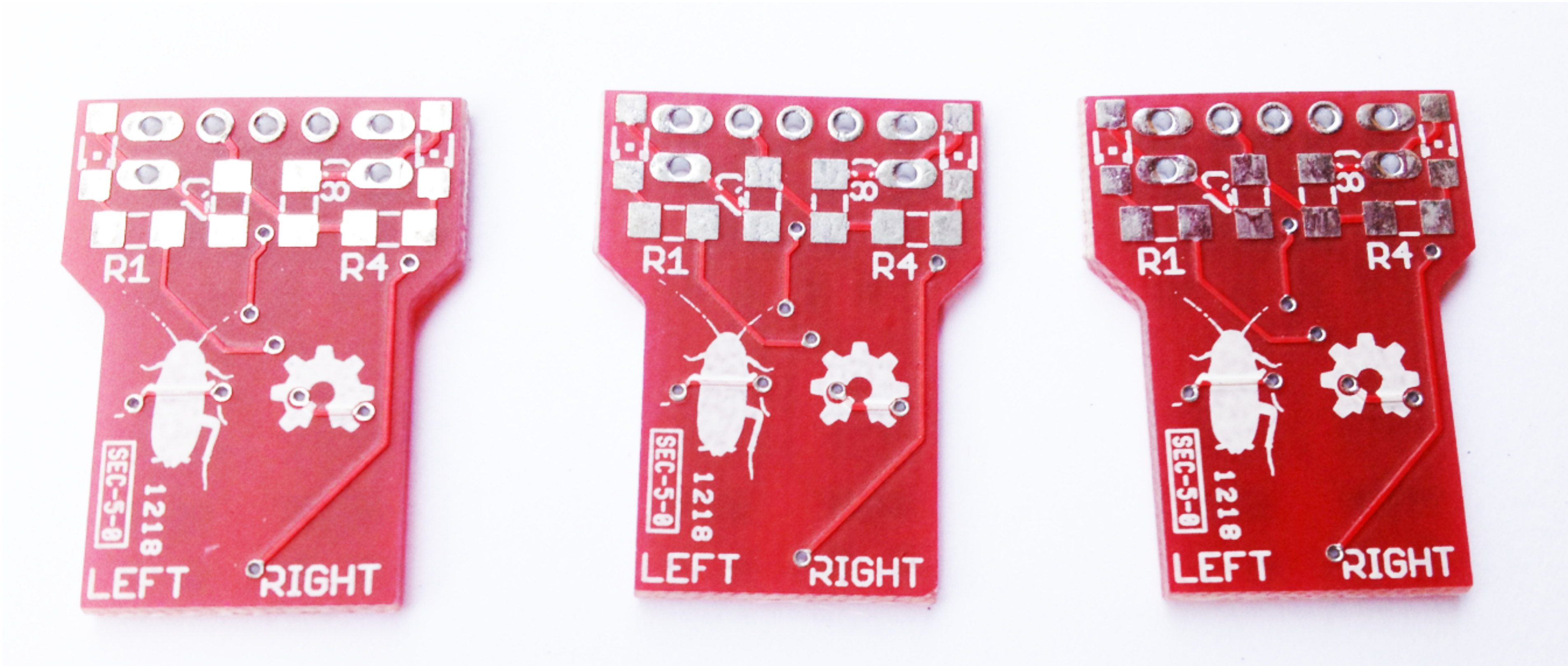
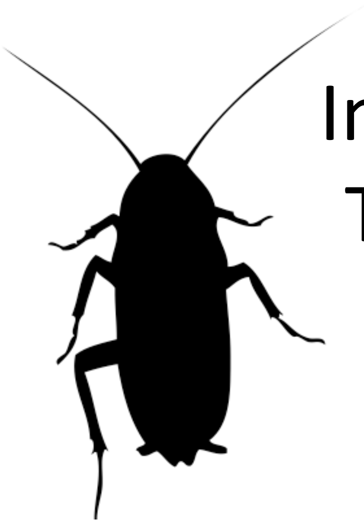
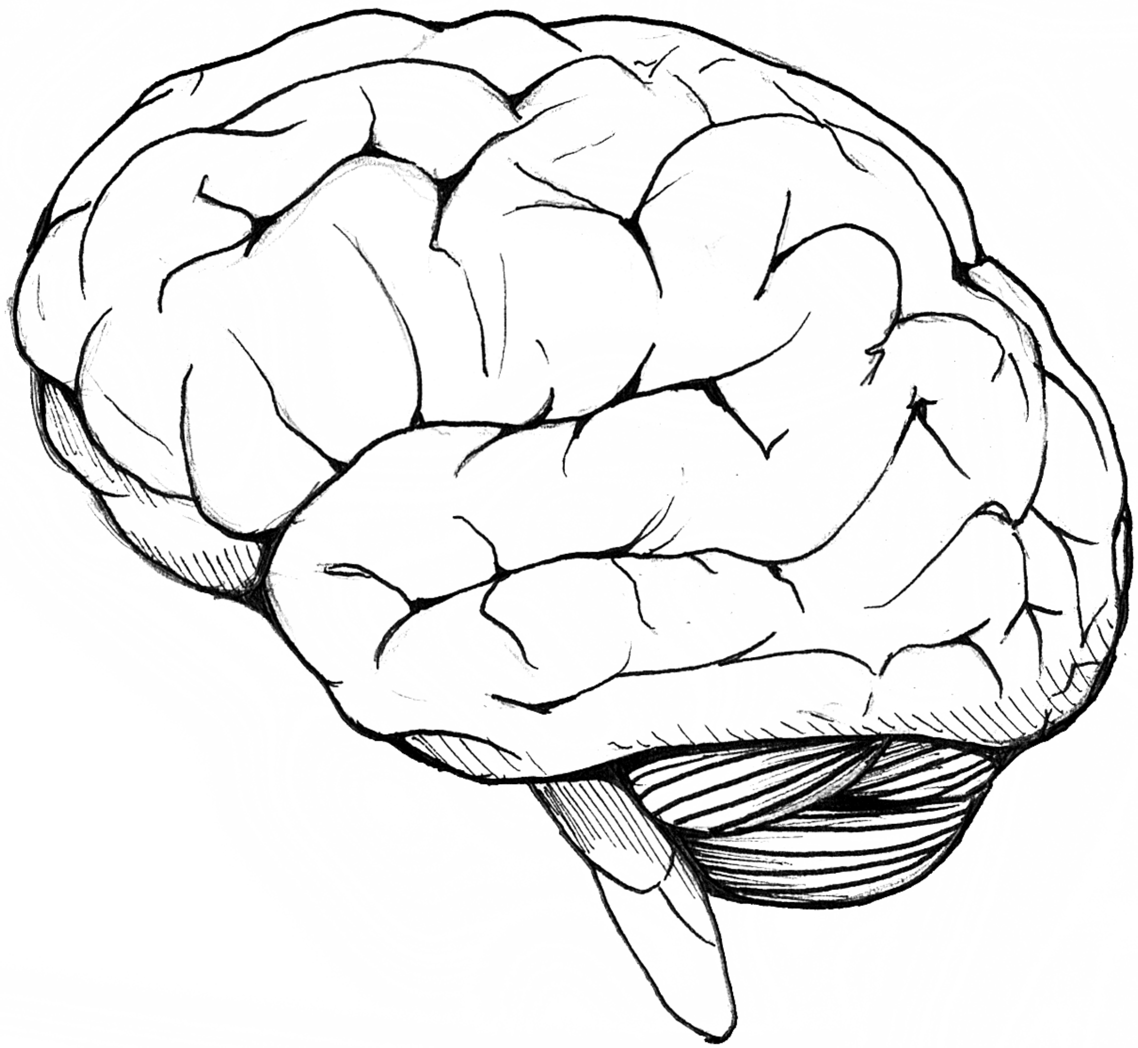


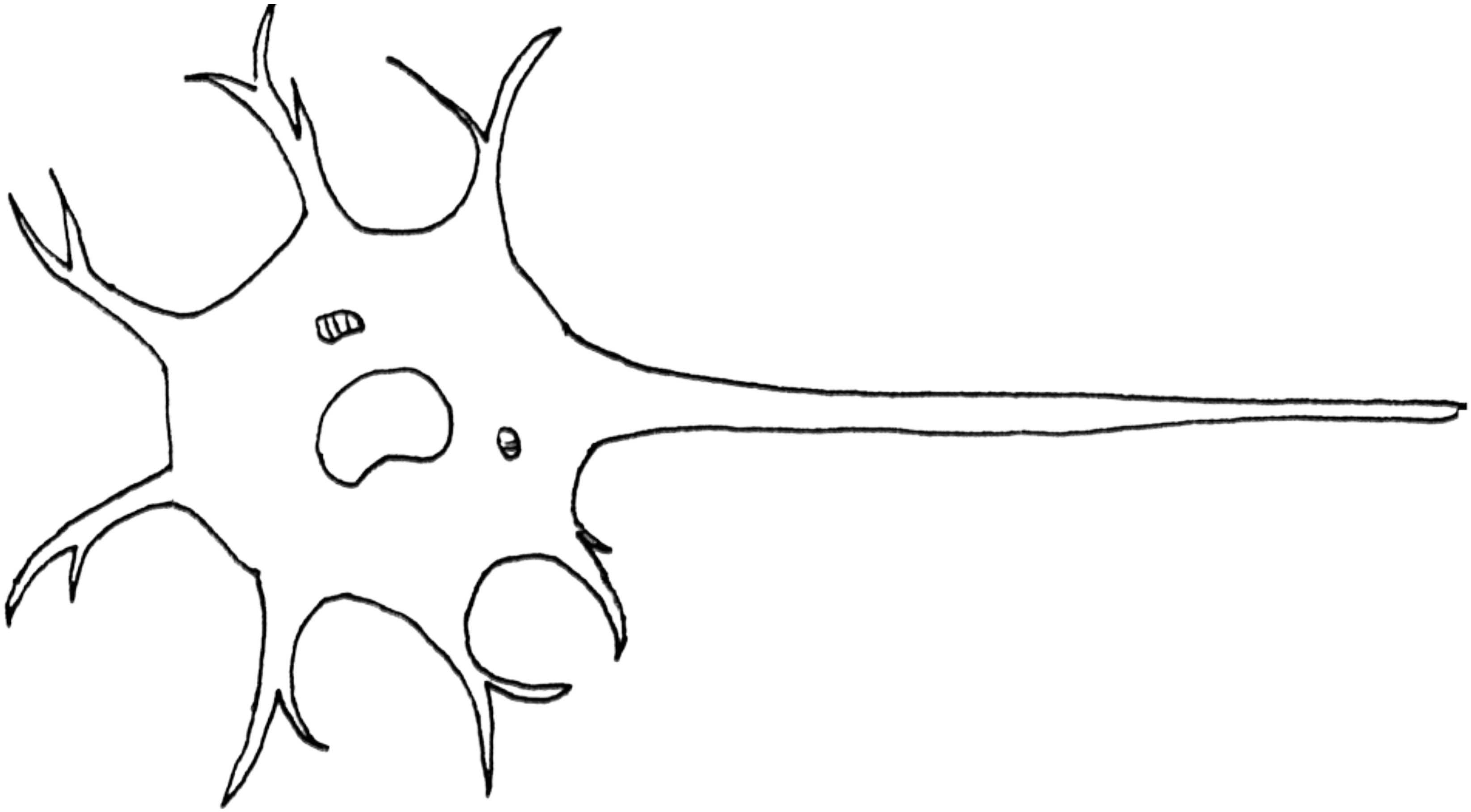
Backyard Brains:

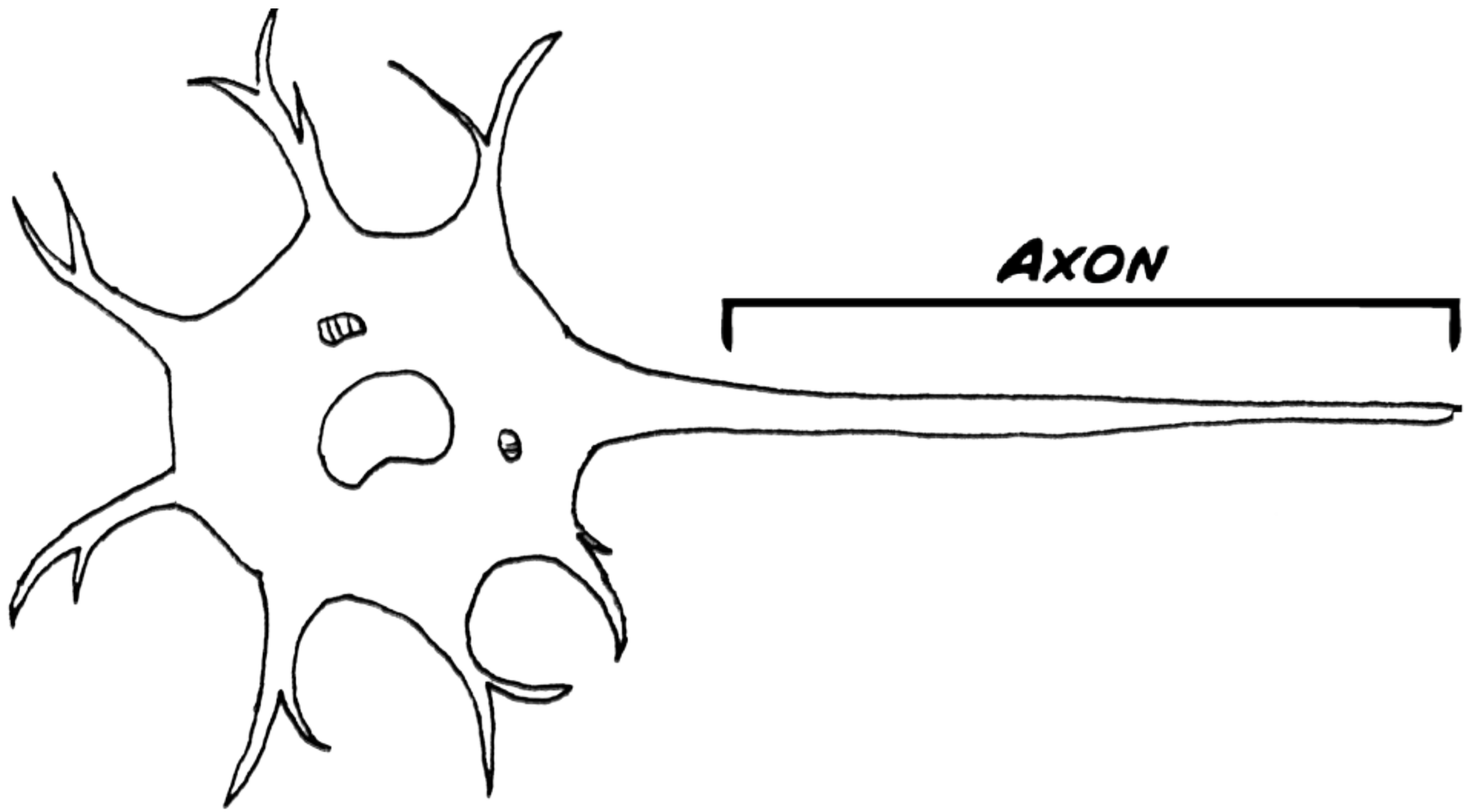
Improving the Understanding of the Brain Through Open Source Neurotechnology

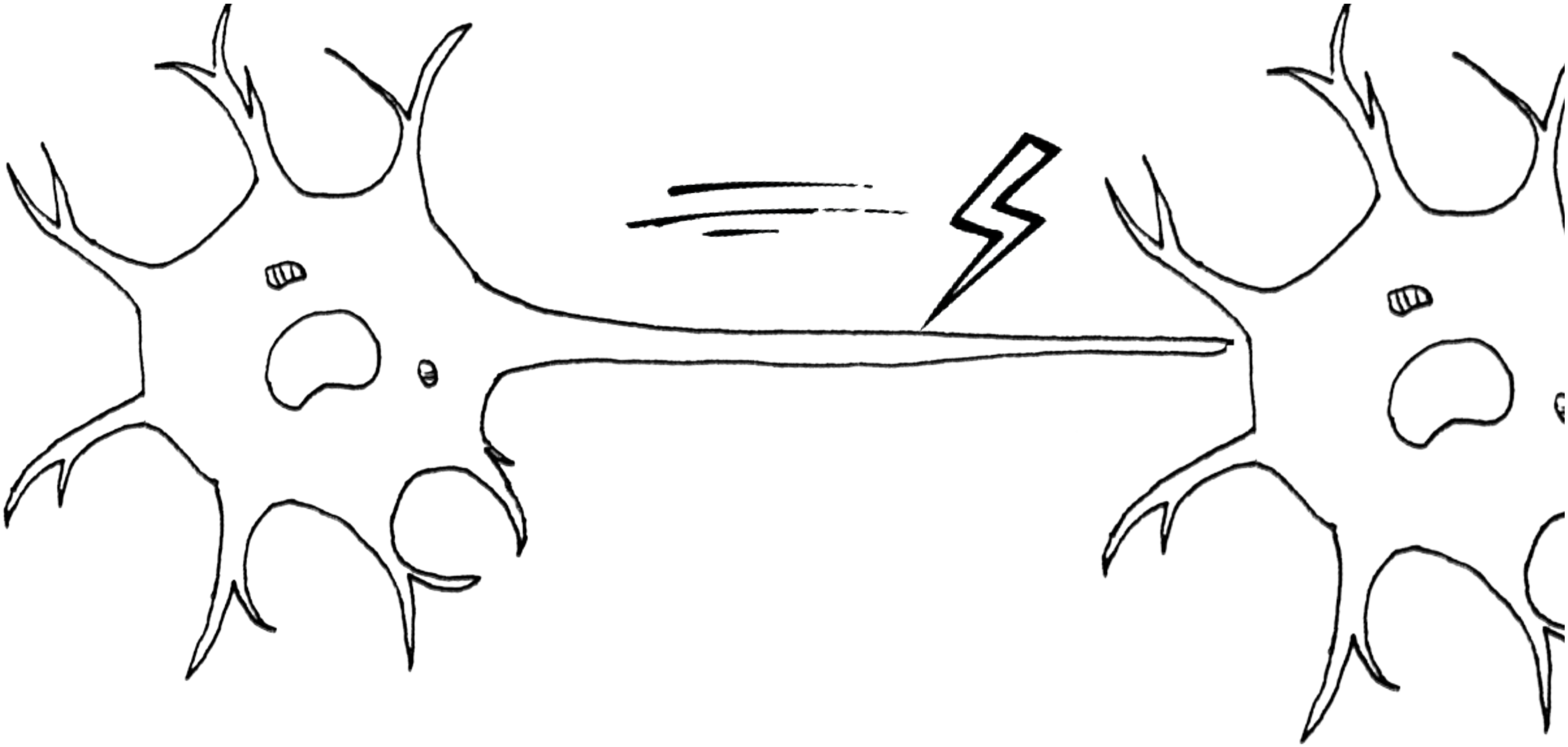


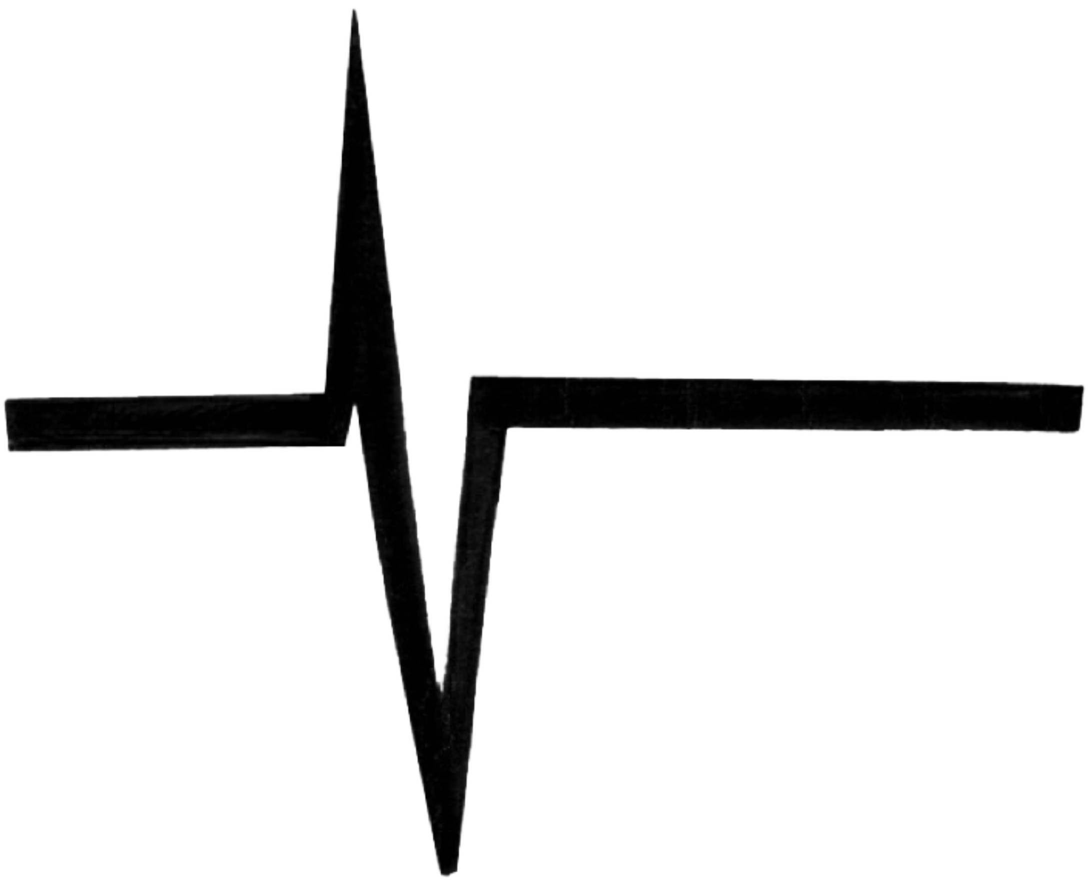
Gregory J Gage, Ph.D.






AXON

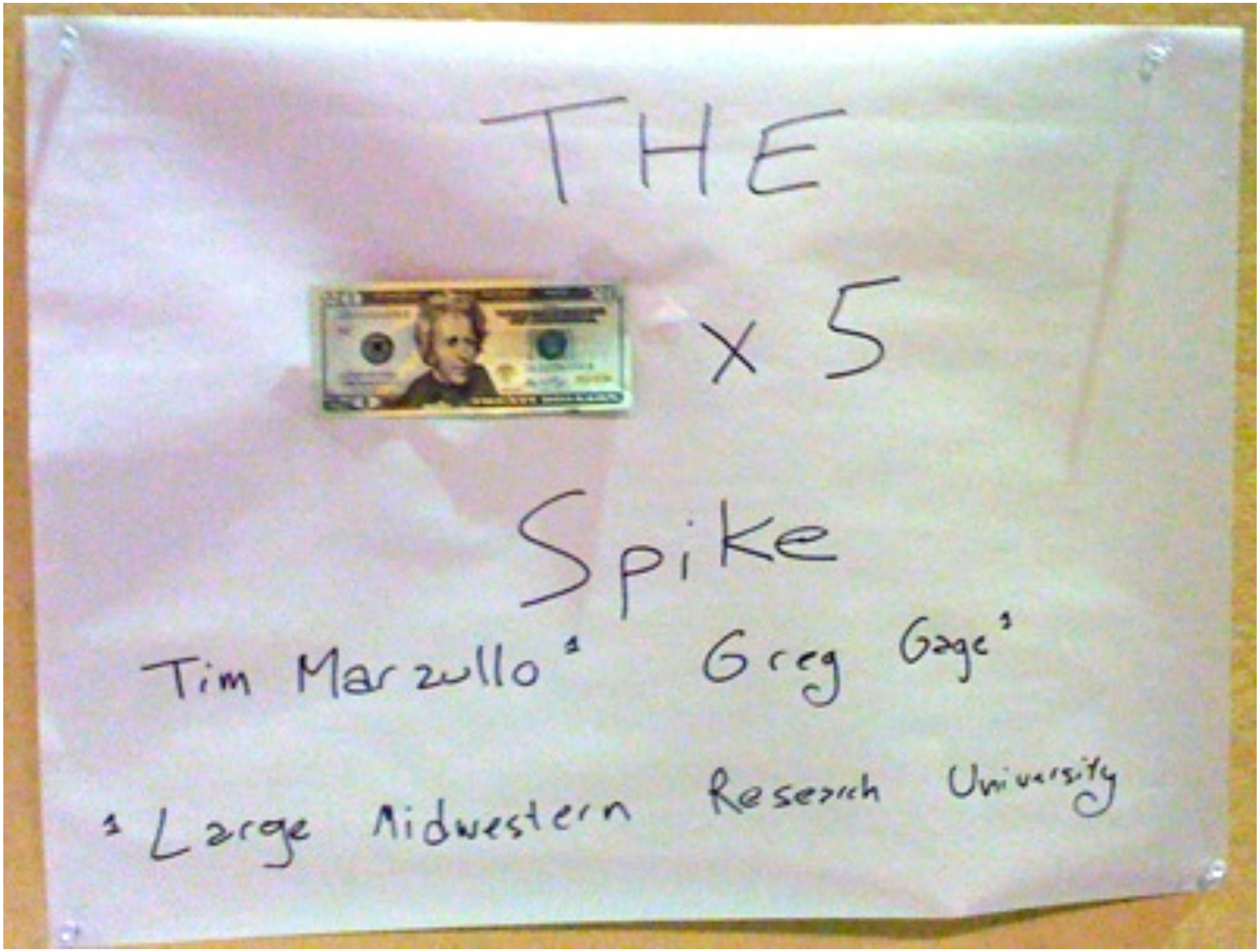


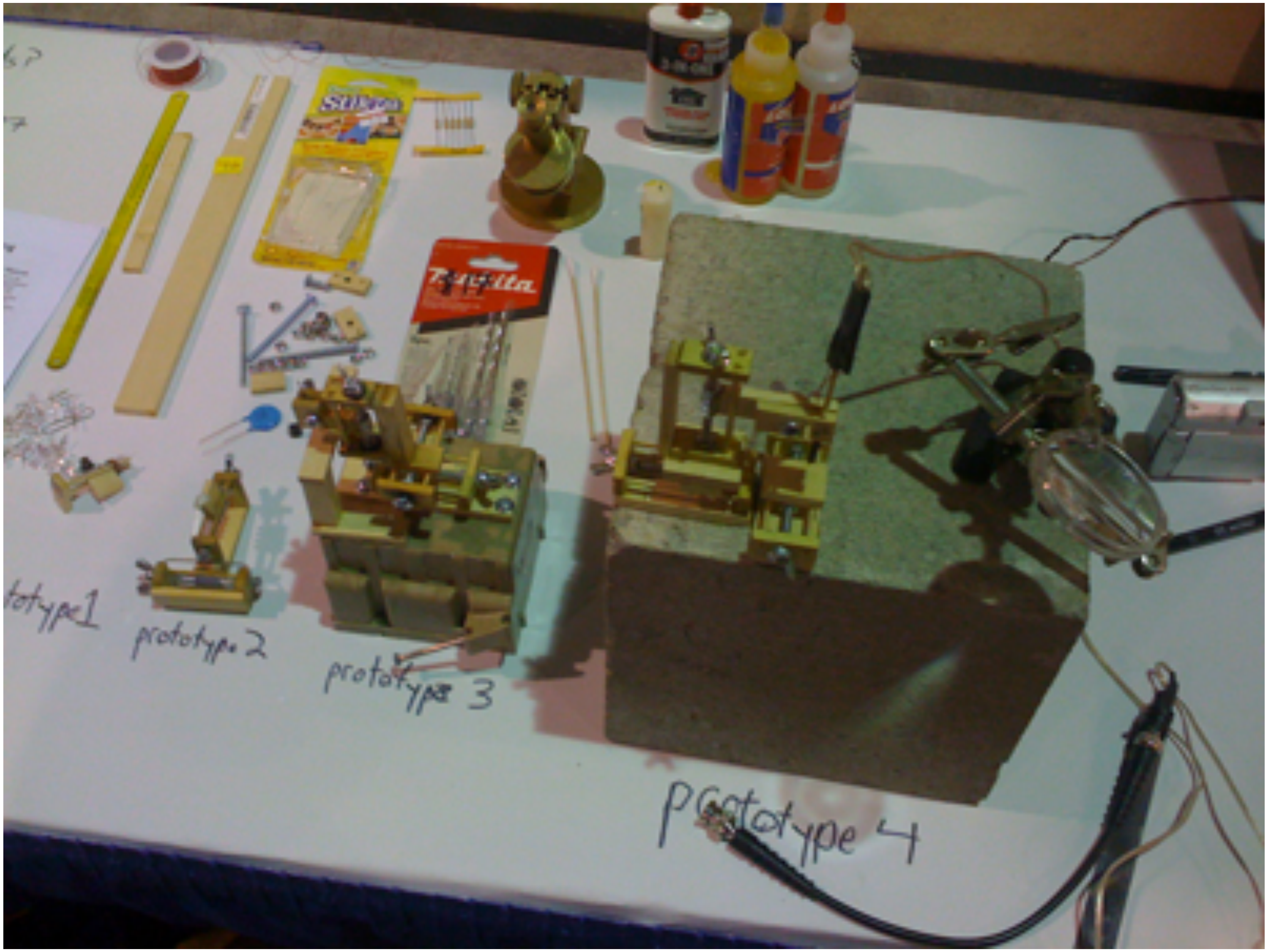


SPIKE!


B
13
14


HIPPOCAMPUS
MEMORY
AMYGDALA
FEAR
MEDULLA
OBLONGATA
MOTOR
CORTEX
TASTE
ASHLEY
KATHERINE
TEVYN
Stephanie
BRAINS RULE!
HANDS-ON

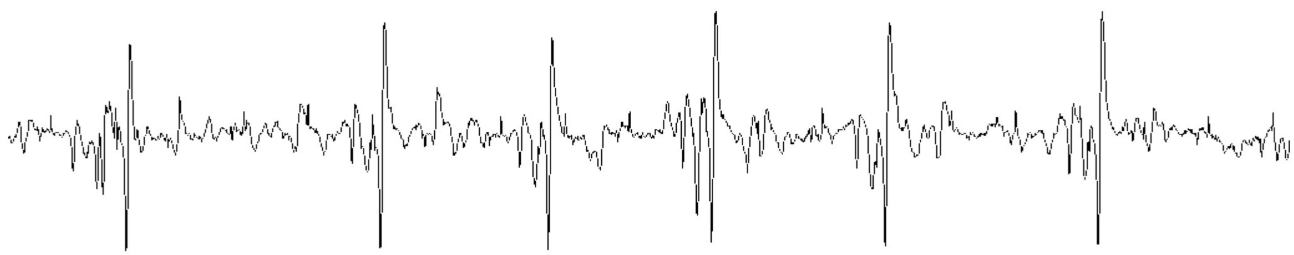

THE
x 5
Spike
Tim Marzullo[1] Greg Gage[1]
[1] Large Midwestern Research University

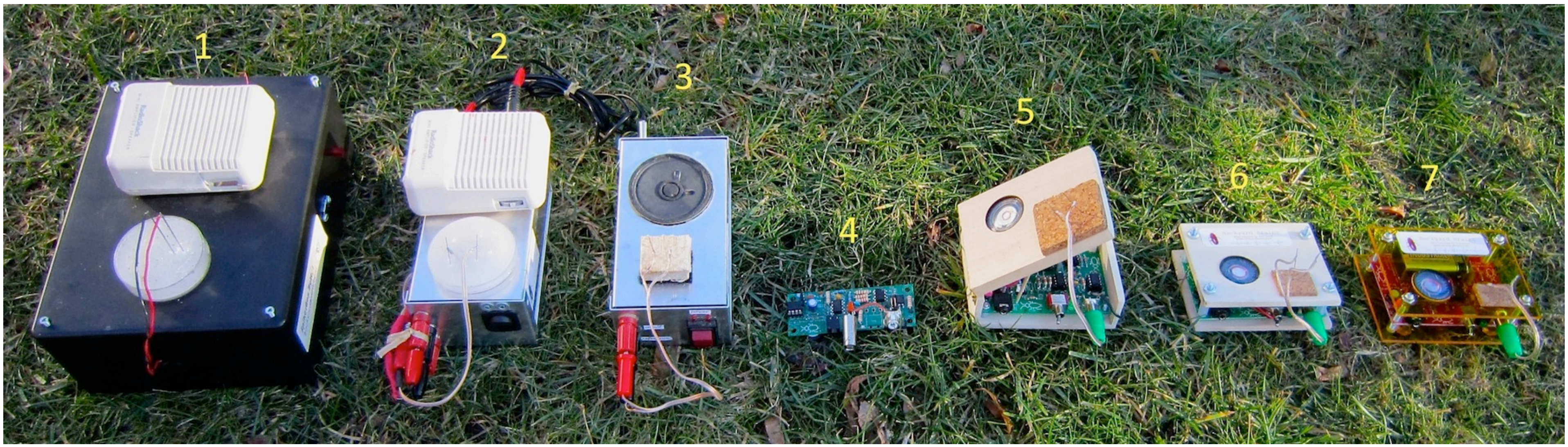


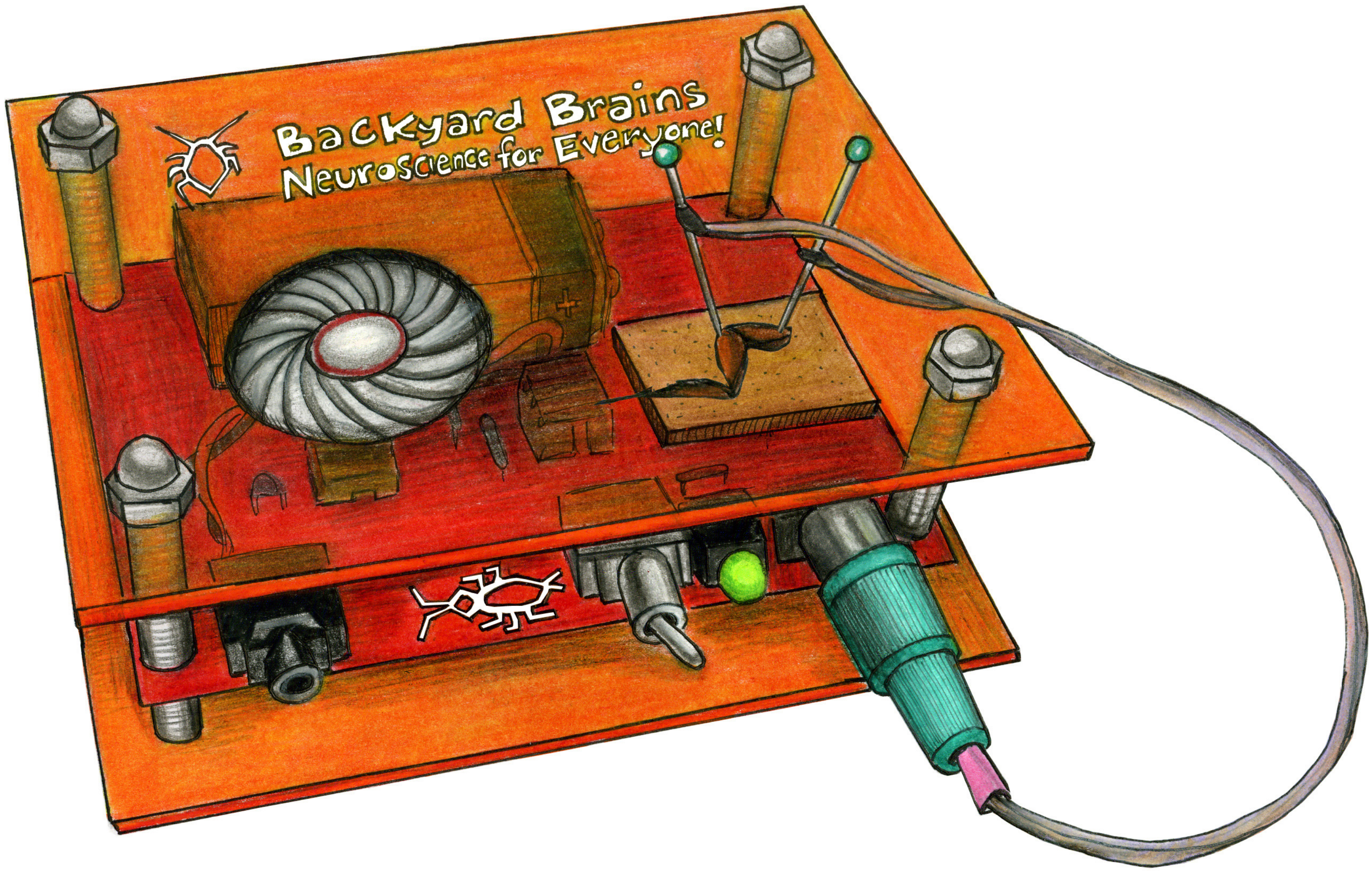
prototype 2
prototype 3
prototype 4

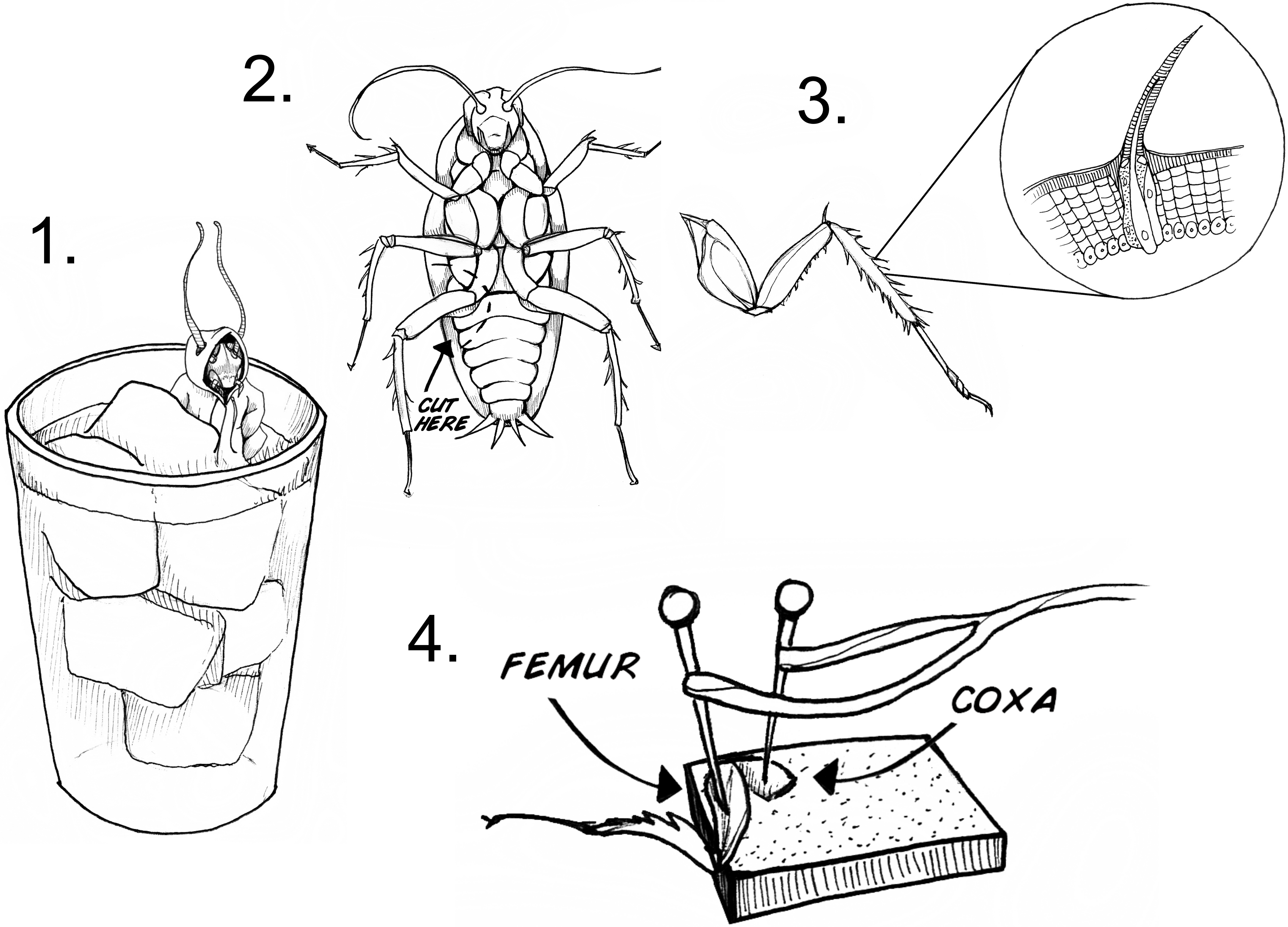
Backyard Brains

Neuroscience for Everyone!
www.backyardbrains.com

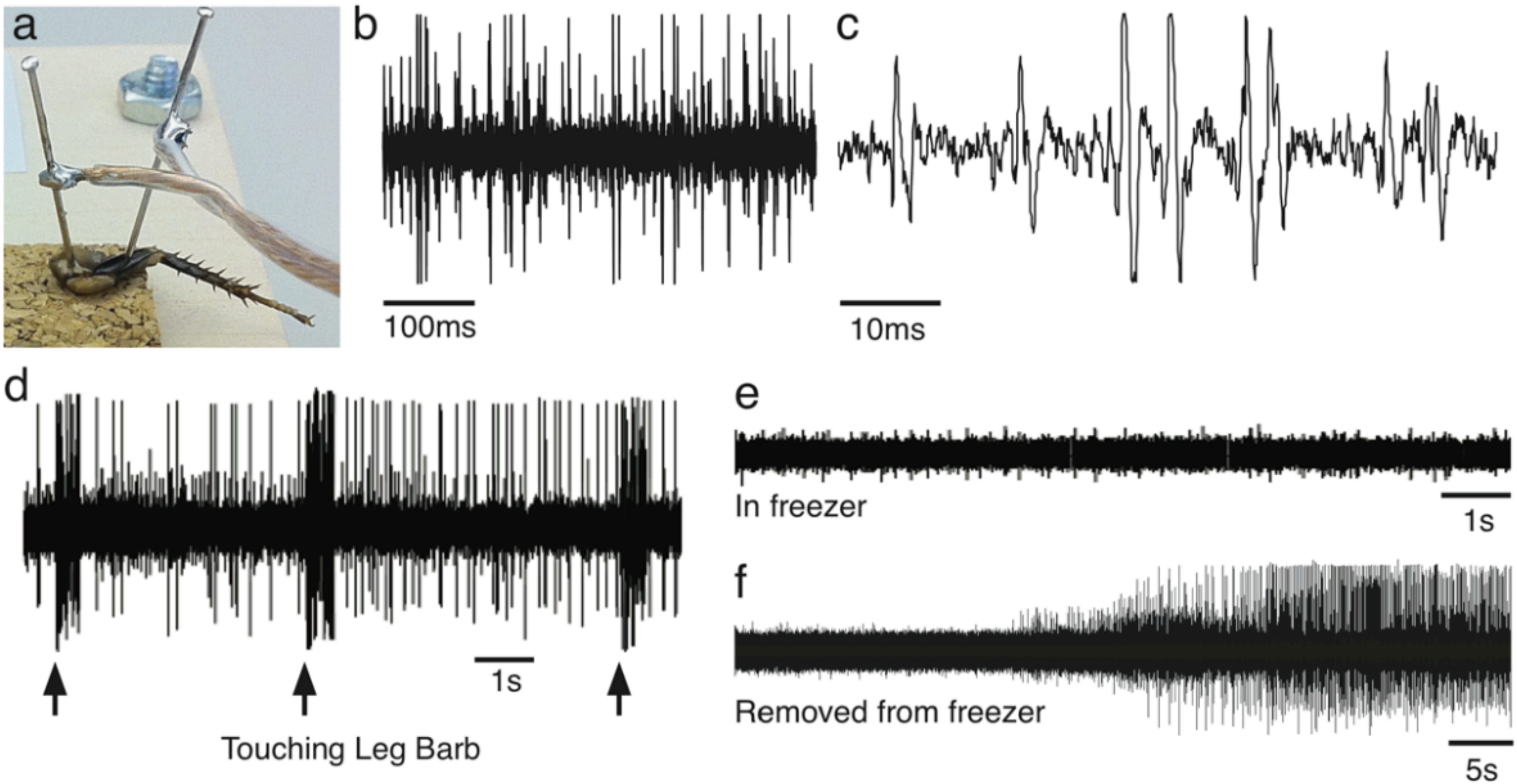



1
2
3
4
5
6
7


Backyard Brains
Neuroscience for Everyone!



1.
2.
CUT HERE
3.
4.
FEMUR
COXA



Marzullo and Gage (2012), PLoS One 7(3): e30837


WILDCATS

16,475 First Time Spikers! (and counting...)

We are proud to announce that as of 9/20/2012 8:54:25 AM, we have introduced 16,475 to the joy of listening to spikes.

First Timers	Event	Location	Date	Presenter
100	PICNIC Conference	Amsterdam, Holland	9/18/2012	Tim
25	Universidad San Sebatián Charla	Santiago, Chile	9/12/2012	Tim
25	Pontifical Catholic University of Valparaíso Charla	Valparaiso, Chile	9/10/2012	Tim
105	Universidad de Chile Mechanical Engineering seminar	Santiago, Chile	9/5/2012	Tim
25	Harvard High School Teacher Science Workshop	Cambridge, MA	8/23/2012	Tim and Greg
25	Universidad Técnica Frederico Santa Maria Seminario (first bluetooth RoboRoach demo)	Valparaiso	8/1/2012	Tim, Alejandro, Rimsky, and Yanko
200	Detroit MAKER faire	Dearborn, MI	7/31/2012	Dana and Teddy
30	National University of Singapore Site Visit	Santiago,	7/24/2012	Tim

Your Cart ($0.00)

Empty Cart

Finish your checkout with:

Google Checkout

PayPal

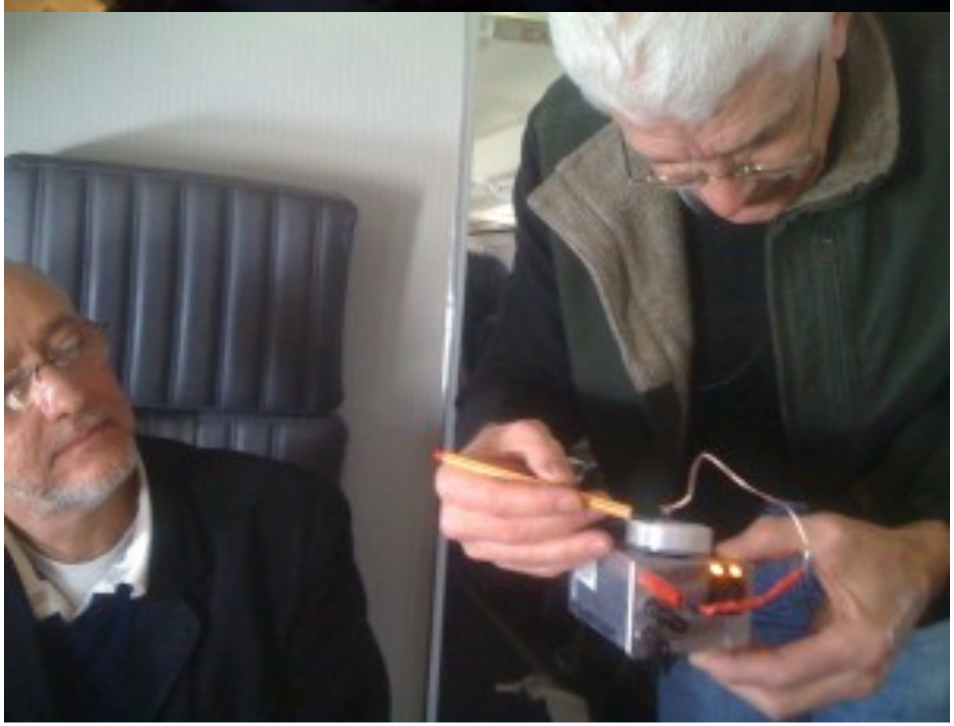
Purchase Order

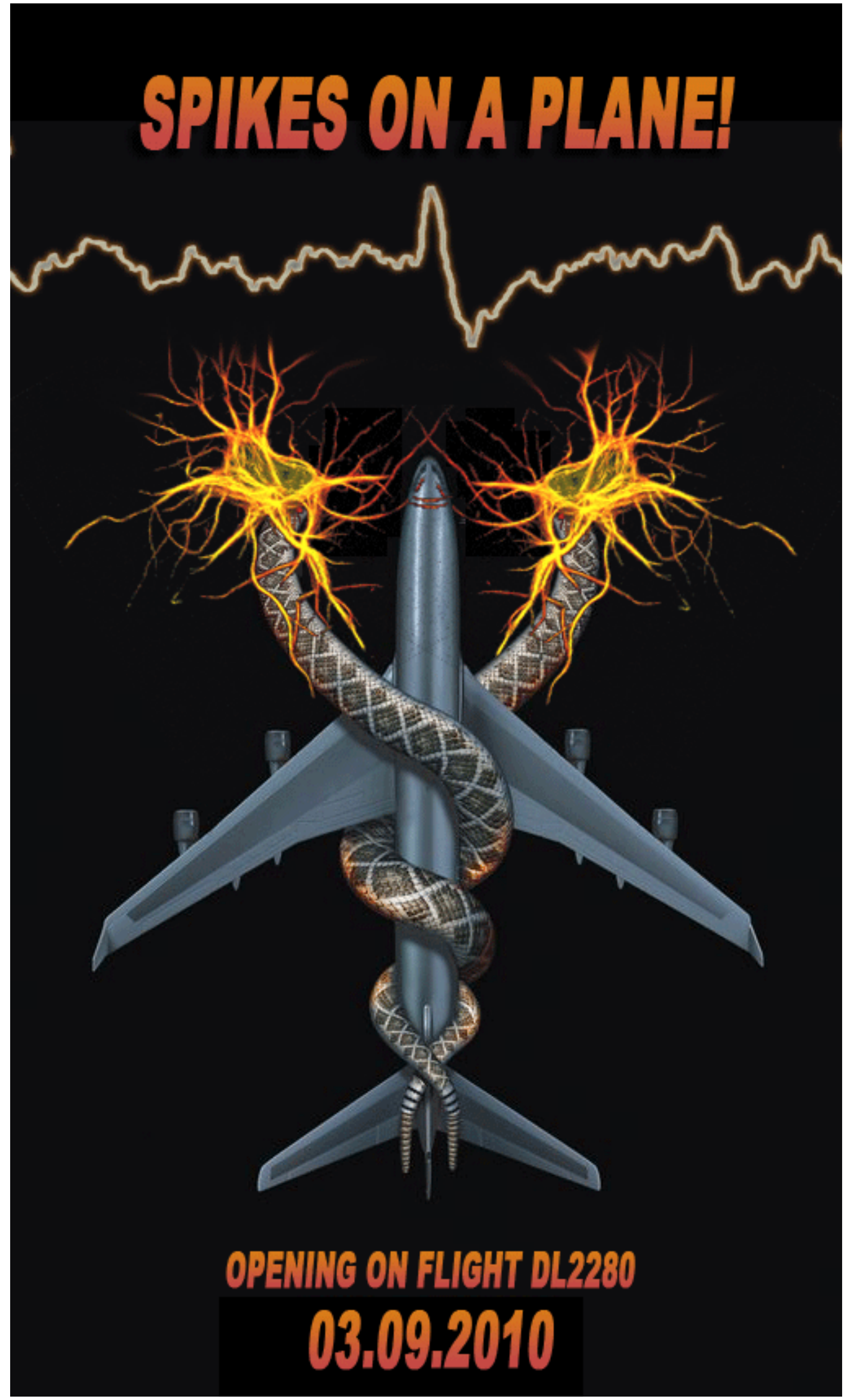
Now Hiring

We are looking for a part-time production technician in downtown Ann Arbor, MI. Know someone that wants to work with us? Let us know!

Products

The SpikerBox - provides a



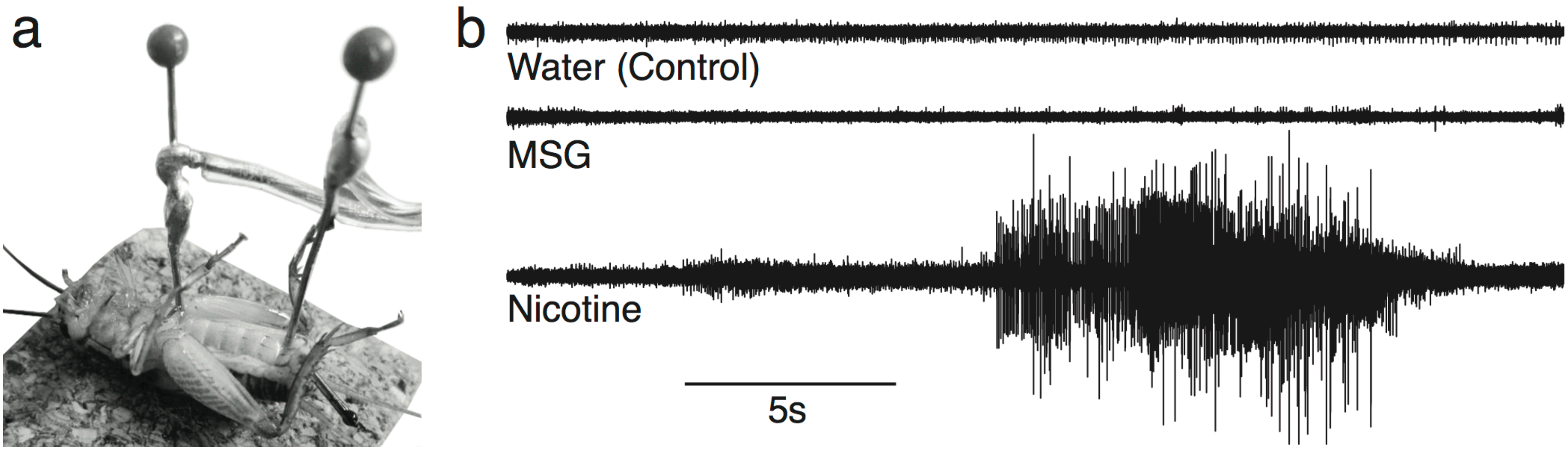

SPIKES ON A PLANE!
OPENING ON FLIGHT DL2280
03.09.2010

Experiments

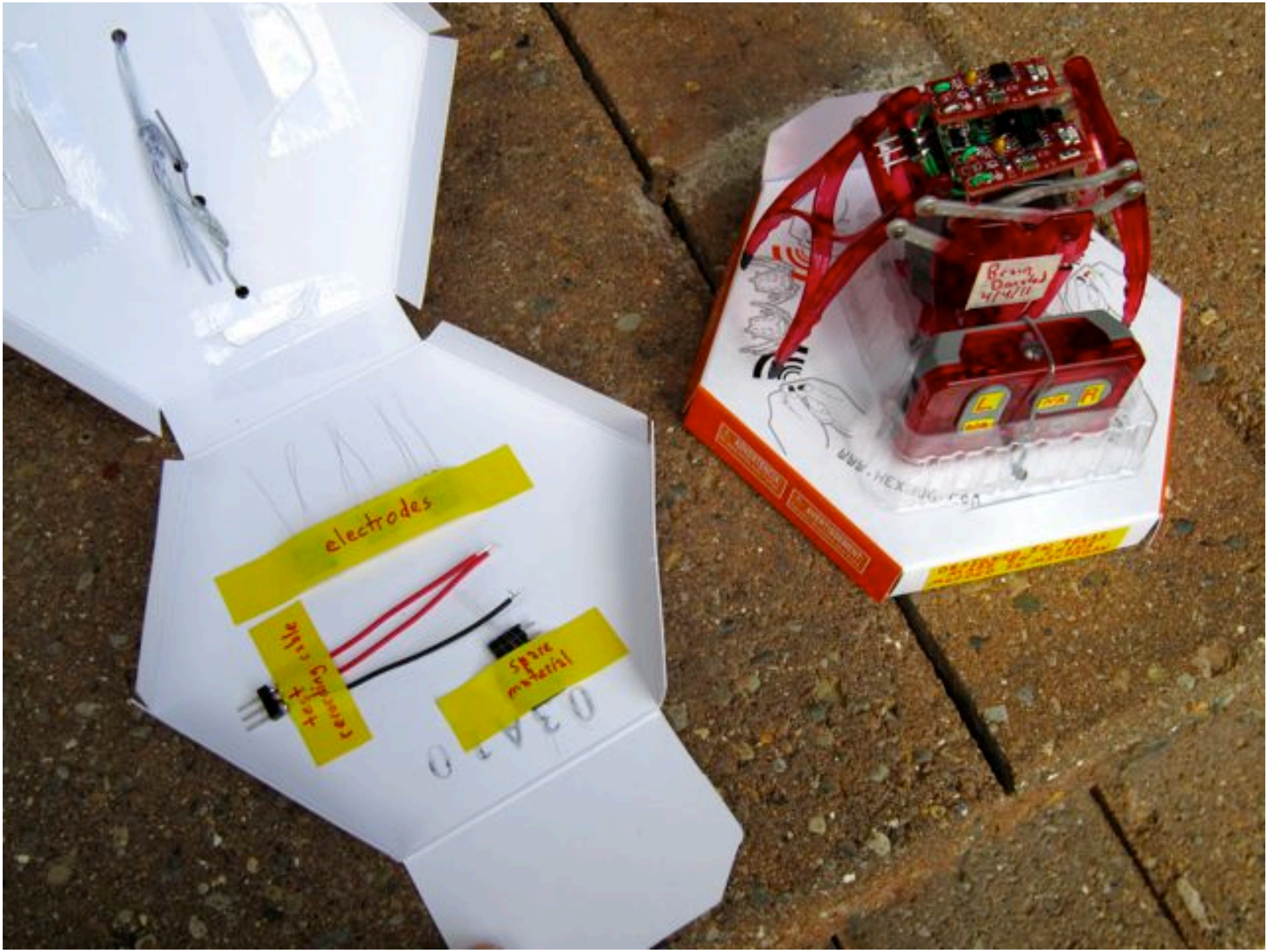
[edit]

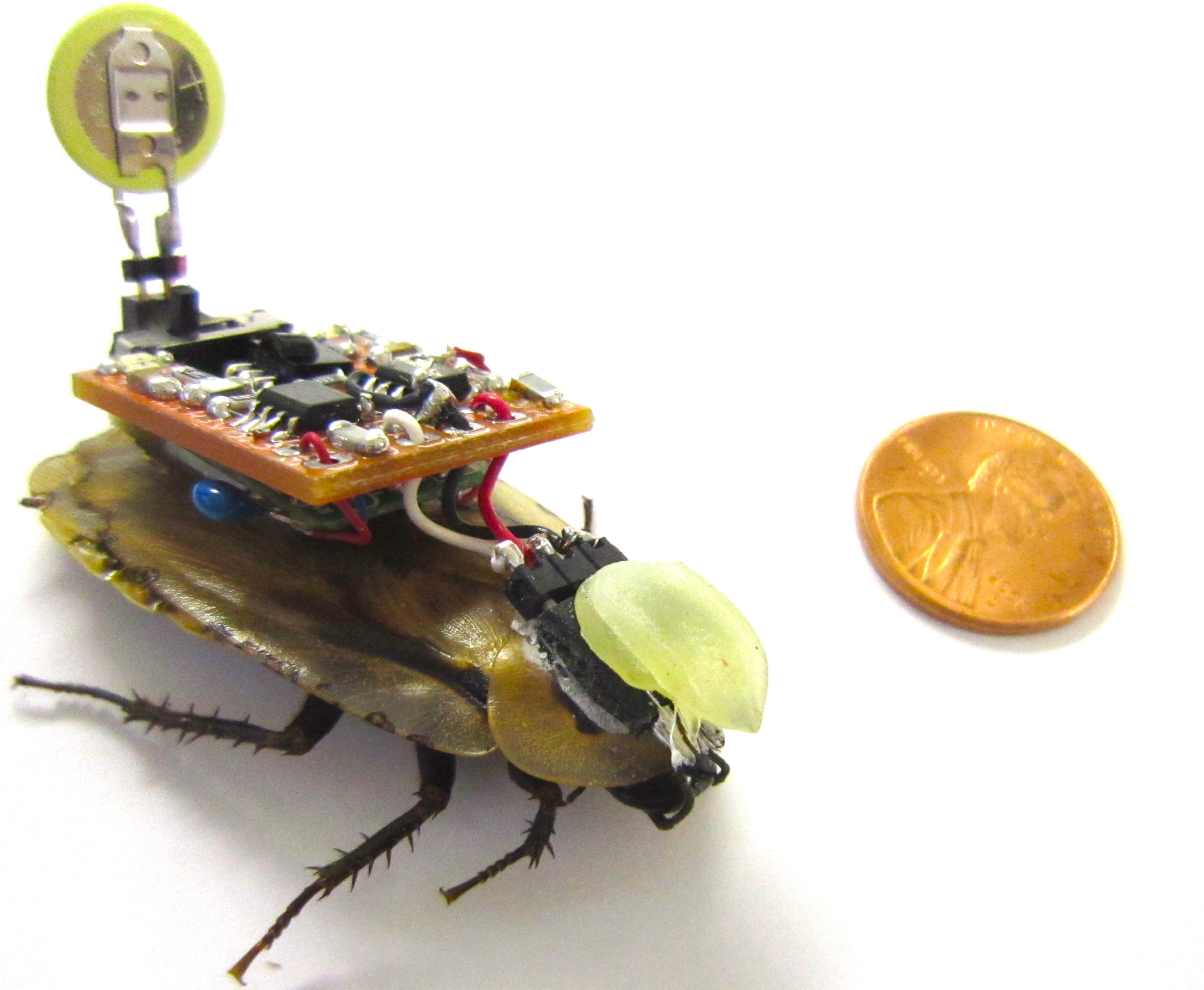
Here is a list of experiments we are currently working on. If you see an error, or want to make it better/clearer, we encourage you to edit the section. To keep the spam robots at bay, please e-mail us if you want to get an account to this wiki.

Exp	Name	Description	Lessons	
1	Getting Started with Spikes	In this module, you will listen to action potentials and view "spikes" in real time. An excellent starting point for your SpikerBox.	DOC	PPT
2	Introduction to Rate Coding	How do neurons encode information? One way is through rate coding.		
3	Effect of Temperature on Neurons	Here, you can investigate the effect of temperature on the firing rate of neurons.	DOC	PPT
4	Somatotopy	By manipulating the barbs on the cockroach leg, you can learn basic principles of nervous system organization.	DOC	PPT
5	Microstimulation of Neurons and Muscles	It's the 1780's all over again. Investigate excitability of nervous and muscle tissue with this experiment.	DOC	PPT
6	Measuring Power Consumption in Neurons	Does the leg ever run out of ATP? Here's an advanced experiment to measure power consumption.		
7	Referencing your Spikes	There's no such thing as a perfect ground, but some grounds are better than others, depending on what you are studying.	DOC	PPT
8	Anuradha Rao Memorial Experiment: Effect of Nicotine and MSG on Neurons	We now move to the cricket cercal preparation to investigate neuropharmacology.	DOC	PPT
9	NeuroProsthetics	What if we fed the neural activity of one cockroach leg into another? Neural Engineering 101 in session.	DOC	PPT
10	Oxygen and Spiking	Why do we need so much of that simple molecule oxygen anyway? Here you find out.	DOC	PPT
11	Speed of Neurons	With our 2-Channel SpikerBox, you can measure how fast action potentials travel down a nerve. How fast are they?		
12	The Faraday Cage	A simple piece of metal screening can drastically reduce electrical noise. But how does it work?	DOC	PPT

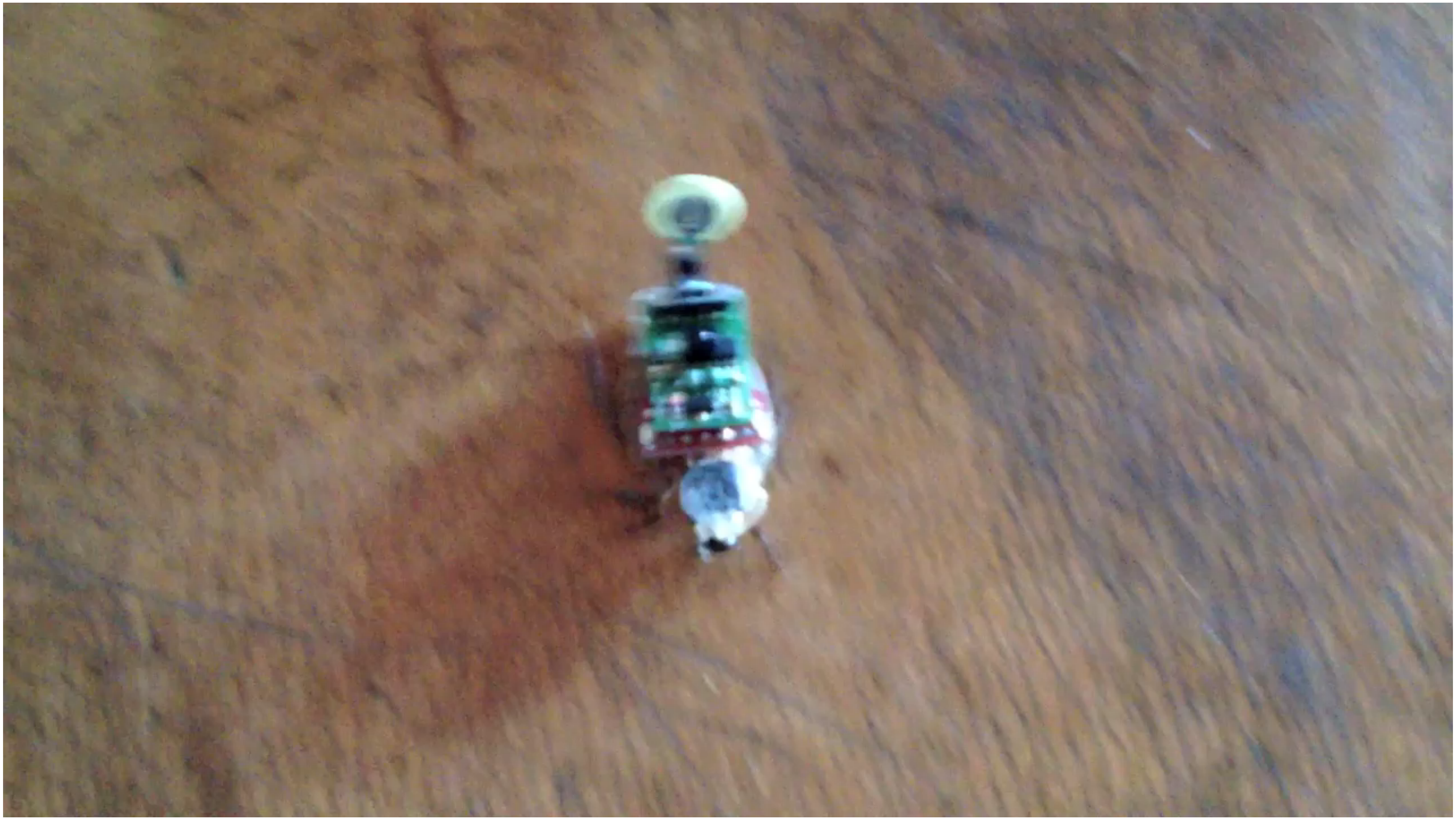


Marzullo and Gage (2012), PLoS One 7(3): e30837


electrodes
test recording cable
spare material
Brain Donated

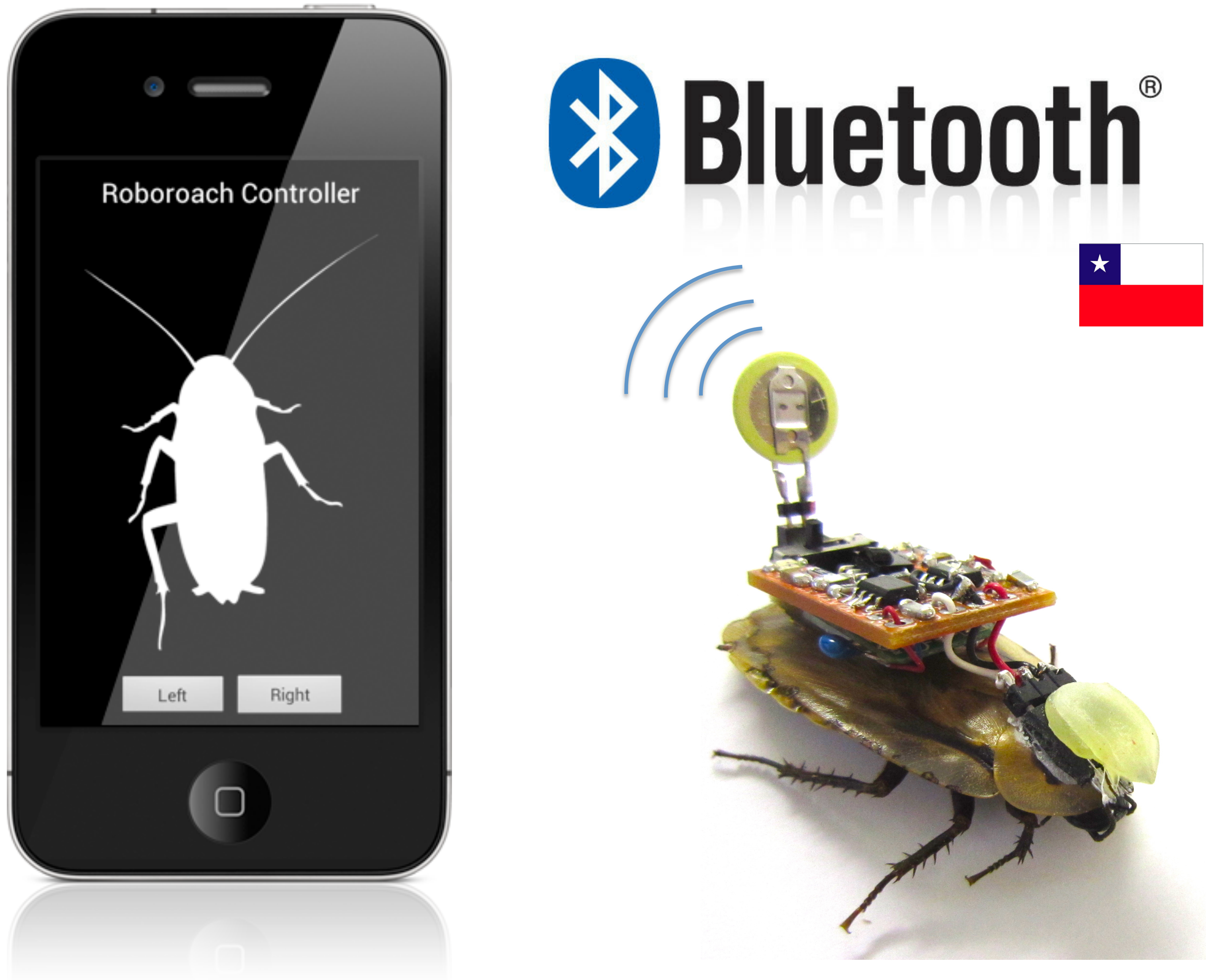


http://roboroach.backyardbrains.com

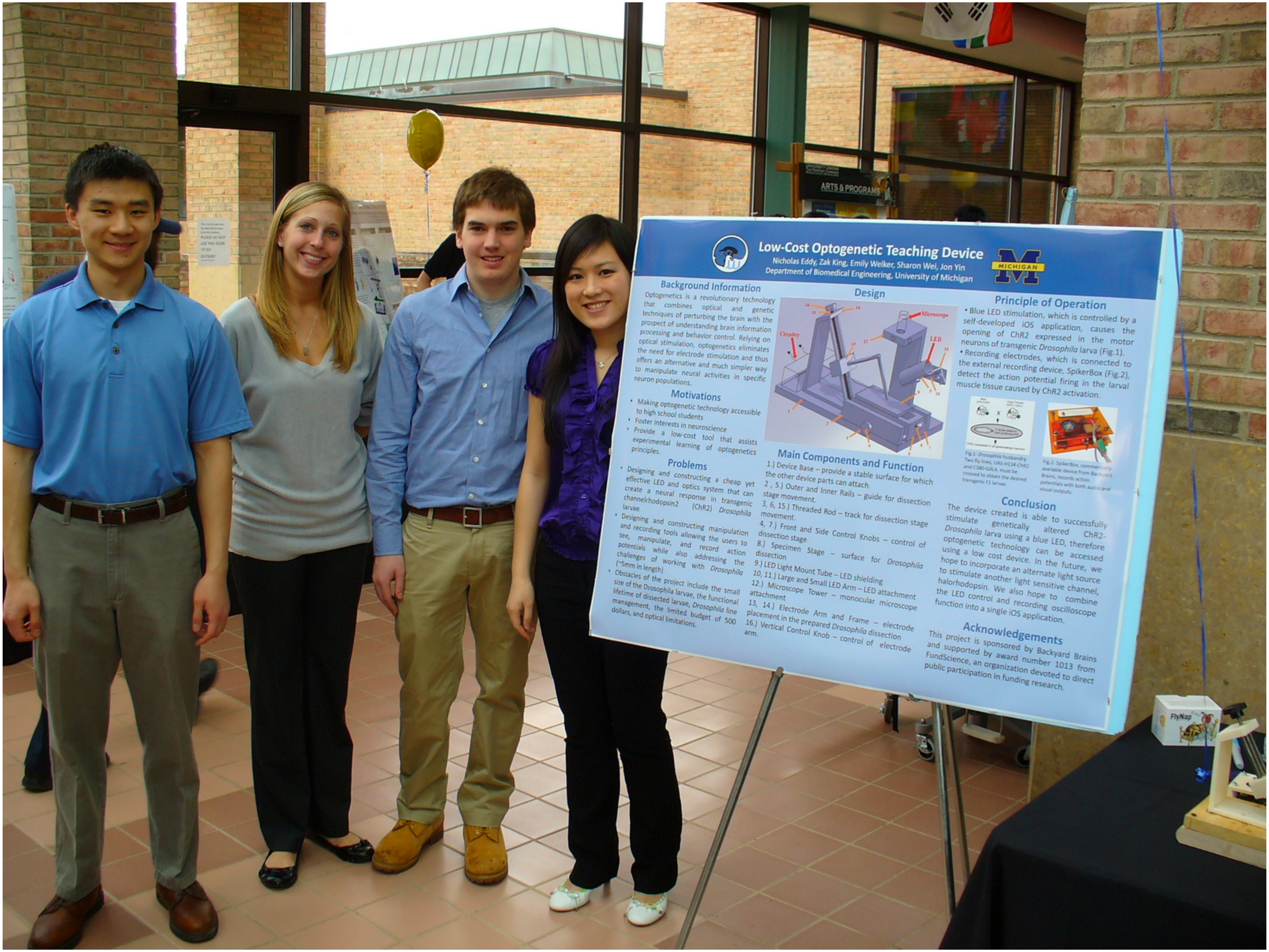


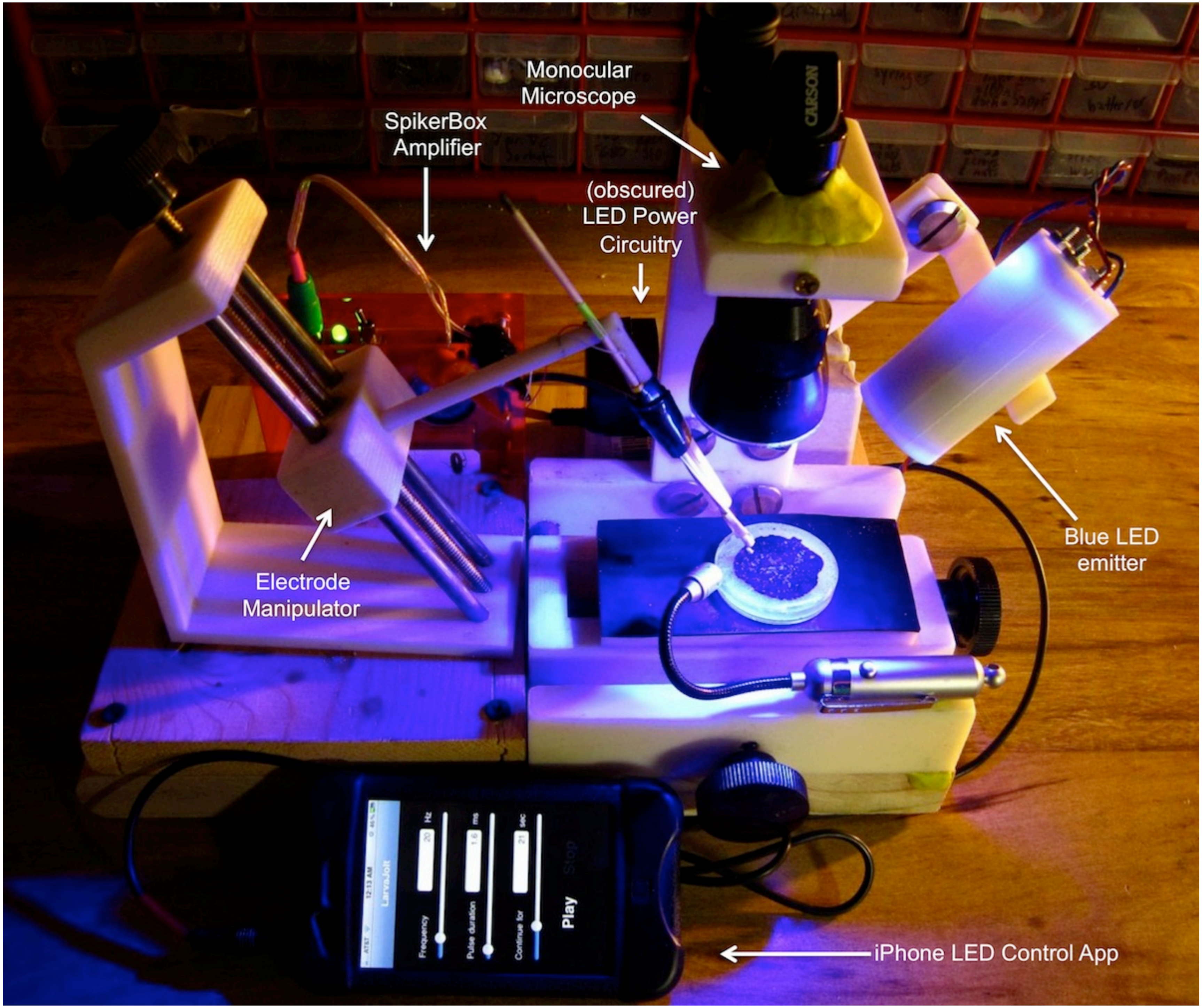
http://roboroach.backyardbrains.com

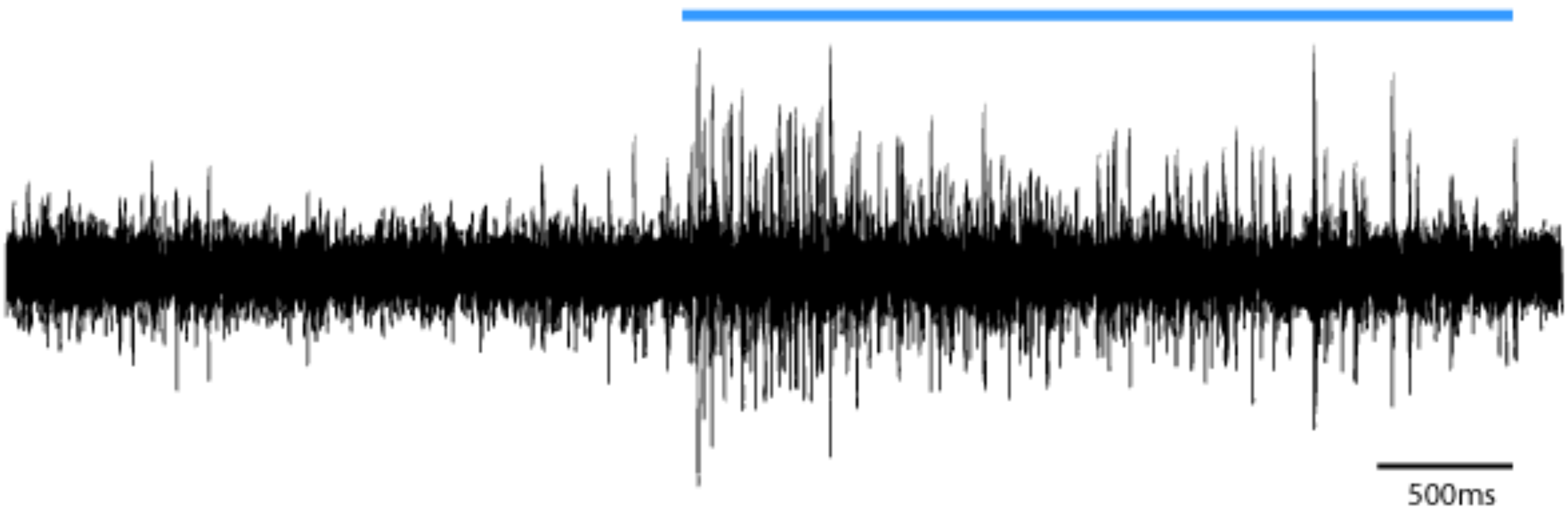
UNIVERSIDAD TECNICA FEDERICO SANTA MARIA


Roboroach Controller
Left
Right
Bluetooth

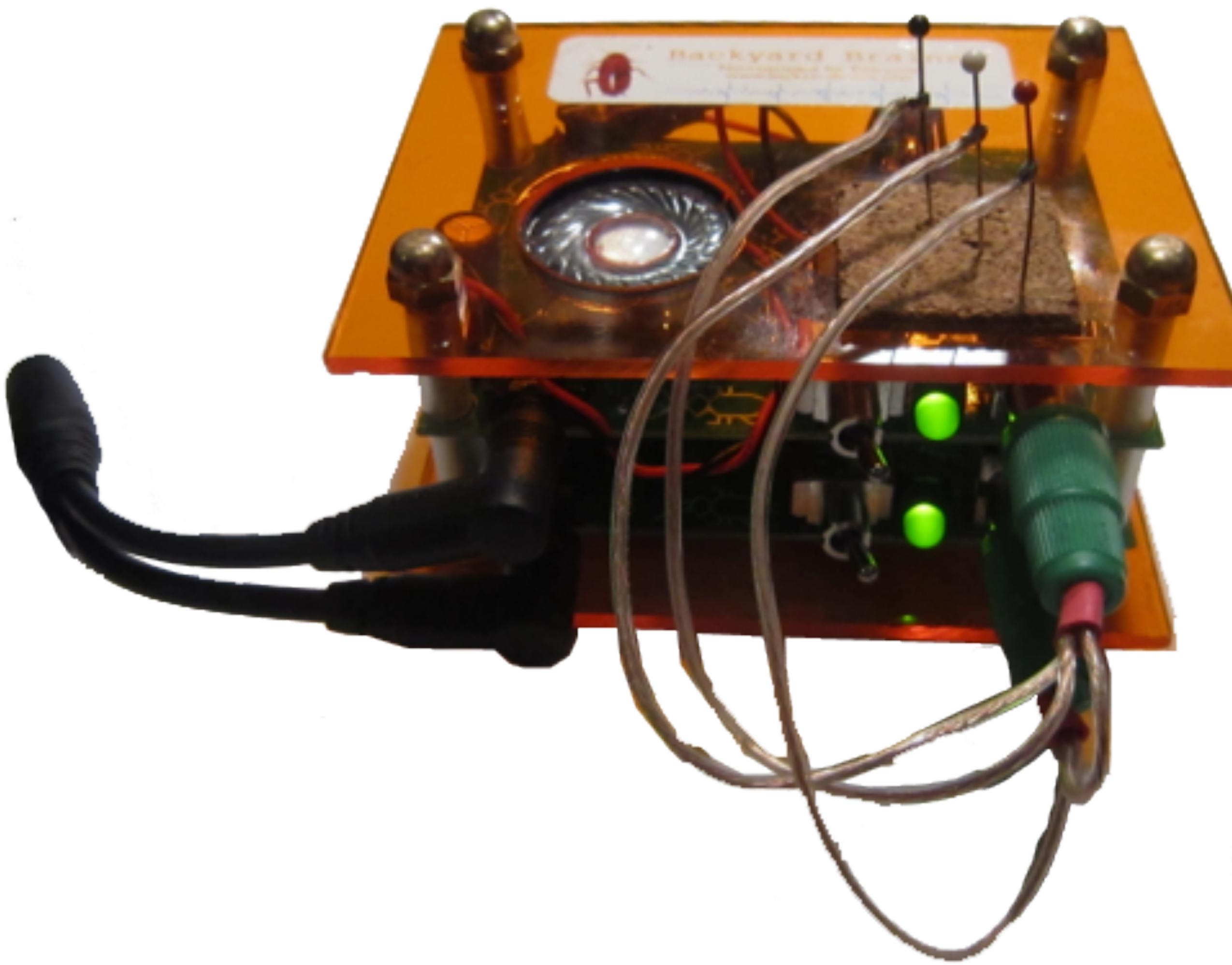
Credit: Karl Deisseroth

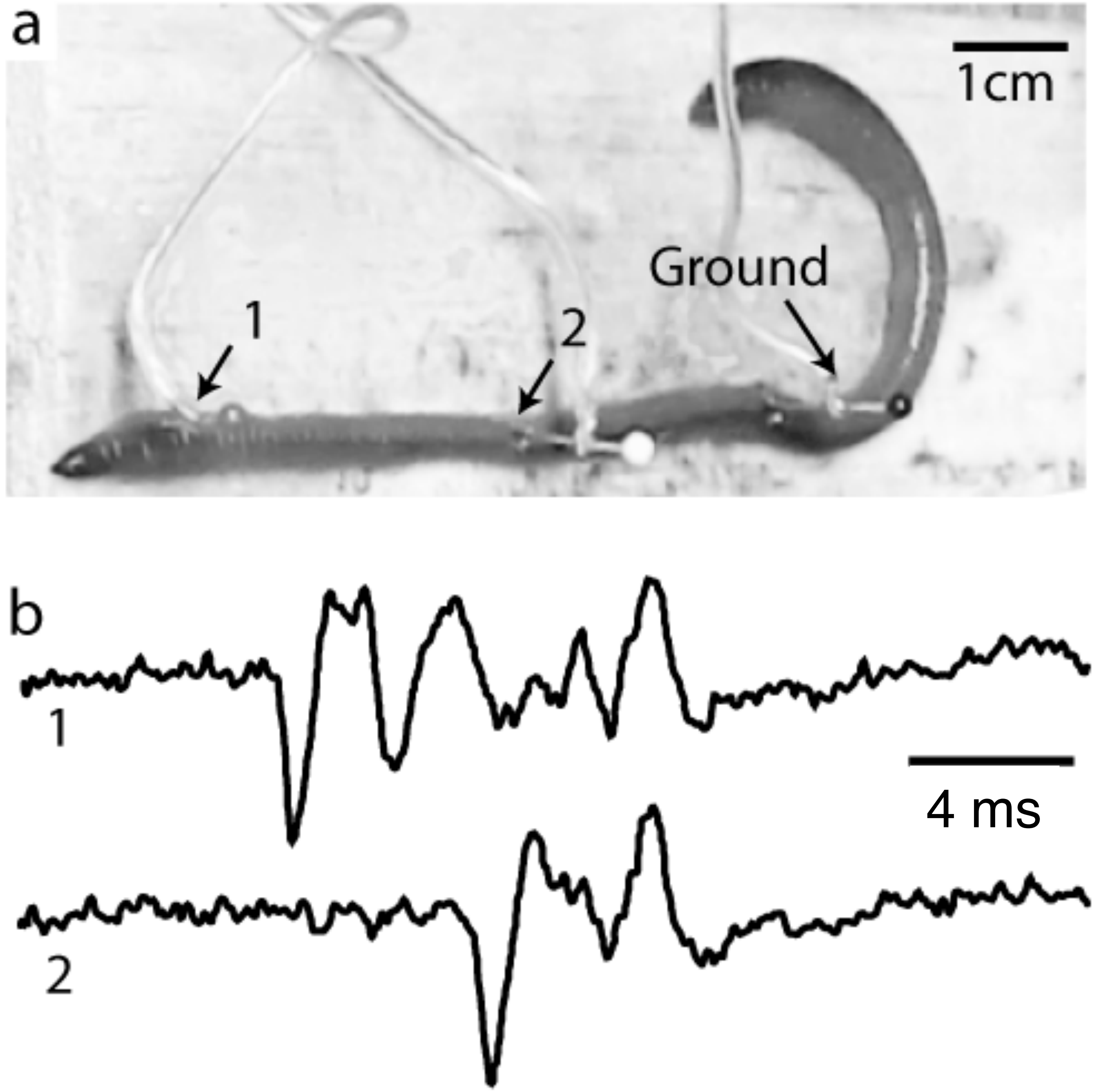

Low-Cost Optogenetic Teaching Device
Nicholas Eddy, Zak King, Emily Welker, Sharon Wei, Jon Yin
Department of Biomedical Engineering, University of Michigan
MICHIGAN
Background Information
Optogenetics is a revolutionary technology that combines optical and genetic techniques of perturbing the brain with the prospect of understanding brain information processing and behavior control. Relying on optical stimulation, optogenetics eliminates the need for electrode stimulation and thus offers an alternative and much simpler way to manipulate neural activities in specific neuron populations.
Motivations
• Making optogenetic technology accessible to high school students
• Foster interests in neuroscience
• Provide a low-cost tool that assists experimental learning of optogenetics principles.
Problems
• Designing and constructing a cheap yet effective LED and optics system that can create a neural response in transgenic channelrhodopsin2 (ChR2) Drosophila larvae.
• Designing and constructing manipulation and recording tools allowing the users to see, manipulate, and record action potentials while also addressing the challenges of working with Drosophila (~5mm in length).
• Obstacles of the project include the small size of the Drosophila larvae, the functional lifetime of dissected larvae, Drosophila line management, the limited budget of 500 dollars, and optical limitations.
Design
Circuitry
Microscope
LED
Main Components and Function
1.) Device Base – provide a stable surface for which the other device parts can attach.
2 , 5.) Outer and Inner Rails – guide for dissection stage movement.
3, 6, 15.) Threaded Rod – track for dissection stage movement.
4, 7.) Front and Side Control Knobs – control of dissection stage
8.) Specimen Stage – surface for Drosophila dissection
9.) LED Light Mount Tube – LED shielding
10, 11.) Large and Small LED Arm – LED attachment
12.) Microscope Tower – monocular microscope attachment
13, 14.) Electrode Arm and Frame – electrode placement in the prepared Drosophila dissection
16.) Vertical Control Knob – control of electrode arm.
Principle of Operation
• Blue LED stimulation, which is controlled by a self-developed iOS application, causes the opening of ChR2 expressed in the motor neurons of transgenic Drosophila larva (Fig.1).
• Recording electrodes, which is connected to the external recording device, SpikerBox (Fig.2), detect the action potential firing in the larval muscle tissue caused by ChR2 activation.
Fig.1: Drosophila husbandry. Two fly lines, UAS-H134-ChR2 and C380-GAL4, must be crossed to obtain the desired transgenic F1 larvae.
Fig.2: SpikerBox, commercially available device from Backyard Brains, records action potentials with both audio and visual outputs.
Conclusion
The device created is able to successfully stimulate genetically altered ChR2-Drosophila larva using a blue LED, therefore optogenetic technology can be accessed using a low cost device. In the future, we hope to incorporate an alternate light source to stimulate another light sensitive channel, halorhodopsin. We also hope to combine the LED control and recording oscilloscope function into a single iOS application.
Acknowledgements
This project is sponsored by Backyard Brains and supported by award number 1013 from FundScience, an organization devoted to direct public participation in funding research.
ARTS & PROGRAMS
FlyNap

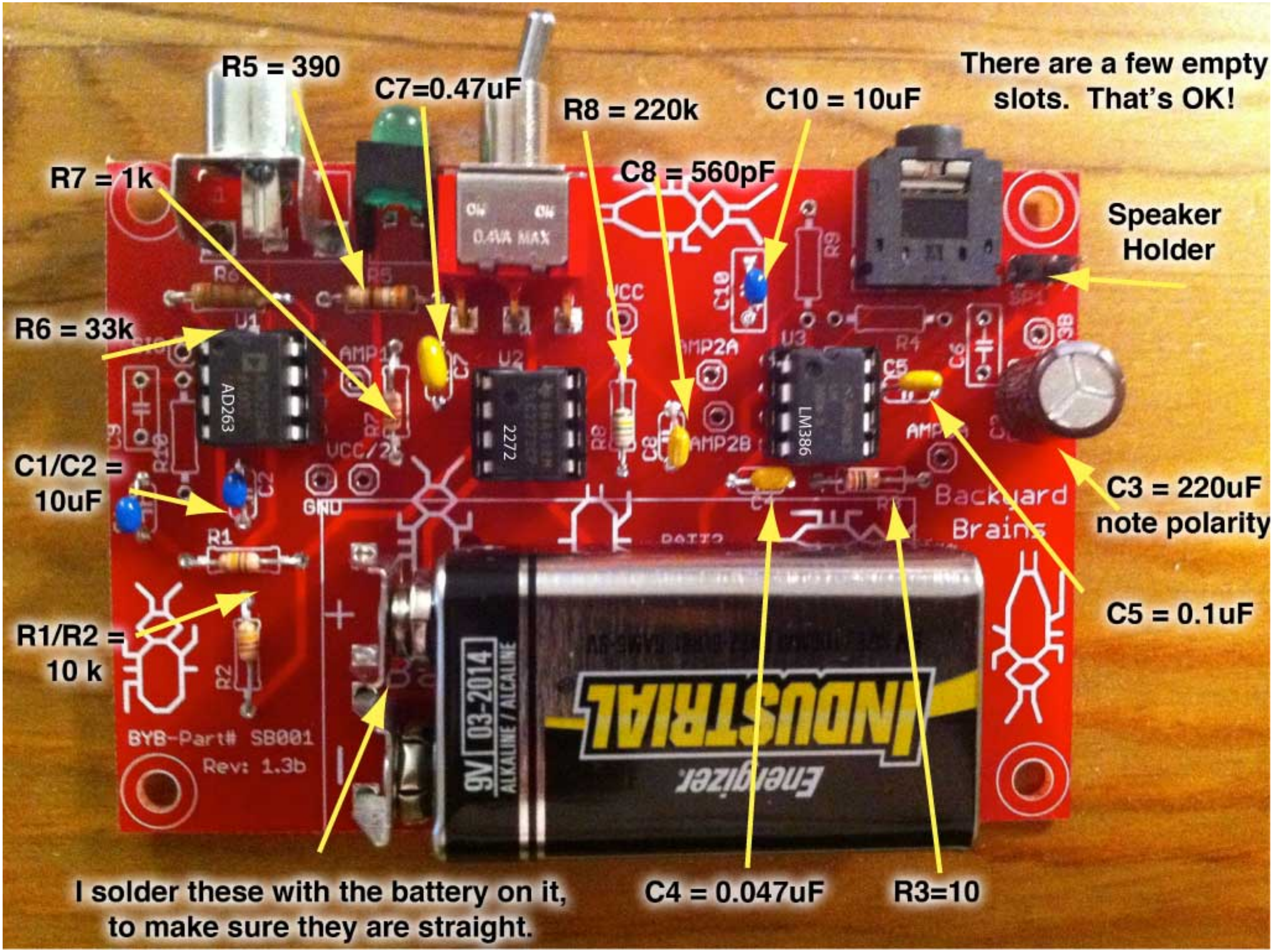

Monocular
Microscope
SpikerBox
Amplifier
(obscured)
LED Power
Circuitry
Electrode
Manipulator
Blue LED
emitter
iPhone LED Control App



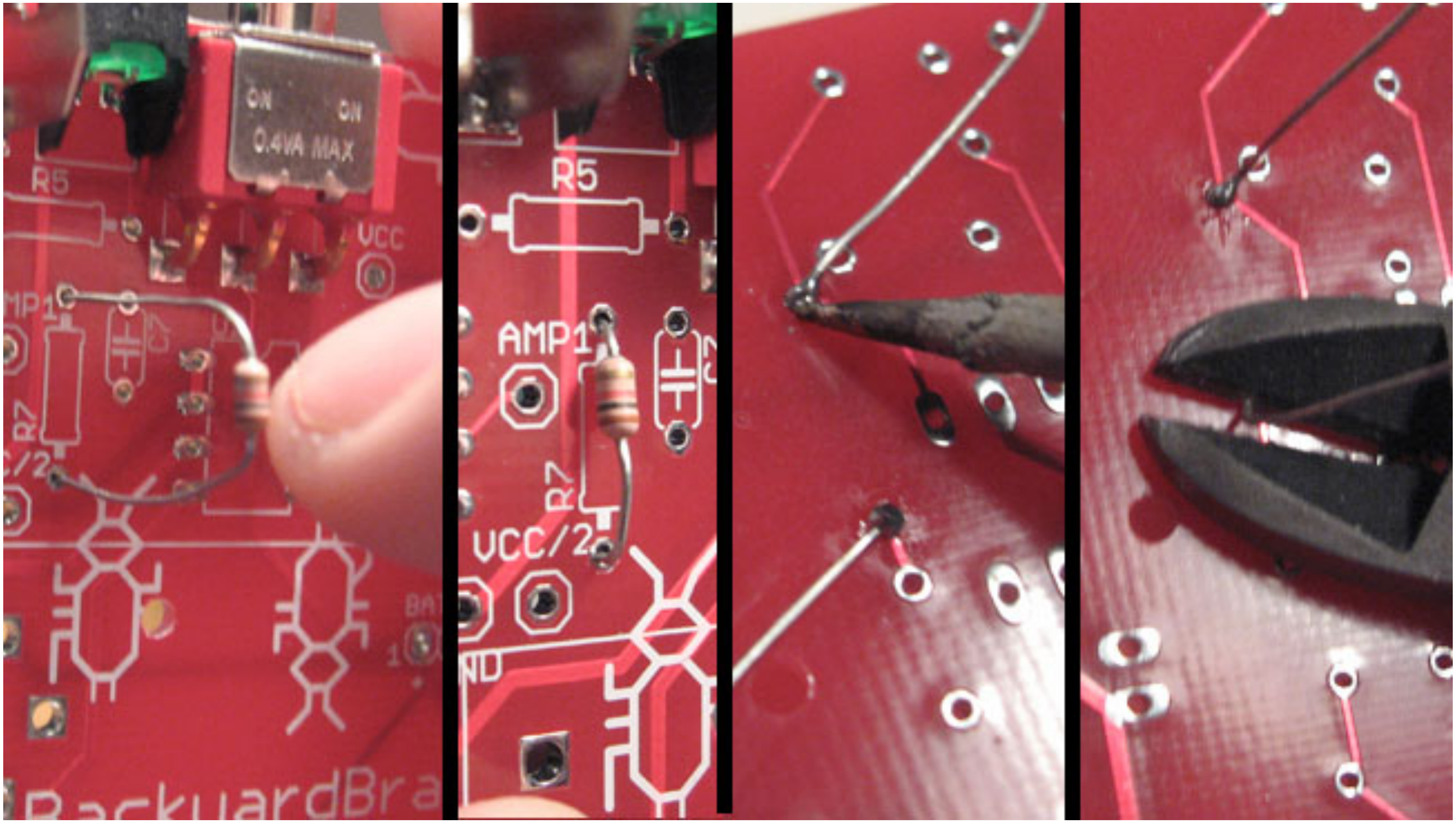
Source: Live Recording from Poster at SFN 2011


Backyard

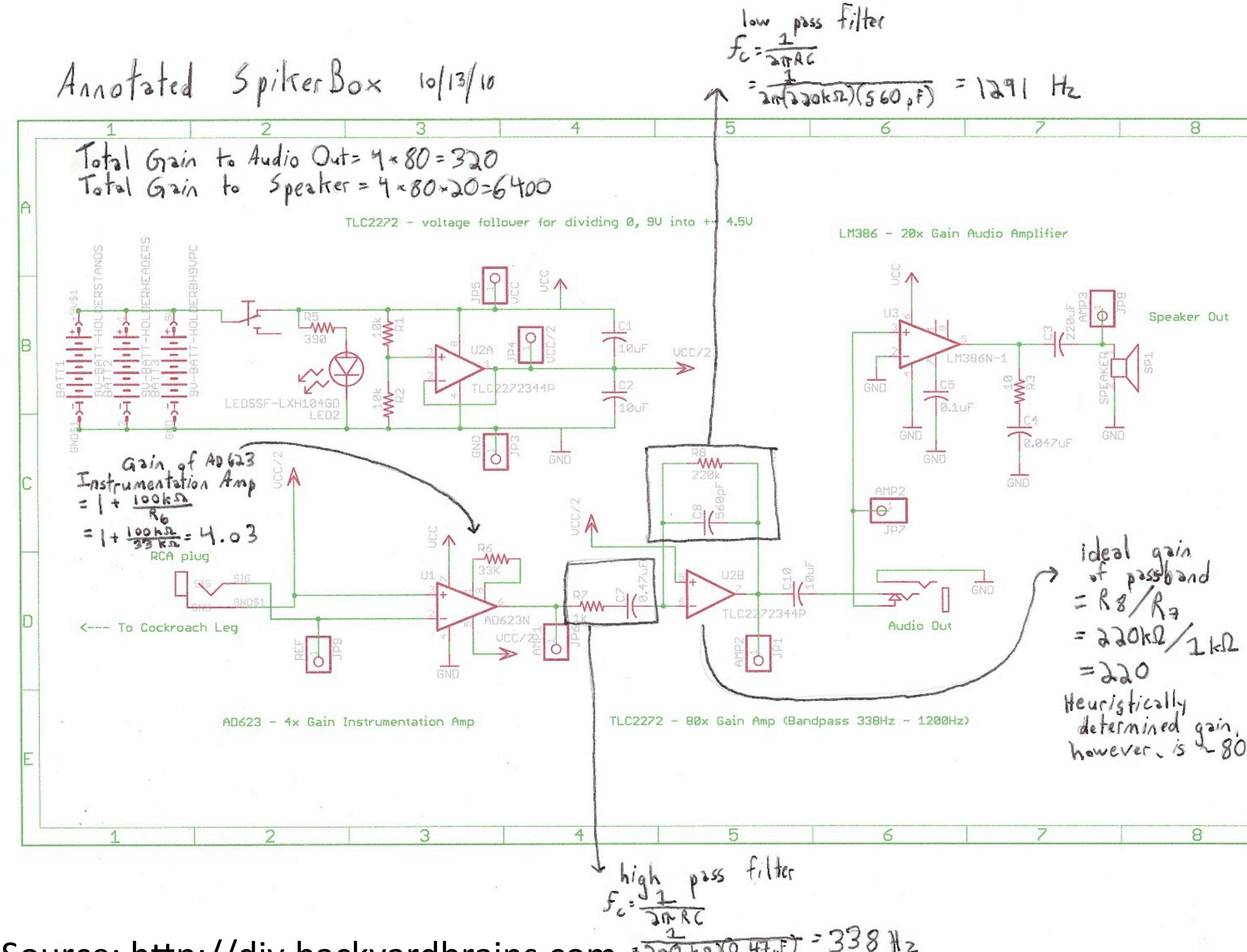

a
1cm
Ground
1
2
b
1
4 ms
2



R5 = 390
C7=0.47uF
R8 = 220k
C10 = 10uF
There are a few empty slots. That's OK!
C8 = 560pF
R7 = 1k
Speaker Holder
R6 = 33k
C1/C2 = 10uF
C3 = 220uF note polarity
C5 = 0.1uF
R1/R2 = 10 k
I solder these with the battery on it, to make sure they are straight.
C4 = 0.047uF
R3=10

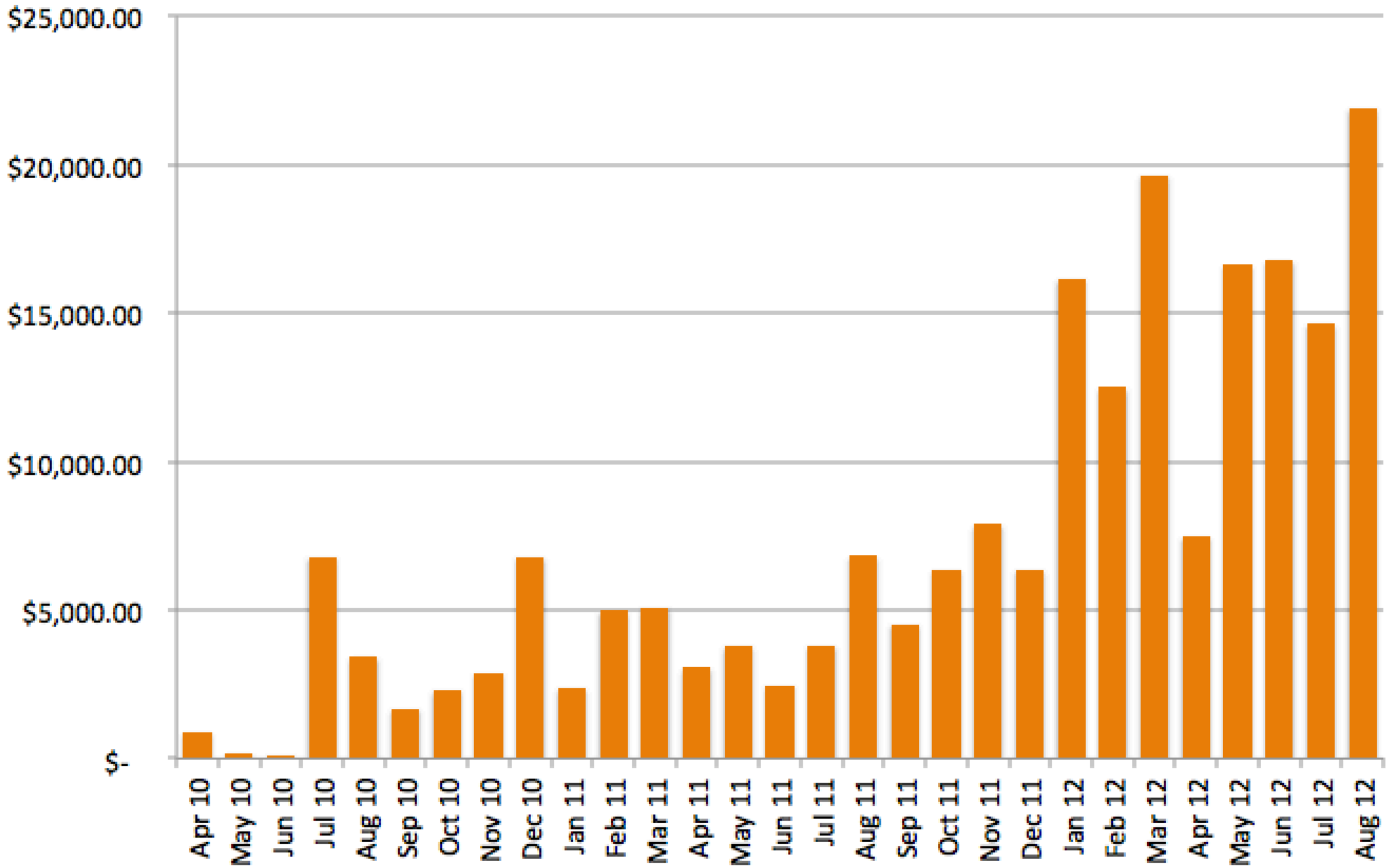


Source: http://diy.backyardbrains.com

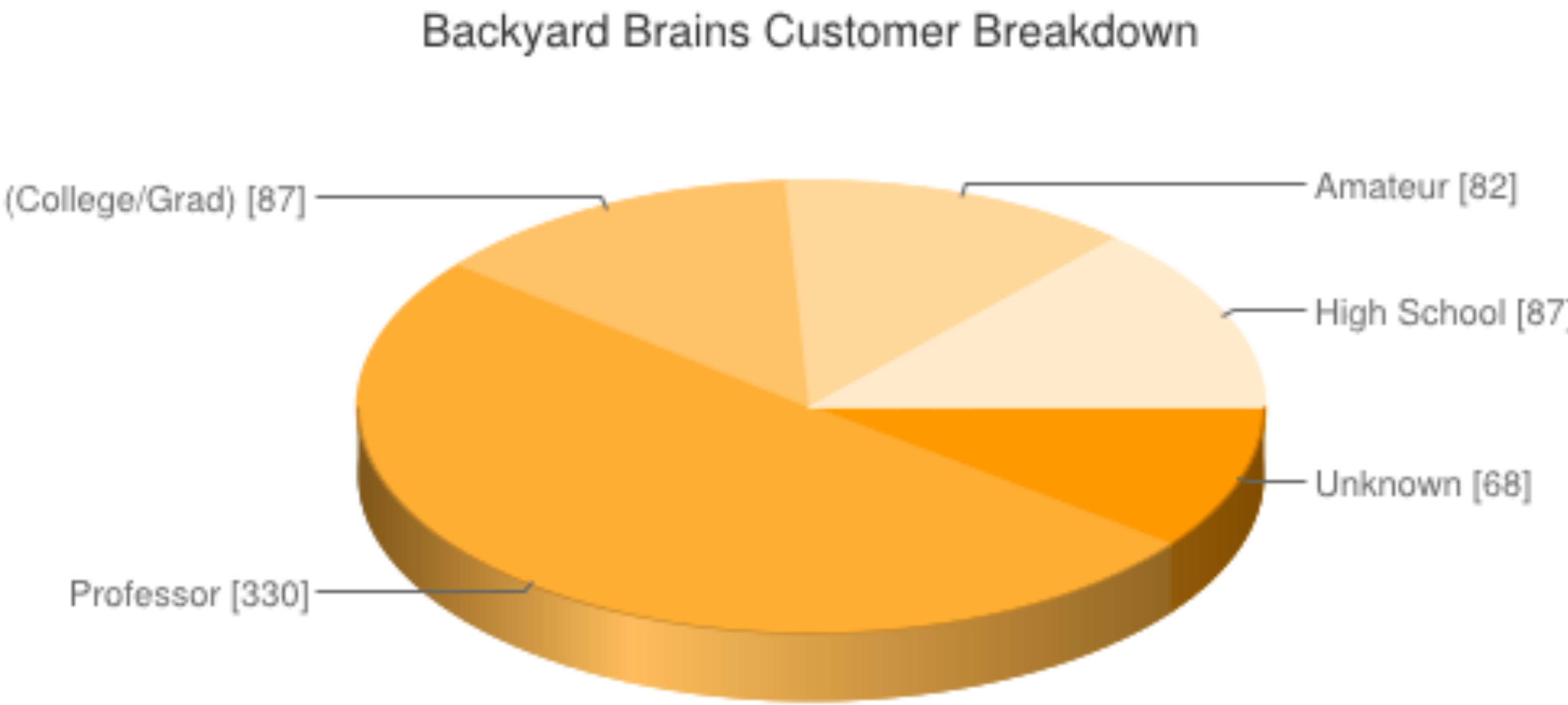


Source: http://diy.backyardbrains.com

Open Finances – Monthly Sales



Source: http://finance.backyardbrains.com



Source: http://finance.backyardbrains.com

Source: http://maps.backyardbrains.com


Production
Teddy
Illustrator
Christina
Developer
Nate
Education
Andre
Engineer
Tim
Education
Jen
Engineer
Greg
PAD
Drawing

- Raised over $610,000 in Grant Funding
  - NIH SBIR – Kaufman Foundation
  - TED Fellowship – Start Up Chile
- Sales! Over $215,000 in Revenue
- Sold over 2,000 SpikerBoxes
- First Publication in 2012: PLoS One
  - Crowd sourced publication fee ($1,350)