

Project Title: Rodent Sleep Deprivation Device

Team Members: Kyle Anderson, John Diaz de Leon, Peter Guerin, Rebecca Stoebe

Client: Rama Maganti

Advisor: Chris Brace

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Problem Statement: A research group intends to study the effects of sleep deprivation in pubertal and epileptic mice and how this affects learning and memory. To accomplish this research, a device is needed that can awaken mice as they are beginning to fall asleep. The device should be easily programmable by a user and should monitor the mice and deliver a non-painful stimulus to awaken the mice as well as allow arbitrary control of this function.

Function: This group intends to create a device that can monitor rat (??) and awaken rats without harming them. This device will ideally operate for (??) length of time etc..., and will also allow arbitrary control of this feature.

Client Requirements:

- Stable housing for 1 mouse that provides access to food and water, fits within a 20 by 35 cm area and is able to deliver a stimulus that will awaken the mouse.
- Intuitive user interface for programing speed, frequency, and duration of mouse stimulus.
- Feedback system that can monitor the mouse and deliver a stimulus if the mouse is falling asleep
- System must be able to operate continuously for up to three weeks and should be able to operate and store mouse data without being connected to a computer
- System must be able to be sterilized between uses and should be able to withstand 82 degrees Celsius

Design Requirements:

1) Physical and Operational Characteristics

- a. Performance Requirements:** Device will be used on a weekly or semi-weekly basis and will house one mouse at a time. The mouse will weigh, on average, 25-90 g and can escape through an aperture of 6 cm². The stimulus delivered by the device will occur several hundred to several thousand times over the course of the experiment (720 – 60,000).
- b. Safety:** All materials and systems used in contact with mouse will be subject to IACUC regulations. Additionally, it is vital to note

that any exposed electrical or chemical elements in the mouse housing are a safety hazard to the mice. Finally, since the device will be operating continuously for extended periods of time, careful consideration must be given to ensure that the device does not overheat.

- c. **Accuracy and Reliability:** Mice should not be able to sleep at all during the course of the experiment (ideally the device should promote 100% sleep prevention). In practice the device will prevent sleep at least 97% of the time and will be able to do so over a period of up to 3 weeks.
- d. **Life in Service:** Experiments using the device range from 6 hours to 3 weeks in length. Therefore the device should be able to deliver up to 60,000 stimuli over the course of one experiment (1 stimulus every 30 seconds for 21 days). Additionally, the product should be able to be used for at least 2 years.
- e. **Shelf Life:** While storage of this device will occur in normal environmental conditions, materials and circuit components will be chosen such that no component of the device will degrade within the 2 year minimum life of the product.
- f. **Operating Environment:** Corroding could result from mouse bodily fluids, and materials will be selected such that this does not occur.
- g. **Ergonomics:** Any stimulus used should not cause lasting physiological or psychological damage to the mouse. Additionally, mouse housing must provide reasonable space for mouse bedding and general habitability in accordance with IACUC regulations.
- h. **Size:** Housing must be able to fit in pre-existing 20 by 35 cm mouse cage.
- i. **Weight:** Must be able to be carried easily by researcher (<4.5 kg) but must also not be able to be lifted by mouse to allow escape (>0.45 kg)
- j. **Materials:** As stated previously, any materials used must follow IACUC guidelines. Additionally, materials should be able to withstand 82 degrees Celsius for 15-20 minutes. Finally, materials should not be able to be chewed through or degraded by mouse action.
- k. **Aesthetics:** Mouse cage should be transparent.

2) Production Characteristics

- a. **Quantity:** 8
- b. **Target Product Cost:** \$1000 for 8 mice sleep deprivation devices plus software and circuitry

3) Miscellaneous

- a. **Animal Restrictions:** All materials used, sleep deprivation mechanisms, and cage conditions are subject to IACUC regulation because of the involvement of live mouse specimens.
- b. **Client Specific Information:** Mice can sleep for as little as 30-90 seconds at a time. Even this much sleep is unacceptable. Therefore, the device must either be extremely precise in monitoring the mice or must be able to deliver a stimulus every 30 seconds for the duration of the experiment.
- c. **Sterilization:** Materials will be sterilized between use and should be able to be autoclaved (withstand 82 degrees Celsius for 15-20 minutes)
- d. **Competition:** Many rodent sleep deprivation devices are currently available in market. Examples of these can be found below. The aim of this project is to create a cage coupled with a software that is more widely applicable (is not product specific) and less expensive than current devices.

Appendix I: Links to current devices and IACUC guidelines:

Current Devices:

https://www.lafayetteneuroscience.com/product_list.asp?catid=120

www.limef.com/downloads/sleepscience_2009.pdf

www.limef.com/downloads/FV_2008.pdf

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2982737/>

www.sciencedirect.com.exproxy.library.wisc.edu/science/article/pii/S0165027011000409

www.pinaclet.com/sleep-deprivation.html

IACUC Documents and Guidelines page:

<http://www.iacuc.org/usa.htm>

Appendix II: Flow diagram of system process:

