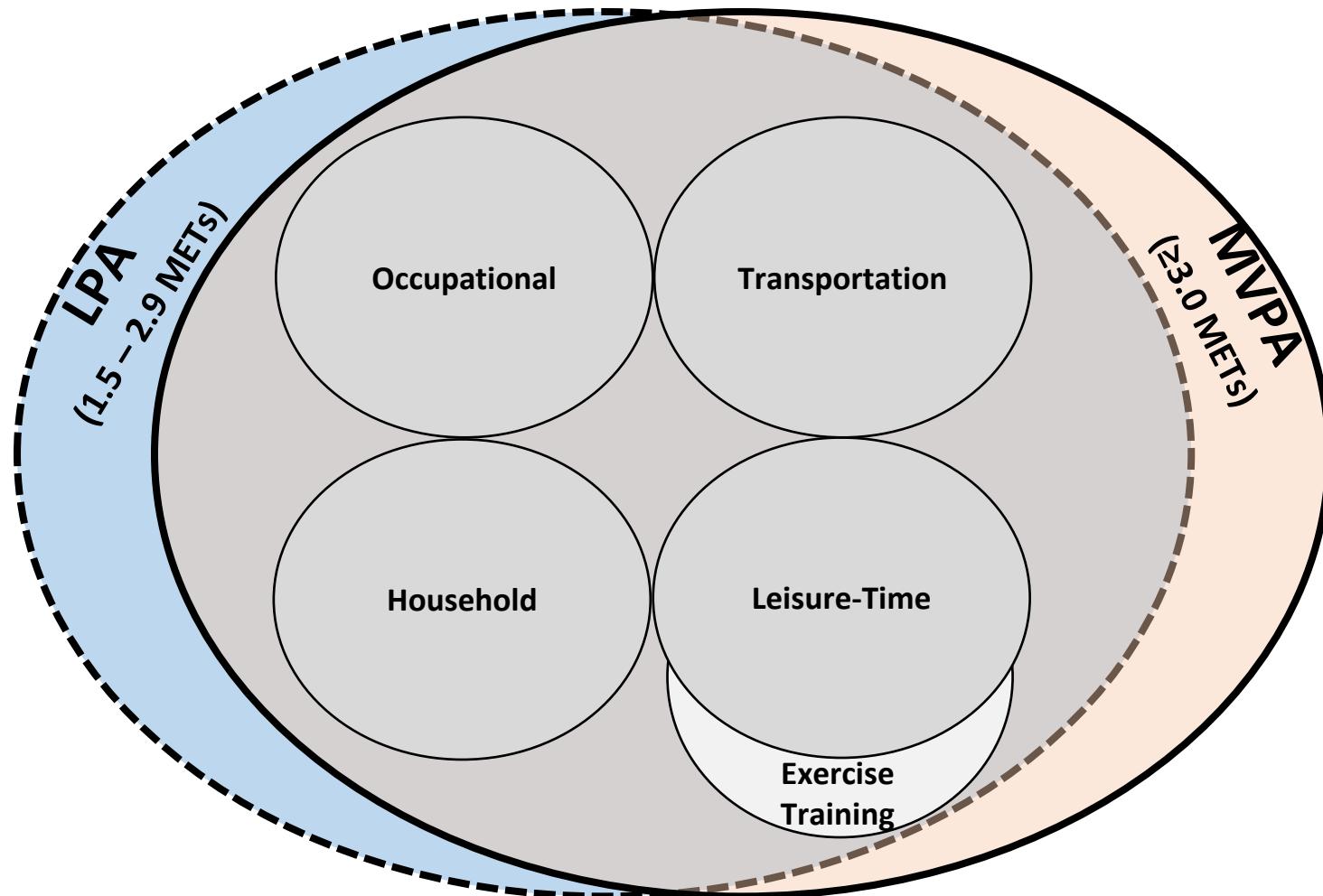
WHAT IS THE 24-HOUR ACTIVITY CYCLE?



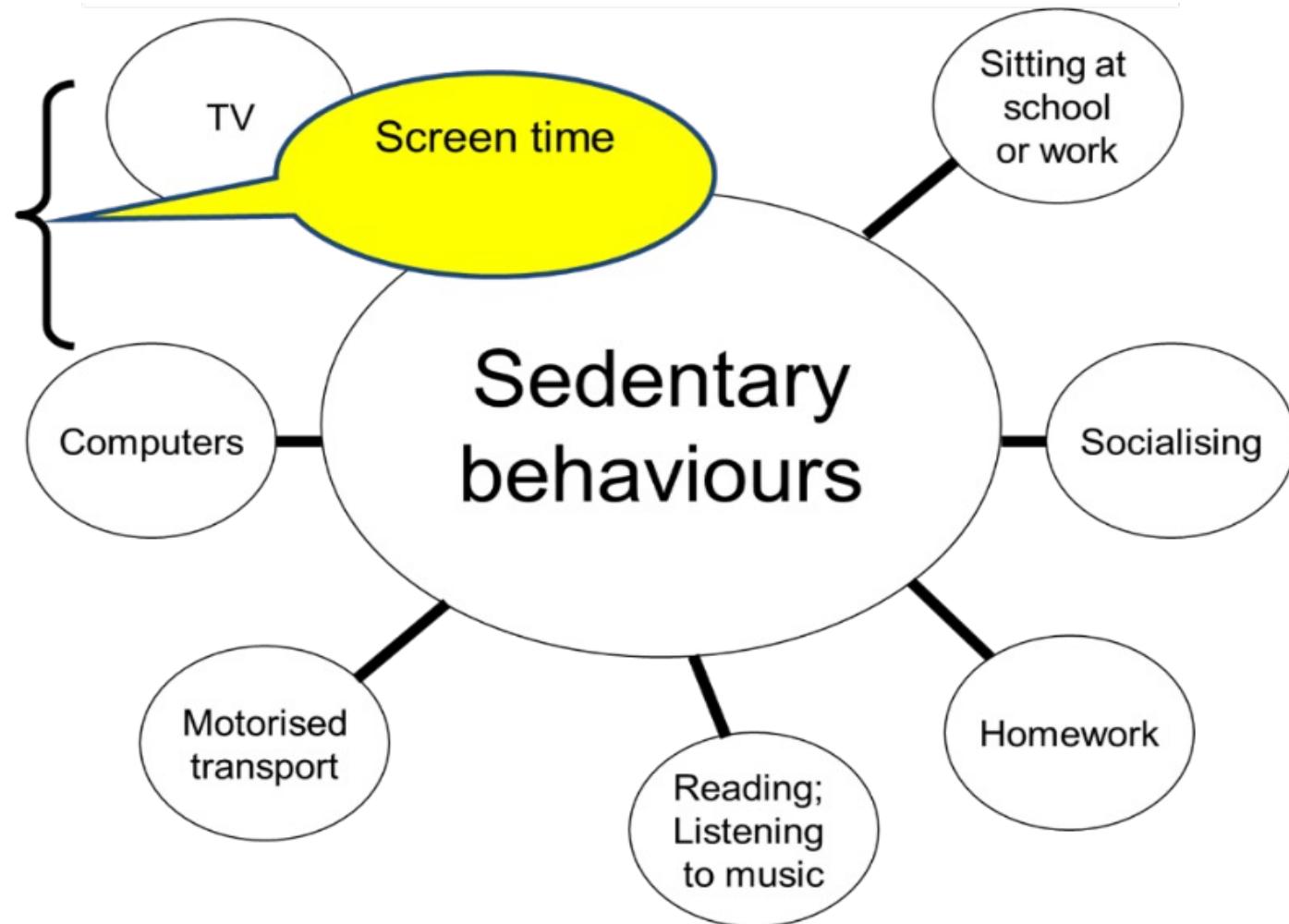
THE 24-HOUR ACTIVITY CYCLE AND COGNITIVE HEALTH



WHAT IS PHYSICAL ACTIVITY?



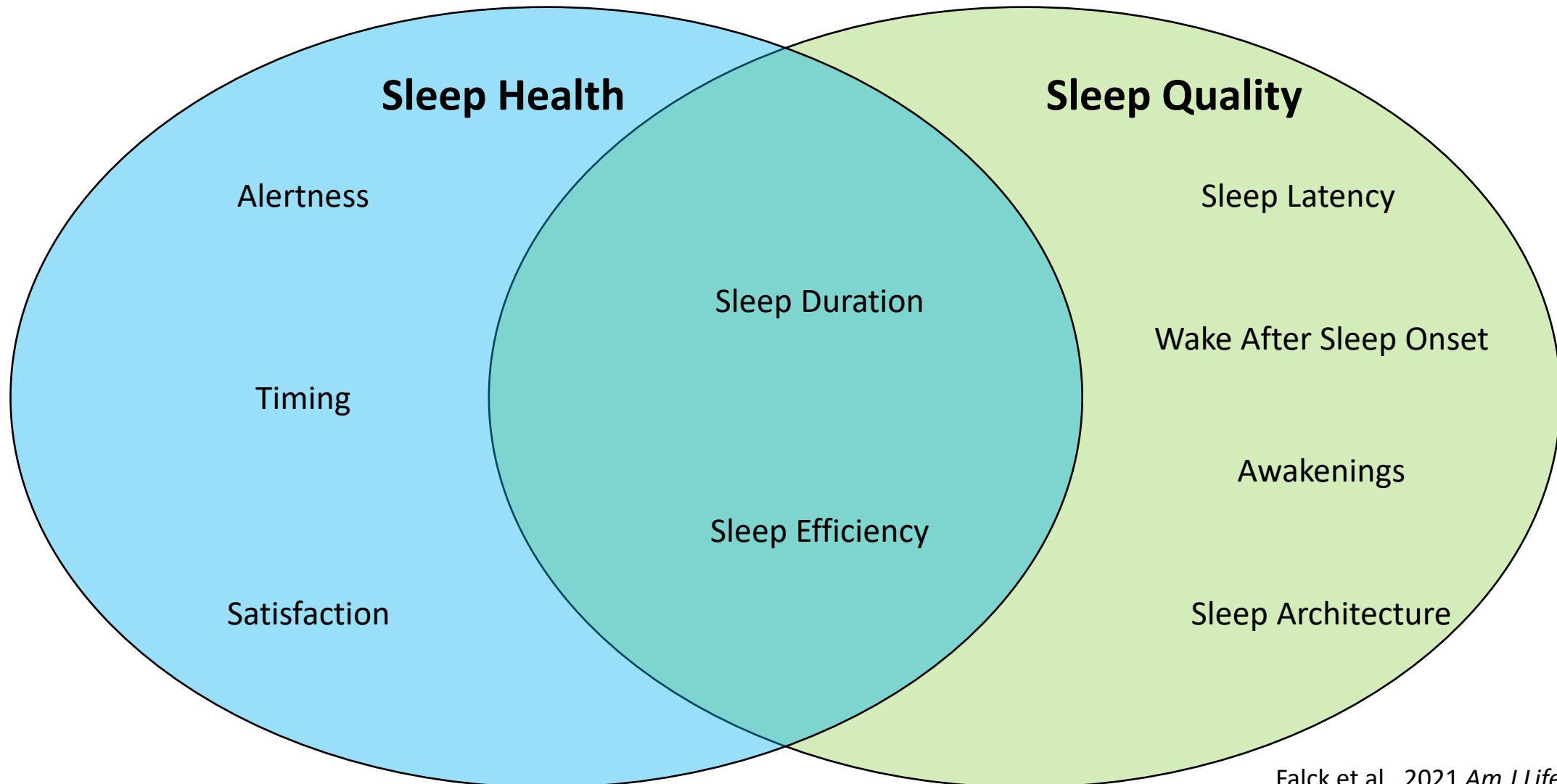
WHAT IS SEDENTARY BEHAVIOUR?



WHAT IS SLEEP?



WHAT IS SLEEP?





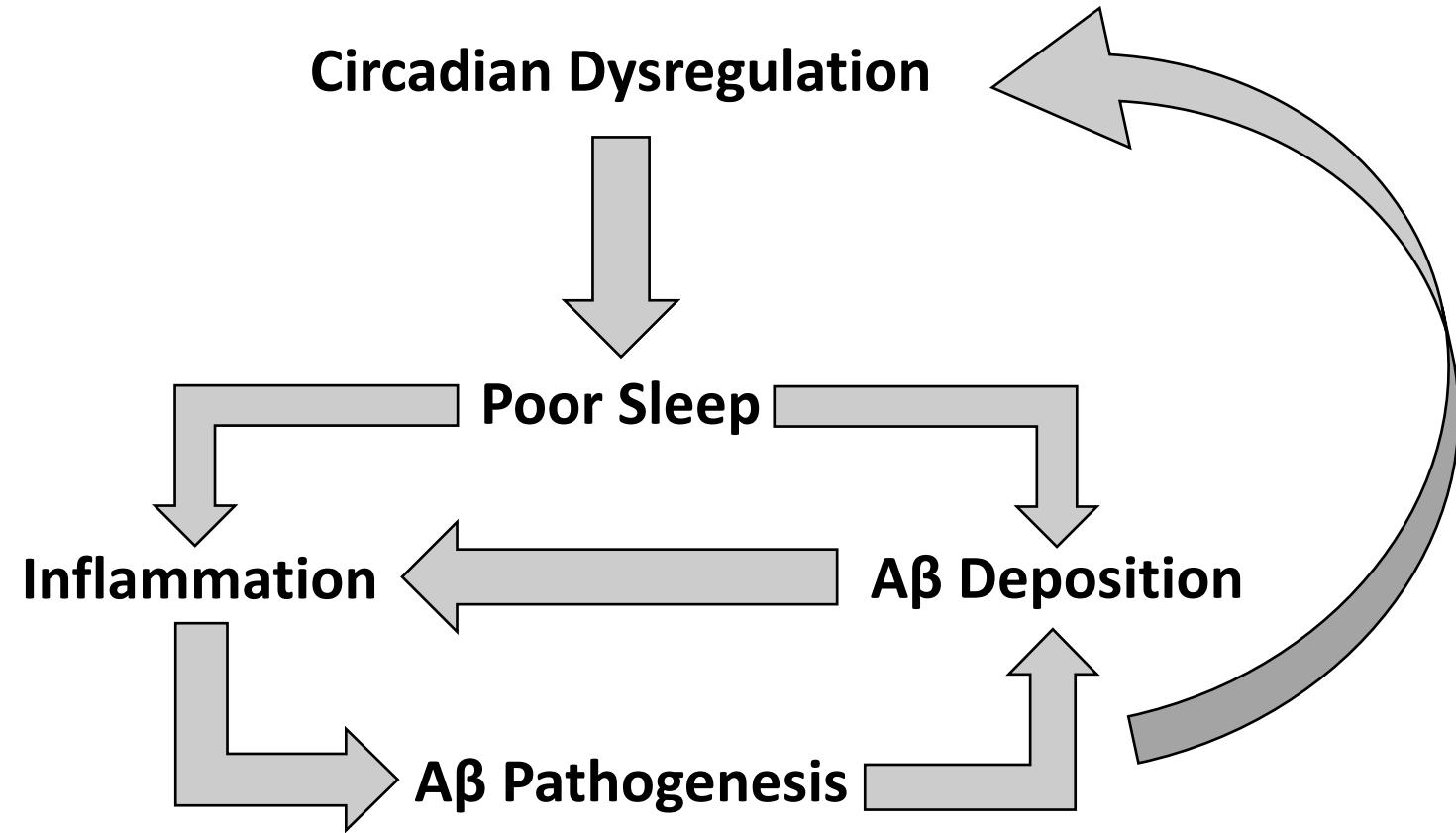
CAN WE USE TECHNOLOGY TO PROMOTE THE 24-HOUR ACTIVITY CYCLE?

SLEEP, CIRCADIAN RHYTHMS AND COGNITIVE

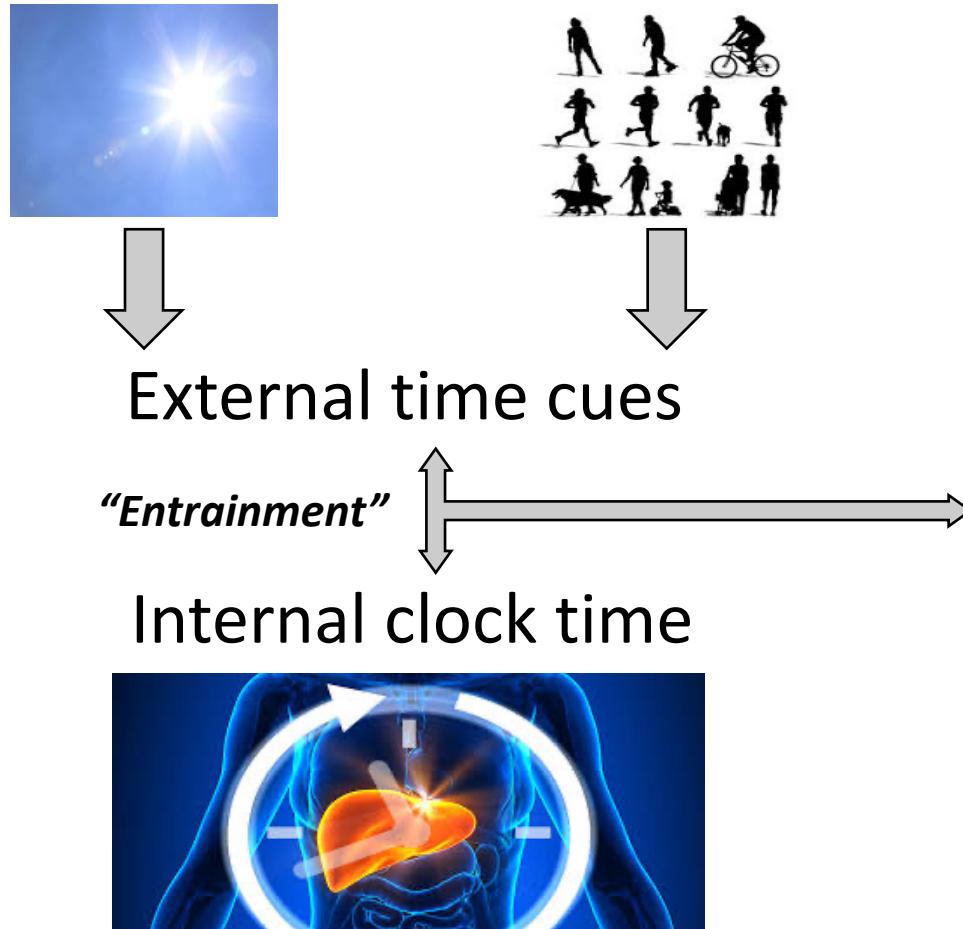
Older adults with poor sleep have ↑risk of MCI and dementia
(da Silva and Chaves, 2015)

Older adults with MCI have ↑risk of sleep disturbances
(Naismith et al., 2014)

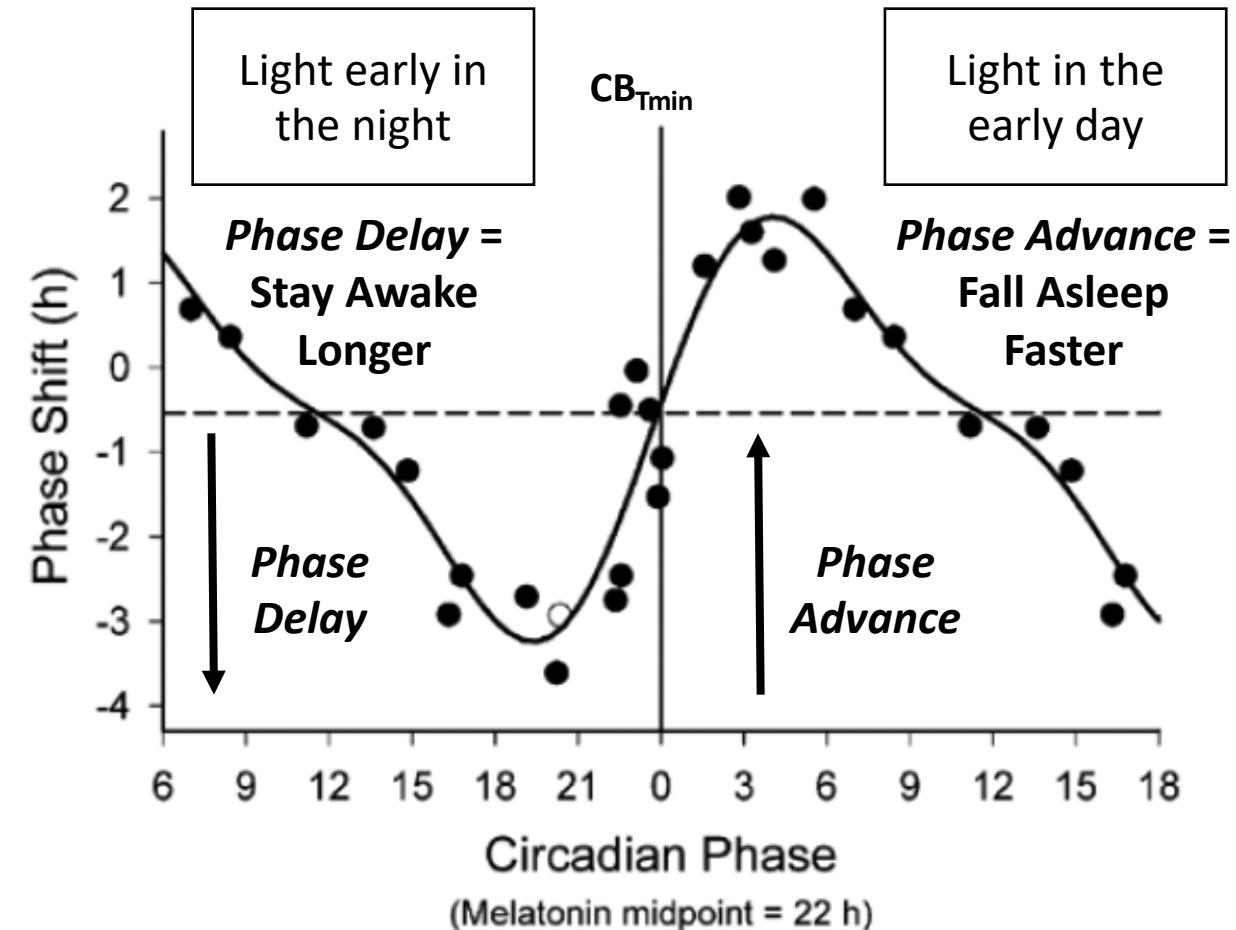
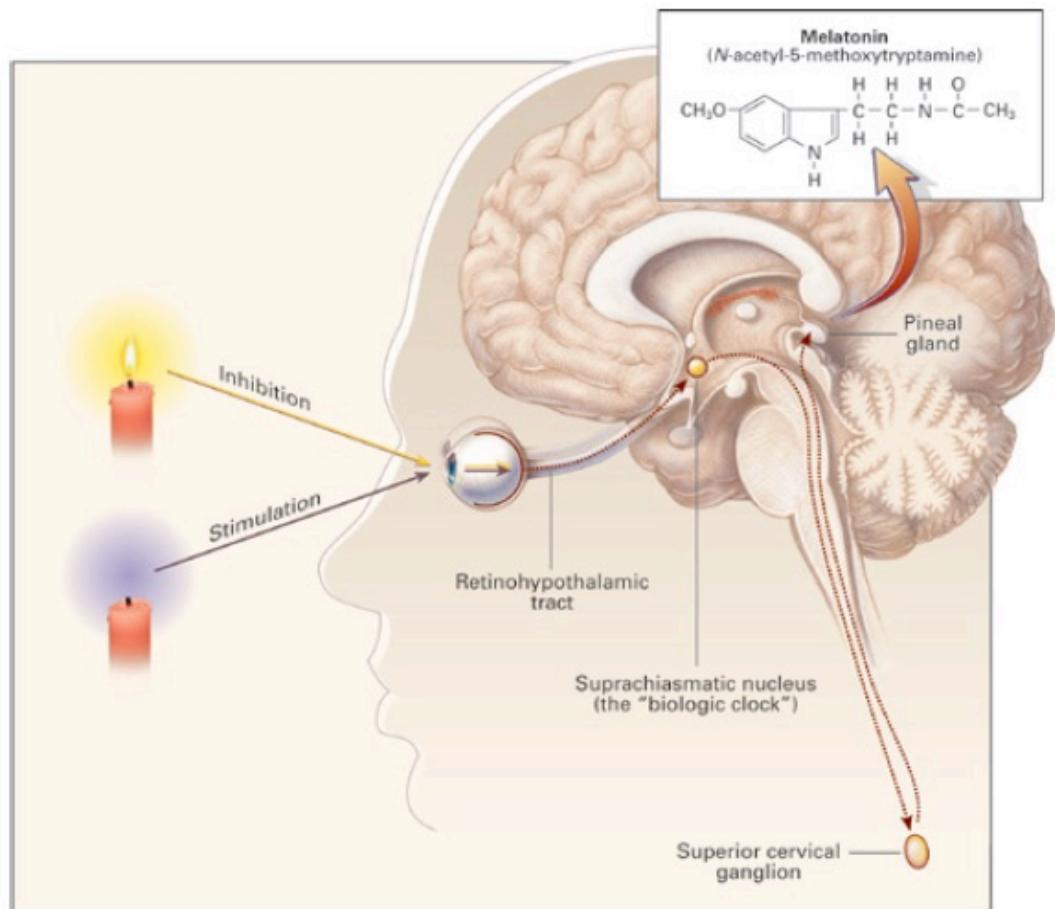
Poor sleep and sleep-wake disturbances associated with ↑risk of converting MCI → dementia
(Tranah et al., 2011)



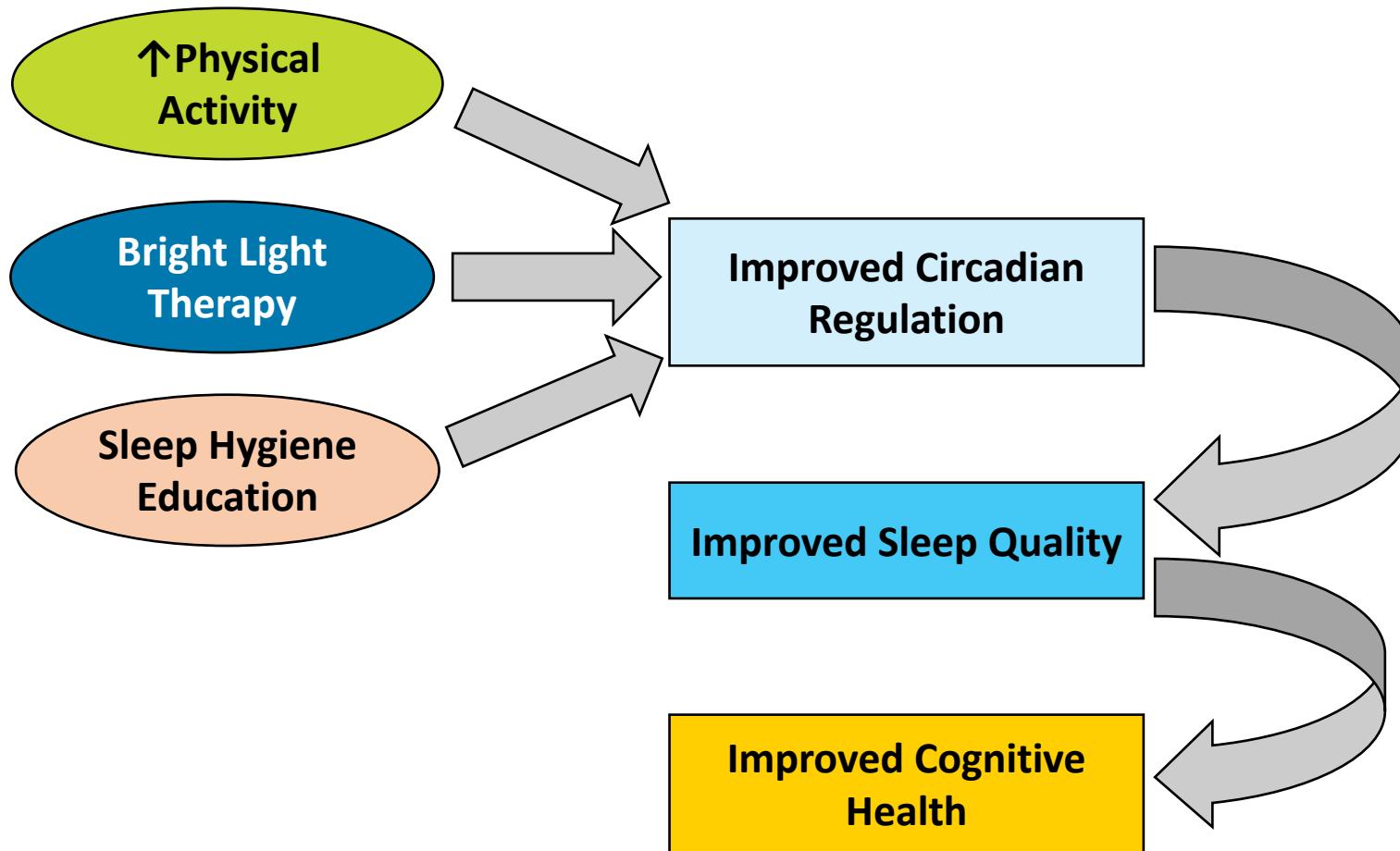
WHAT IS CHRONOTHERAPY?



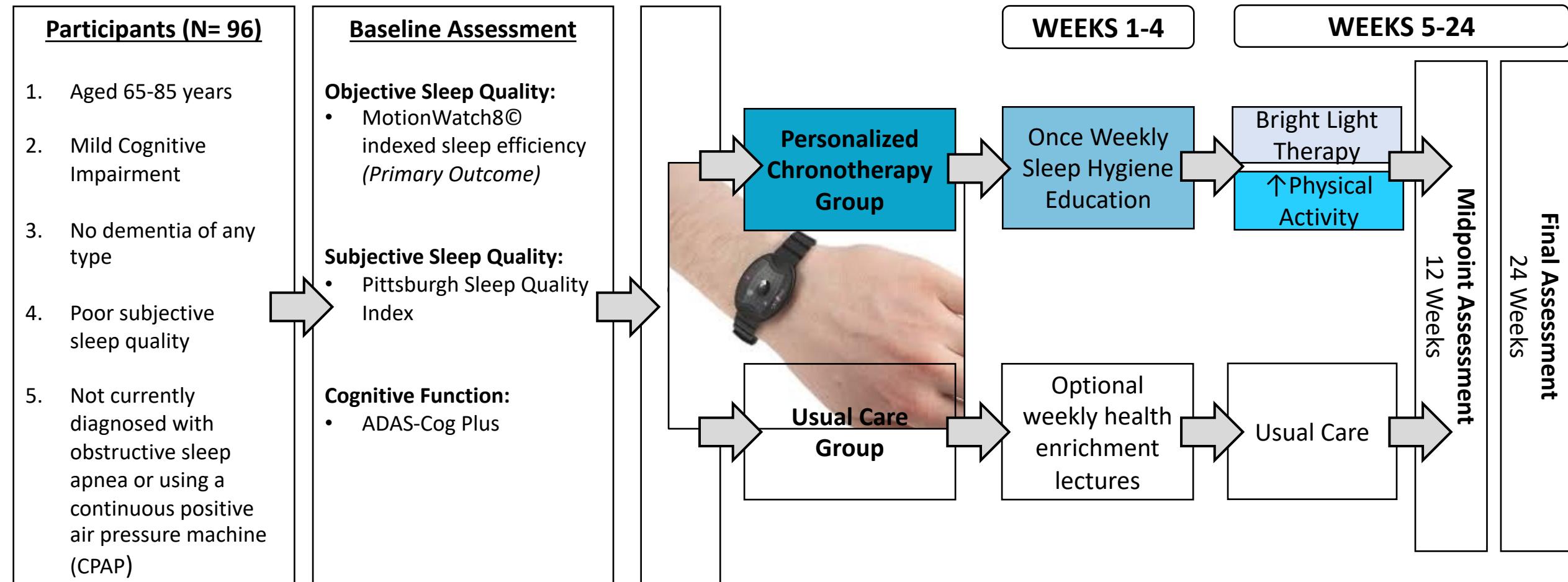
THE EFFECT OF LIGHT ON SLEEP AND CIRCADIAN RHYTHMS



CAN WE USE CHRONOTHERAPY FOR COGNITIVE HEALTH?



BUYING TIME: A 24-WEEK RCT



Determine if possible obstructive sleep apnea (OSA) risk

Use STOP-BANG Questionnaire to determine OSA risk

Low Risk: 0-2

Moderate Risk: 3-4

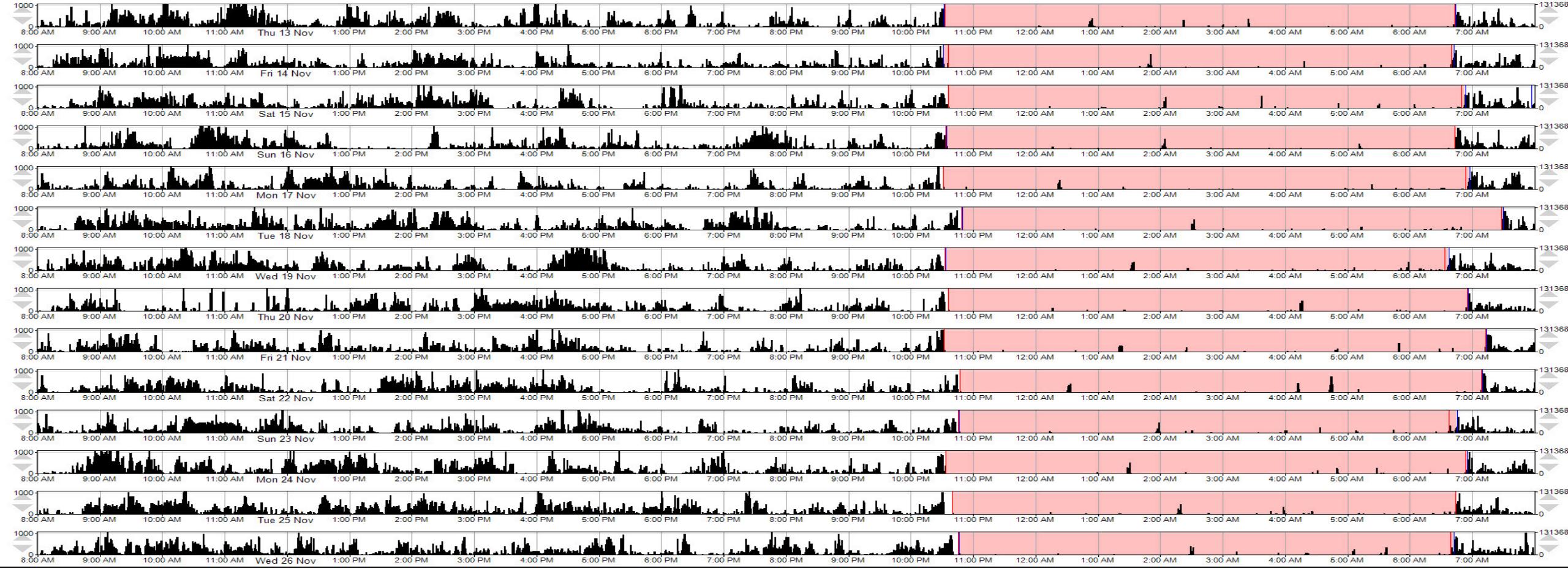
High Risk: 5-8

High or Moderate Risk of OSA

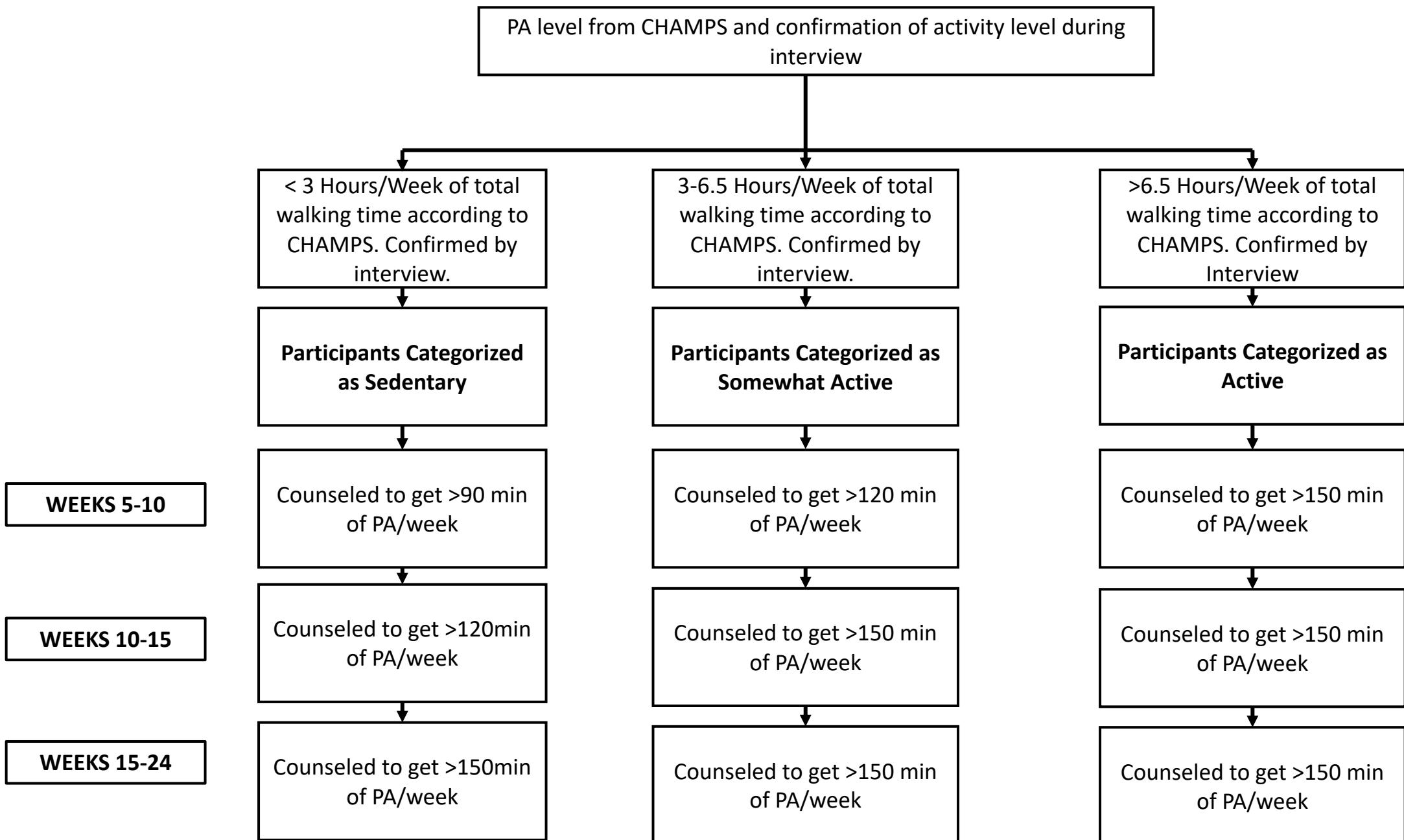
Low Risk of OSA

Counsel participant to see physician about possible OSA

Determine best asleep time and wake up time which works best with the participant's schedule to attain 8 or more hours of sleep duration







BASELINE CHARACTERISTICS

Participant Characteristic (Mean, SD)	Multimodal Personalized Chronotherapy (N=48)	Usual Care + Education (N= 48)
Age	72 (5)	74 (5)
%Female	47.90%	66.70%
Body Mass Index (kg/m ²)	26.90 (4.20)	26.28 (4.66)
Education		
<i>High School Degree or Less</i>	16.60%	10.40%
<i>Trade School or Some University</i>	41.70%	39.60%
<i>University Degree or Higher</i>	41.70%	50.00%
Cognitive Function		
<i>ADAS-Cog Plus</i>	-0.39 (0.57)	-0.42 (0.53)
Total Physical Activity (Hours/Week)*	8.9 (4.4)	9.5 (6.4)
Sleep Quality		
<i>MW8 Sleep Efficiency (%)</i>	81.18 (7.93)	82.47 (5.23)
<i>Pittsburgh Sleep Quality Index Total Score</i>	9.9 (2.6)	10.5 (2.9)

*Measured using CHAMPS Questionnaire

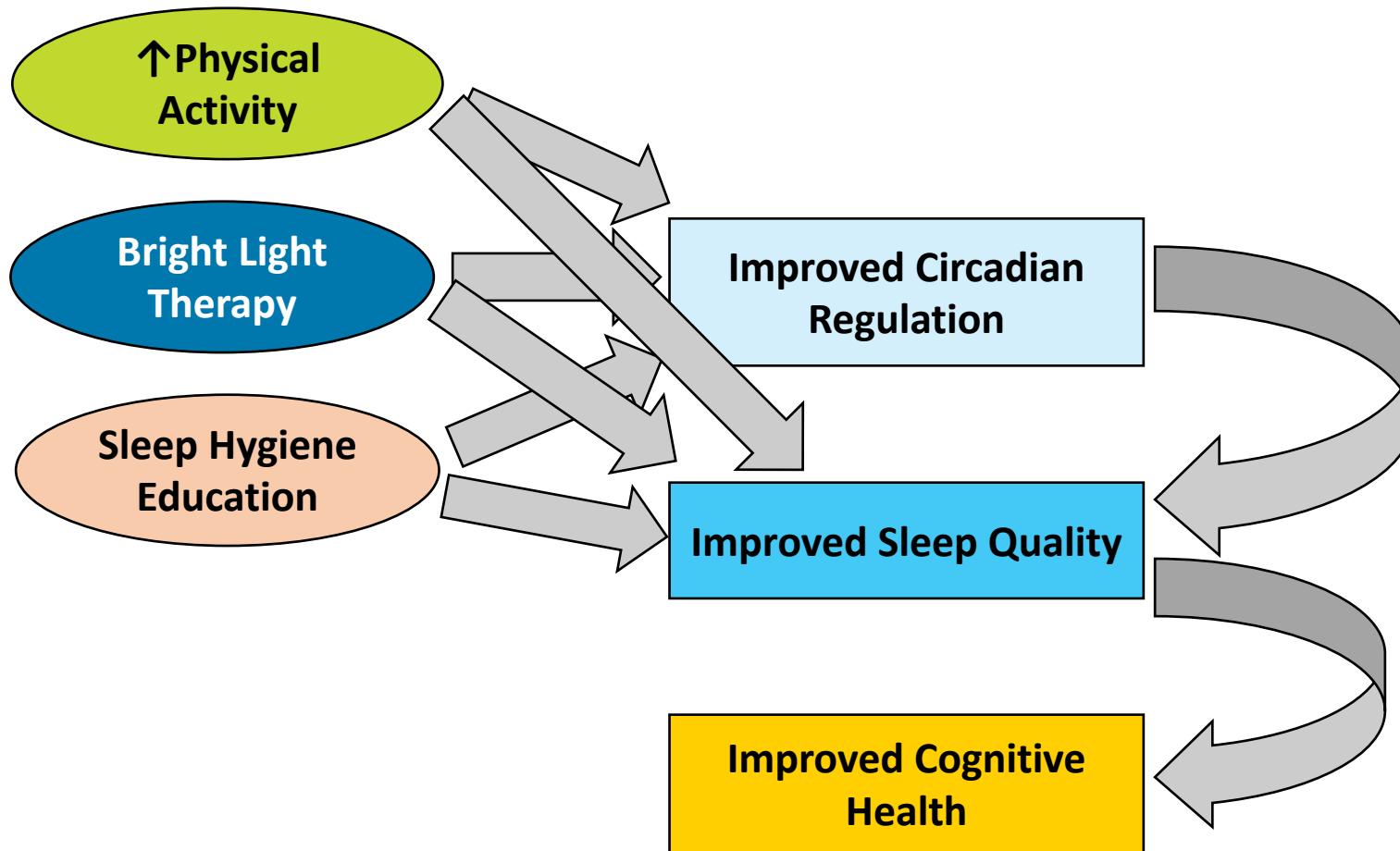
EFFECTS OF THE INTERVENTION ON SLEEP AND COGNITIVE FUNCTION IN PEOPLE WITH MILD COGNITIVE IMPAIRMENT



Outcome	Between Group Differences (Intervention Minus Control)			
	Estimated 12-Week Difference (95% CI)	p	Estimated 24-Week Difference (95% CI)	p
Primary Outcome				
Sleep Efficiency (%)	1.02 (-0.36, 2.40)	0.144	0.99 (-0.78, 2.76)	0.268
Secondary Outcome: Subjective Sleep Quality				
PSQI Total Score ³	-1.30 (-2.60, 0.00)	0.051	-1.47 (-2.74, -0.20)	0.024
Secondary Outcome: Cognitive Function				
ADAS-Cog Plus	-0.01 (-0.17, 0.15)	0.931	0.14 (-0.02, 0.31)	0.081

*All models controlling for baseline outcome of interest

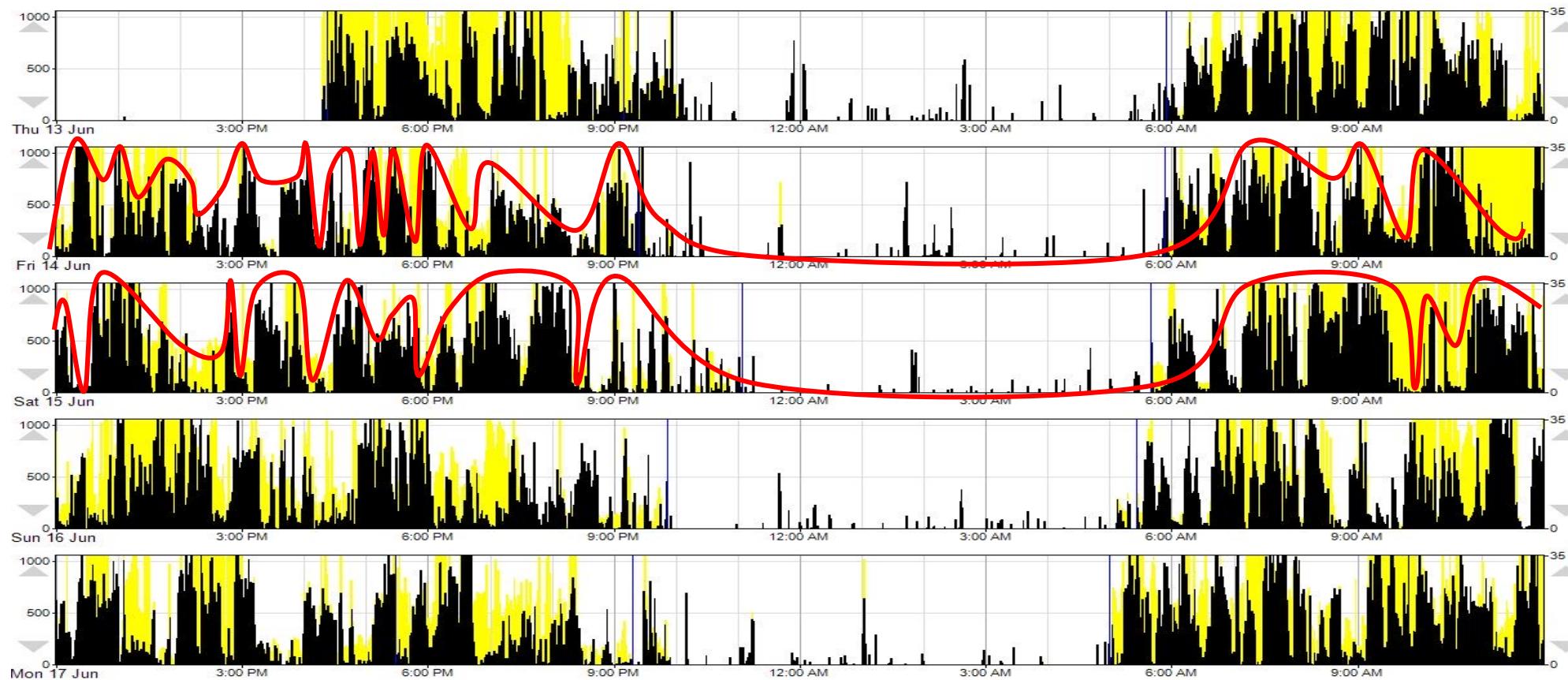
SUMMARY





FUTURE OPPORTUNITIES

24-HOUR ACTIVITY CYCLE PATTERNS



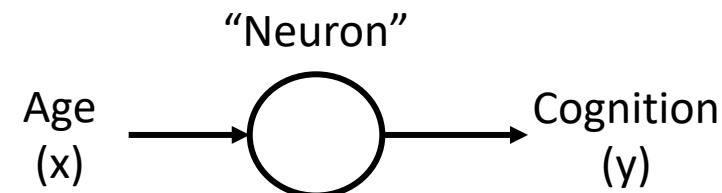
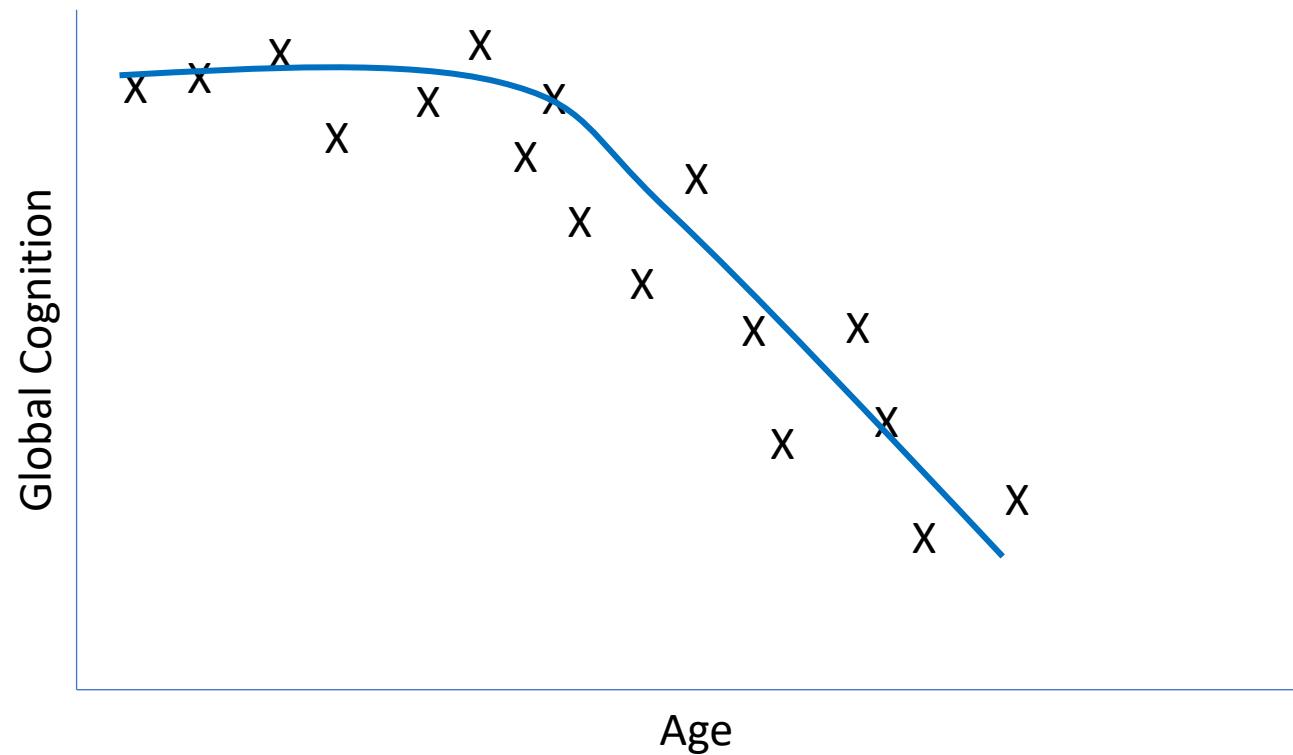
NEURAL NETWORKS



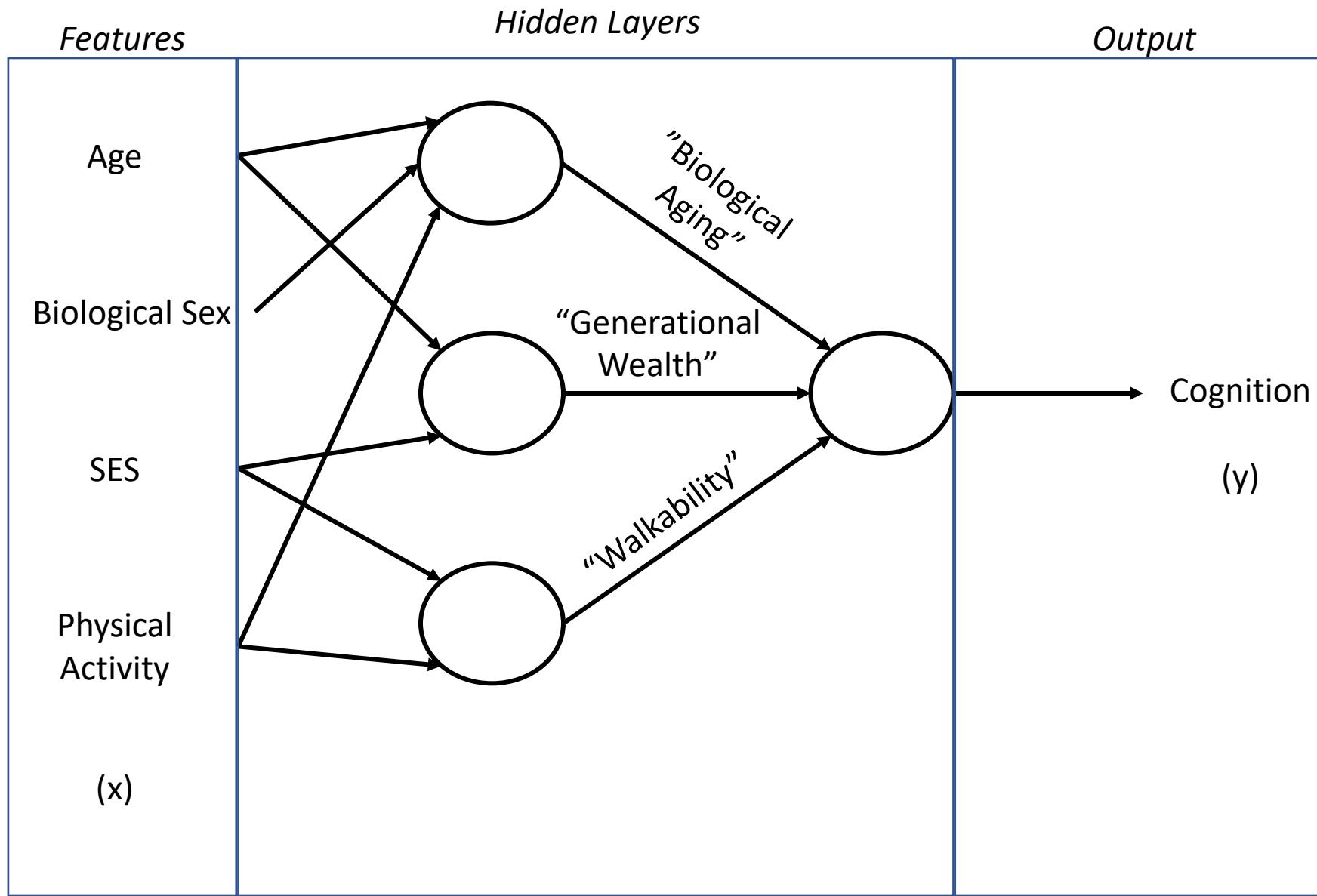
Numerous uses, including:

- Photo tagging
- Online advertising
- Natural language processing (e.g., autocorrect)
- Autonomous driving

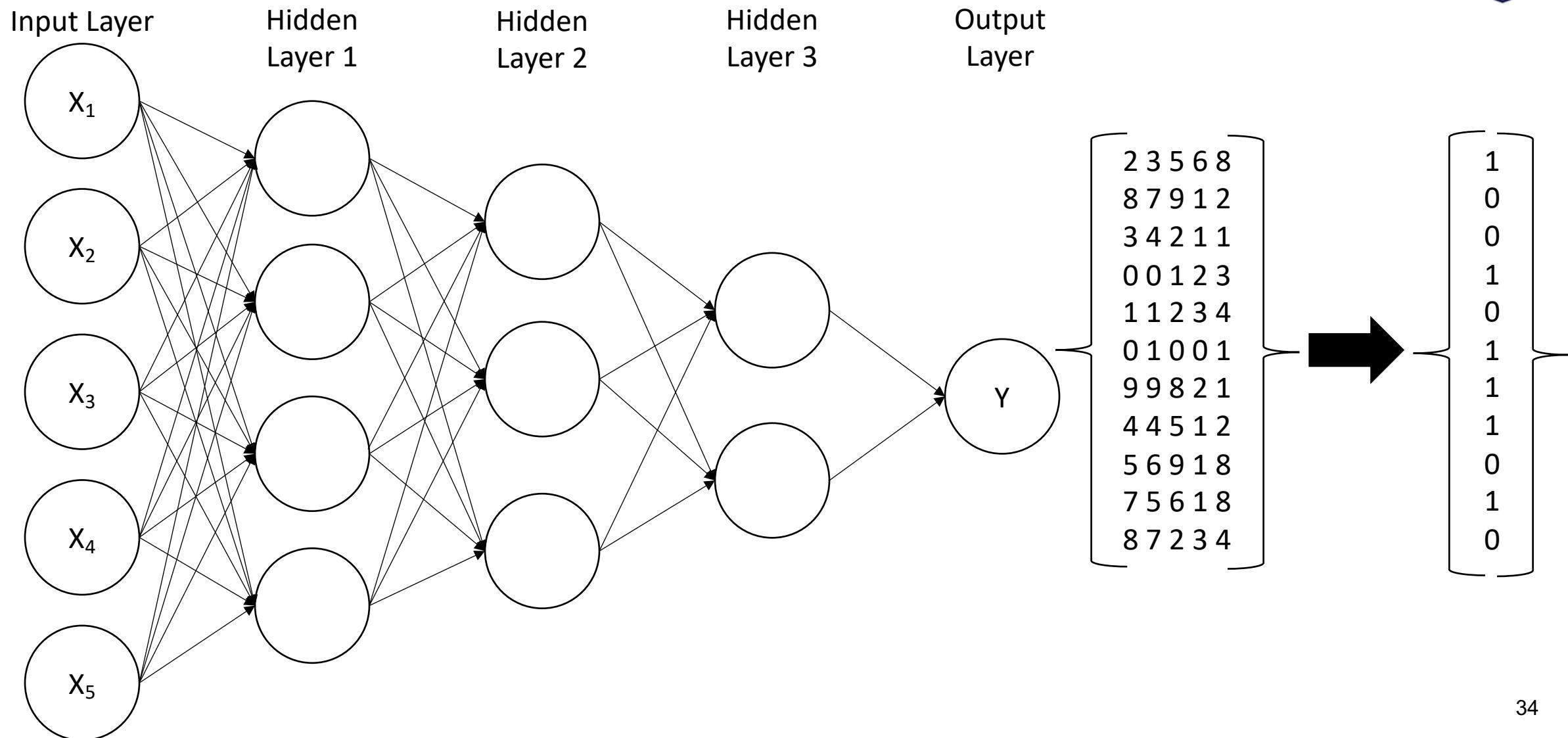
NEURAL NETWORKS



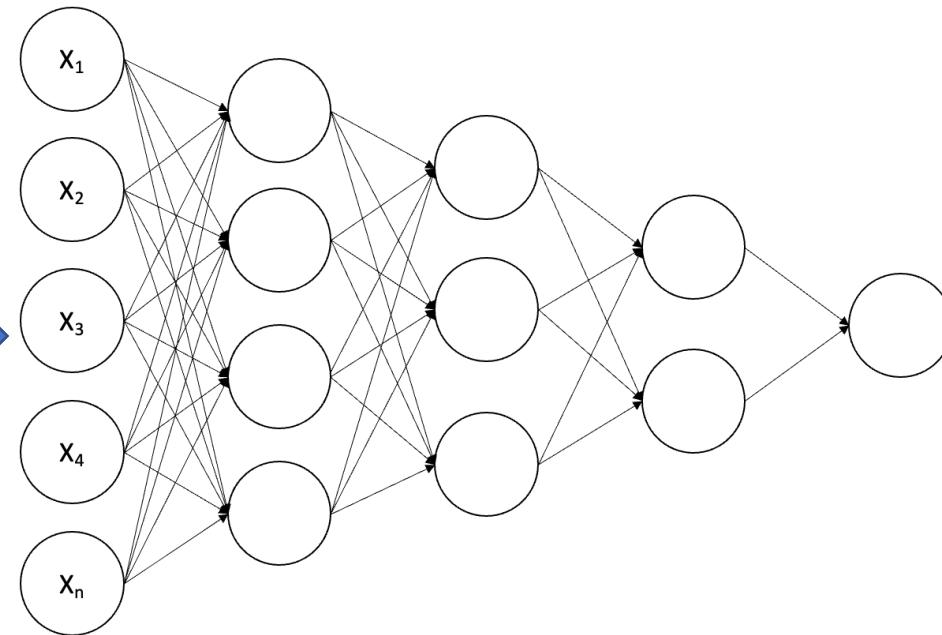
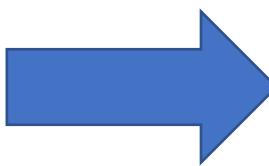
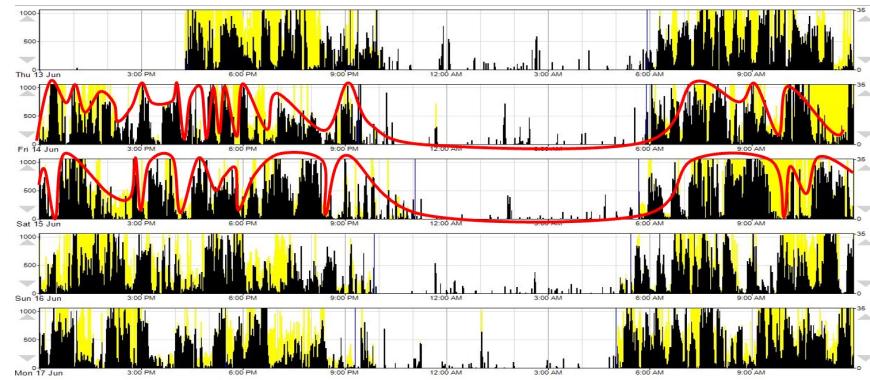
NEURAL NETWORKS



NEURAL NETWORKS



USING MACHINE LEARNING TO UNDERSTAND THE 24-HOUR ACTIVITY CYCLE



POTENTIAL OUTCOMES
Dementia
(Yes/no)

Cognitive Changes

Brain Structural
Changes



CURRENT ISSUES

1. Data management
 - a. Acquisition
 - b. Management
 - c. Storage
2. Feature design
 - a. Maintaining temporality of actigraphy
 - b. Using raw versus filtered data?
 - c. Other features to use
3. Model development
 - a. Sample size
 - b. Network design
 - c. Parameter tuning

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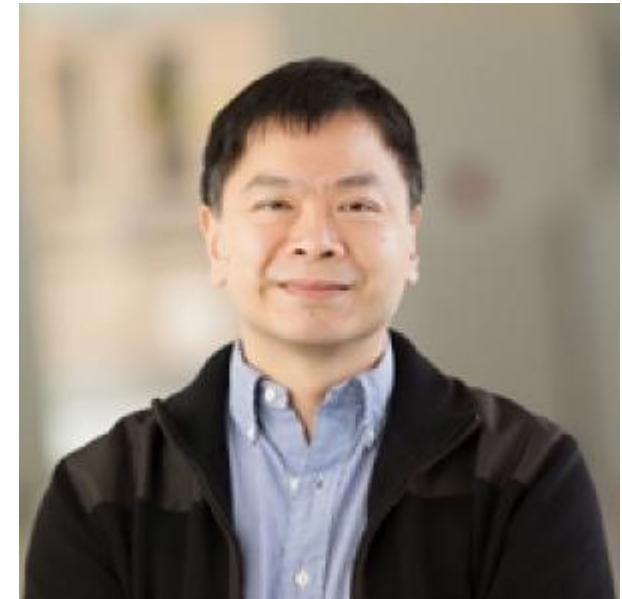
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