How much is left in your "sleep tank"? A simple model for sleep history feedback

Dorrian J, Hursh S, Waggoner L, Gupta C, Grant C, Pajcin M, Coates A, Kennaway D, Heilbronn L, Della Vedova C, Banks S
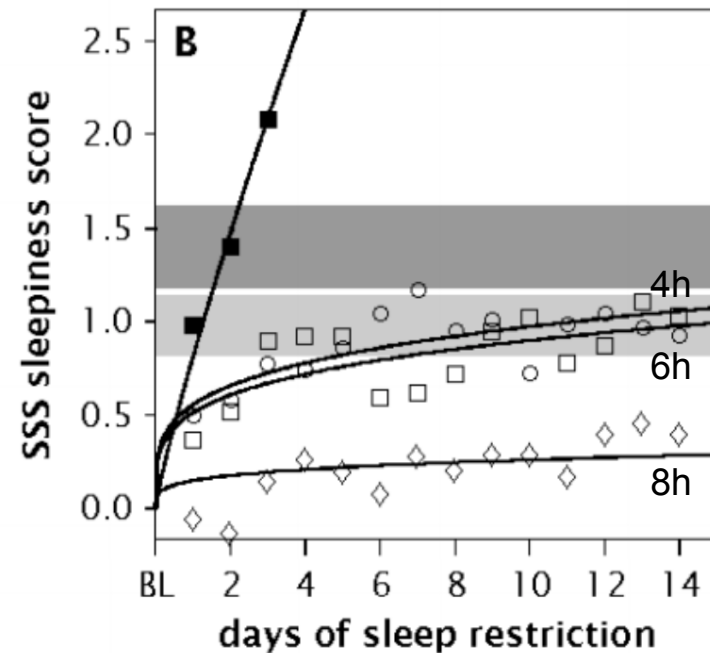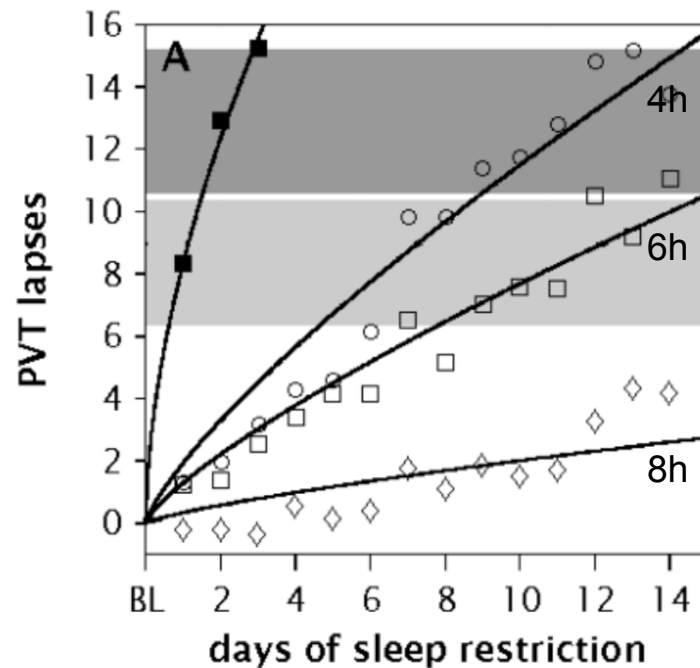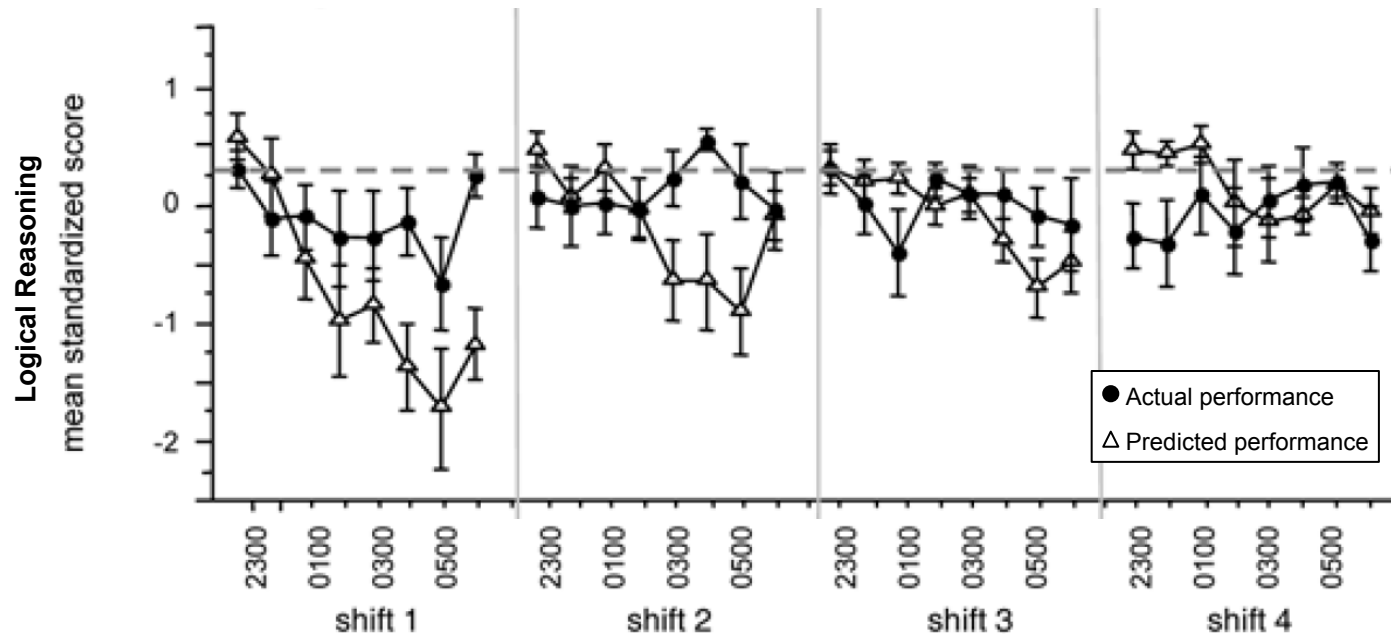
- Sleepiness is often used as an indicator of impairment, and in many circumstances, it tracks performance measures

- Measuring sleepiness is not necessarily measuring awareness of risk

- Performance ratings often track sleepiness more closely than they track performance

- What else can we use in addition to sleepiness?

Sleep history feedback may help with fatigue-related decision making

SA Ambulance Service

Government of South Australia — SA Health

SA Ambulance Service

Fatigue Score Calculator

	Sleep Last 24 hours:	5 hours
	Sleep Previous 24 hours:	5 hours
	Sleep Last 48 hours:	10 :00 hours
	Last awoke at:	23:00 yesterday
	Hours awake:	2 :00 hours
	Fatigue score at:	**Recalculate**

Score:	Now	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00
	4	4	4	4	4	4	4	4	4	5	6	7
	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00
	8	9	10	11	12	13	14	15	16	17	18	19

Score 1-4: Keep an eye on yourself.
Score 5-8: Look out for each other.
Score 9+ : Notify State Duty Manager to discuss options.

- People also need to project into the future - Towards the end of my shift, will I still be fit for work, or for my commute?

- Can we develop a simple model to transform sleep history to support fatigue-related decision-making and forward planning?

http://www.saambulancestaff.com.au/FatigueCalculator/

Technology-supported methods for sleep recording are everywhere

"Despite a paucity of clinical validation with traditional sleep technologies (e.g., polysomnography (PSG), multiple sleep latency testing (MSLT), and clinical-grade actigraphy), CSTs are here to stay because of their innovative nature, convenience, and affordability." p.1455
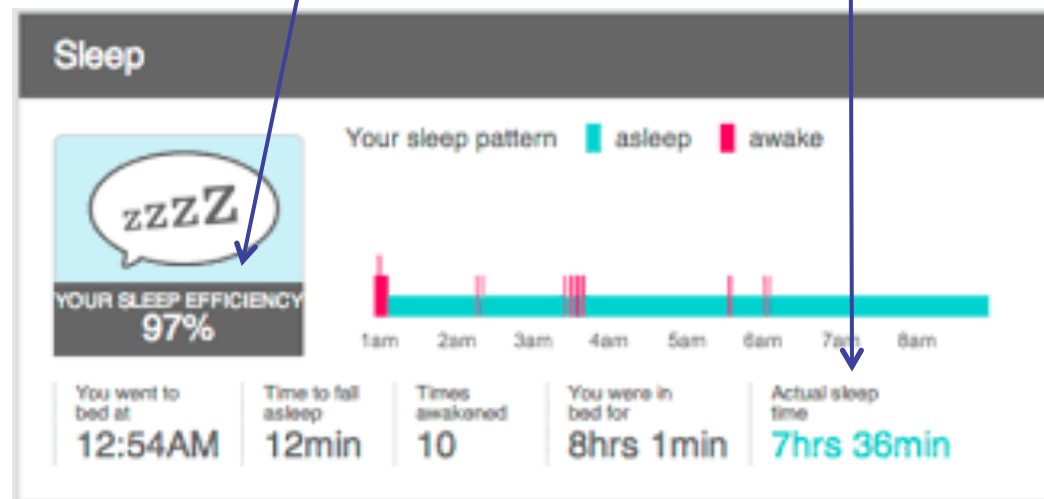
Consumer Sleep Technologies: A Review of the Landscape

Ping-Ru T. Ko, MD[1]; Julie A. Kientz, PhD[2]; Eun Kyoung Choe, PhD[3]; Matthew Kay, MS[4]; Carol A. Landis, PhD, RN, FAAN[5]; Nathaniel F. Watson, MD, MSc[6]

efficiency

sleep duration

Sleep

Your sleep pattern ■ asleep ■ awake

zZZZ
YOUR SLEEP EFFICIENCY
97%

1am 2am 3am 4am 5am 6am 7am 8am

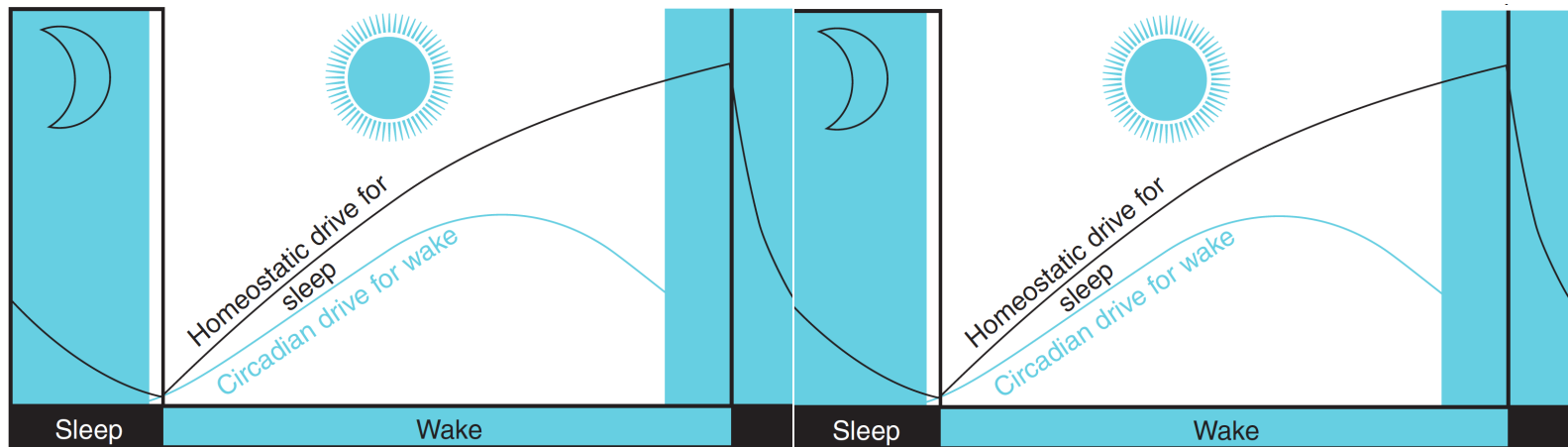| You went to bed at	Time to fall asleep	Times awakened	You were in bed for	Actual sleep time
12:54AM	12min	10	8hrs 1min	7hrs 36min

"Sleep Tank" is refilled by sleep, and depletes during wake

- Tank size = sleep-fuel required to remain awake for 4 days

- Required inputs are sleep period time and efficiency (provided by wearables)

- The model focuses on the sleep process of the two-process model - does not include a circadian factor

Dorrian et al., (2017). Health Psychology, Cambridge Press

PVT

KSS

1. Extremely alert
2. Very alert
3. Alert
4. Rather alert
5. Neither alert nor sleepy
6. Some signs of sleepiness
7. Sleepy, but no effort to keep awake
8. Sleepy, but some effort to keep awake
9. Very sleepy, great effort to keep awake, fighting sleep
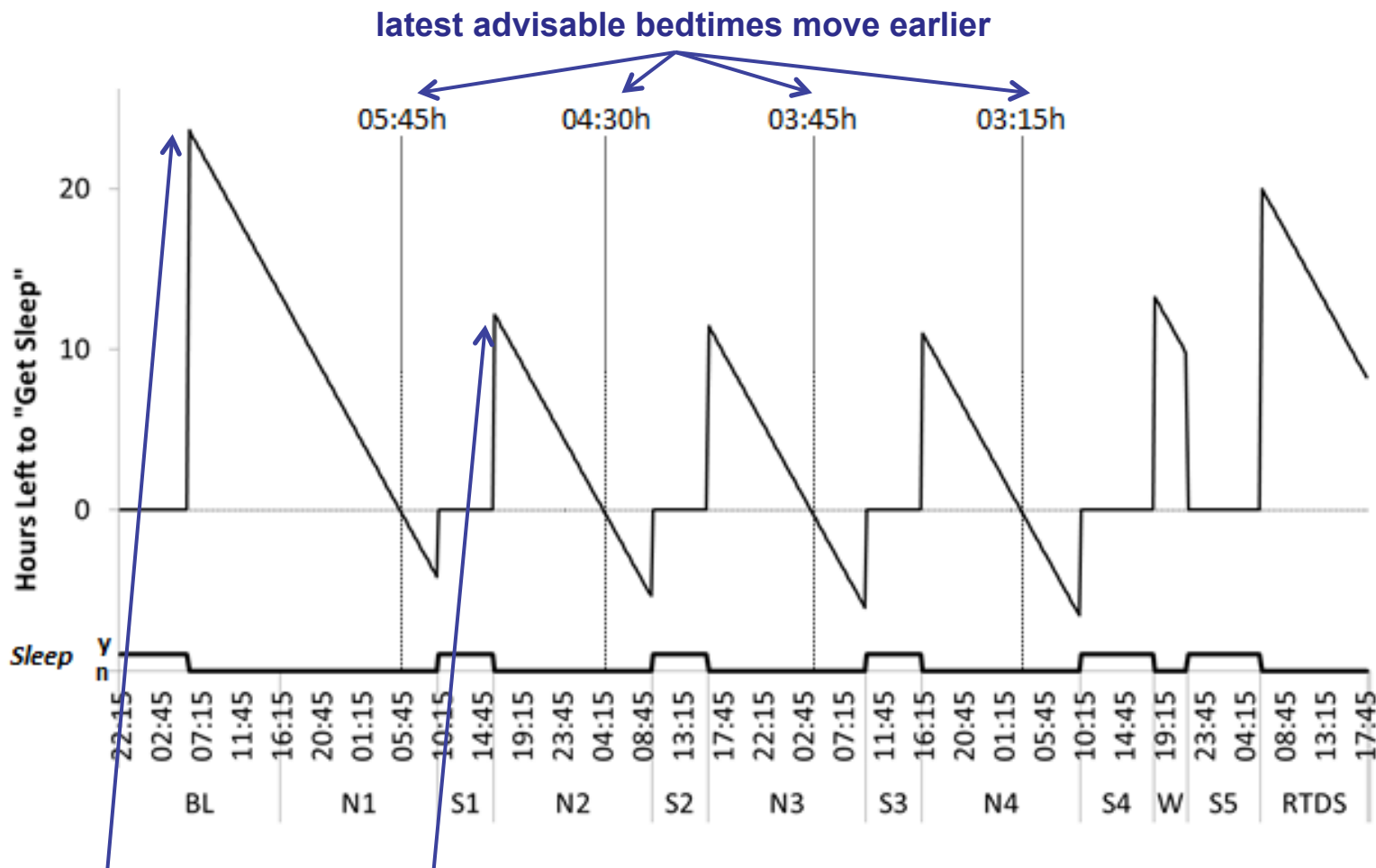

York Drive Sim

- Lapses (>500msec)

- Sleepiness Rating

- %Time in Safe Zone (within 10km/h of the speed limit and within 0.8m of the centre of the lane)

- PSG during sleep periods
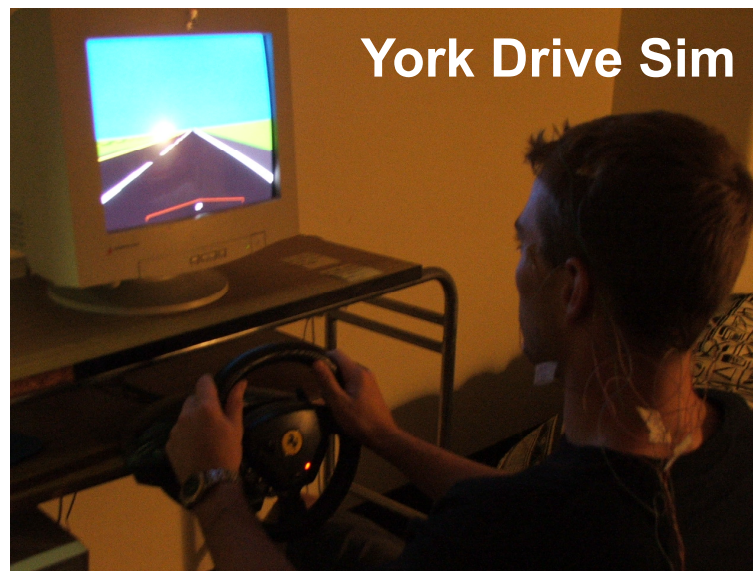
Initial validation: Laboratory-based simulated shiftwork study (*n*=10)
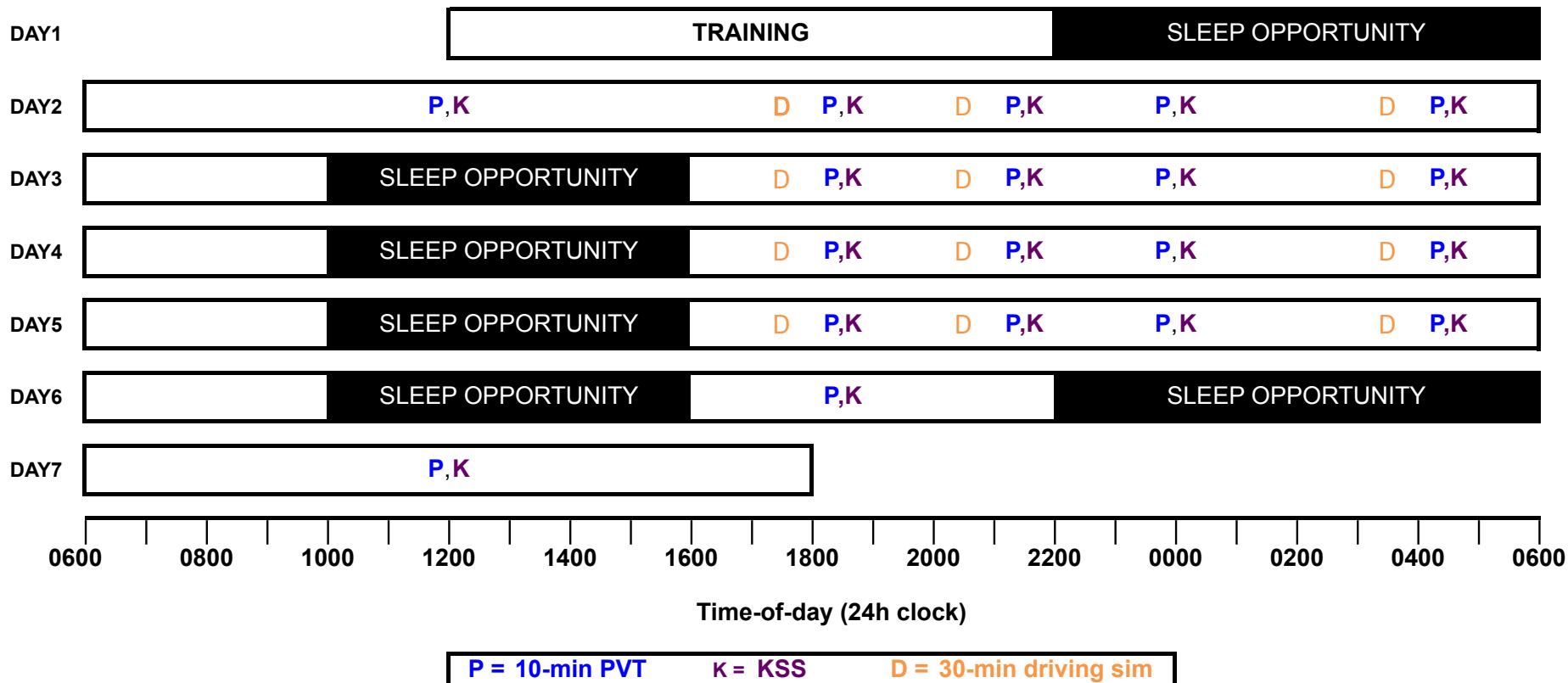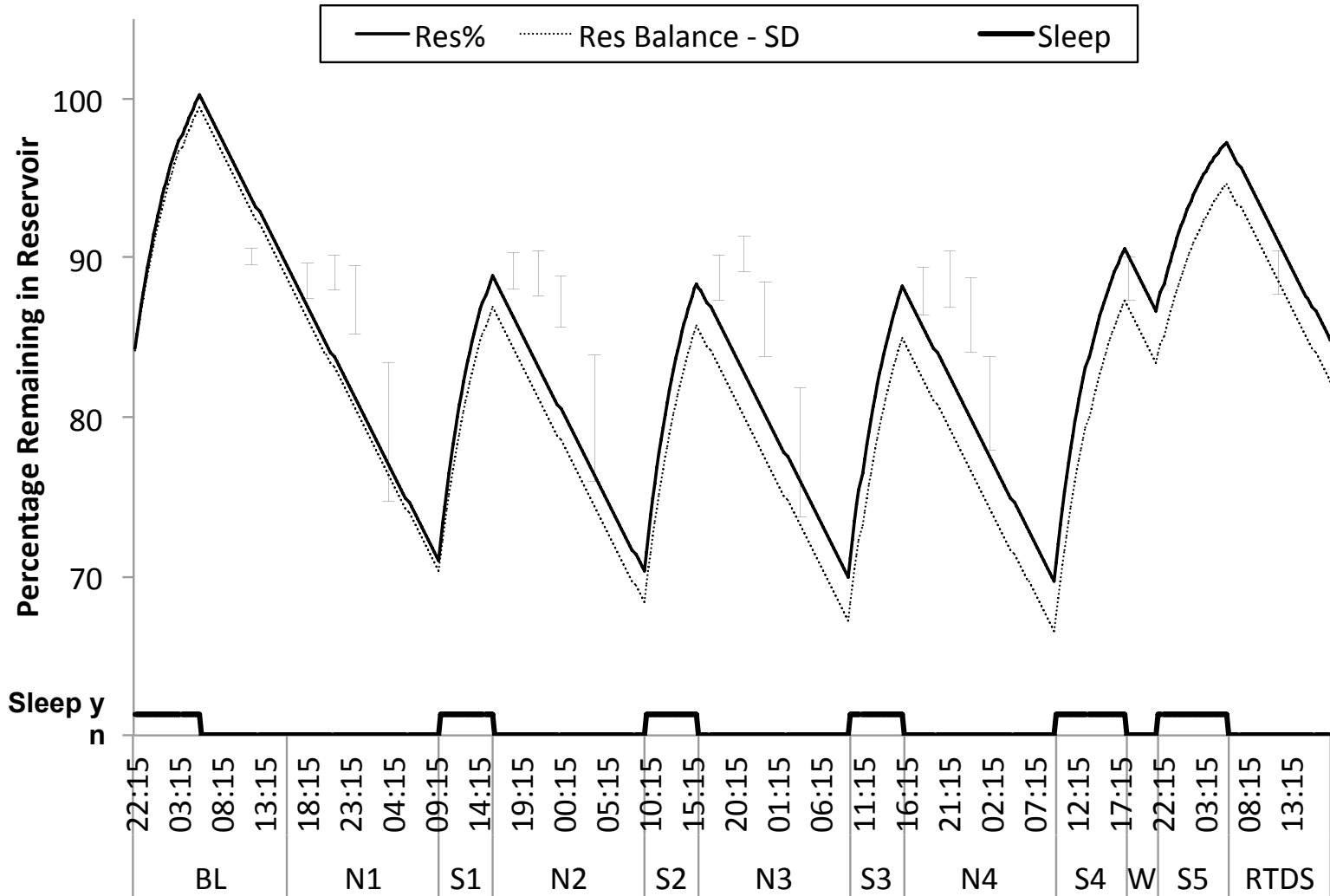
"Hours left to get sleep" metric shows expected changes across simulated night shifts
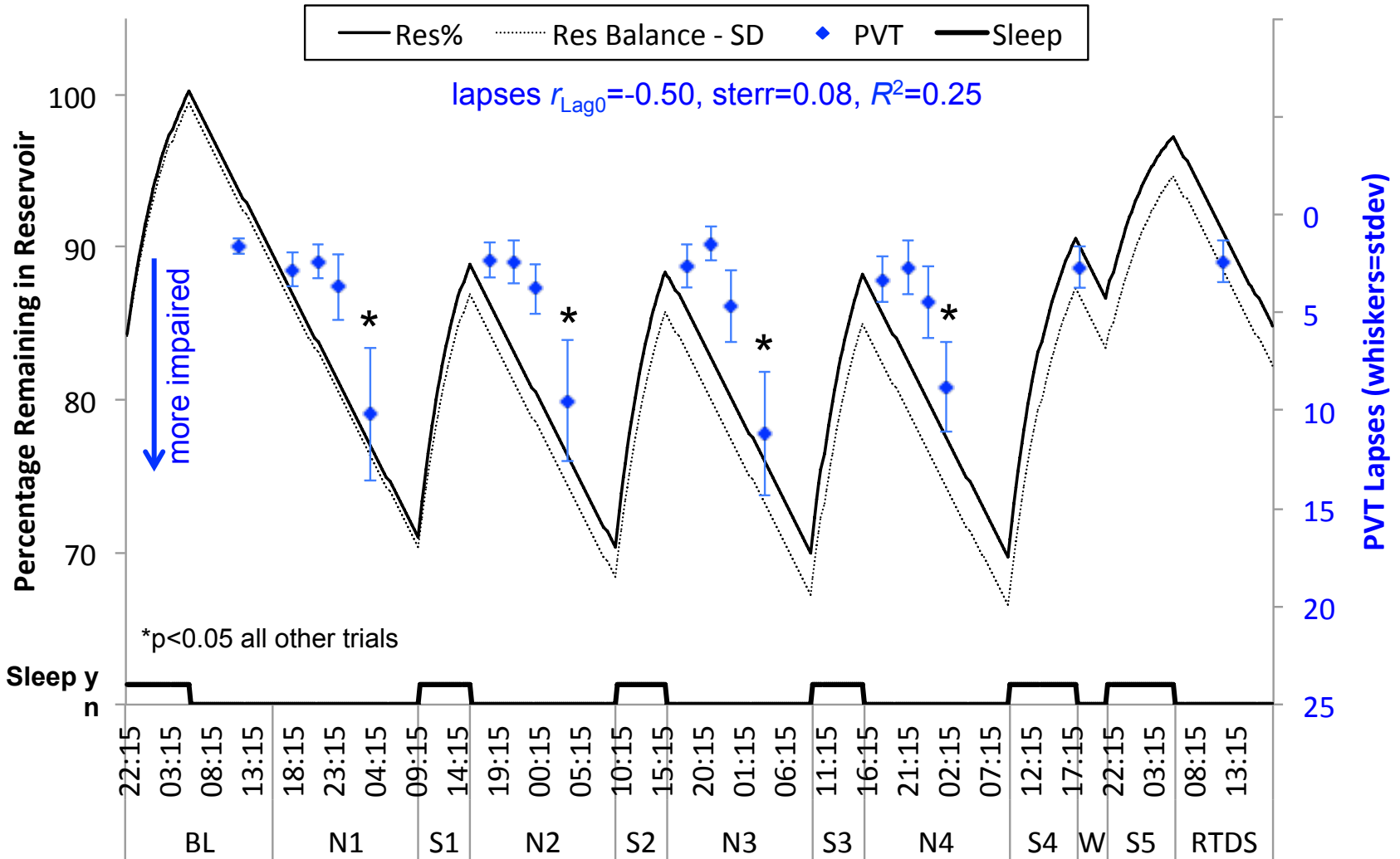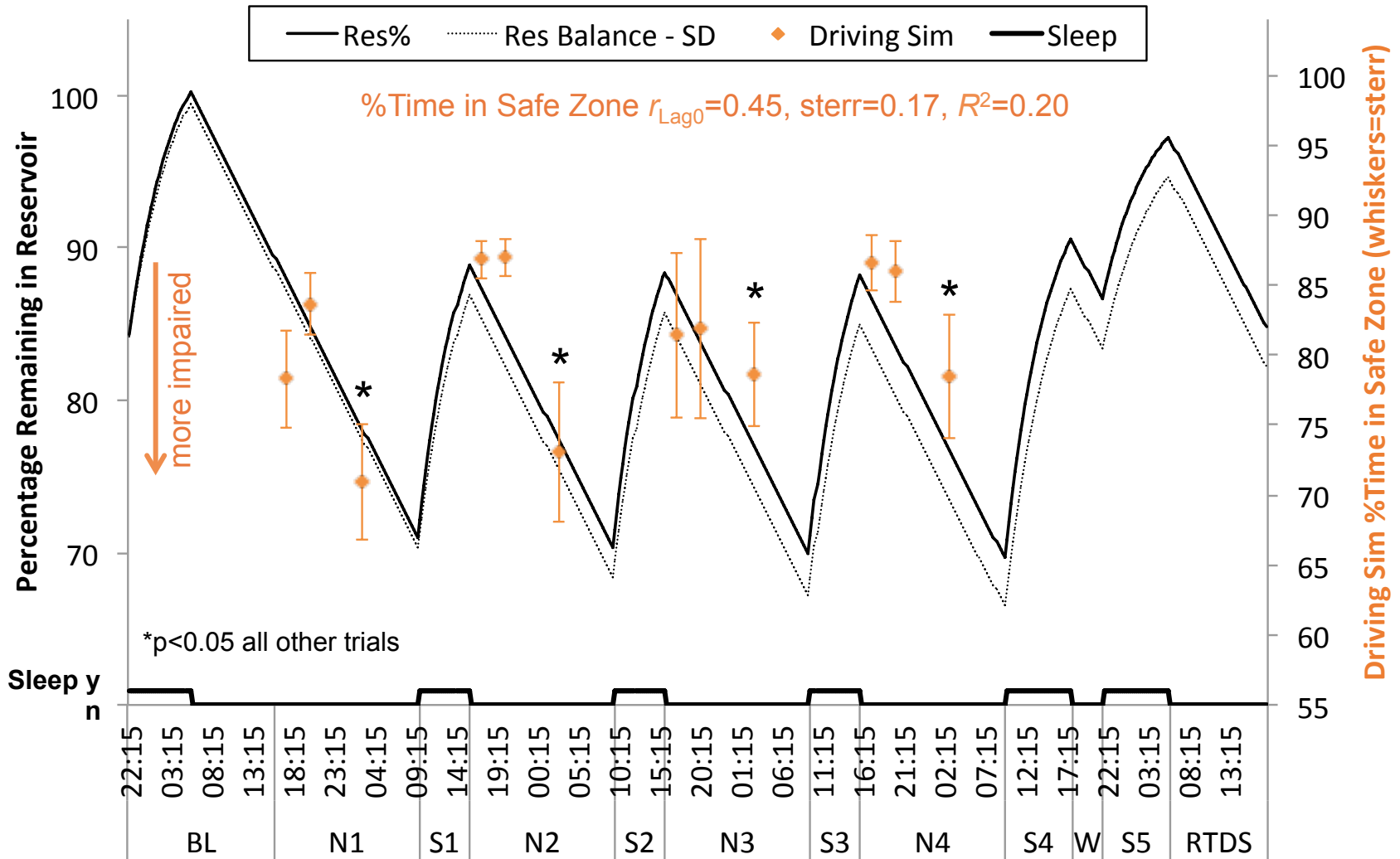
Every 5% reduction in the tank resulted in an increase of one lapse

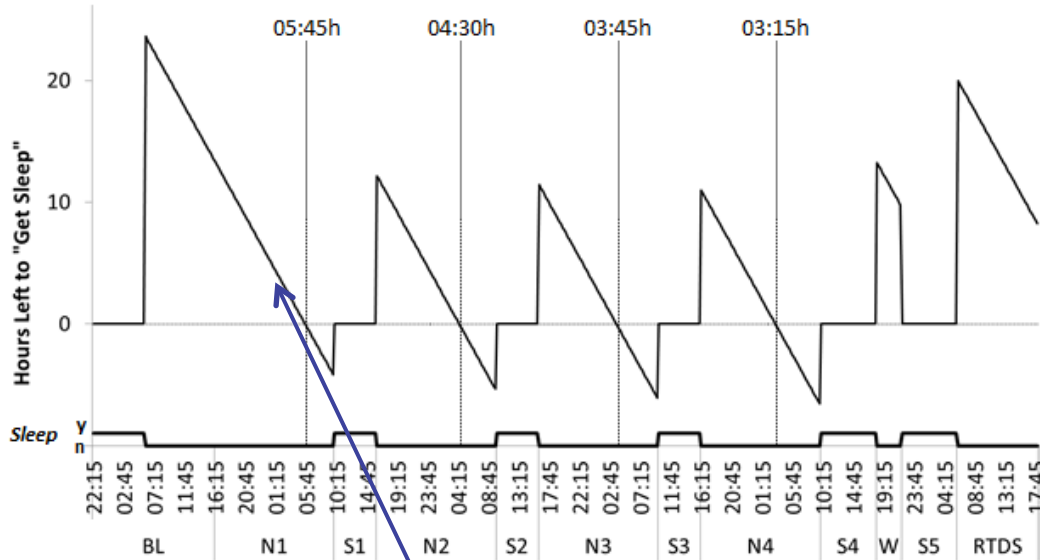Every 5% reduction in the tank resulted in an increase of one point on the KSS
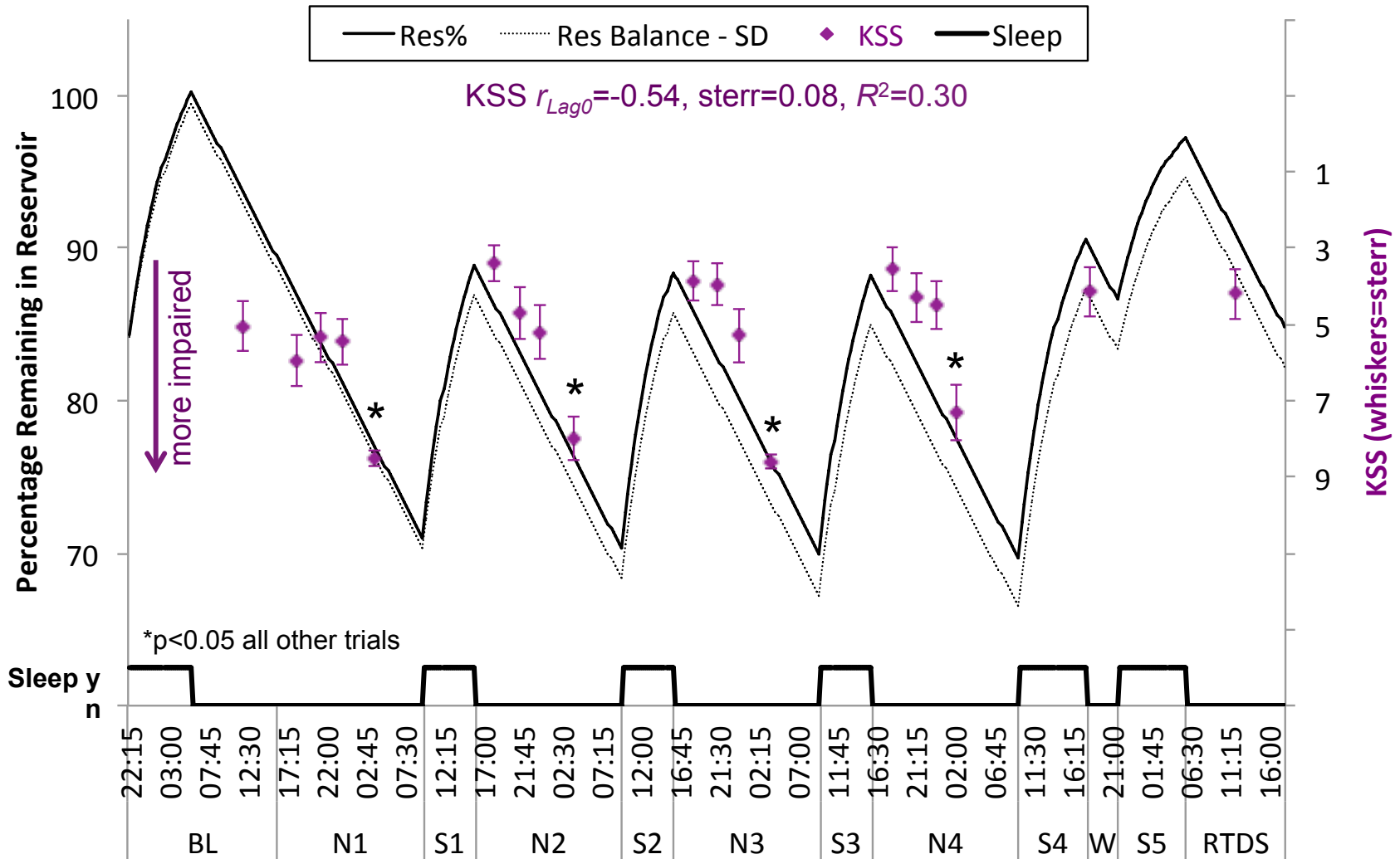
Every 1% decrease in the tank resulted in a 0.75% decrease in time spent in the Safe Zone

- Initial support for "Sleep Tank" transformation tracking performance data during simulated night work

- Next steps include validation with actigraphy/wearables, rotating shift patterns in the lab and field

- Following further validation "Sleep Tank" calculations could be added to consumer-grade actigraphs and/or apps to map performance implications of recent sleep history, to aid fitness for work decisions at that moment, and across a coming shift

Left in tank: 2.4h

Latest advisable sleep time: 5:45am

E   F

Discussion

- Continuous metric that can facilitate forecasting

What if I napped here?
How long would I need to nap to be safe on my commute?

Forecast

Date: 03/21/2017
Start: 3:00am
Finish: 3:45am

Latest advisable
sleep time:…………..