Preliminary Presentation: Pain-Informative Mouse Activity Wheel

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Background:

Musculoskeletal Research Requires Data on Pain Experienced by Mice

Musculoskeletal diseases are often sources of great pain to humans, but utilizing mice to model such disease states poses an issue since they cannot report the extent to which they experience pain.

With limited information on a condition’s impact on the lab mouse, it is often difficult to measure the comparability of the disease state in the mouse model, to the disease state in humans and to measure the effectiveness of possible solutions.

Background: Pain Assays

It may be impossible to report the pain an animal feels due to a disease such as intervertebral disc degeneration, but there are measurable behaviors that are believed to be correlated with pain experience.

Nature Methods 7 447-449 2010 (Langford)

The Mouse Grimace Scale is an example of a behavioral pain assay used to measure chronic pain that relies on operator interpretation of facial expressions in mice.

Our Client

Dr. Simon Tang

Lab focuses on the the overall theme of understanding the biological regulation of skeletal matrix quality. Using engineering and biology this lab aims to:

(1) understand the effect of disease mechanisms on the structure-function relationships of skeletal tissues

(2) develope translatable therapeutic and regenerative strategies for these diseases.

Need Statement

Researchers investigating pain in mouse models are in need of an activity wheel that automatically collects better pain-informative voluntary activity data inside of existing mouse cages.

Project Scope

We propose a way of incorporating more pain-informative features into the general mouse activity wheel so that researchers can get improved in-cage mouse activity data that better assesses the pain experienced by the animal.

Goals:

- Deliver a mouse activity wheel prototype that fits into laboratory mouse cages
- Automatically collects movement data based on the rotation of the wheel
- Cheaper than $150,
- Has at least one additional pain-informative feature

Initial Design Specifications

- Fit: Fit in the conventional mouse cage as small as LxWxH 14 7/16 x 8 ⅛ x 5 ½ in.
- Autoclavable: Fewer than 5 parts which can be disassembled and autoclaved separately
- Inexpensive: Less than $150
- Non-disruptive (does not disturb animal's normal living conditions): No odor, no lights, little sound, takes up no more than ⅓ of the animal's normal living space
- Simple Data Collection: Automatically stores CSV formatted data with less than 5 minutes needed for operator setup between trials
- Versatile: >1 pain-informative feature besides rotation data
- Durable: biting of exposed parts poses no risk to animal or to functionality of the system (stainless steel, polycarbonate materials)
- Data length: Able to collect data in intervals of at least 2 hours

Existing Solutions:

Mouse Activity Wheels

LE905 activity wheel for mice

The Rodent Activity Wheel by Harvard Apparatus

Monitor activity level of mice by recording data based on the rotation of a running wheel.

Typically measures:

- Speed
- Duration
- Distance Travelled

Next steps

Assignment 1

Creation and development of an interactive and informative, web-based project

Assignment 2

Draft of a dimensional schematic depicting specific measurements and scales in order to ensure accurate calculations.

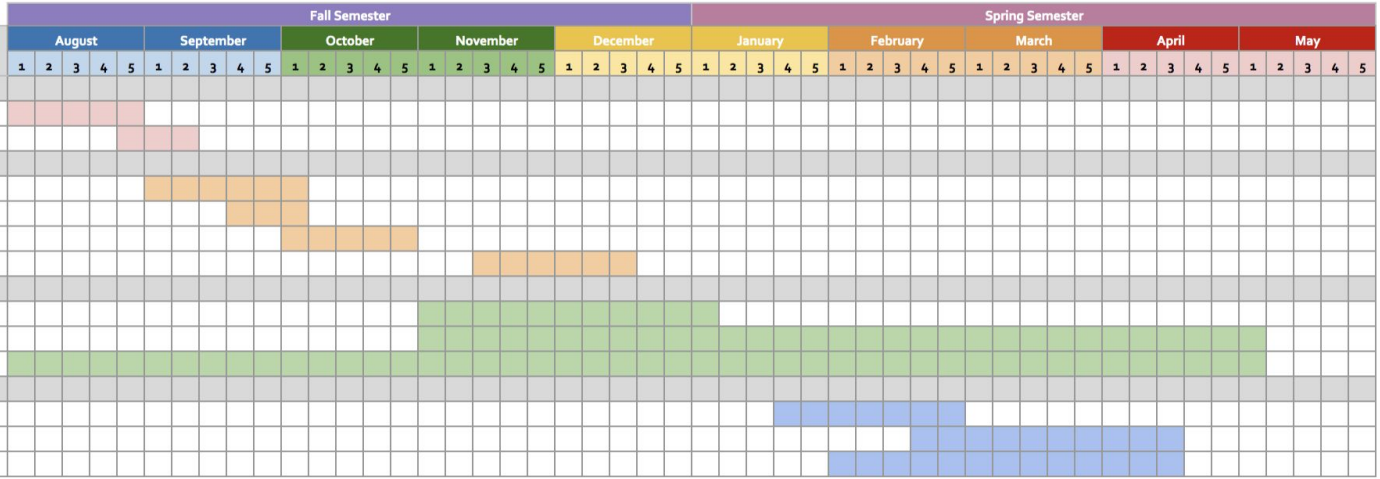
Assignment 3

Design and production of a prototyped mouse functionality wheel with real-time, automated data collection

Preliminary Design Schedule

PROJECT TITLE	Pain Informative Mouse Acitvity Wheel	Group	7
Team	Olivia Martin, Kiran Bora, Donny Aboytes	Date	10/4/2019

TASK TITLE	DUE DATE
Project Conception and Initiation	
Client Search	Summer
Project Idea	Summer
Project Definition and Planning	
Needs Statement and Project Scope	9/16/19
Preliminary Report	10/4/2019
Web Page Design	10/21/2019
Budget and Justification	12/6/2019
Project Launch and Execution	
Prelimnary Design	
Website Updates	weekly
Weekly Project Updates	weekly
Project Performance / Monitoring	
Verification and Validation	2/28/2020
Final Protoype Demo and Results	4/17/2020
Safety Analysis	4/20/2020



Preliminary Design Schedule

Team

Donald Aboytes:

- Maintain consistent contact and good communication with our client, Dr. Simon Tang
- Programming

Kiran Bora:

- Spearhead the electrical work of the activity wheel
- Budget

Olivia Martin:

- Ensure that the project is moving along according to schedule
- Mechanical work

Thank you

References:

1) Langford, Dale & Bailey, Andrea & Chanda, Mona Lisa & Clarke, Sarah & Drummond, Tanya & Echols, Stephanie & Glick, Sarah & Ingrao, Joelle & Klassen-Ross, Tammy & LaCroix-Fralish, Michael & Matsumiya, Lynn & Sorge, Robert & Sotocinal, Susana & Tabaka, John & Wong, David & Maagdenberg, Arn & Ferrari, Michel & Craig, Kenneth & Mogil, Jeffrey. (2010). Coding of facial expressions of pain in the laboratory mouse. Nature methods. 7. 447-9. 10.1038/nmeth.1455.