Measuring Physical Activity, Sedentary Behaviour, and Sleep Using Wrist-Worn Actigraphy

Practical Solutions for Imperfect Technologies

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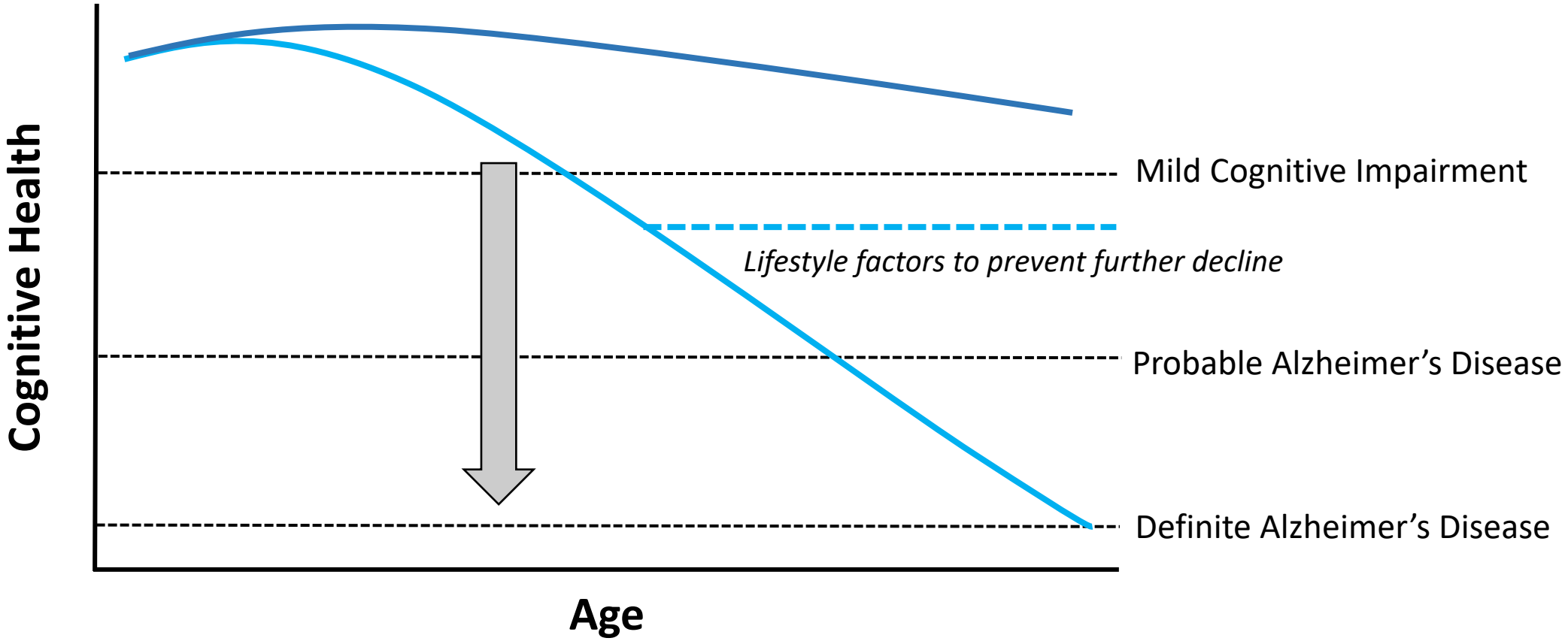
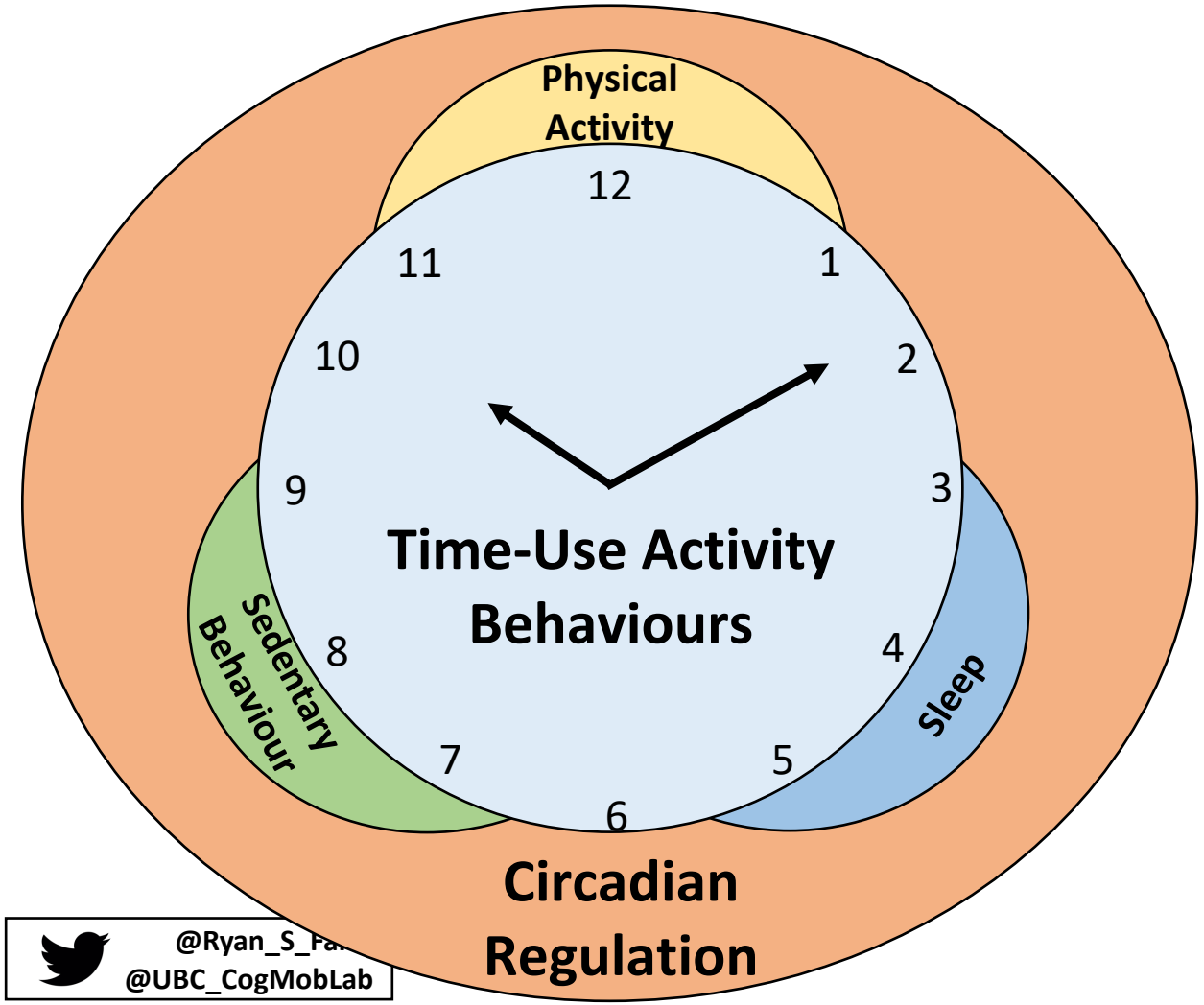
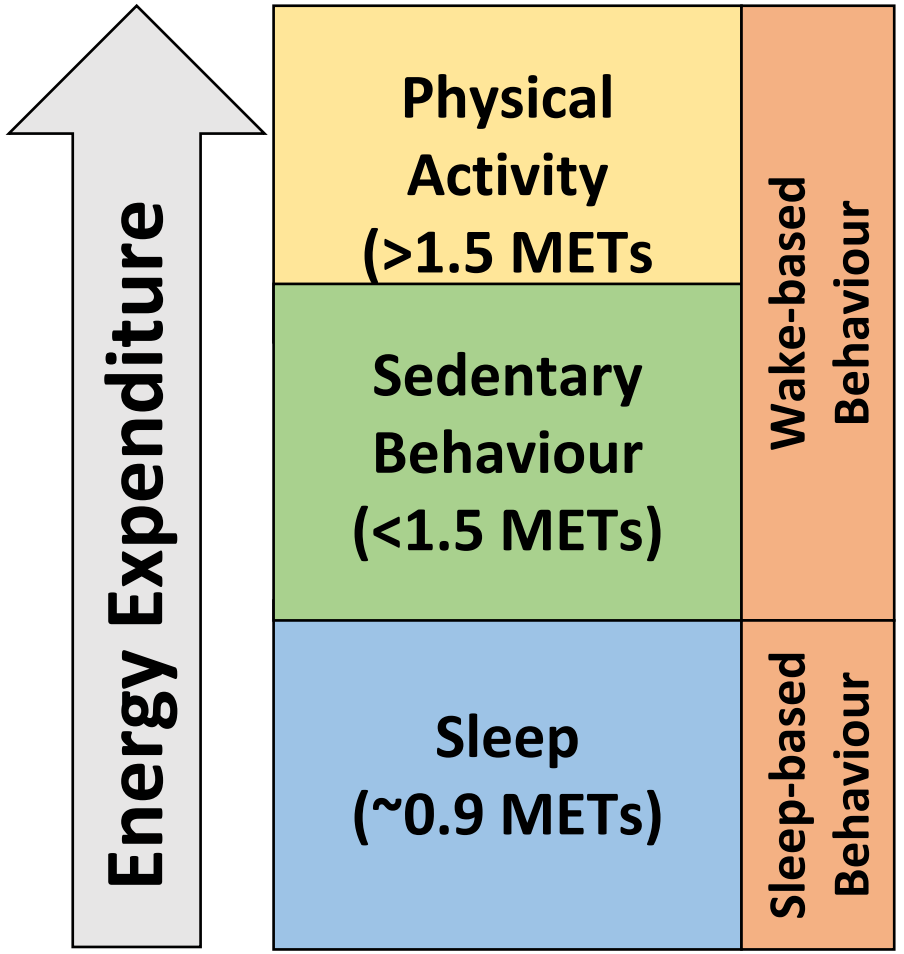
Older Adult Cognitive Health: A growing public health challenge



Petersen et al., 2001

Understanding Physical Activity, Sedentary Behaviour, and Sleep





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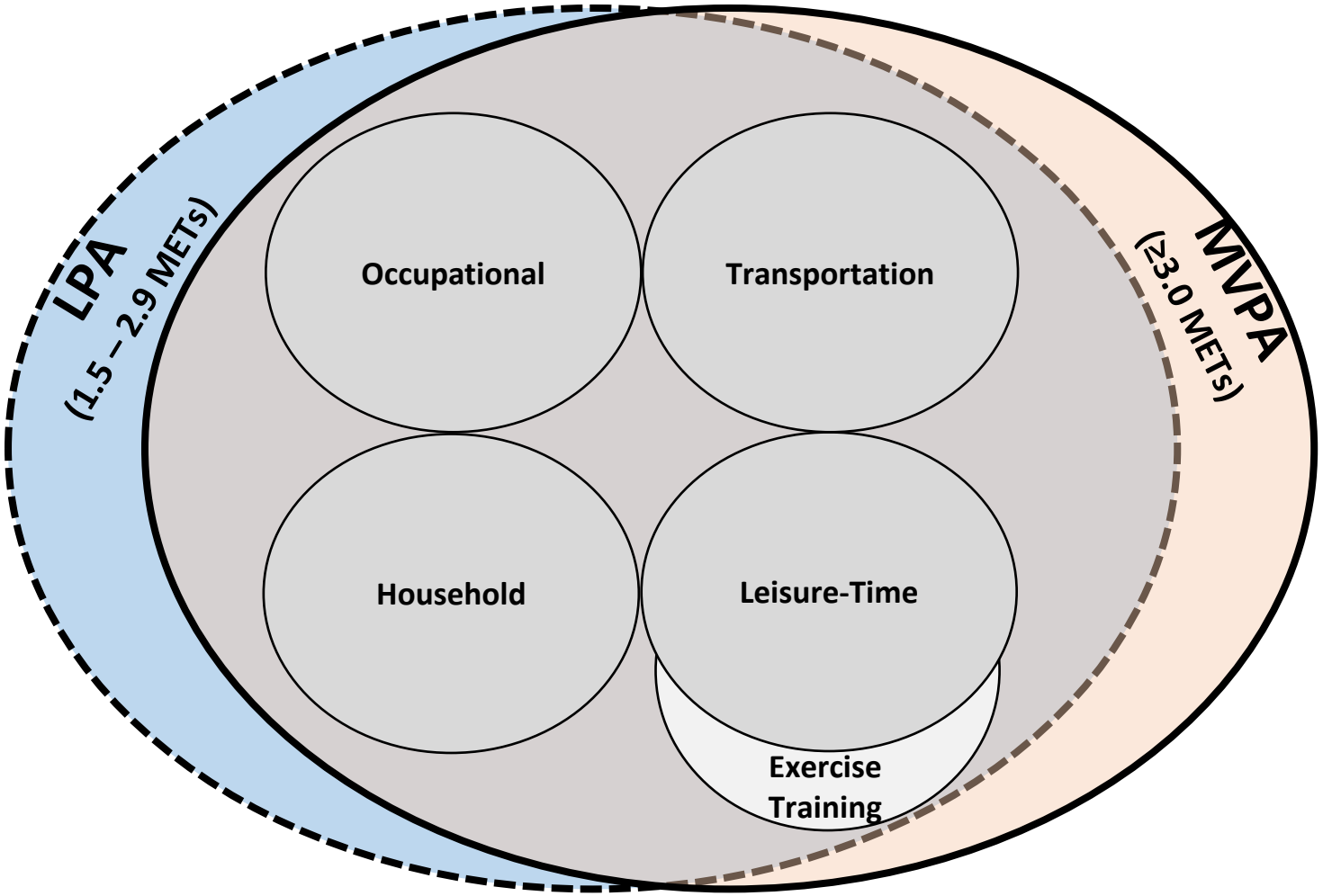
What is Physical Activity?



Physical Activity Measurement

Subjective Measures

Objective Measures

Behavioural Measurement

Biomechanic Measurement

Thermodynamic Measurement

Diaries Logs

Surveys Questionnaires

EMA

Pedometers

Accelerometers

HR Monitors

Multimodal Sensors

Direct Observation

Calorimetry

Doubly Labeled Water

Low Cost — High Cost

Low Sensitivity — High Sensitivity

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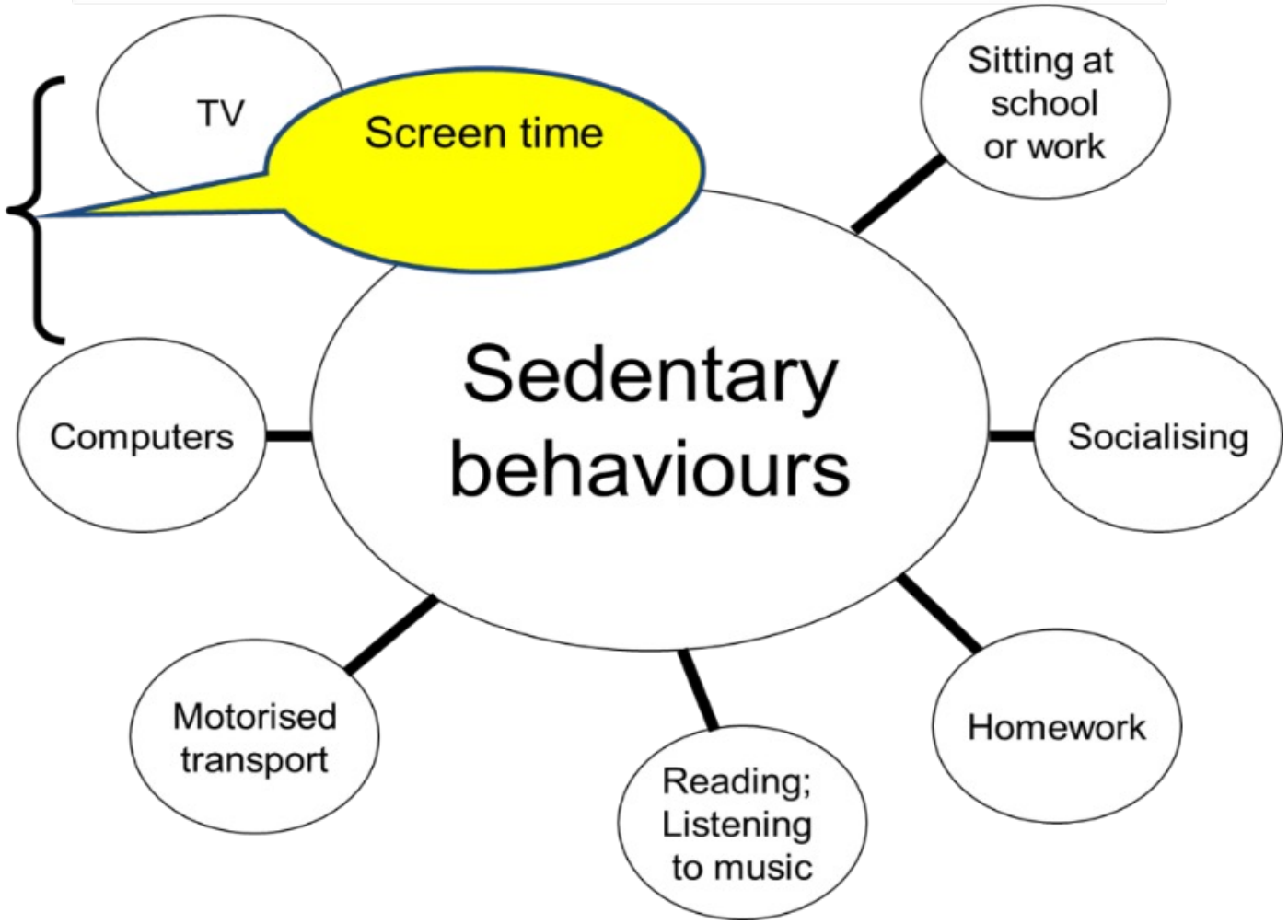
What is Sedentary Behaviour



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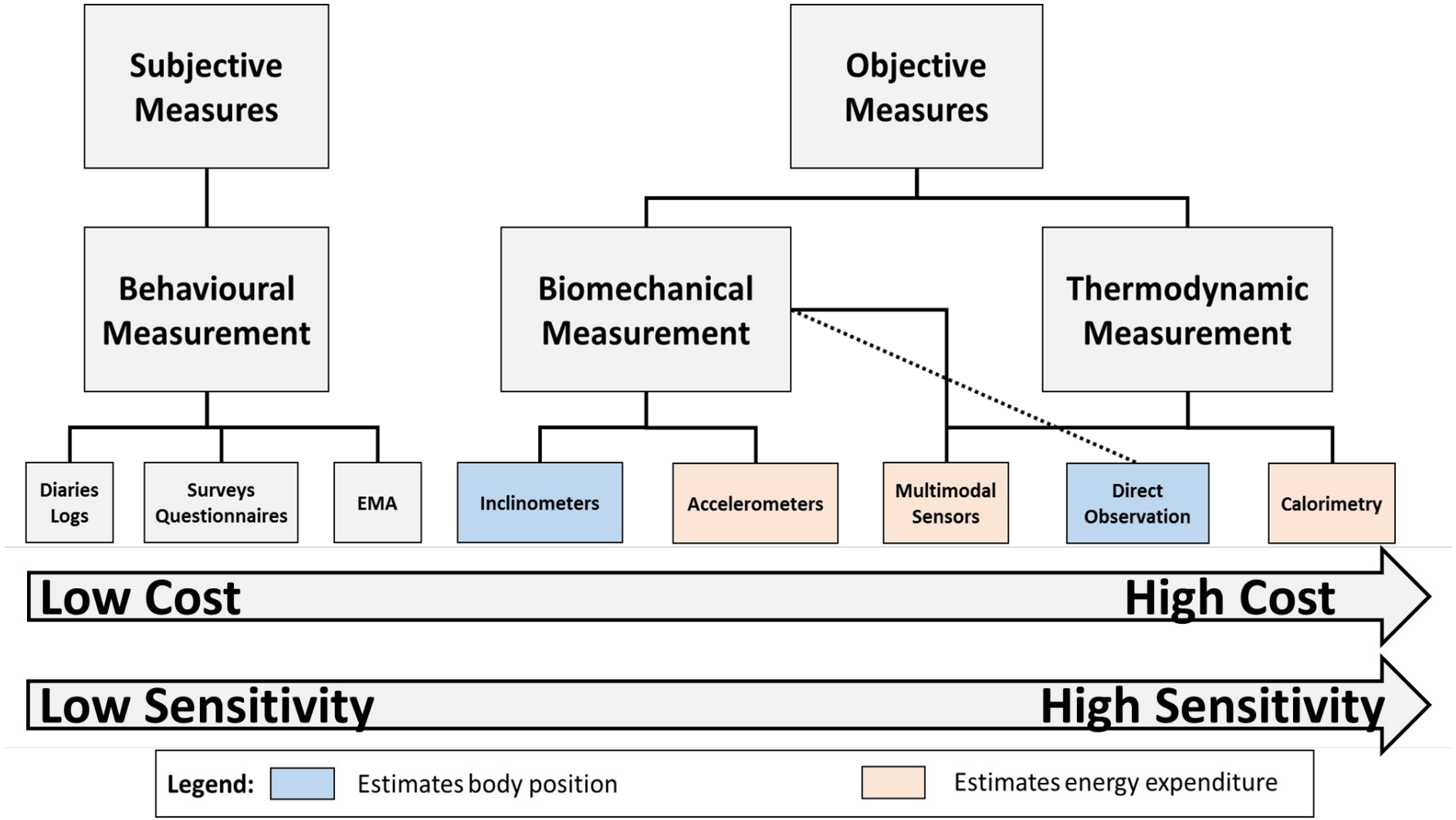
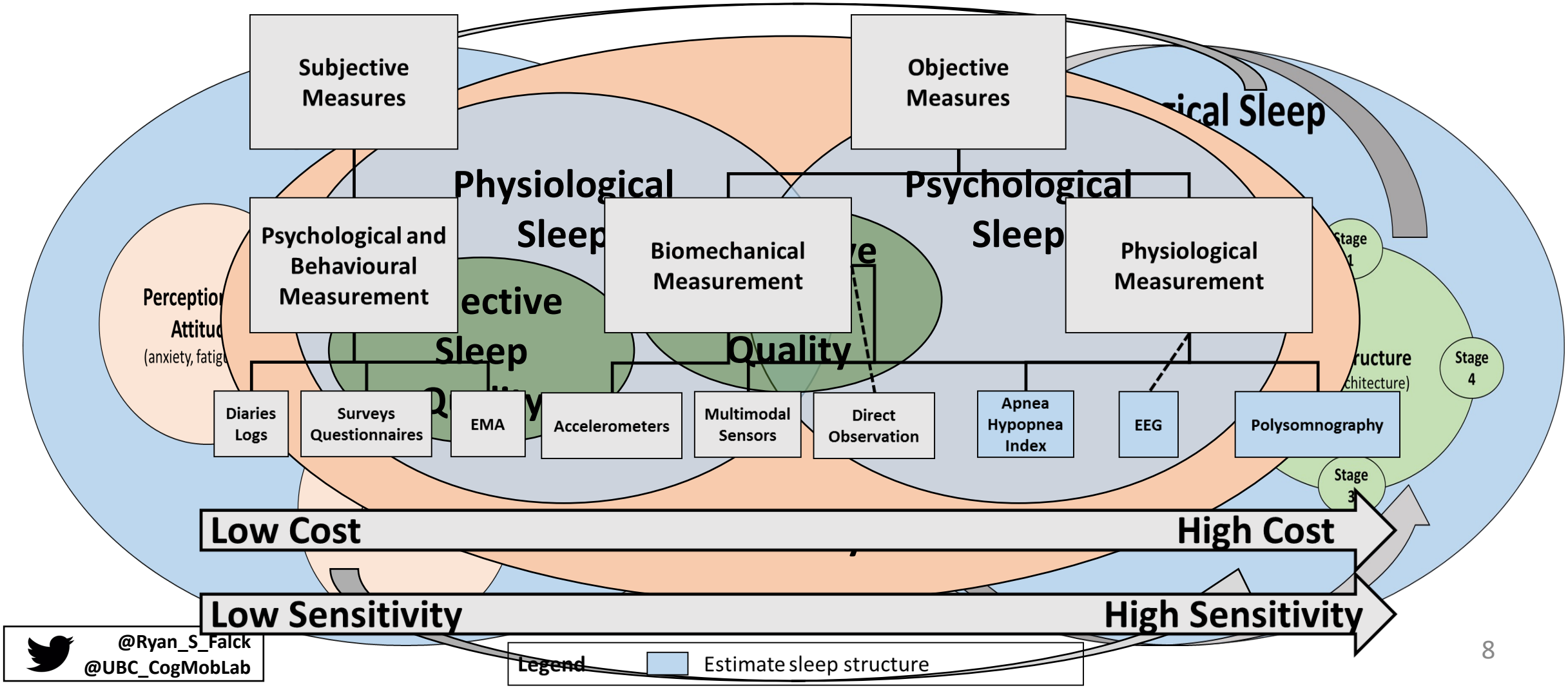
Sedentary Behaviour Measurement



Sleep Classification and Measurement



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Wrist-Worn Actigraphy: A Practical Technology

**Can also estimate sedentary behaviour*

What are the benefits?

What are the drawbacks?

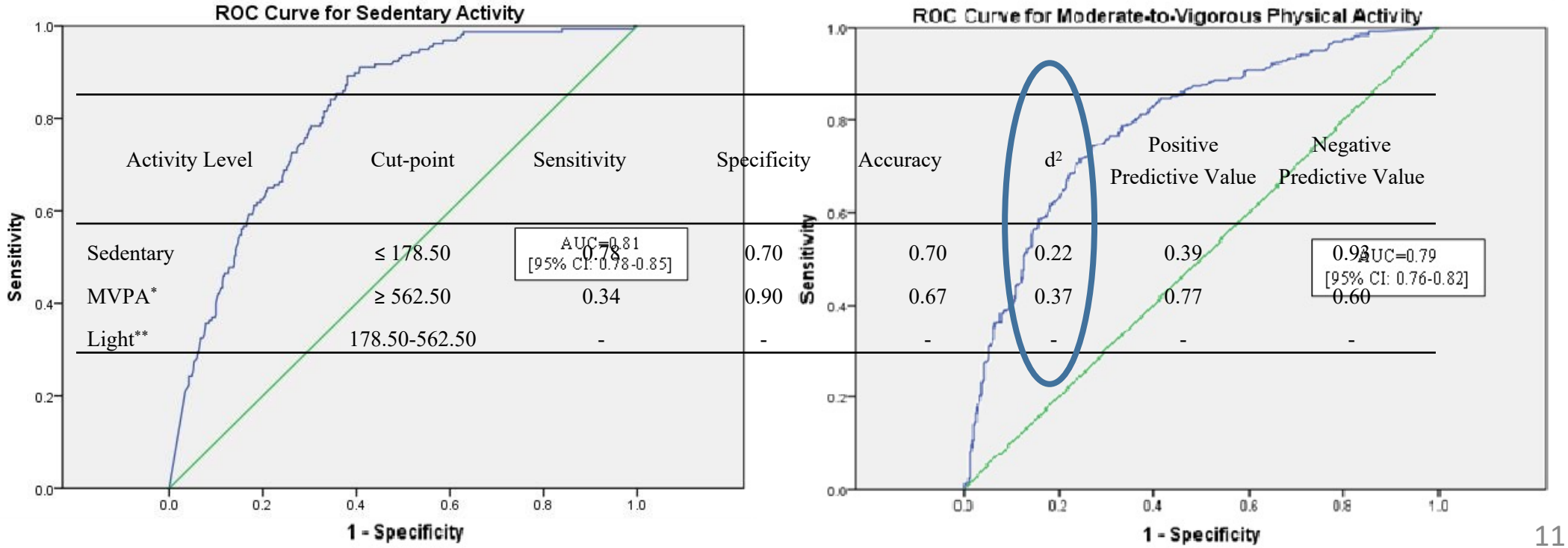
Measuring Time-Use Activity Behaviour Using Actigrpahy

- Actigraphy estimates energy expenditure using Newton's second law (F= ma)
  - Uniaxial or triaxial
  - Actigraphs can detect acceleration of 0.01 to > 10 g (depends on manufacturer)
  - Sampling frequency (Hz) depends on manufacturer (3 – 100 Hz)

- Each behaviour must first be derived from:
  - **Counts** = arbitrary unit of actigraph
  - **Epochs** = rate at which data is collected

Measuring Physical Activity/Sedentary Behaviour Using Actigrpahy

Counts/Epoch (usually counts/minute [cpm]) can then be classified as different intensities of physical activity based on an actigraph's corresponding cut-points

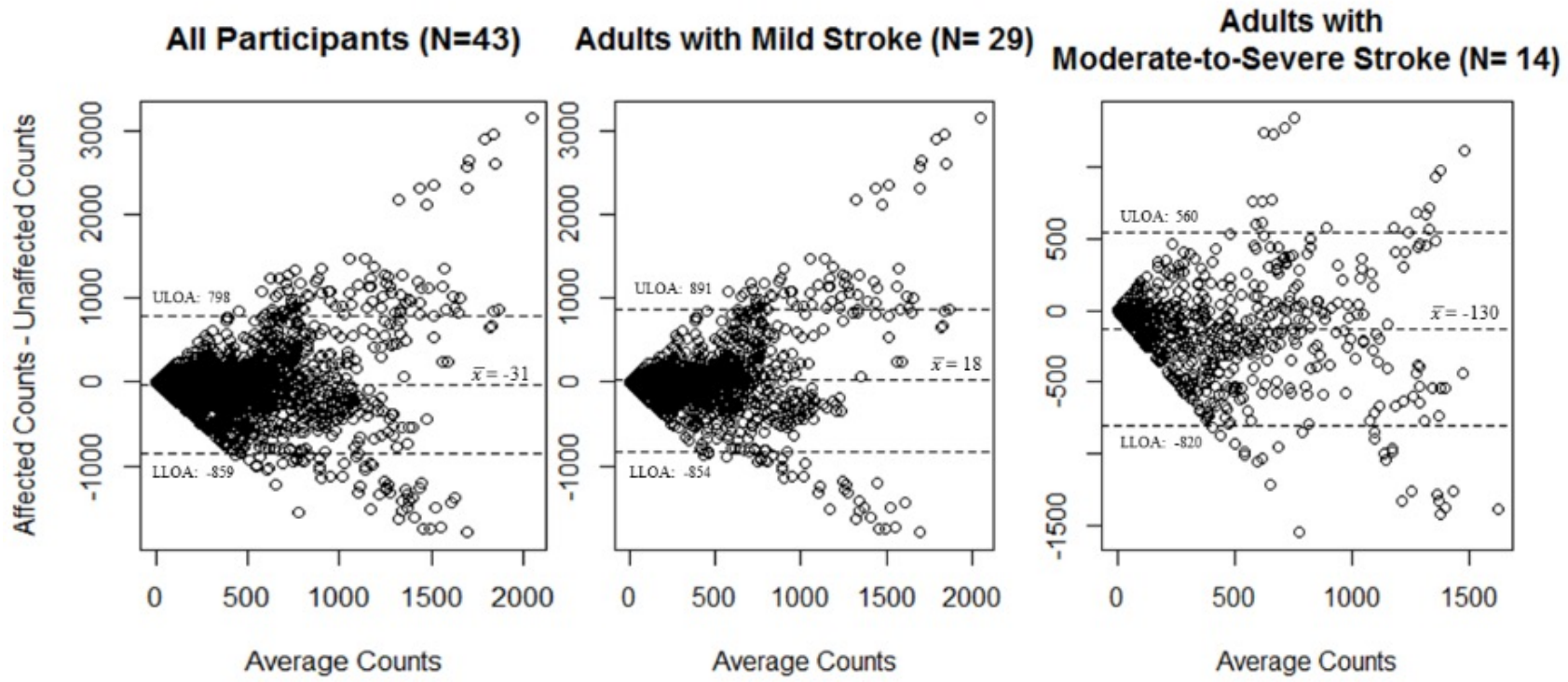


Activity Level	Cut-point	Sensitivity	Specificity	Accuracy	d^2	Positive Predictive Value	Negative Predictive Value
Sedentary	≤ 178.50	0.78	0.70	0.70	0.22	0.39	0.93
MVPA*	≥ 562.50	0.34	0.90	0.67	0.37	0.77	0.60
Light**	178.50-562.50	-	-	-	-	-	-

Landry et al., 2015

Measuring Physical Activity/Sedentary Behaviour Using Actigrpahy

Cut-points are *population specific*, and may also depend on which side of the body the device is placed (e.g., people with stroke)



Falck et al., 2019

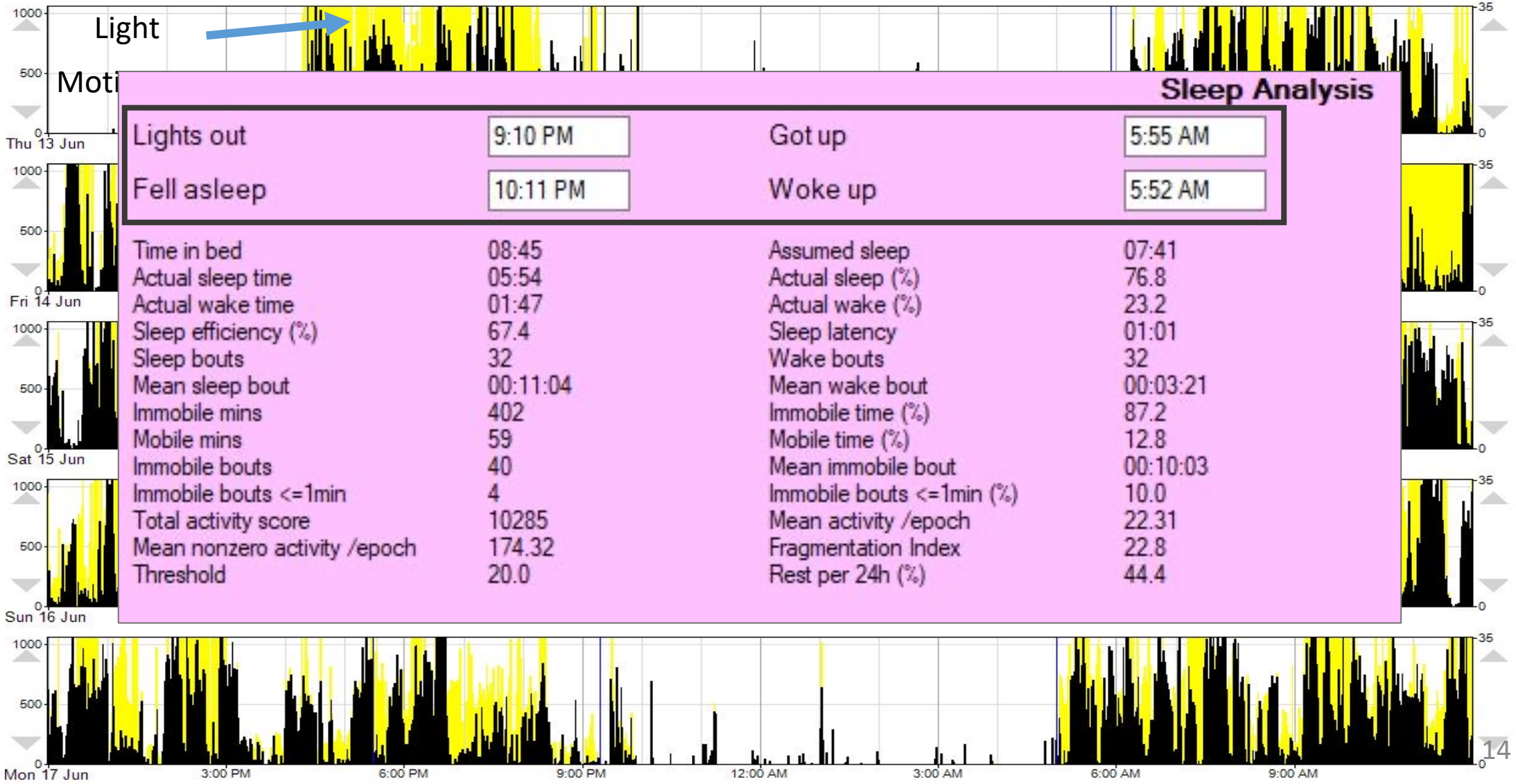
Measuring Physical Activity/Sedentary Behaviour Using Actigrpahy

Getting *reliable* estimates of activity behaviour is also dependent based on how many days we observe

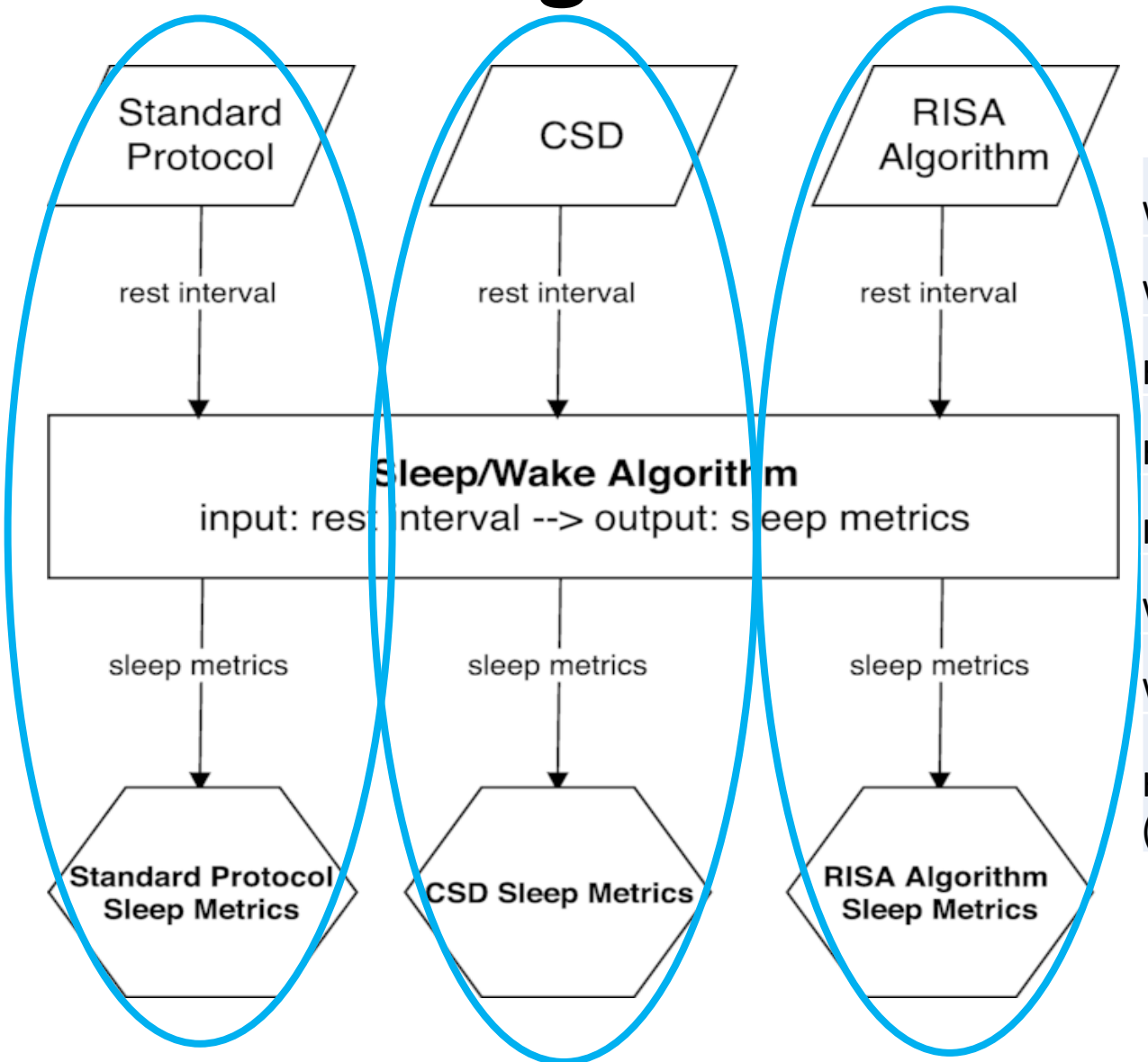
	Interclass Reliability Coefficients (95% CI)					Days of Monitoring Required to Achieve Reliabilities of		
	1 Day	4 Days	7 Days	10 Days	14 Days	0.80	0.90	0.95
Sedentary Activity	0.76 (0.66, 0.84)	0.91 (0.87, 0.94)	0.95 (0.93, 0.96)	0.96 (0.94, 0.97)	0.98 (0.96, 0.99)	1.32	2.97	6.26
Light Activity	0.69 (0.57, 0.78)	0.89 (0.84, 0.92)	0.93 (0.91, 0.95)	0.95 (0.93, 0.96)	0.97 (0.95, 0.98)	1.91	4.30	9.08
MVPA	0.69 (0.56, 0.78)	0.90 (0.86, 0.93)	0.95 (0.93,0.96)	0.96 (0.95, 0.97)	0.97 (0.96, 0.99)	1.49	3.36	7.10

Falck et al., 2016

Determining Wake Time and Sleep Time

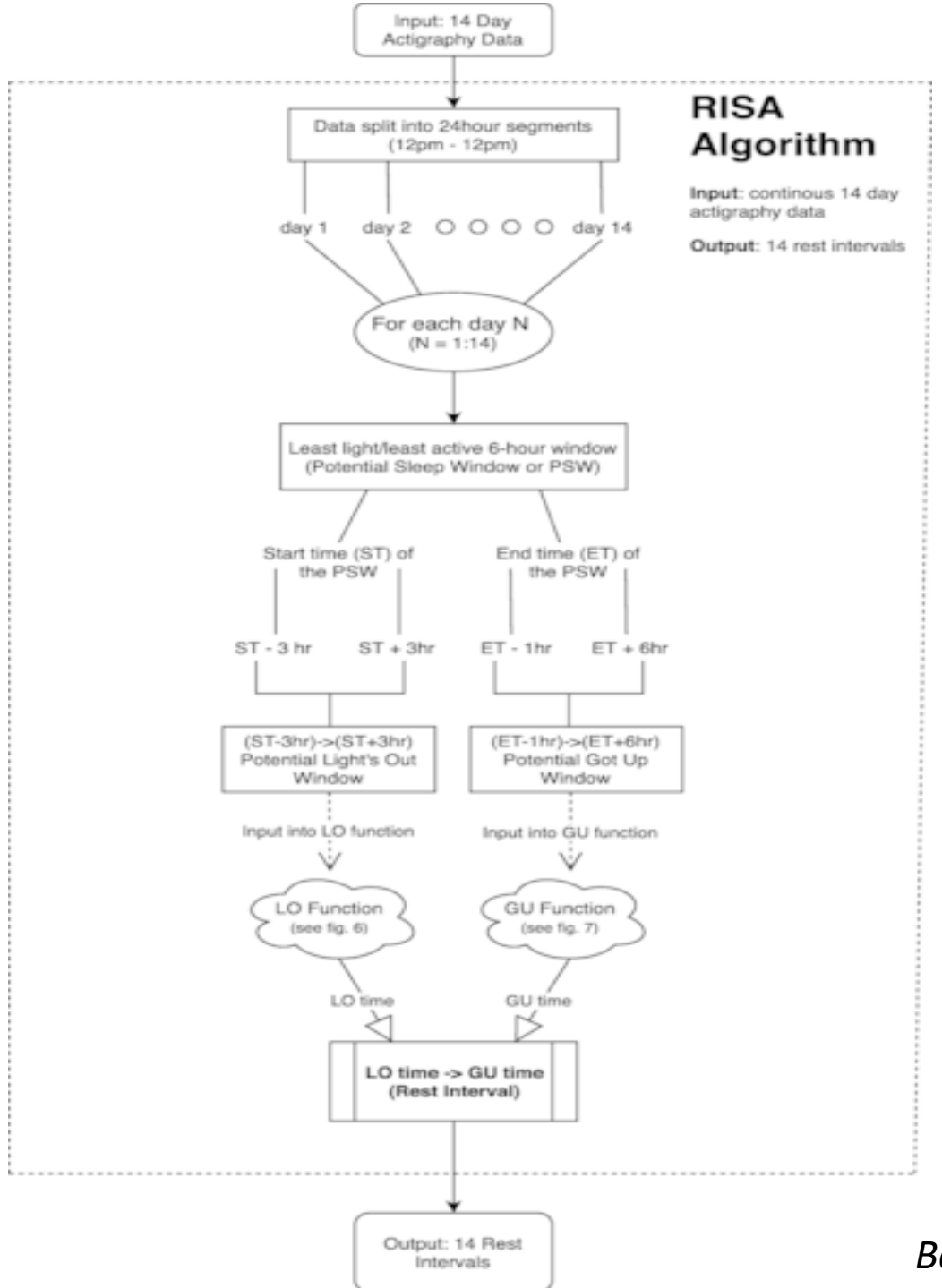


Determining Wake Time and Sleep Time



What time did you get into bed?
What time did you try to go to sleep?
How long did it take you to fall asleep? (minutes)
How many times did you wake up, not counting the final time?
In total, how long did these awakenings last? (minutes)
What time was your final awakening?
What time did you get out of bed for the day?
How would you rate the quality of your sleep? (1=very poor, 2=poor, 3=fair, 4=good, 5=very good)

Backhouse et al., In Press



Backhouse et al., In Press

Mean, SD and p-value for each sleep metric between methods.

Sleep Metric	Method	Mean	SD	p-value
Fragmentation index	LM	31.0	10.4	p>0.05 (F = 0.40)
	CSD	30.1	10.7	
	Protocol	30.6	10.7	
	BM	31.7	10.3	
	BL	31.1	10.4	
Sleep efficiency	LM	82.6	6.1	p>0.05 (F = 1.16)
	CSD	83.4	6.2	
	Protocol	82.7	6.0	
	BM	82.6	5.7	
	BL	81.8	6.4	
Sleep duration	LM	392	48	p>0.05 (F = 1.88)
	CSD	388	57	
	Protocol	404	47	
	BM	395	48	
	BL	394	48	
Sleep latency	LM	6.6	8.7	p<0.05 (F = 14.83)
	CSD	5.9	8.0	
	Protocol	6.7	8.0	
	BM	3.7	4.3	
	BL	12.2	14.6	

LM, light-motion algorithm; CSD, consensus sleep diary; Protocol, standard protocol set by trained user; BM, biased-motion algorithm; BL, biased-light algorithm.

Backhouse et al., In Press

Summary

- There is no one best way to measure physical activity, sedentary behaviour, and sleep concurrently

- Wrist-worn actigraphy is one practical way for measuring all 3 behaviours

- We have recent developed an algorithm for determining the rest-interval from the MotionWatch8© using illuminance and motion data.

Acknowledgements

Supervisors

Teresa Liu-Ambrose, PhD

Karim Khan, MD PhD

Collaborators

Jennifer C. Davis, PhD

John R. Best, PhD

Chung Liang Hsu, PhD

Postdocs

Cindy Barha, PhD

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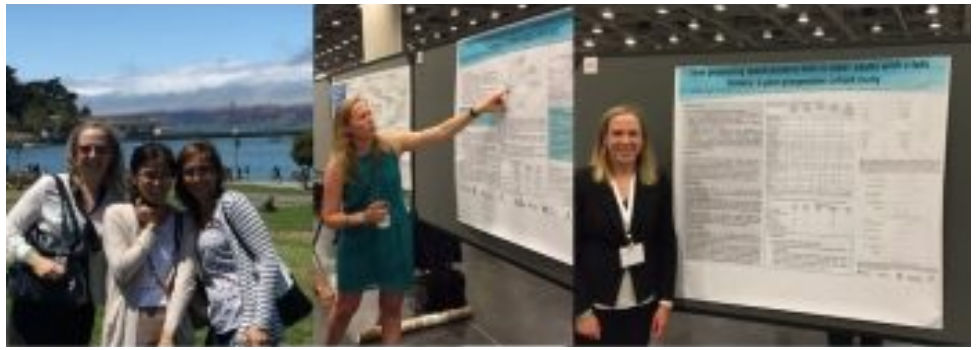

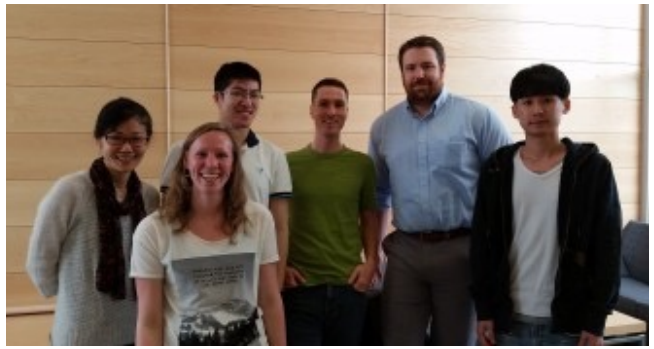

CIHR IRSC Canadian Institutes of Health Research / Instituts de recherche en santé du Canada

COGMOB Aging, Mobility, and Cognitive Neuroscience Lab

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CENTRE for HIP Health and Mobility

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