

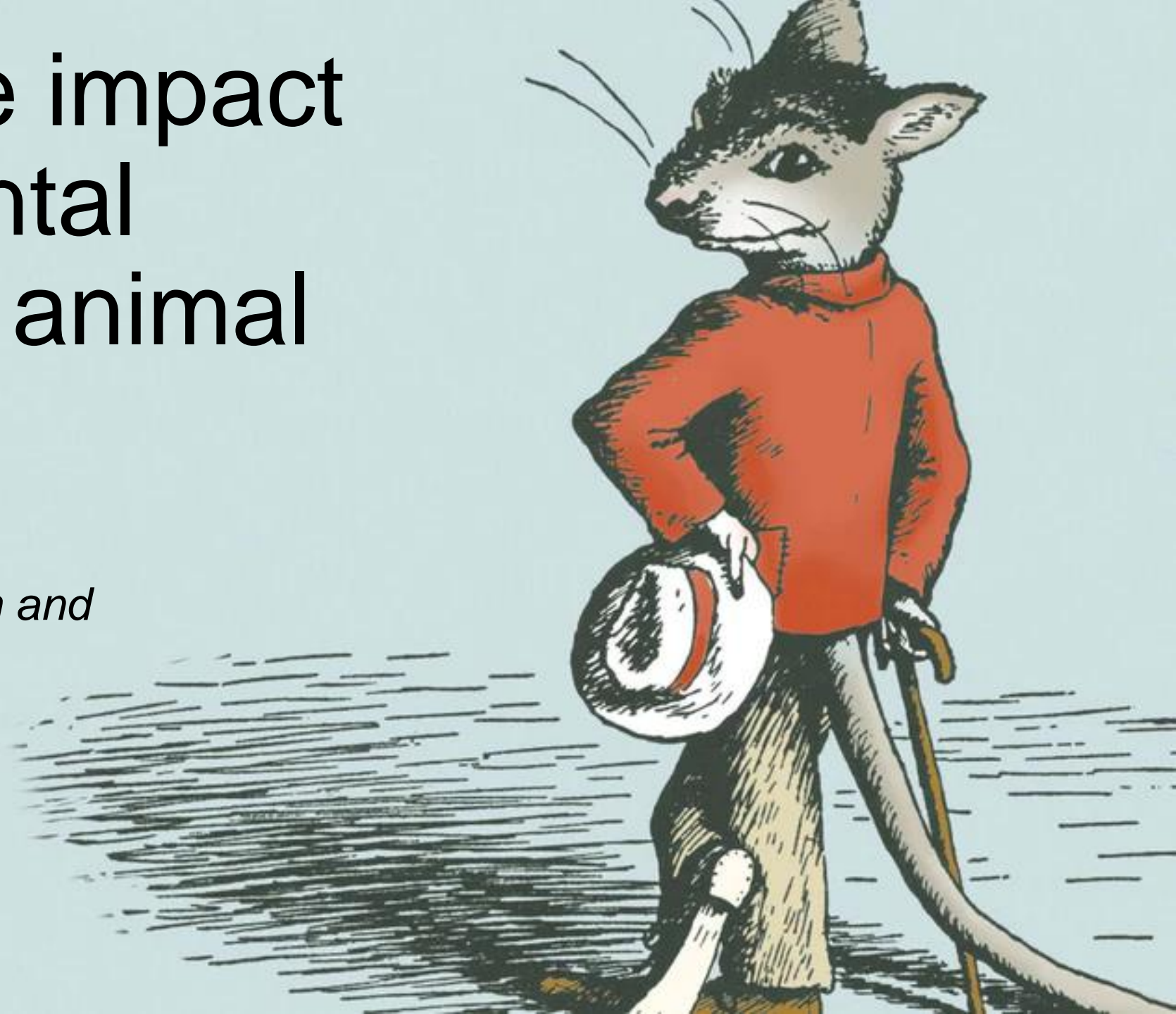
Assessing the impact of environmental conditions on animal behavior

Naureen Ghani

Supervised by Philip Shamash and Tom Mrsic-Flogel, PhD

University College London

 **UCL**



Mouse-motivated behavior in London is highly divergent from what was seen in Basel.

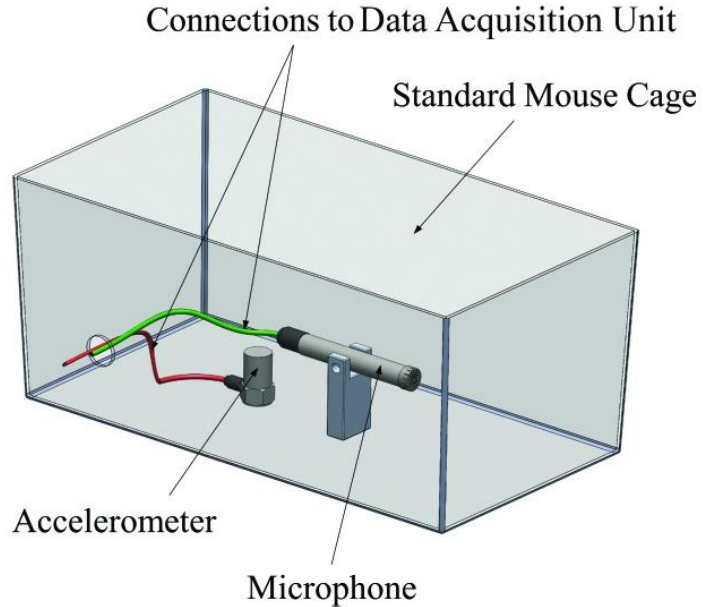
<u>Basel</u>	<u>London</u>
Mice became active in home cage around training time.	Mice are not as active.
Mice have circadian rhythms strongly entrained by food restriction.	Very few mice have circadian rhythms entrained by food restriction.
Mice consume food reward readily.	Mice do not consume food reward as readily.
Mice display signs of stress (freezing or moving slowly in short bursts) only in first few days.	Mice have a “drop-out rate” where they no longer complete the task: <ul style="list-style-type: none">• Sudden• Gradual (as high as 2 months)
100% success rate	10% success rate

Problem: Water-restricted mice in London do not run on wheel for water reward.

Hypothesis: There is an active process in the environment by which mouse stress increases over time.



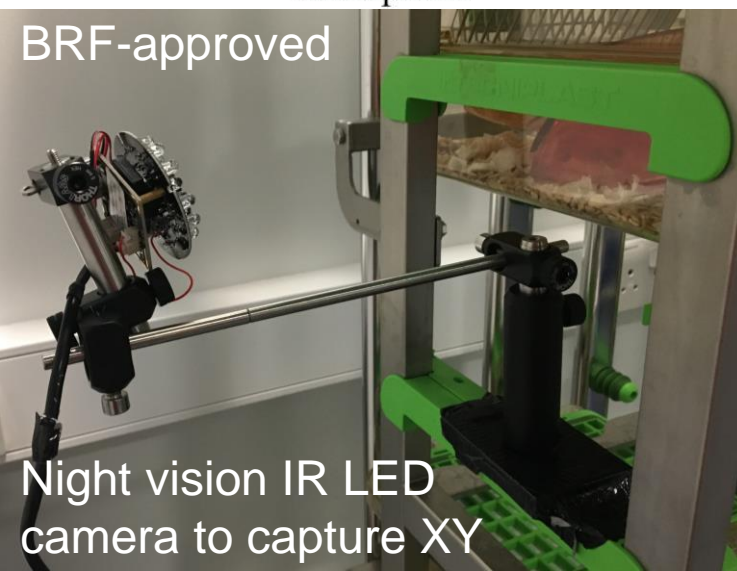
We monitored mice for seven days while recording potential sources of environmental stress.



Animal facilities control for:



- Light cycle duration
- Air quality
- Temperature
- Relative humidity

Sound and **vibration** are not controlled for.

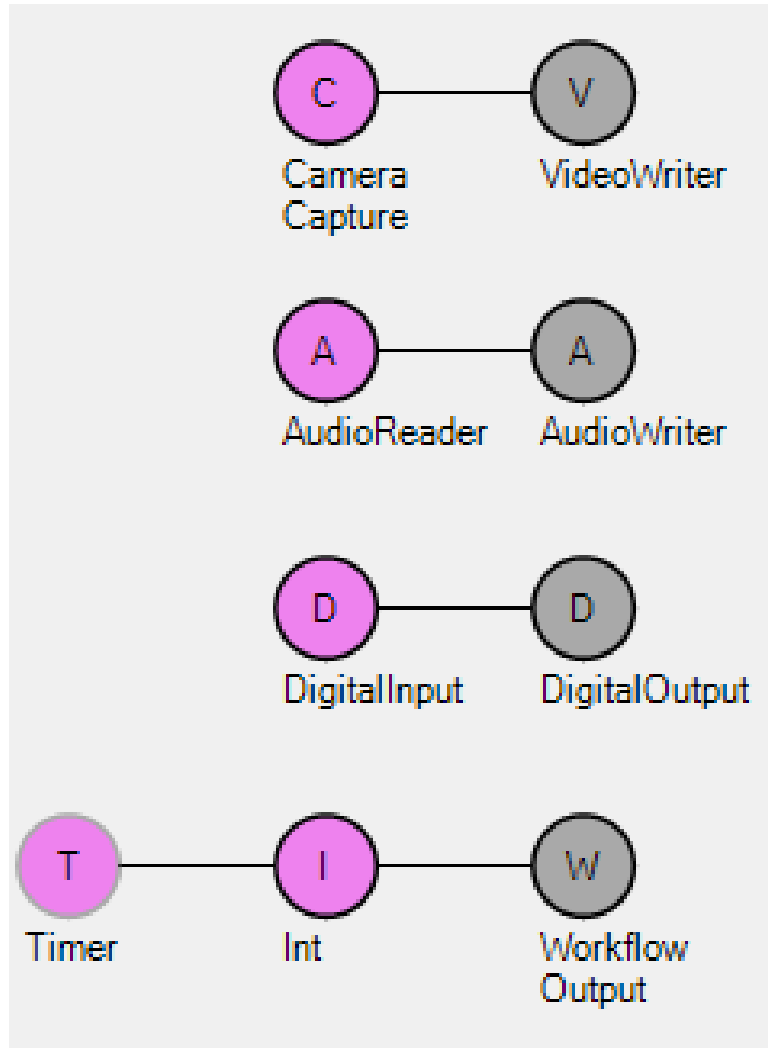


	<u>Sound</u>	<u>Vibration</u>
Device	Ultrasonic Microphone	MMA8451 Accelerometer
Sampling Rate	192kHz or 200kHz	800 Hz
Caveats	<ul style="list-style-type: none">• placement of measurement cage was not random• sound and vibration from outside cage environment can still enter	




We observed six cages in two different rooms.

<u>Ventilated Racks (Room 303)</u>	<u>Flat Wire Racks (Room 363)</u>
Densely populated	Sparsely populated
Cages are held by clip, which can decrease cage-to-rack vibration	Mice are not naïve and selected for behaviour.
Heavier (less vibration)	
Air intake and exhaust system generate minor background vibration	
	

We used Bonsai to sync different data streams.

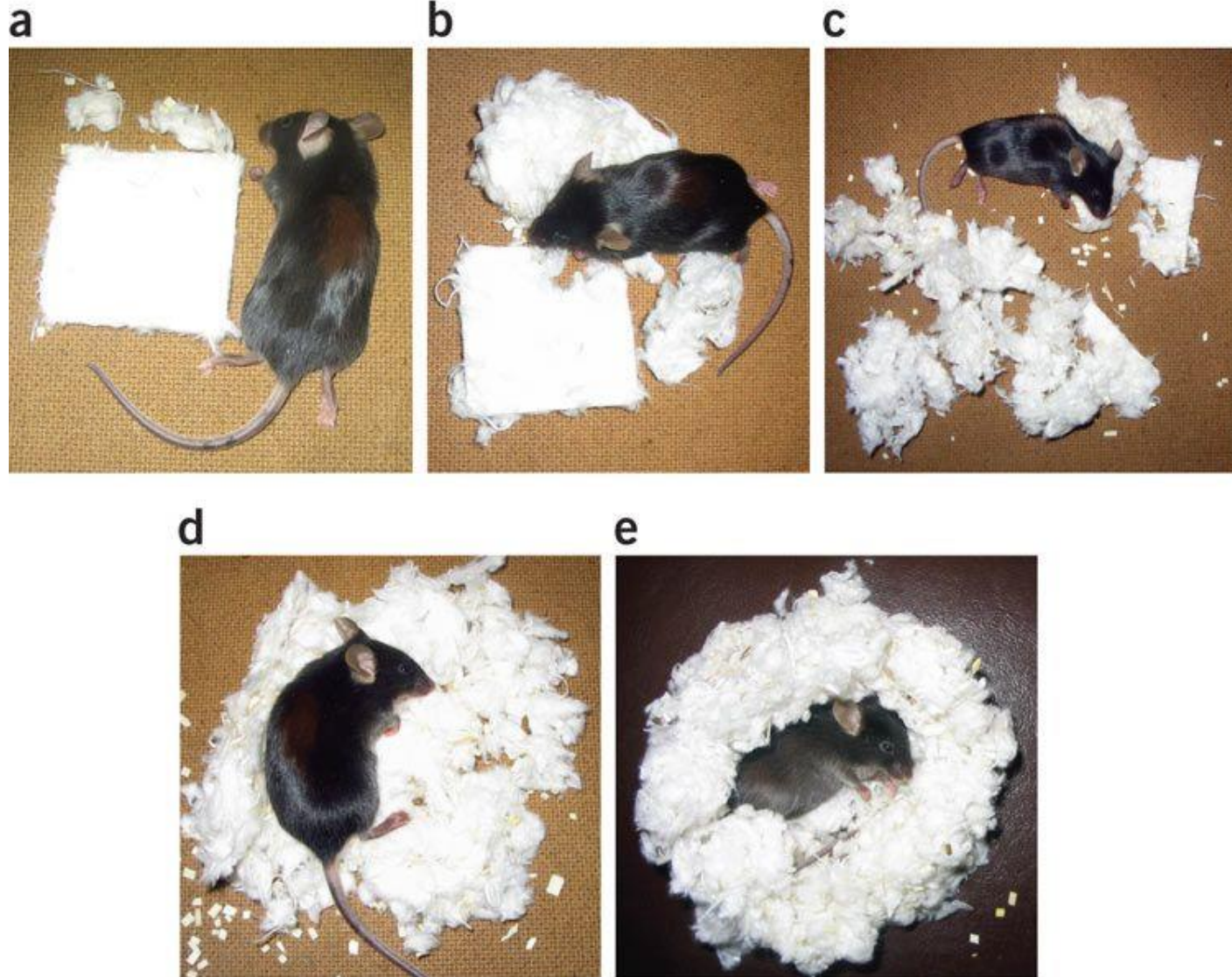


Kampff Lab

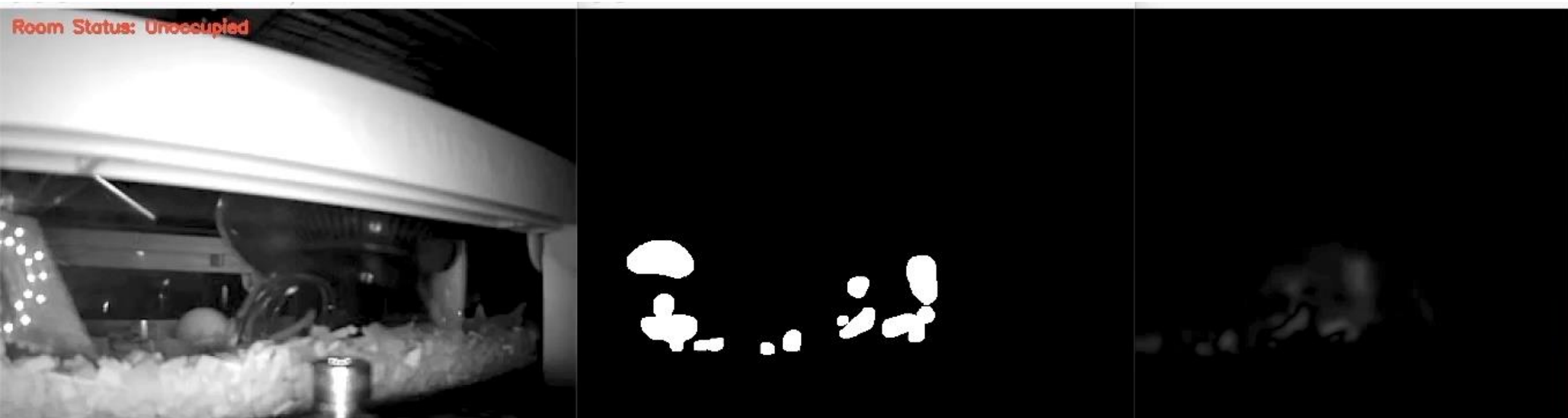
<u>Program</u>	<u>Role</u>
	Automate repetitive tasks with bash scripting
	Wake On Lan to turn on computer remotely
	ExpanderDrive to mount Google Drive

Recording for 24 hours over days with Bonsai requires additional help

Machine learning approaches to video tracking do not work on our low-resolution videos.



We used a simple video-tracking code based on contrast for speed over precision.



Frame Rate = 15 or 30 FPS for data storage

24 x 6 x 7 = **1008 hours** of video

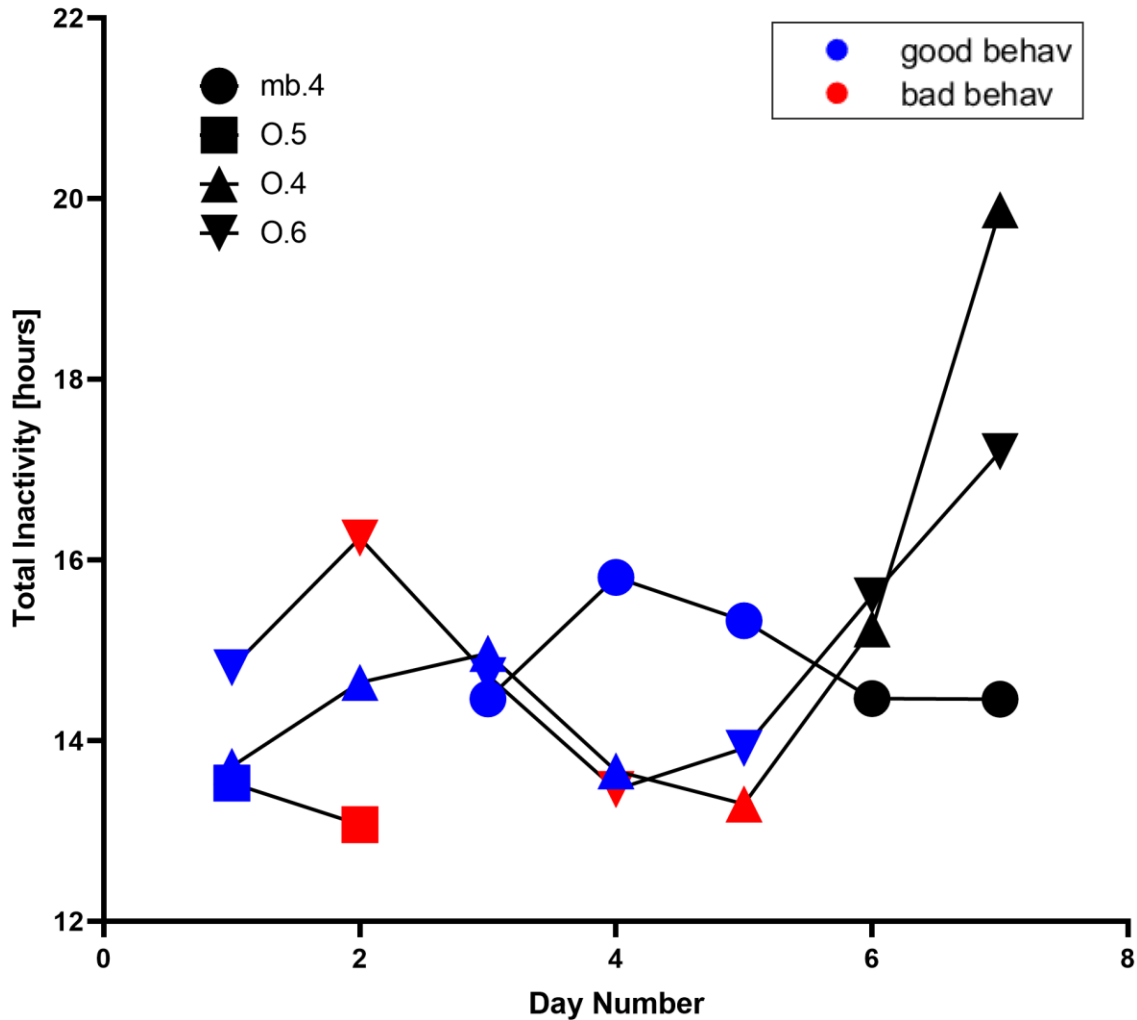
All analysis was done on the High Performance Cluster (HPC) over several days

230 GB of data

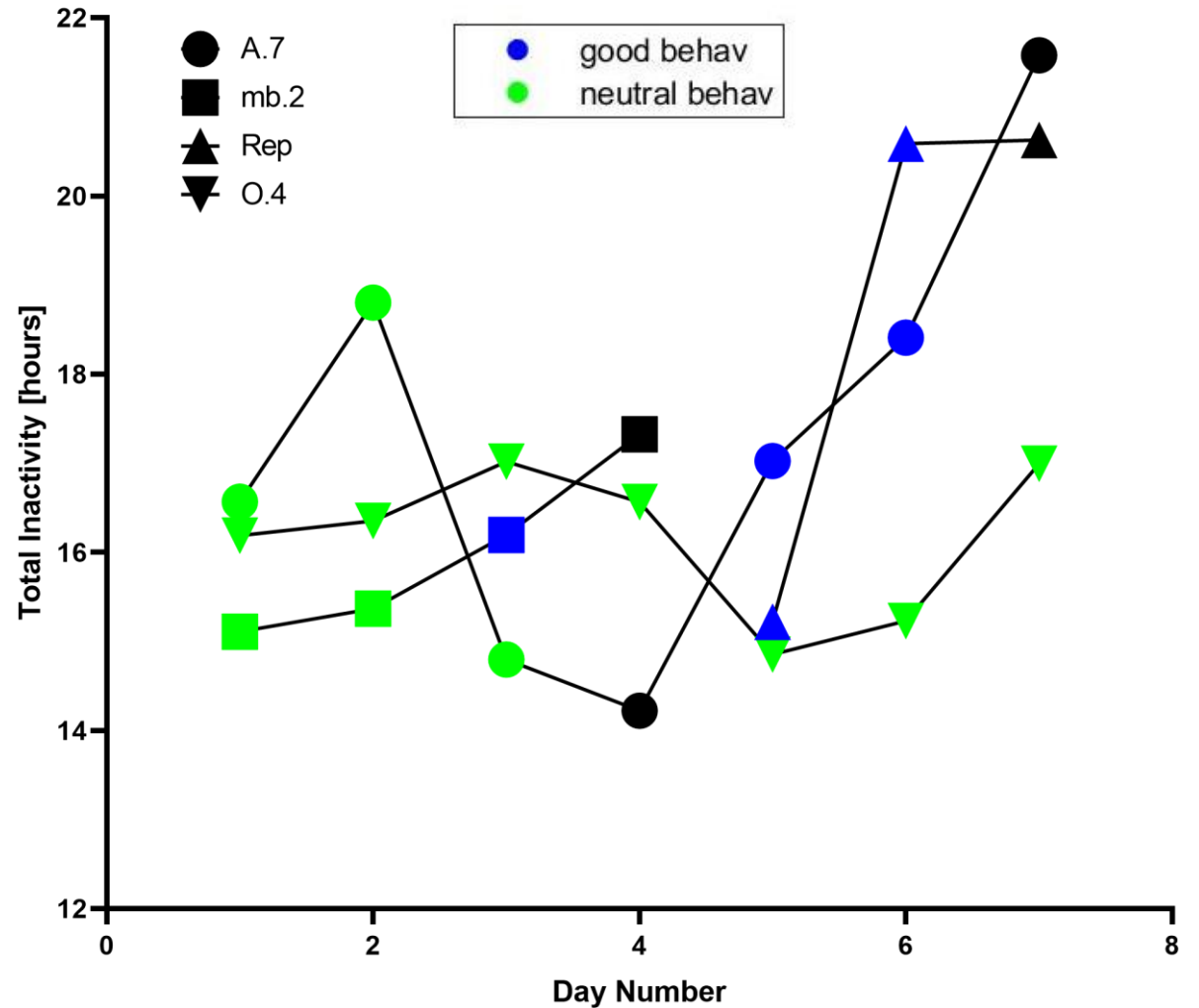
generated on each PC daily . . .

In Room 303, mouse behavior performance decreases over time.

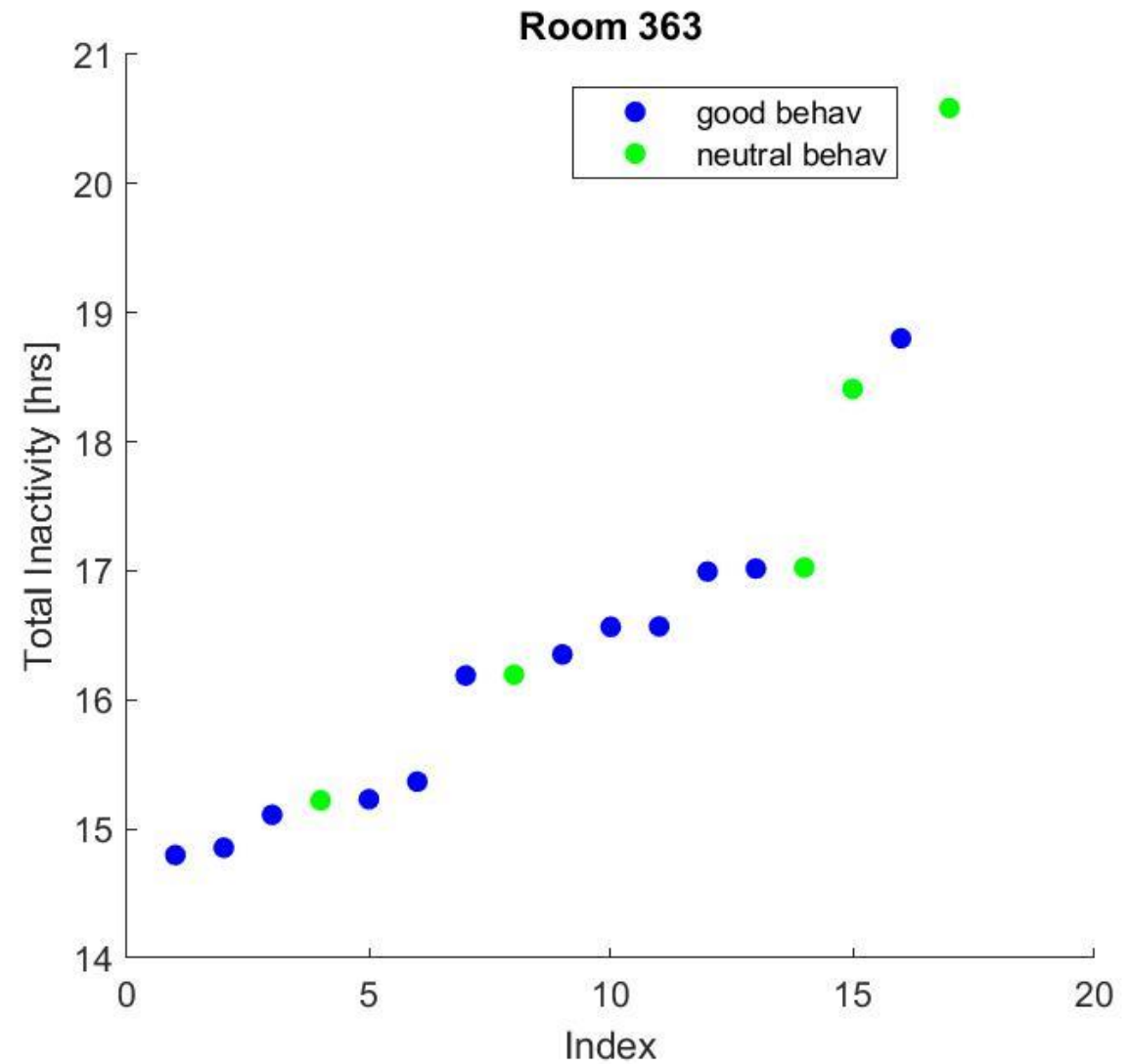
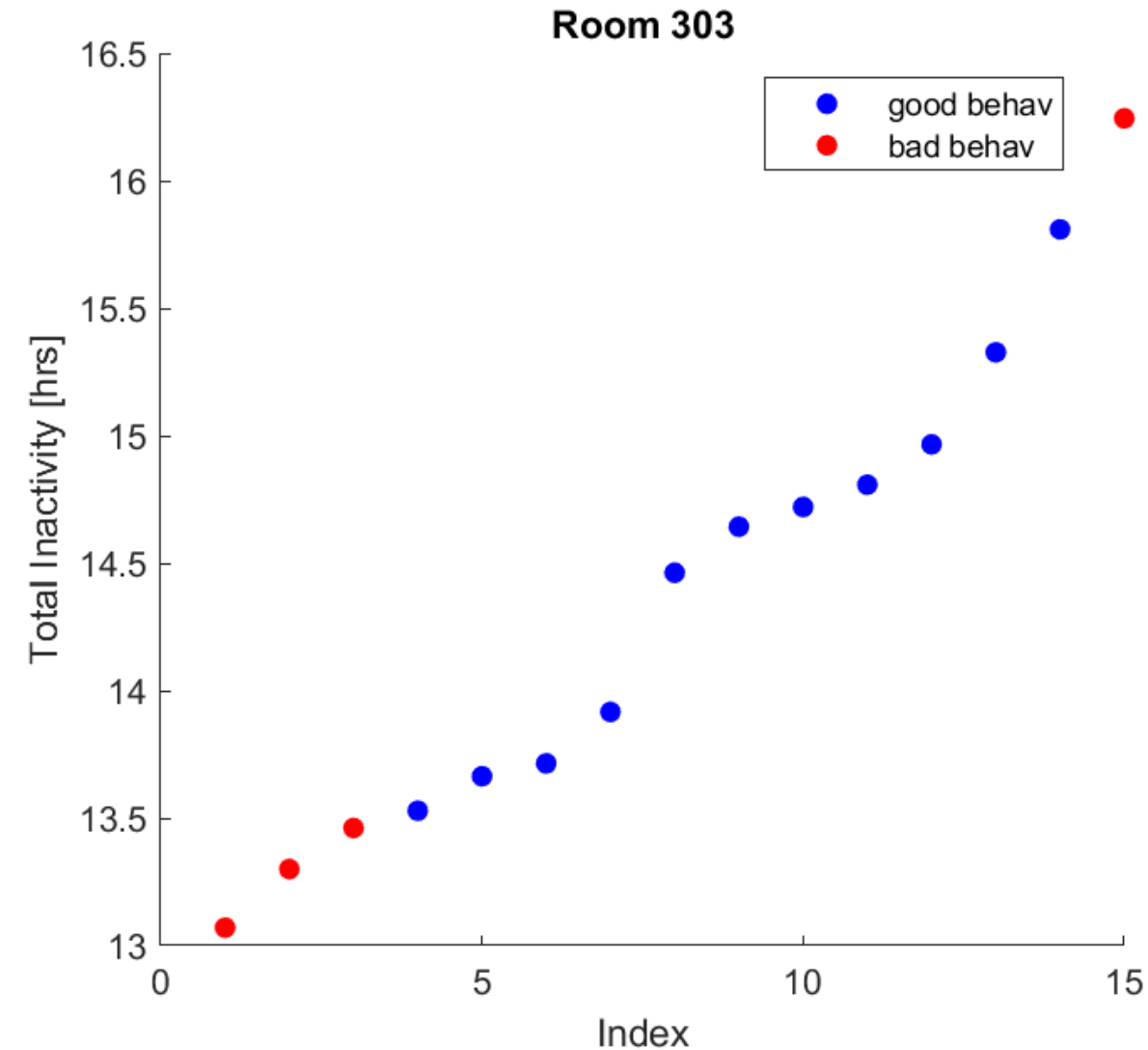
Room 303



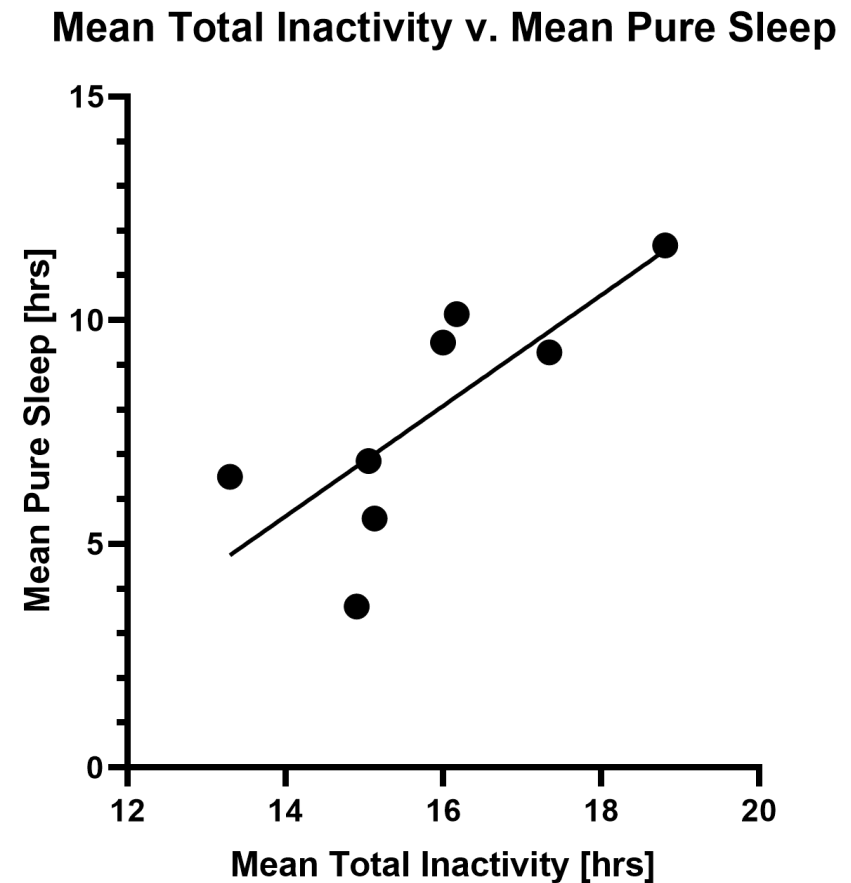
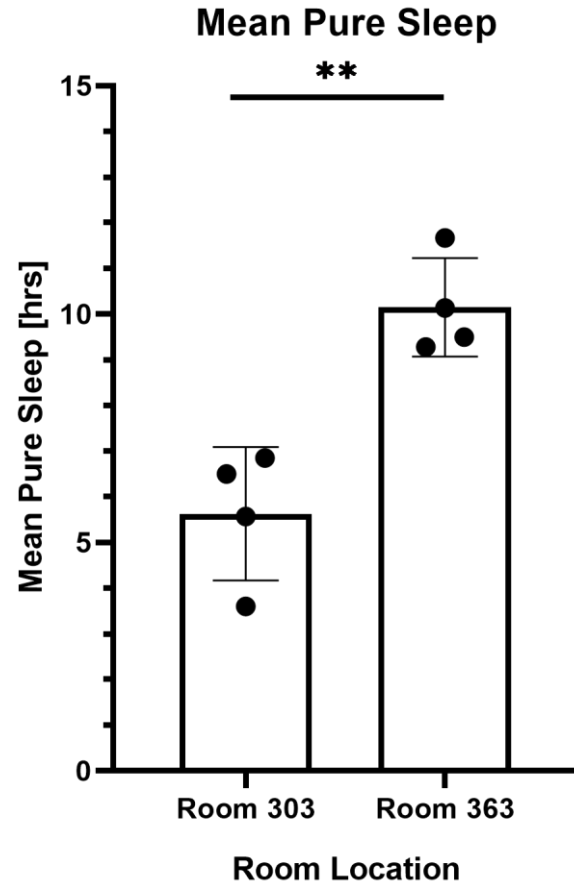
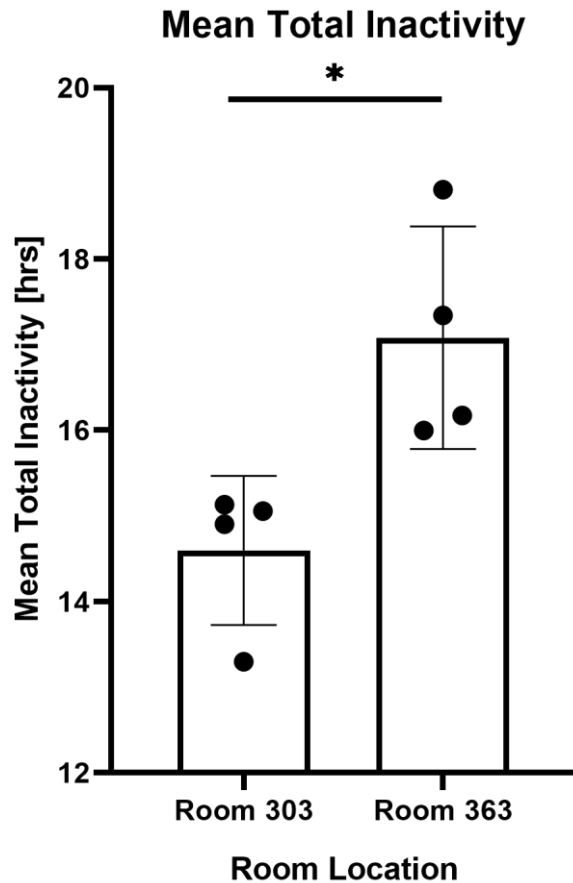
Room 363



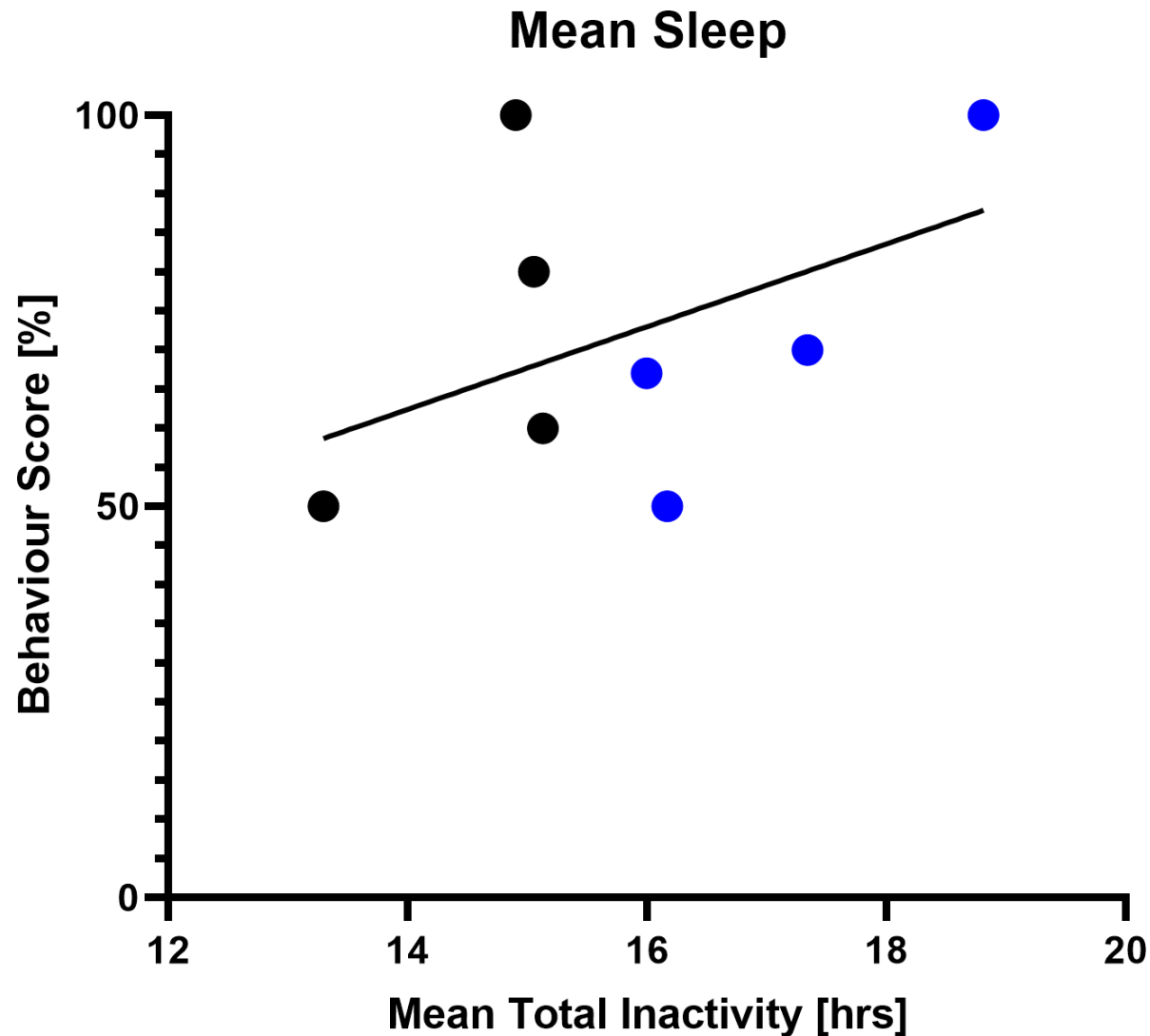
There is a correlation between mouse inactivity and behavior performance the next day.



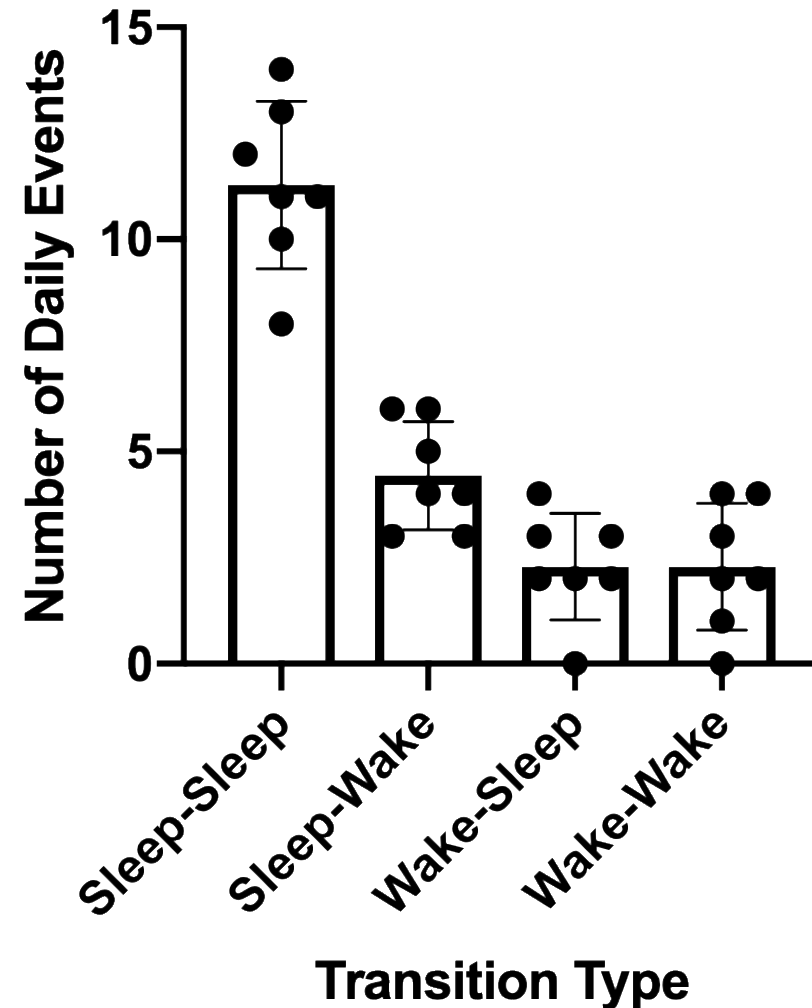
The mean total inactivity and mean pure sleep of mice in Room 303 is less than that of Room 363.



The mean total inactivity is positively correlated with behavior score.



Peak Vibration in Consecutive Days



Ultrasonic noise was identified as a source of stress across institutions.



Randy Bruno
@brunocolumbia

Follow



Mouse Behavior labs: Get an ultrasonic microphone to check behavior and colony rooms. Someone might install a device that emits loud ultrasound, which can stress out your mice.

Ultrasonic noise (>20kHz) caused by:

- motion sensors
- fluorescent lights
- mobile phones



Yale

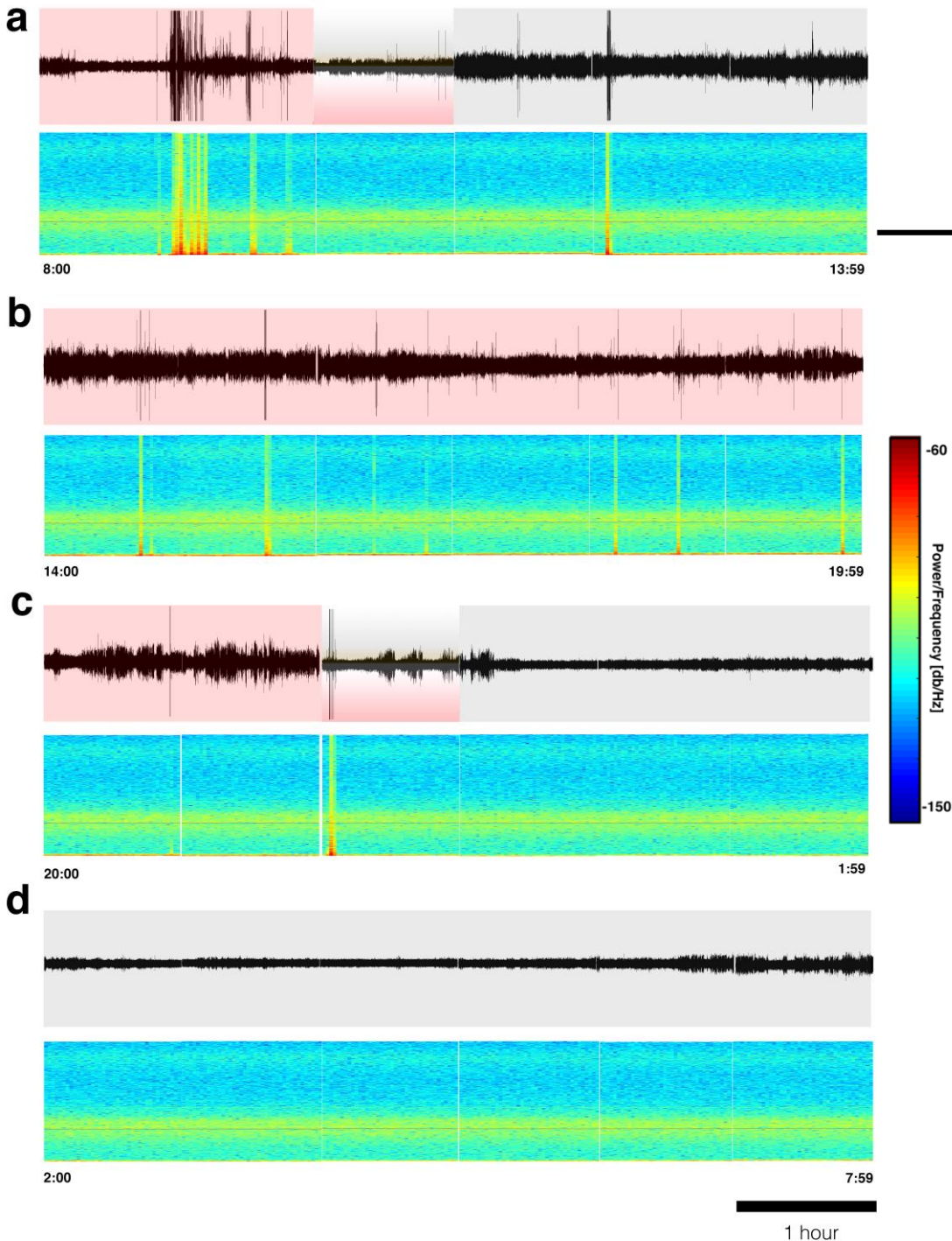


NYU

MAYO
CLINIC



Ultrasonic noise is not an issue for the SWC.

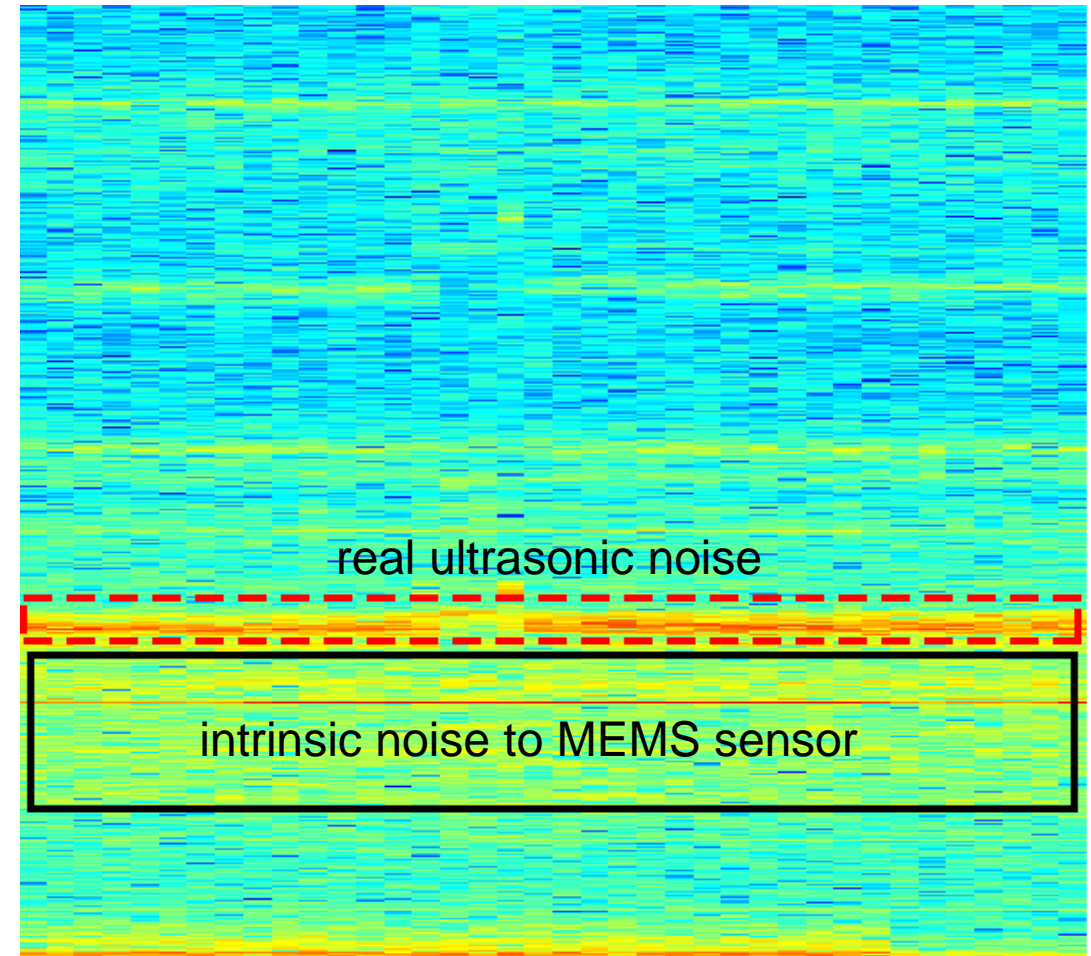
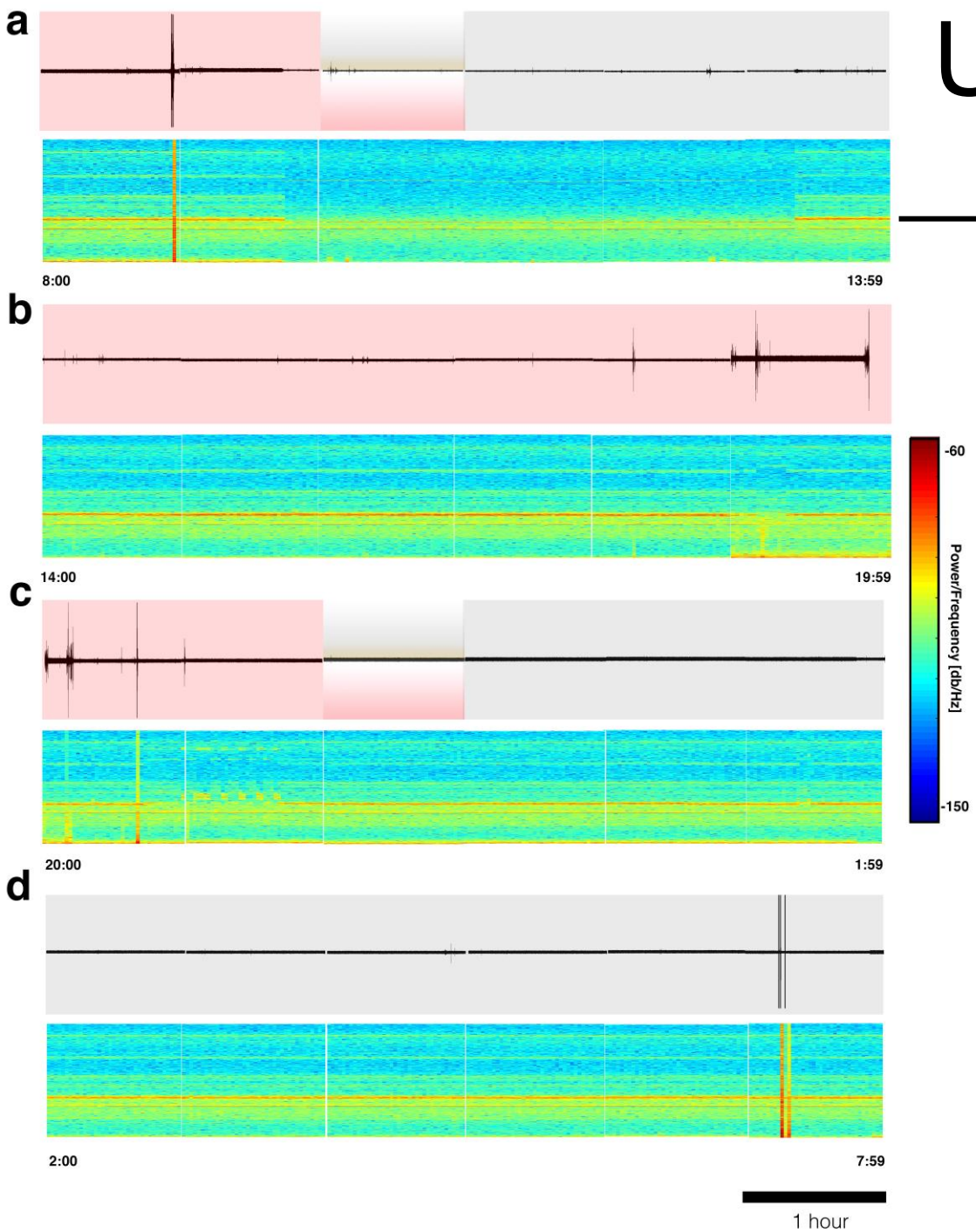


- The constant 20-30 kHz band (yellow) is an artefact.
- Since all electronic devices emit ultrasonic noise, the ultrasonic microphone is no exception ...

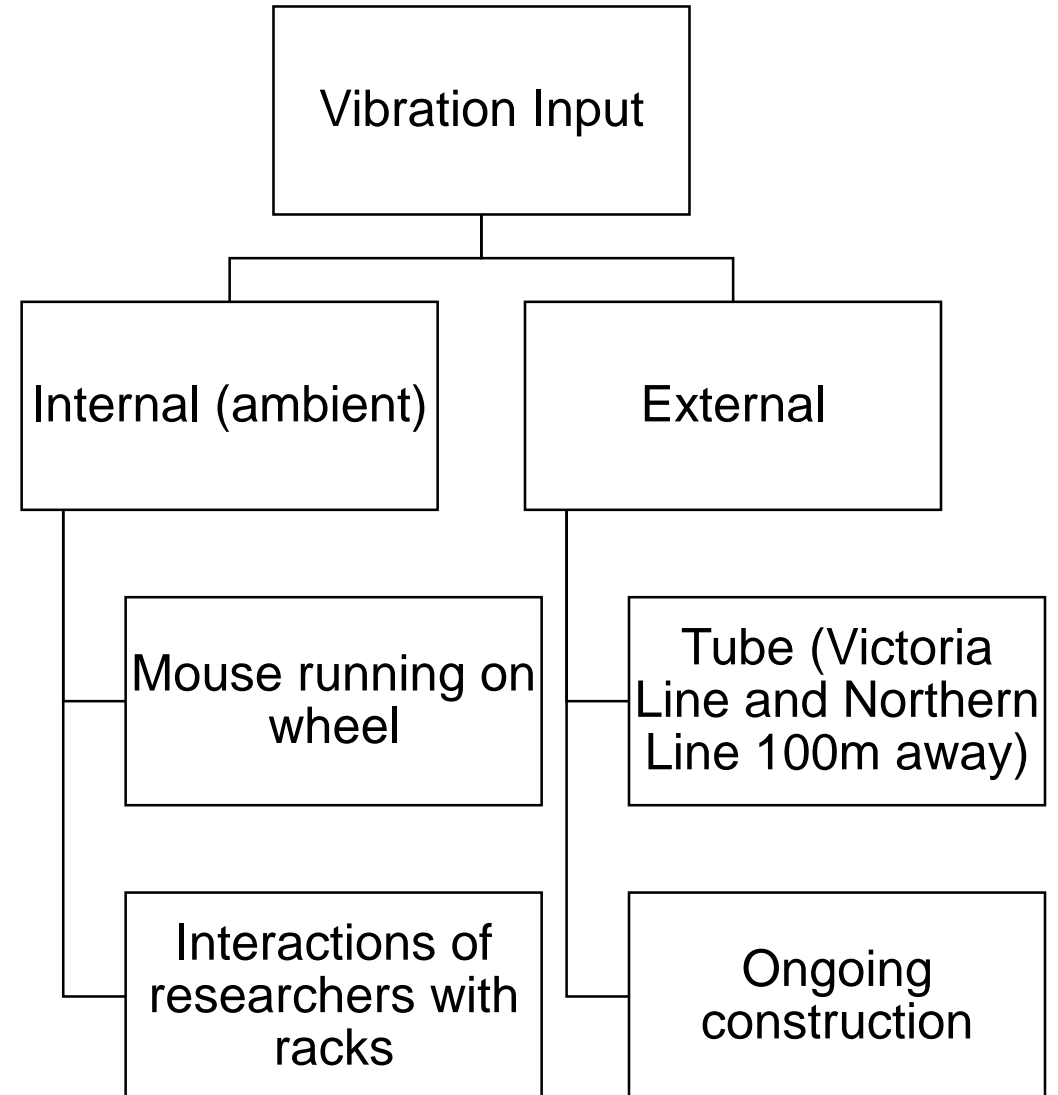
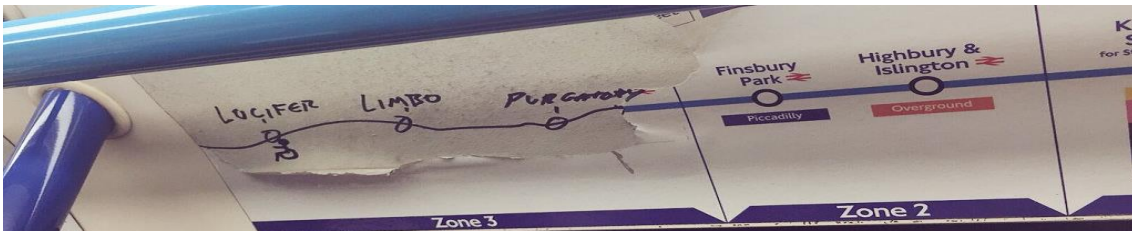
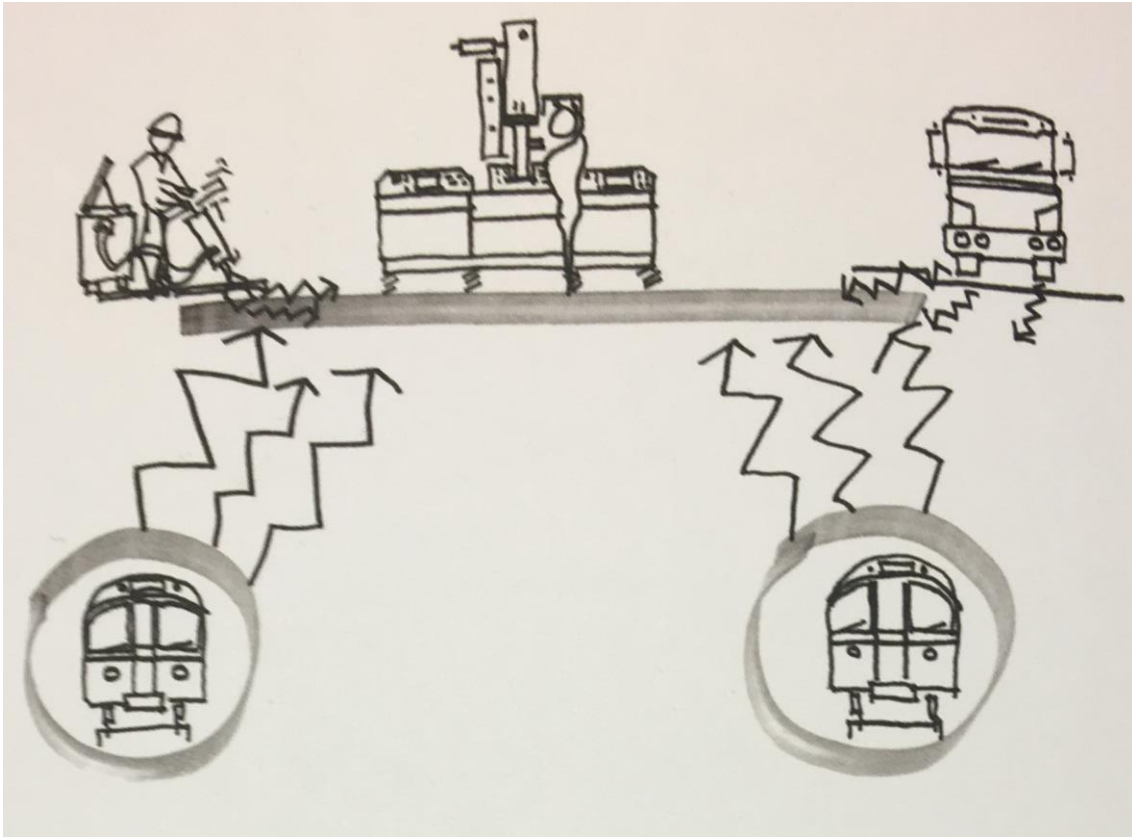
The SWC was designed to minimize ultrasonic noise:

- porcelain basins
- infra-red motion sensors

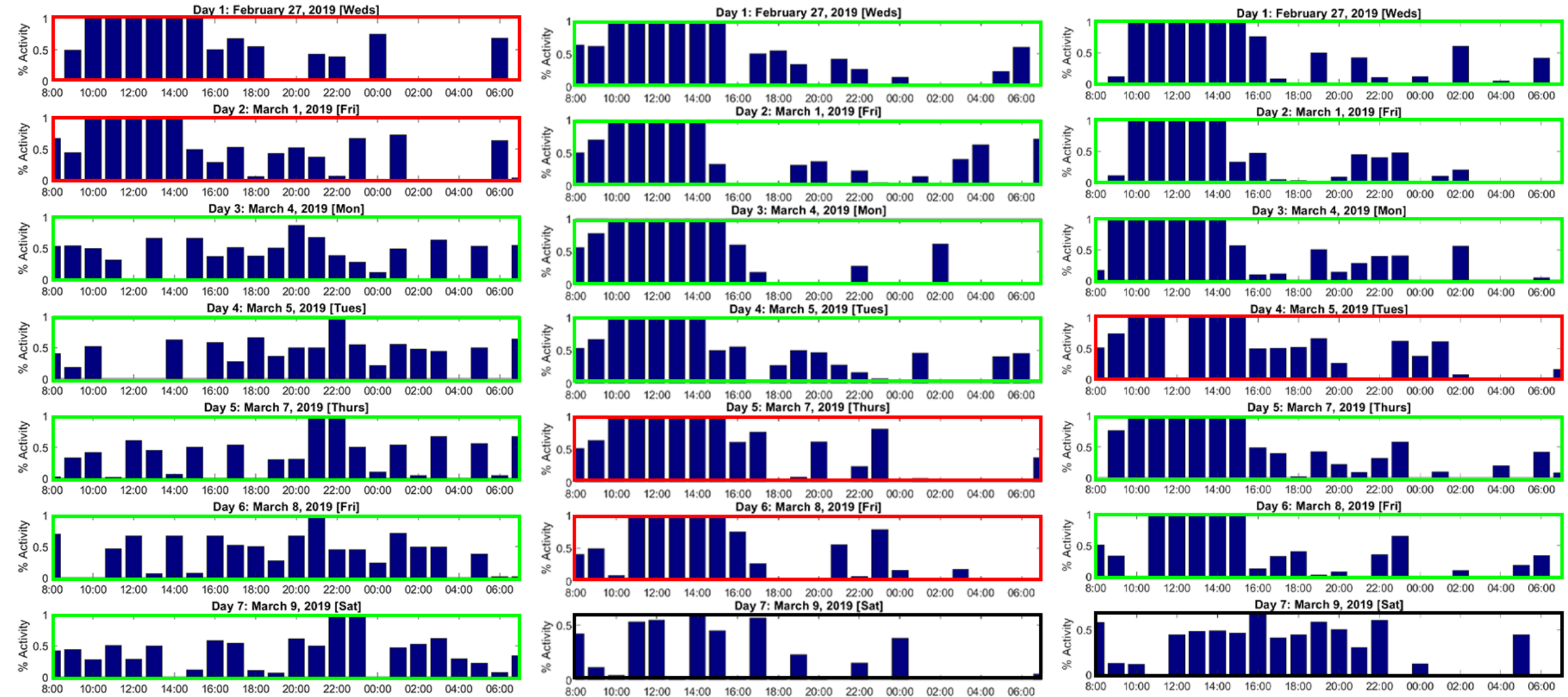
Ultrasonic noise is an issue for the Cruciform.



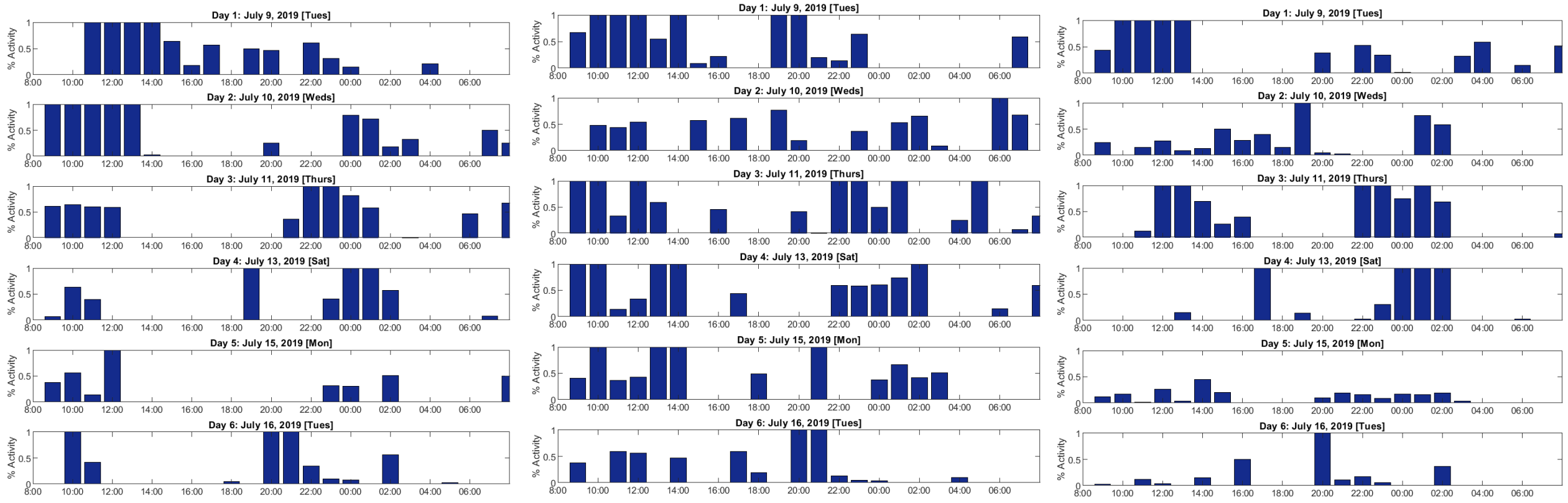
The variety of vibration inputs may make it difficult for the mice to adapt to the vibrations.



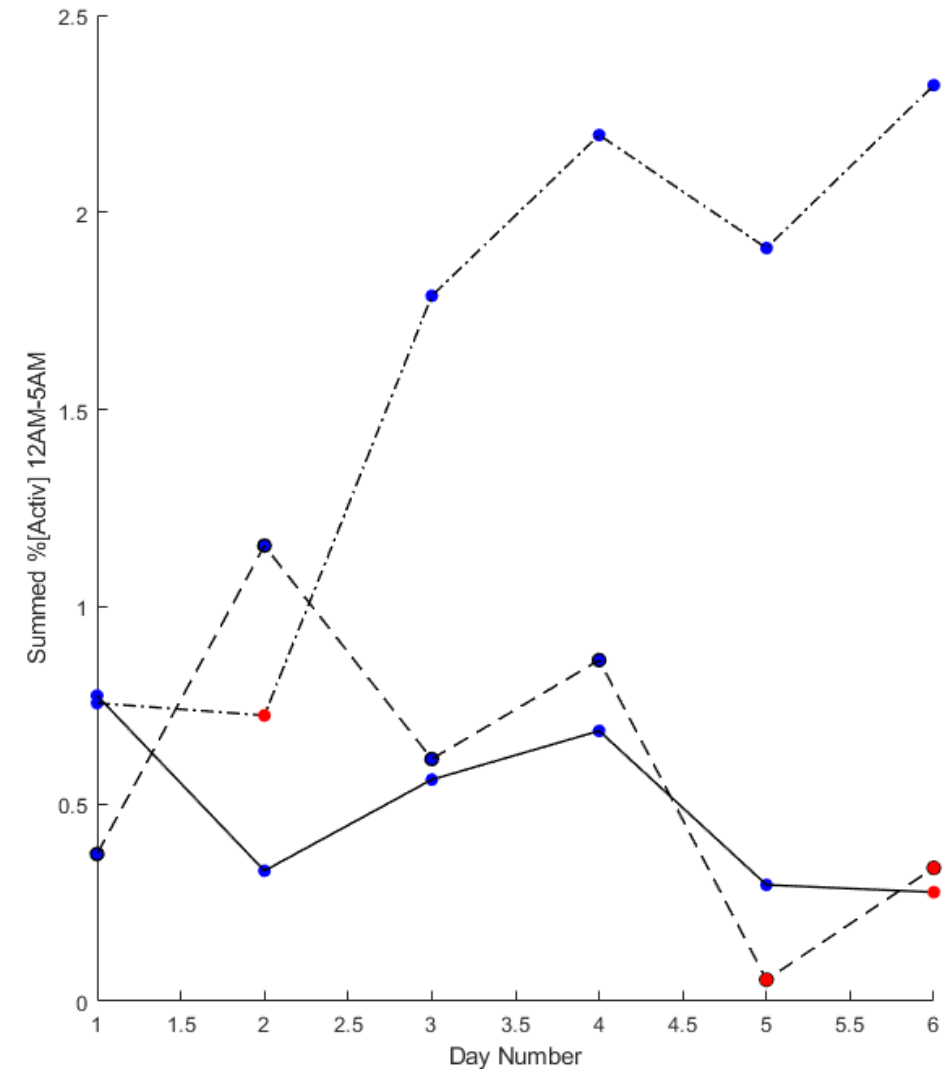
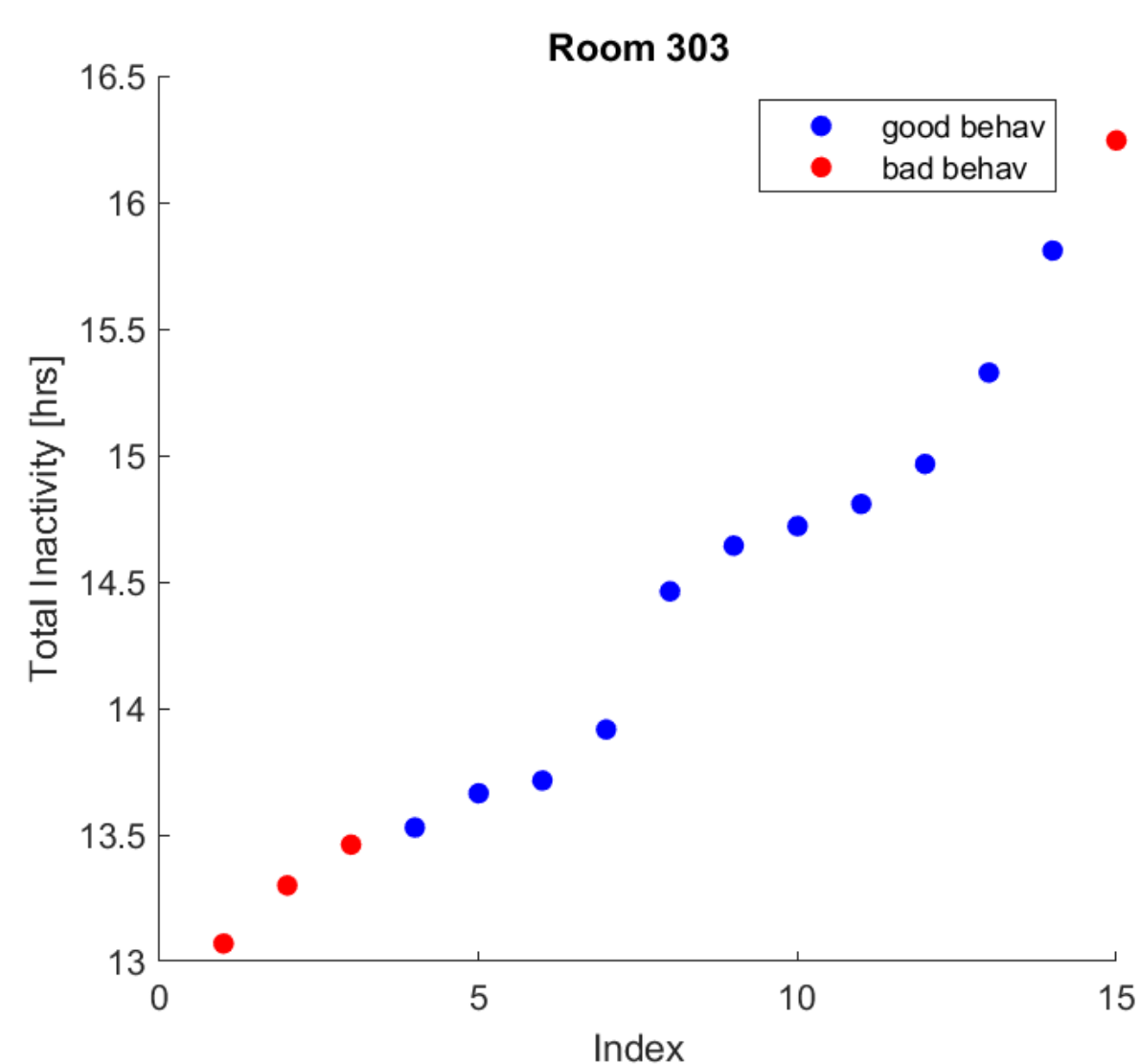
Sleep/Wake Cycle Activity in Room 303, Pre-



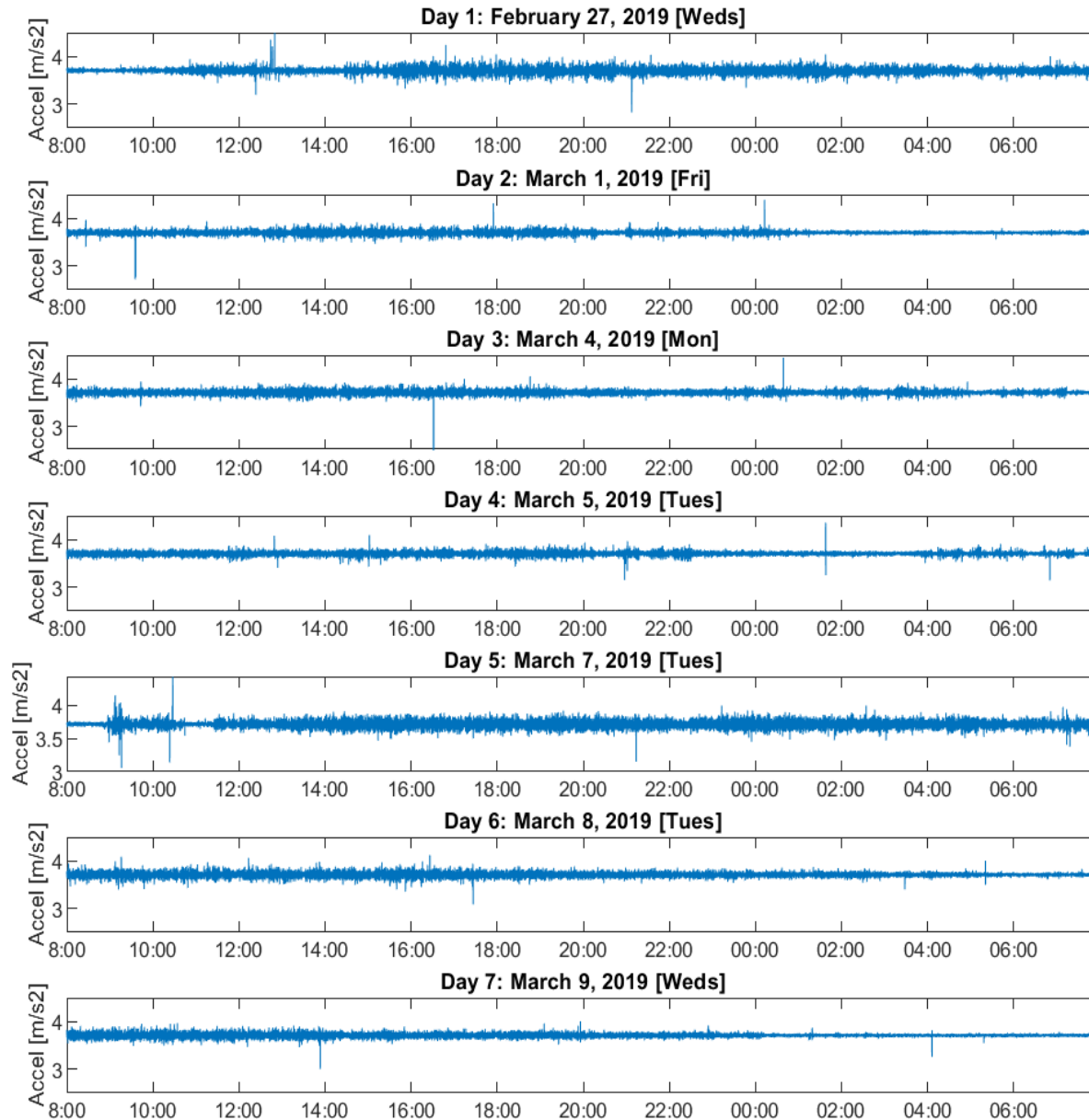
Sleep/Wake Cycle Activity in Room 303, Post-



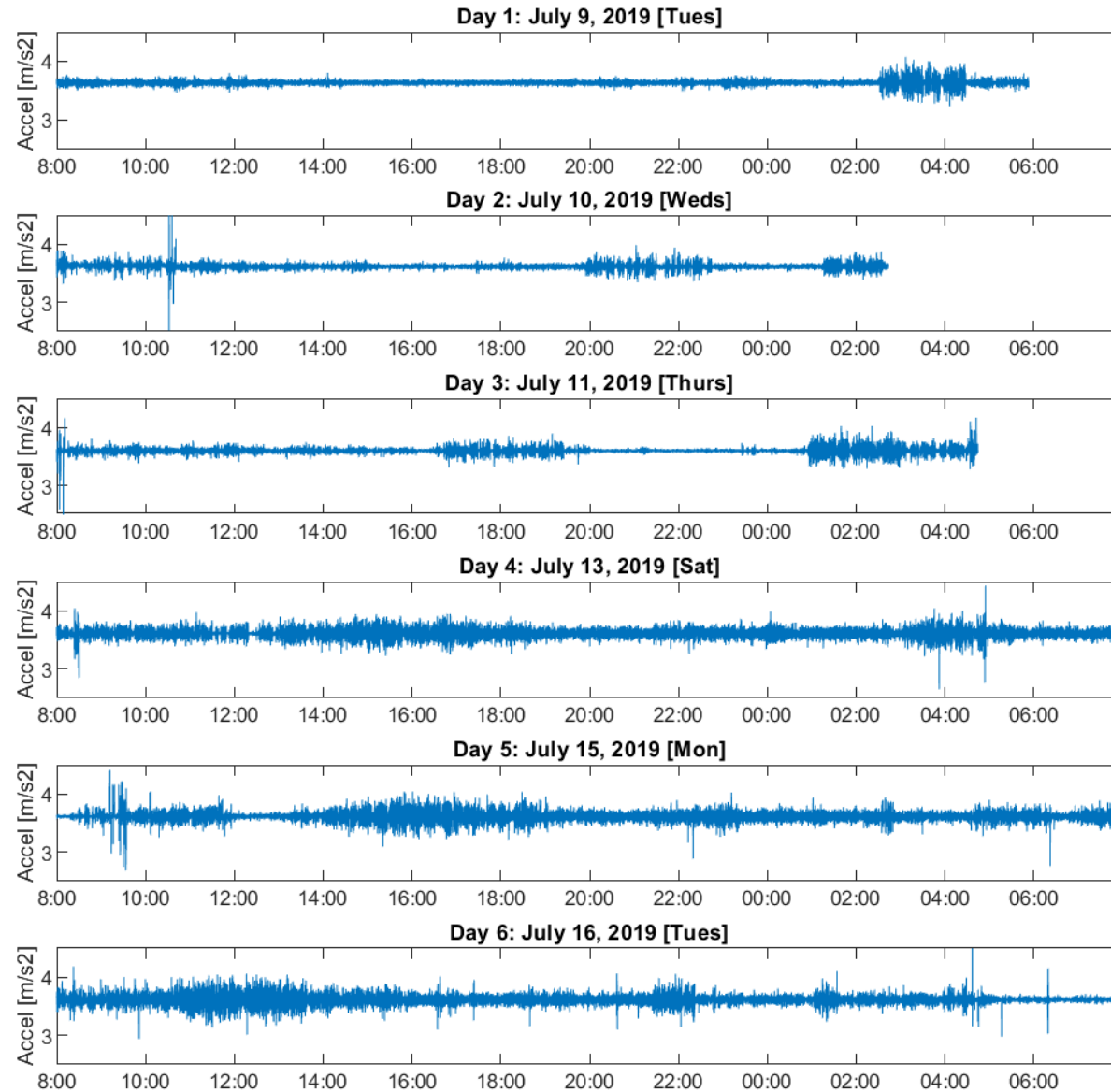
There is a correlation between mouse inactivity and behavior performance the next day.



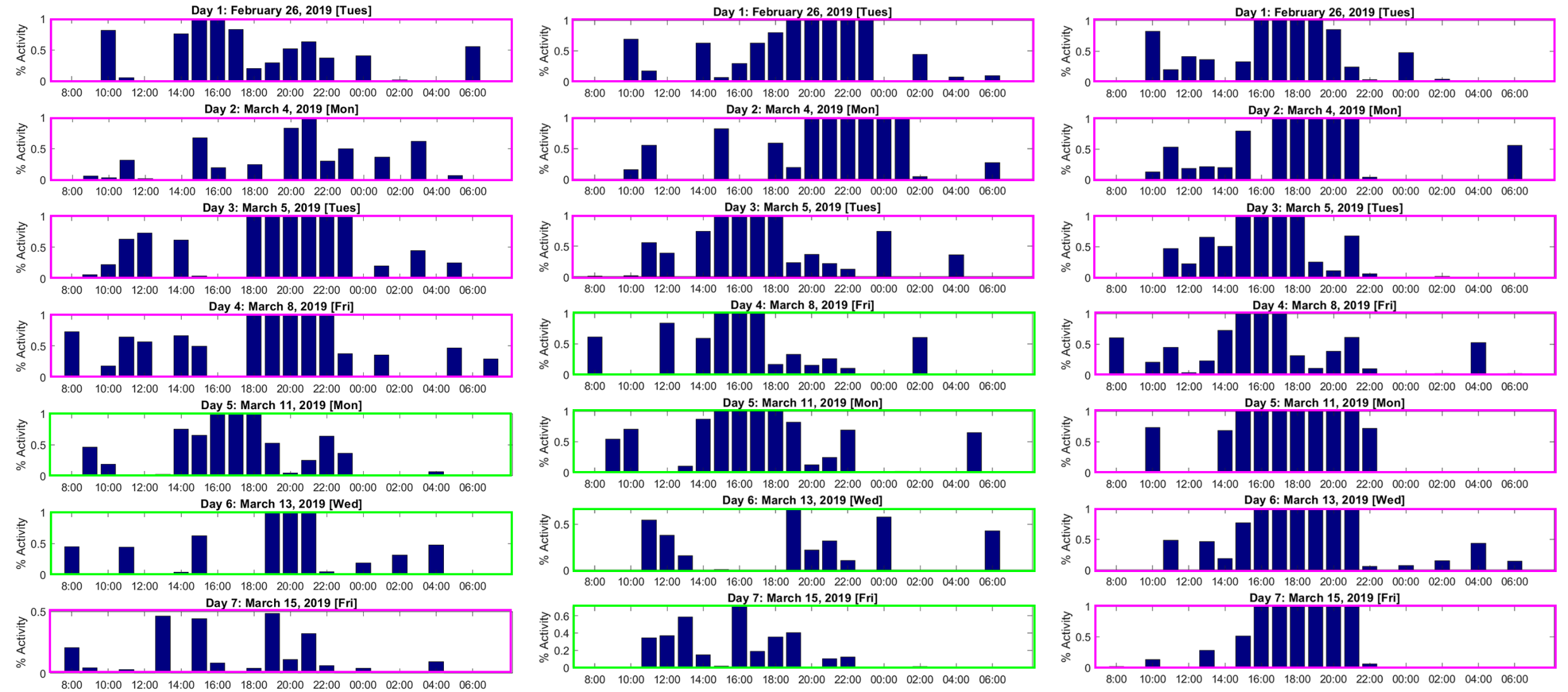
Vibration Analysis in Room 303, Pre-



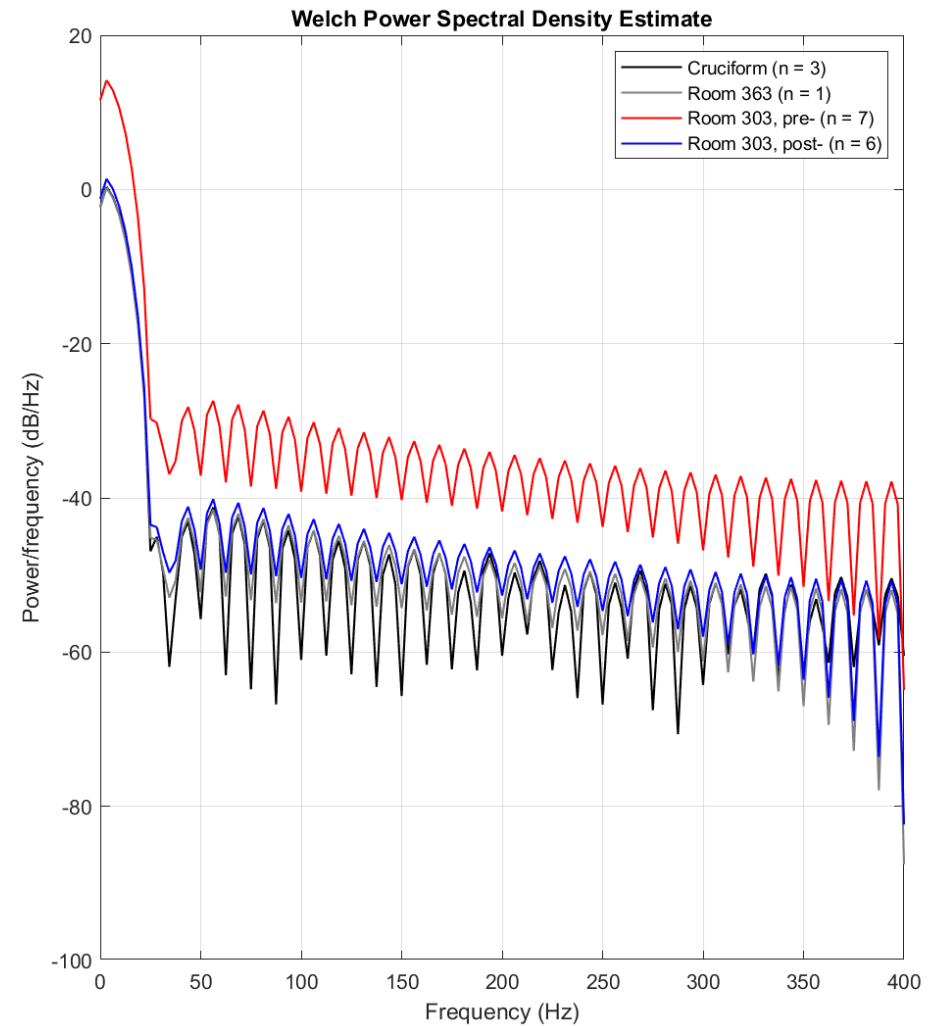
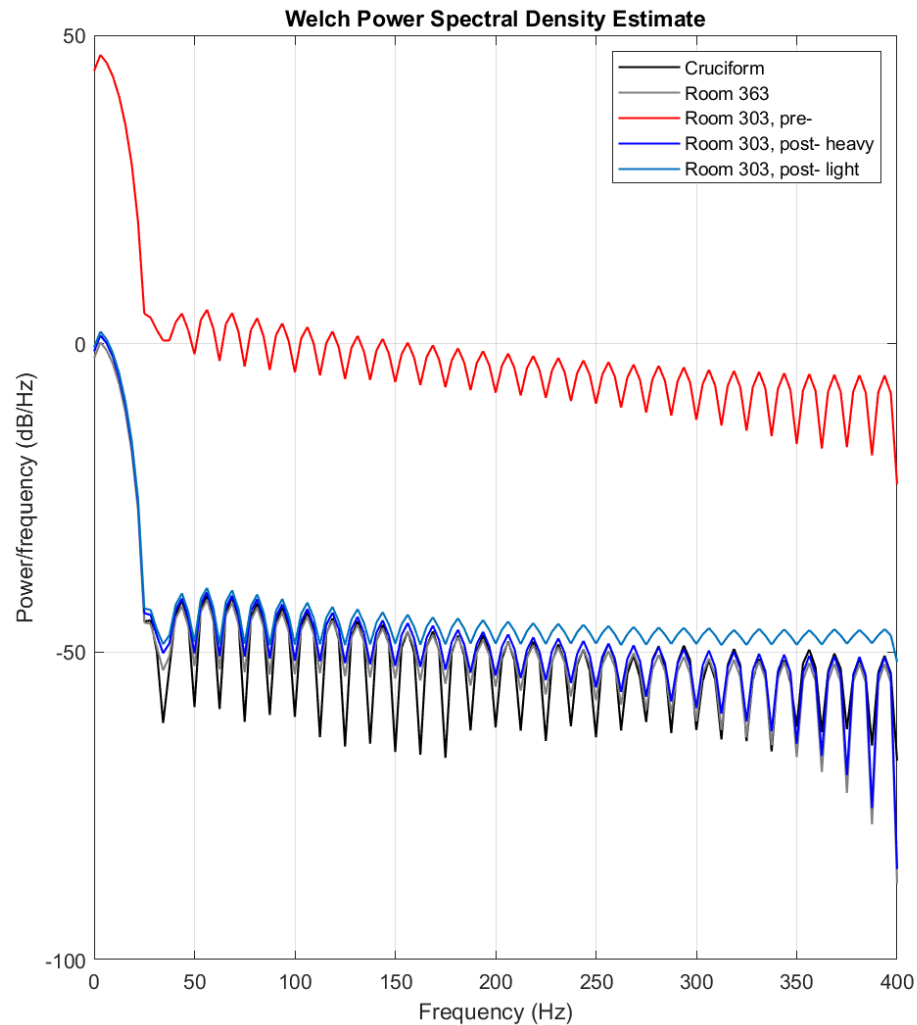
Vibration Analysis in Room 303, Post-



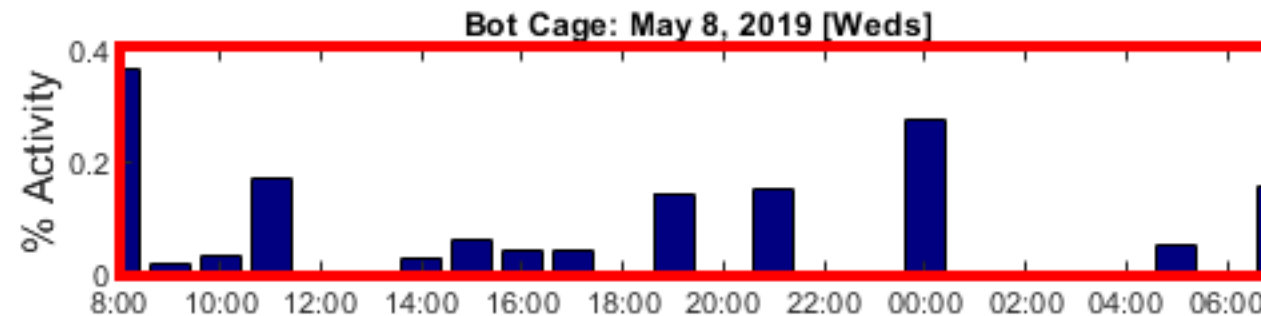
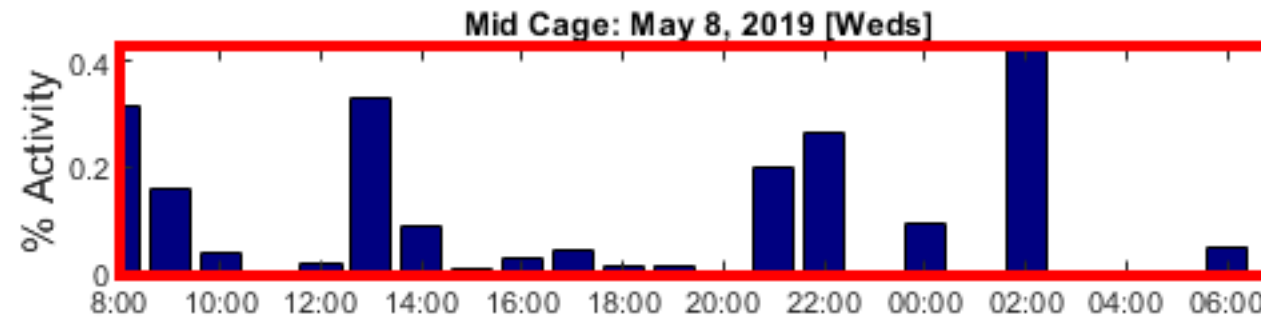
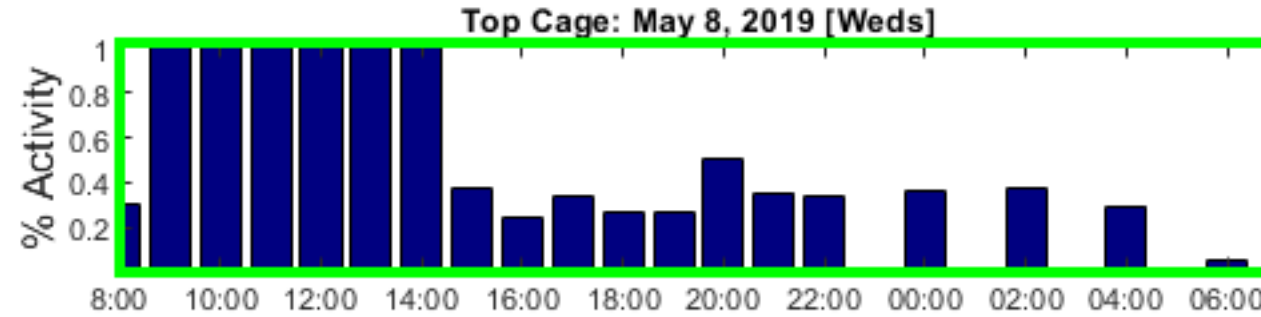
Sleep/Wake Cycle Activity in Room 363



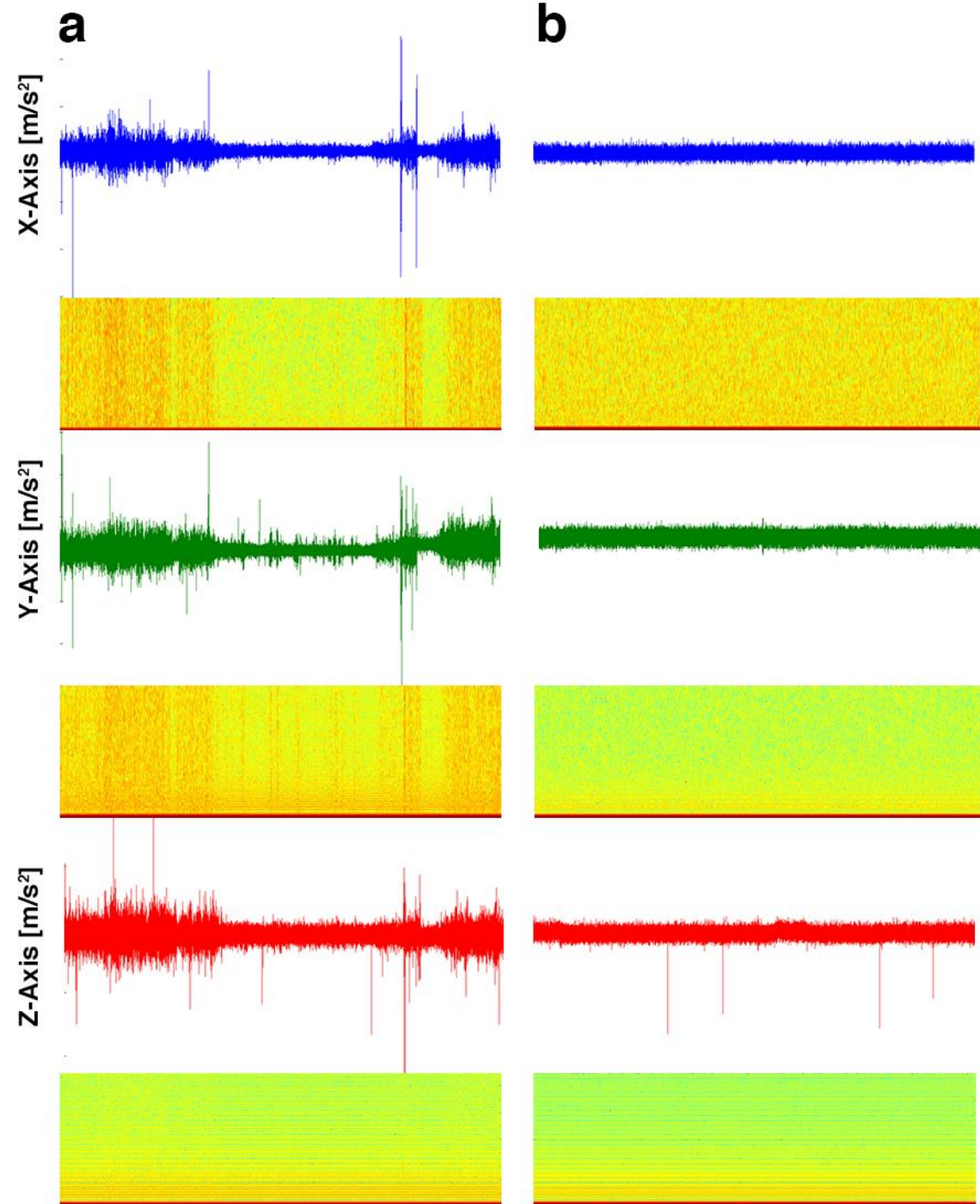
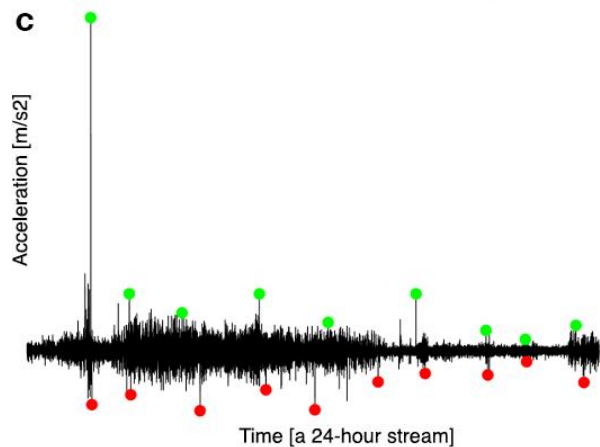
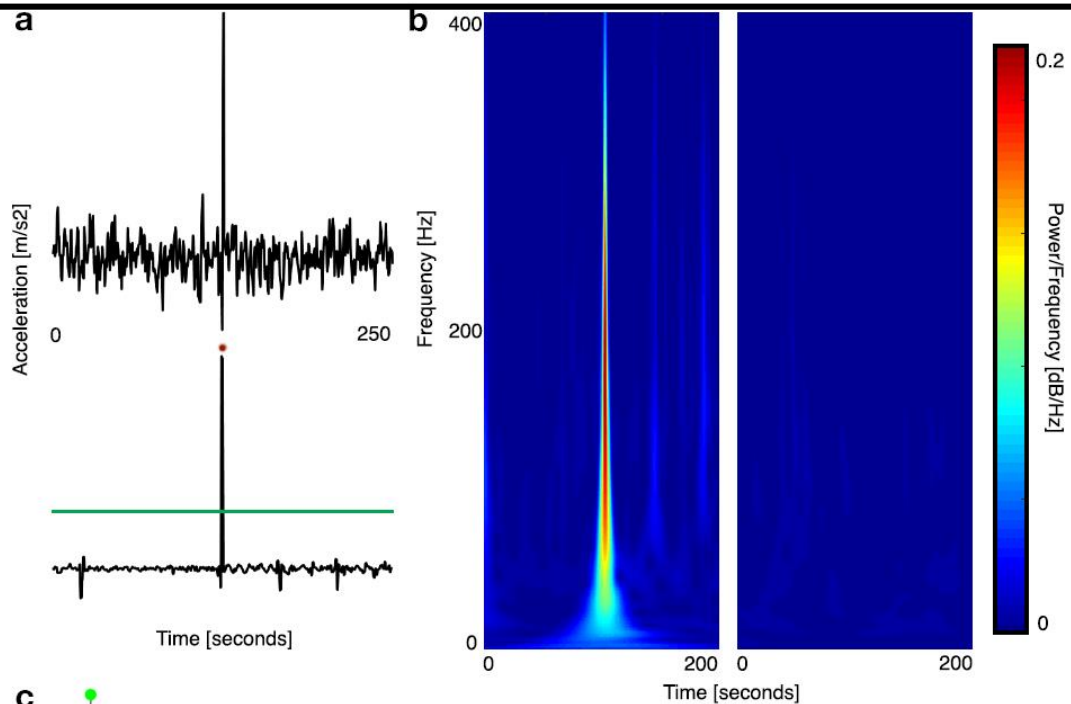
Pre- and Post- Vibration Analysis



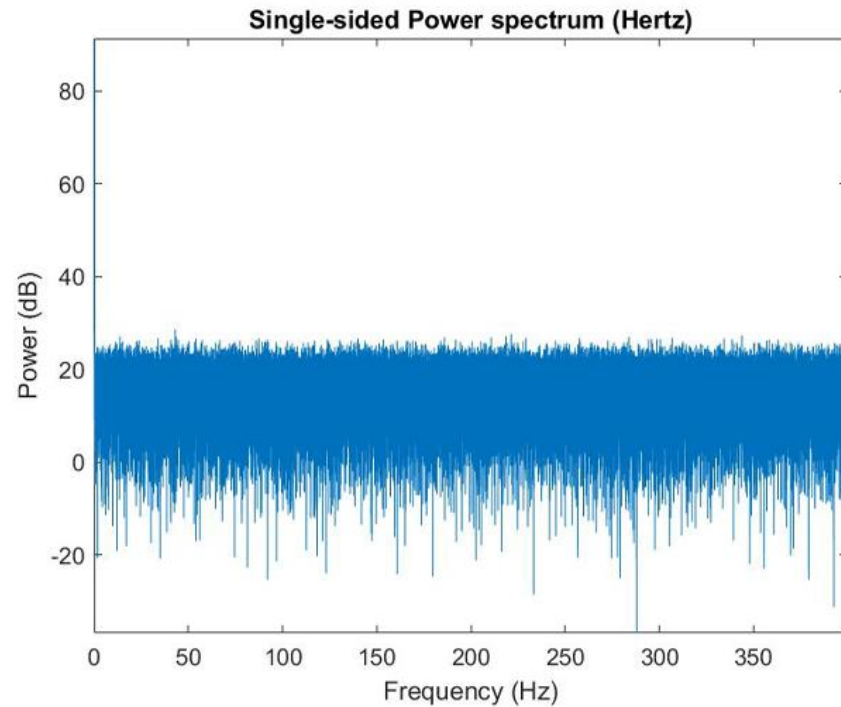
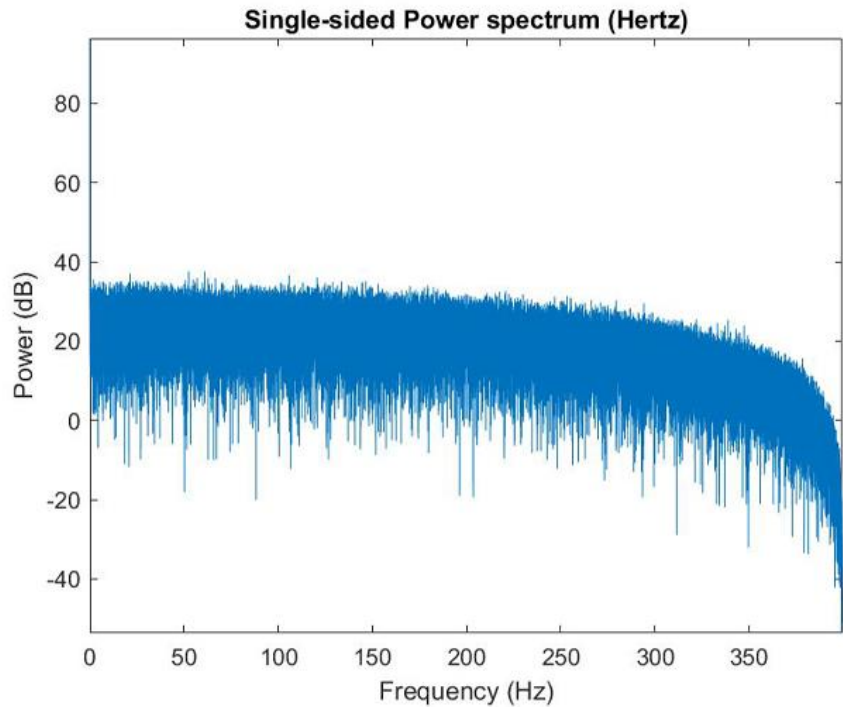
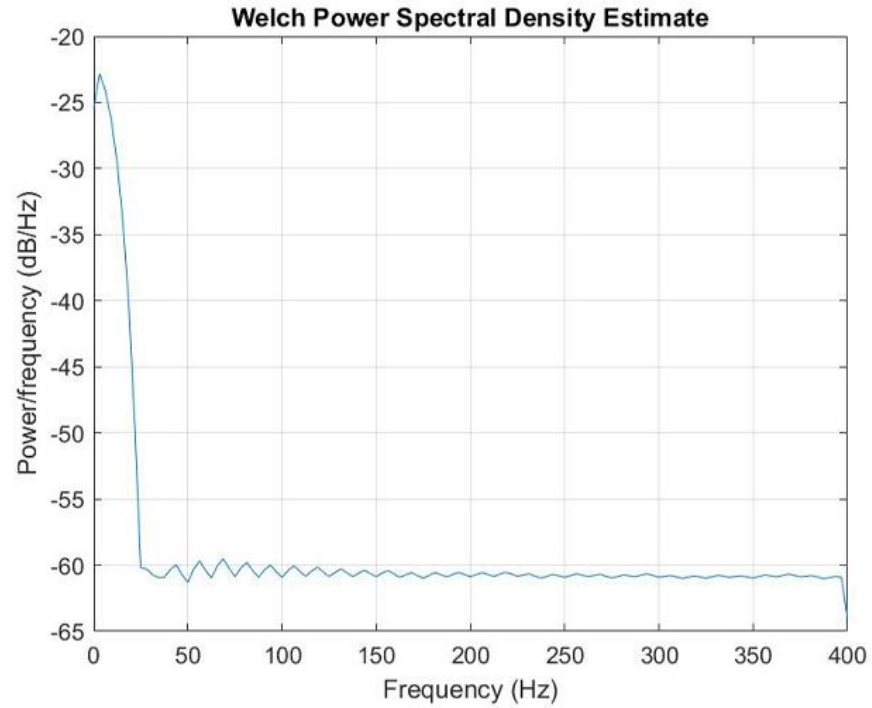
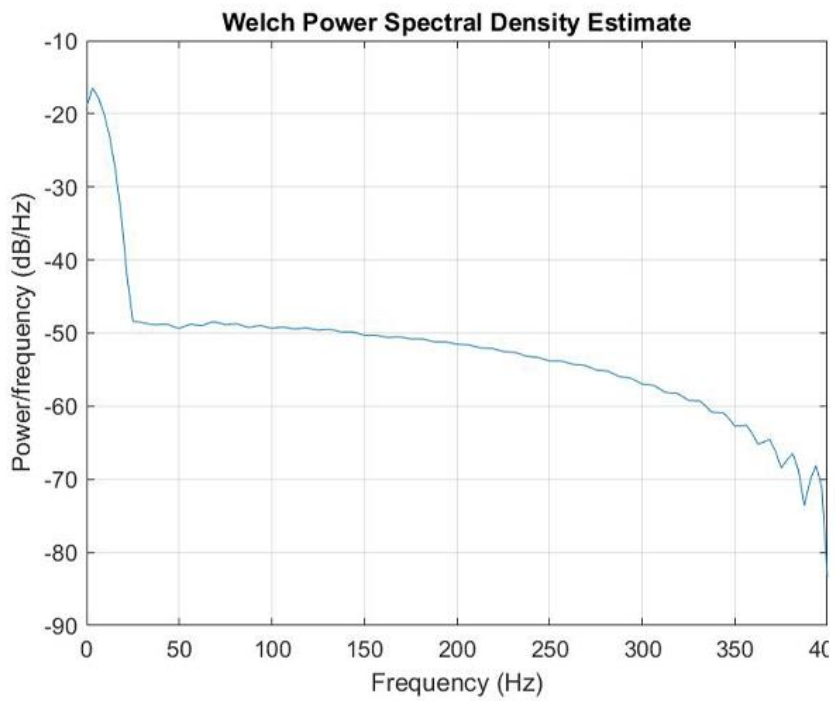
Increased Monitoring of Poor-Performing Mice



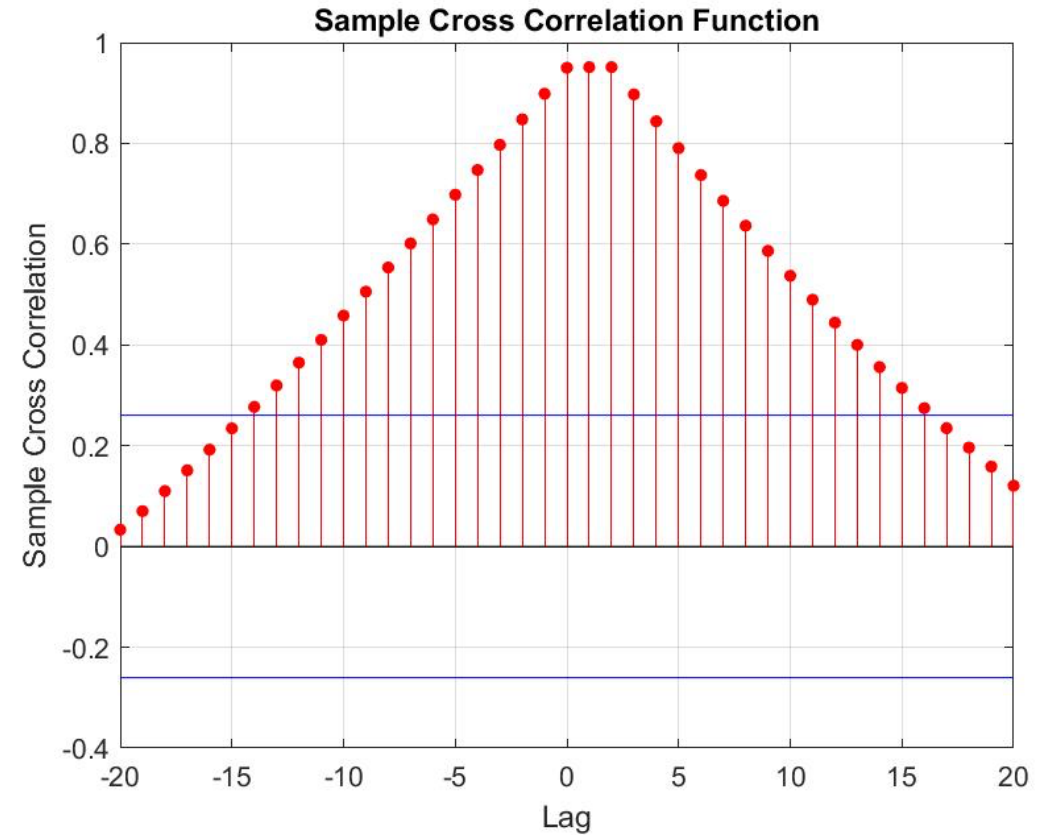
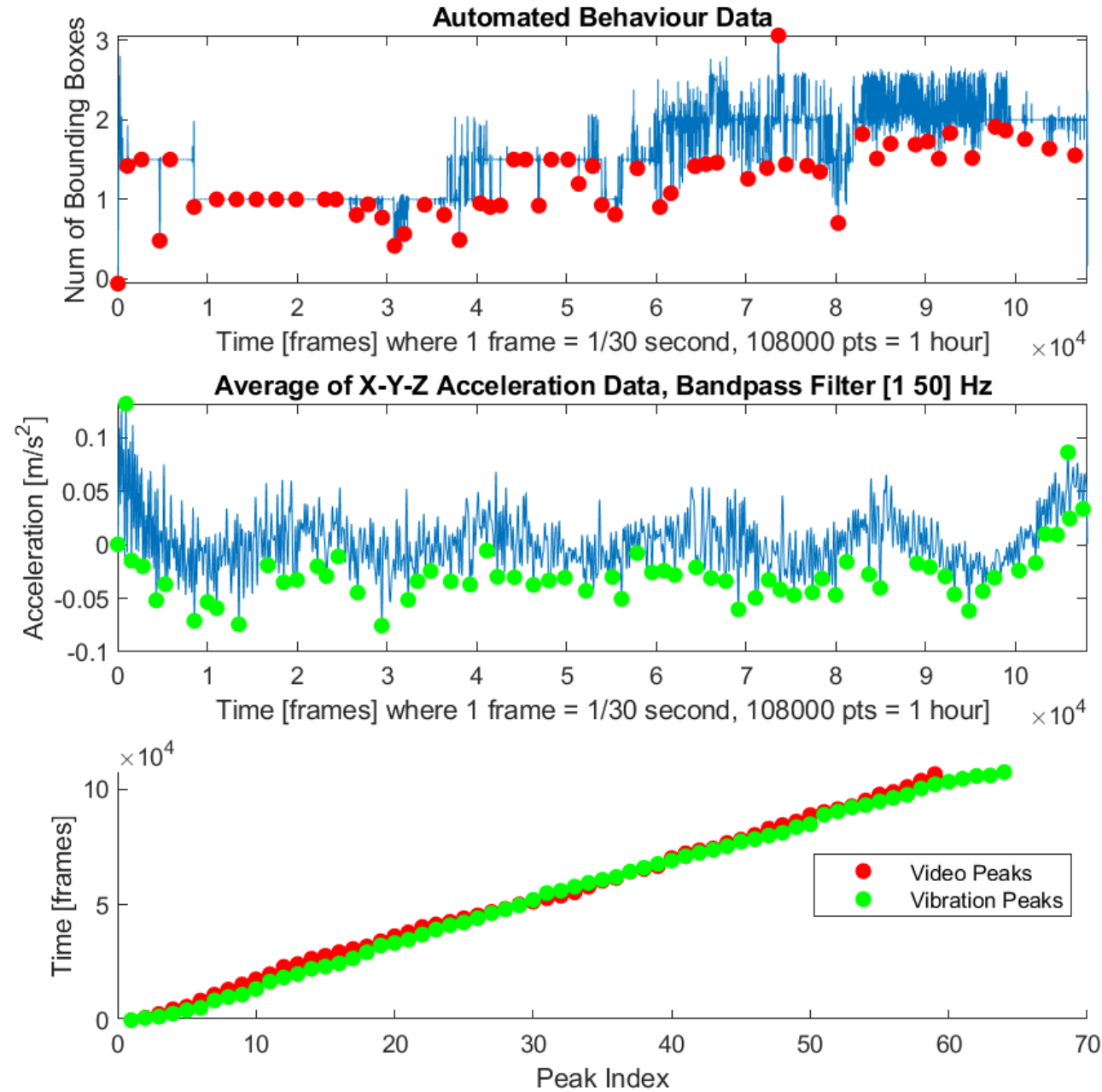
Preliminary Vibration Analysis



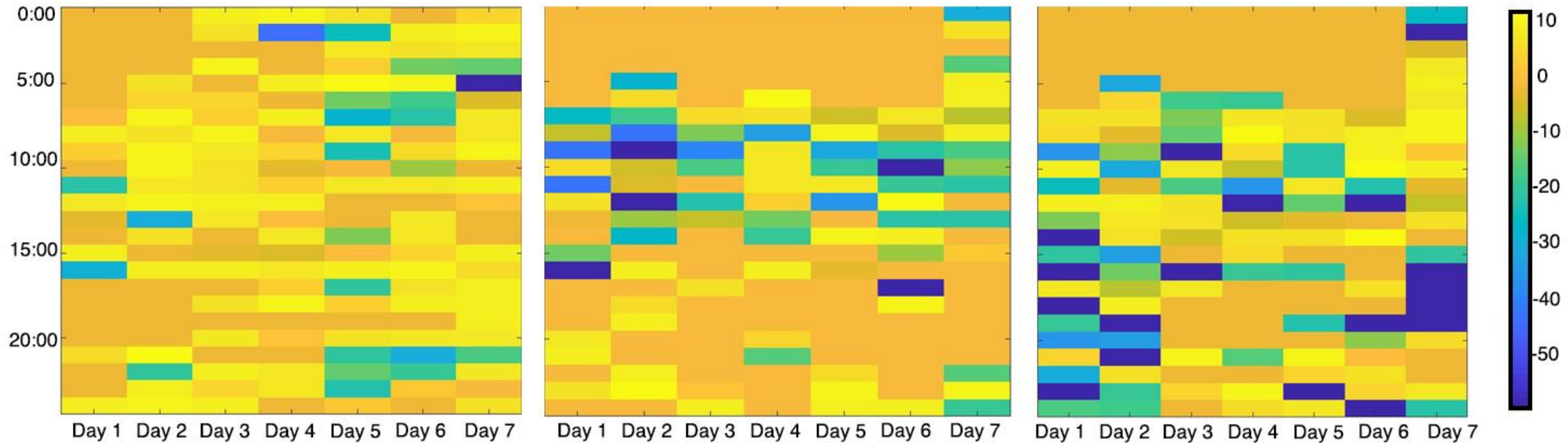
HariCari v Mrsic-Flogel



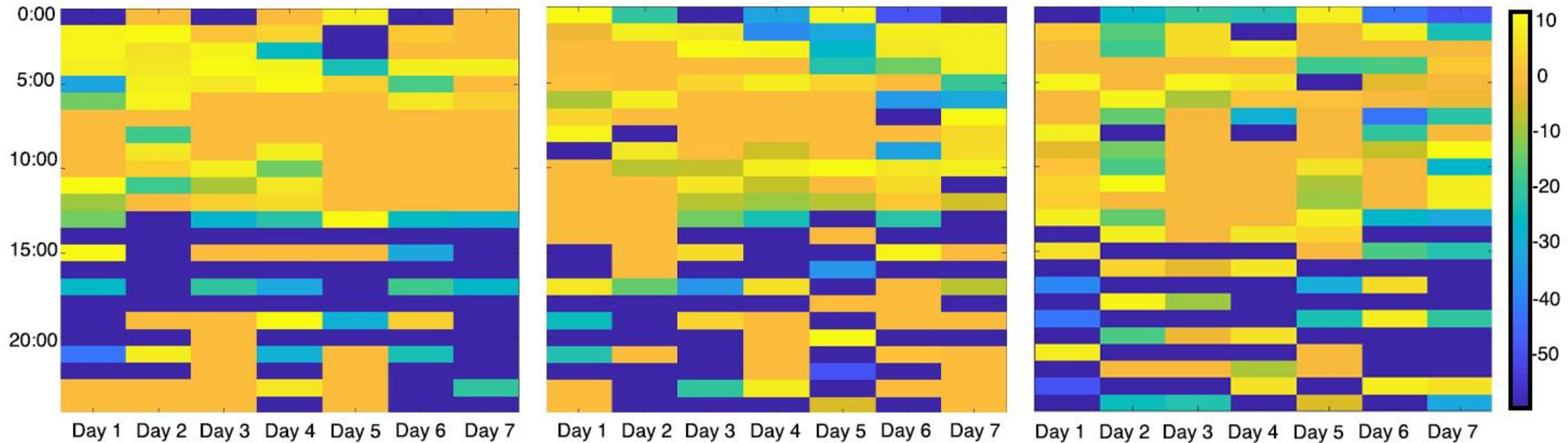
Peak Vibration v. Mouse Activity



Room 303 CCG Area in 3 cages



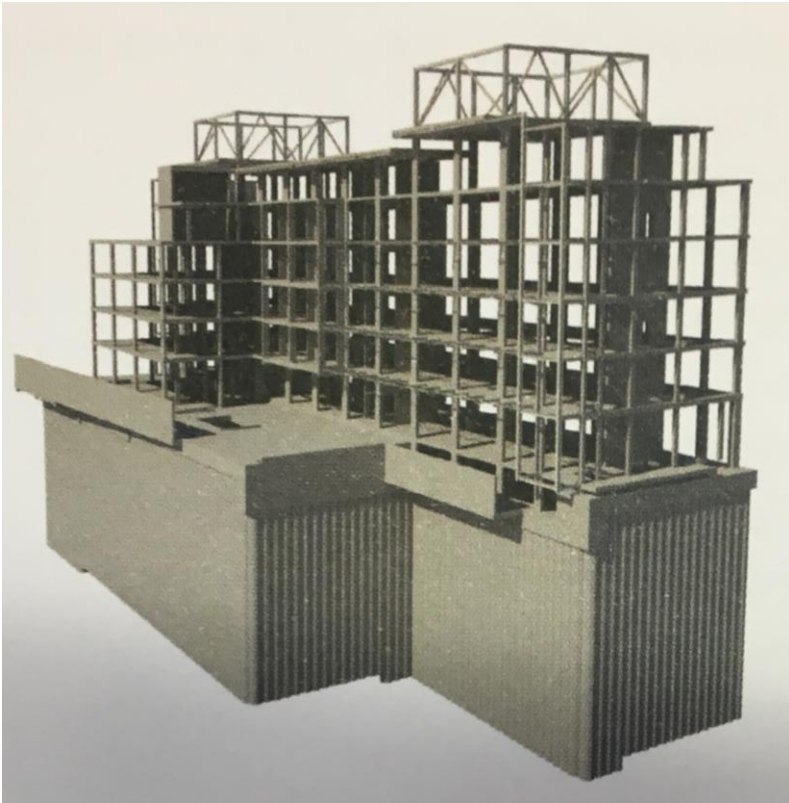
Room 363 CCG Area in 3 cages



The trend is taller, slimmer, and lighter structures, which are more vibration-prone.



The SWC used a light frame for cost over vibration considerations.



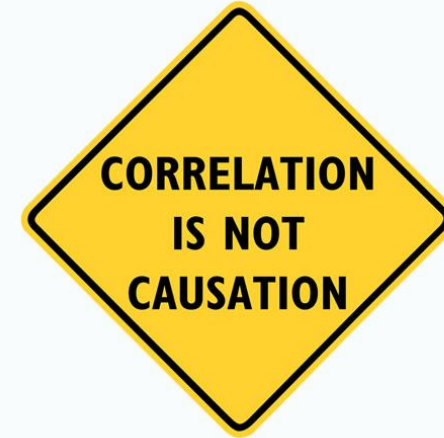
To limit vibration, concrete support columns are spaced relatively close together

- lecture theatre has two columns because directly above it is a lab
- air tables (£10,000) cost less than engineering the building
 - mutual decision to not put viscoelastic coupling dampeners in floors

Concrete Frame Structures

We predict that vibration is the cause of mouse stress.

1. Mouse inactivity is correlated with behavioural performance the following day.
2. The SWC (**3rd floor**) experiences a higher baseline level of vibration than an identical lab in the Cruciform.
3. There are no known issues in **B2** and **1st floor**.
4. The vibration peaks are correlated with perturbations in mouse activity.



Solution:

- Test if correlation is causation with an air table
- If this is the case:
 - anti-vibration padding
 - lubricant for mouse wheel

Thank You

*Thank you to all members
of the lab for discussion
and support*

Special thanks to:

- Matteo Carandini
- Kenneth Harris
- Michael Häusser

And, of course:

- Tom Mrsic-Flogel

