Designing and Constructing a Rat Sociability Chamber

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Abstract

Traumatic brain injury (TBI) affects the lives of 1.7 million Americans every year, and can result in permanent disability [1]. Patients with TBI often experience sociability problems such as communication difficulties, disinterest, disrespect, substance abuse, egocentric thinking with loss of social sensitivity, or lack of empathy. TBI Patients may shy away from conversation, have difficulty paying attention and blocking out extraneous stimuli, be easily fatigued, and experience depression or suicidal thoughts.Our product, the rat sociability chamber, was created for researchers at the NJIT Center for Injury Biomechanics, Materials, and Medicine, for use in research on the effects of different types of traumatic brain injury (TBI), and TBI therapies, on social behavior, empathy, and social recognition memory using rats as models. The customers for this product include biomedical researchers from universities and labs across the world.

The rat sociability chamber is a three chambered apparatus capable of tracking rat position and time spent in each chamber using Anymaze position tracking technology. This chamber facilitates various sociability tests, which are quantitative measures of rat social behavior. For example, the “Social Recognition Memory Test” involves trapping a littermate and an unfamiliar rat in each of the side chambers, and measuring how much time the subject rat spends in either chamber. Similar sociability chamber are available for mice; but our product differentiates itself from competitors because it is built for larger, 10 week old Sprague Dawley rats. In addition, our product incorporates unique features such as removable inner walls and a rolling base for position changes.

The 2’x2’x6’ chamber was built from transparent polycarbonate sheets over the course of two semesters (September 2016 - May 2017). A GoPro camera and adjustable, movable camera stand made from zinc bars was used in conjunction with AnyMaze rat position tracking software, followed by a unique MATLAB program, was used to calculate how much time the subject rat spent in either chamber. This project was successful and will be used in TBI research using rat models.

Customer Needs

There were 5 main customer needs for this project:

- Basic layout must include 3 chambers, transparent walls, floor that provides sufficient contrast, and wire cages
- Chamber that can be easily changed to apply to other tests, using removable inner walls
- Have the ability to record rats as they enter and exit a chamber, either in the form of pre-recorded videos or real-time
- Record the (x,y) position of rats over time; determine entry into sociability zone
- Ensure chamber and video camera mount stability

Design Concept

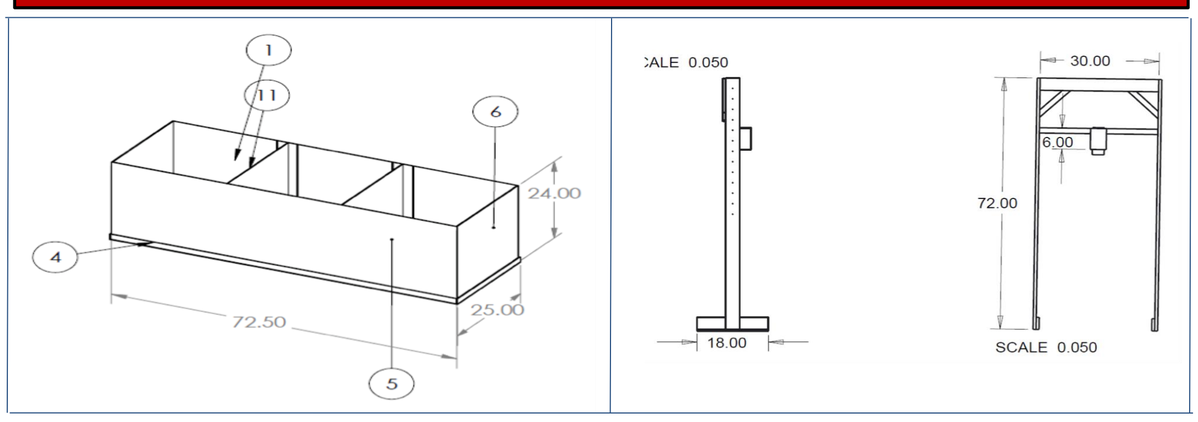
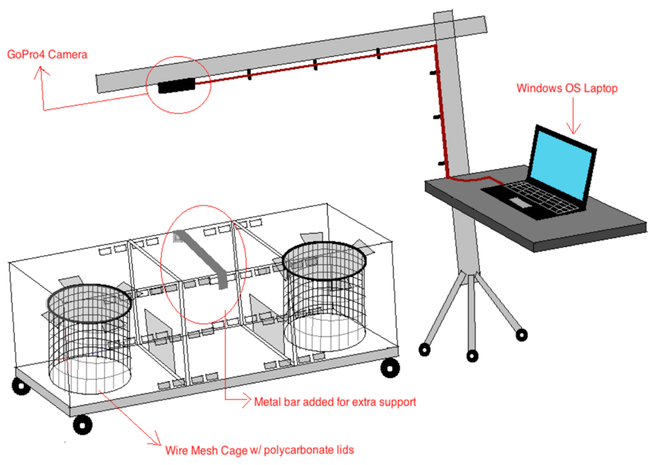


Fig 1. The CAD drawings of the original chamber. LEFT: We planned to use 0.25” thick sheets of Lexan Polycarbonate to construct the chamber. We envisioned a 6’ x 2’ x 2’ chamber with three enclosures that could be adjusted by changing the position of the two inner walls. We planned to place wire cages for the rats in the two outer enclosures and create doors that the rats could pass through on each of the two inner walls. RIGHT: We wanted to construct a video camera stand that would be placed above the chamber to provide an aerial view of the chamber with moving rats inside. We intended for the camera mount, the bar on which the camera would hang, to be adjustable, so that it could placed at different heights to get different views of the chamber.

Fig 2. The proposed complete set-up of the chamber. The chamber features two wire mesh cages in the two outer enclosures, two dividers with insertable doors, and an added metal bar for support. Overlying the chamber is a video camera stand with an attached GoPro camera that records video footage of the rats moving through the chamber. The GoPro camera can be placed at different lengths across the horizontal metal bar, or the height of that metal bar can be adjusted as well. It was originally envisioned that the GoPro camera would take real-time videos of the chamber and that the videos could be displayed on the connected Windows OS laptop, which is shown on the video camera platform.



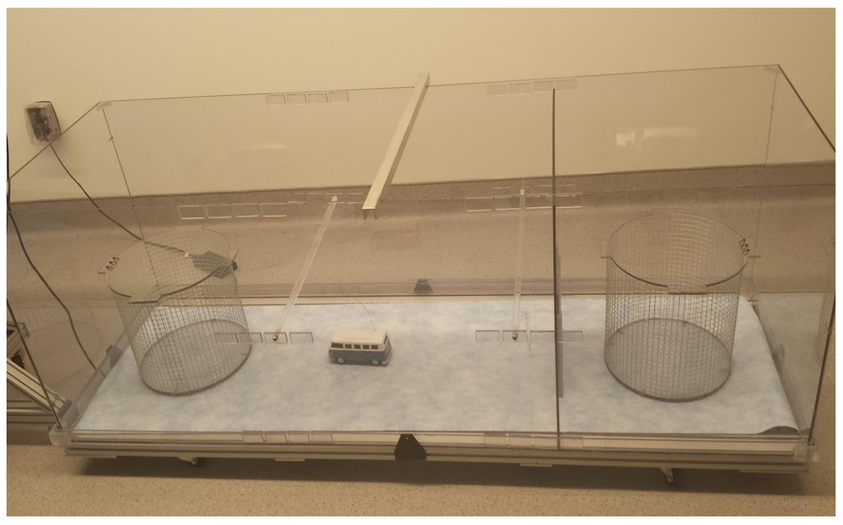


Fig 3. This is the 6’x2’x2’ chamber. The two wire cages are present in opposite ends of the chamber, with thin walls creating the 3 chambers. Looking more closely the stoppers can be seen along the longer walls. In order to provide support to the long and flexible walls, the two clear bars and metal rod was added.

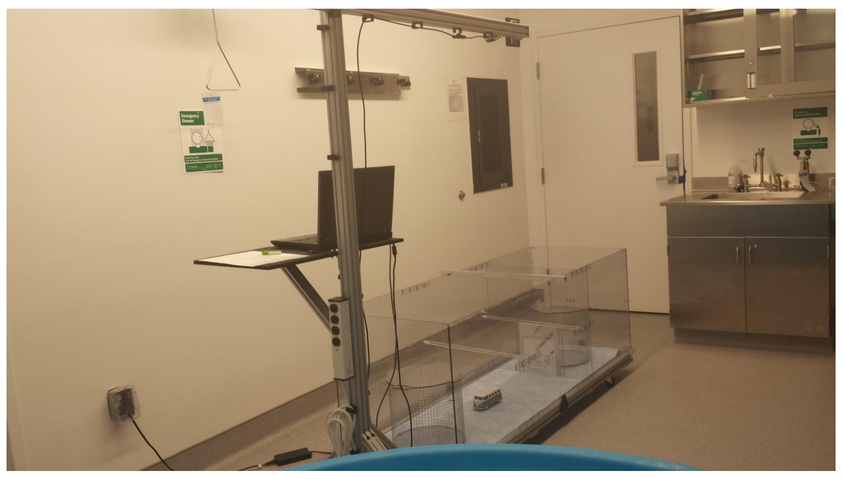


Fig 4. This is the full image of our system. The GoPro is attached to the top of the camera stand and then can be attached to the laptop located on the stand as well. The GoPro at this height is able to get the full visualization of the chamber.

Test Plan

Needs	Requirements	Test Case #	Pass/Fail	Comments
A basic functional 3-chamber layout that can be adapted easily to other tests	Section 5.1, Req 620, Req 720, Req 730	010, 060	Pass	Walls are shatter resistant, base is watertight and provides contrast to white objects, inner walls are removable with doors.
Record rats as they enter and exit a chamber	Sections 5.2, 5.4, 5.5, Req 740, Req 750	020, 040	Pass	A remote controlled car was used to model the movements of a rat. GoPro video footage clearly displays the entire chamber with rats.
Record the (x,y) position of the rats; determine entry into sociability zone	Section 5.6, Req 760, Req 770	050	Pass	A remote controlled car was used to model the movements of a rat. MATLAB program successfully determines sociability based on (x,y) position and time stamps extracted from Any-Maze
Removable inner walls that allow alteration of chambers and their dimensions	Req 030, Req 710	060	Pass	Walls are able to be removed and readjusted less than 2 minutes, which is important to make sure the experiment is done in a timely manner.
Chamber and Video Camera Mount Stability	Section 5.3	030	Pass	Chamber and camera mount design is mechanically stable. Inner and outer corner pieces, along with a stabilizing bar were added to ensure that the walls will not bend.

Acknowledgement

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