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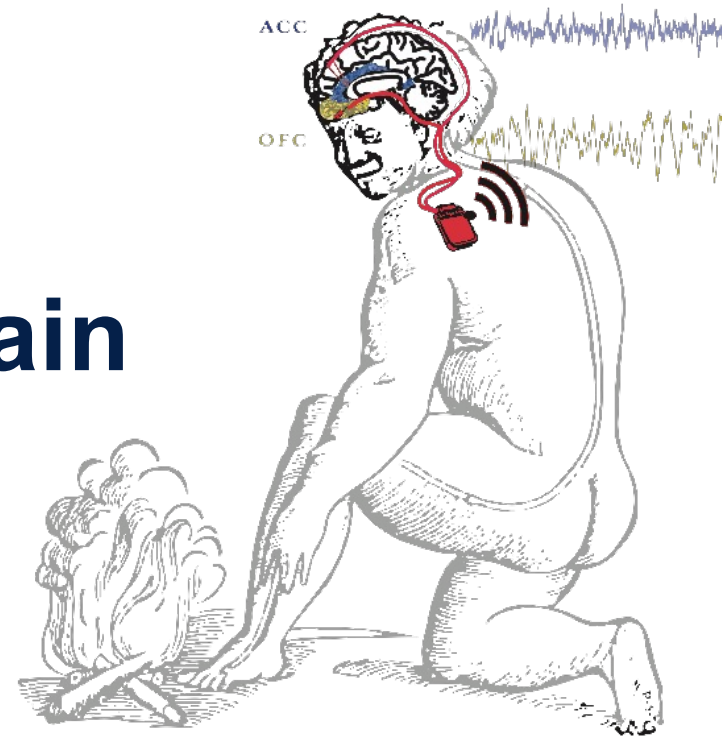
Personalized Brain Stimulation for Chronic Pain

A Scientist's and Patient's Story

Prasad Shirvalkar MD, PhD
Associate Professor, Anesthesiology,
Neurology and Neurological Surgery

Edward Mowery
Husband, Musician,
Clinical Trial Participant

2/9/2024



New Cases of Chronic Pain Outnumber Those of Diabetes or Depression, Study Shows

Research from the N.I.H. illustrates how persistent and pervasive the condition is across the United States.

Original Investigation | Neurology

May 16, 2023

Estimated Rates of Incident and Persistent Chronic Pain Among US Adults, 2019-2020

Richard L. Nahin, MPH, PhD¹; Termeh Feinberg, MPH, PhD²; Flavia P. Kapos, DDS, MS, PhD³; [et al](#)

[» Author Affiliations](#) | [Article Information](#)

JAMA Netw Open. 2023;6(5):e2313563. doi:10.1001/jamanetworkopen.2023.13563

Pain as the 5th vital sign?

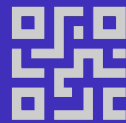


But there is no objective measure of pain!

OUTLINE



Pain is in the Brain



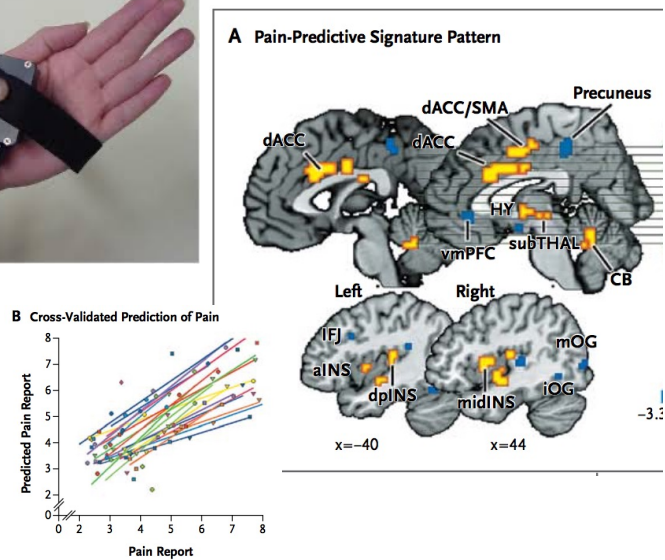
Decoding Chronic Pain



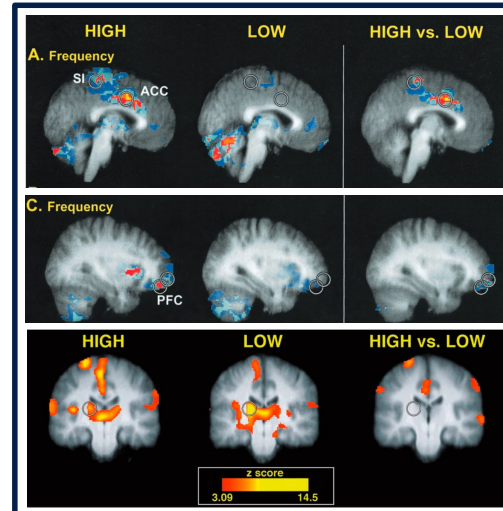
Closed loop DBS for pain

Pain is in the BRAIN.

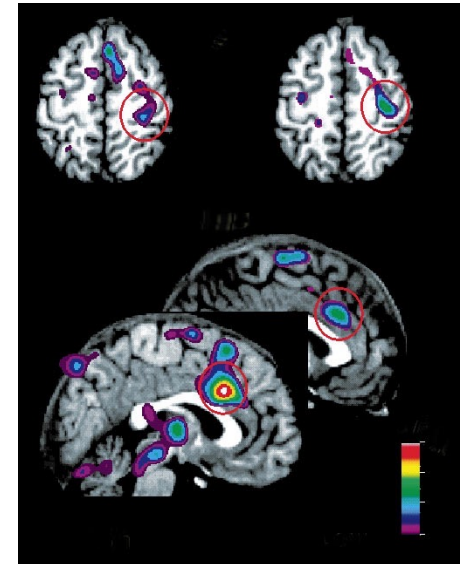
Heat pain testing



Wager et al., NEJM 2013

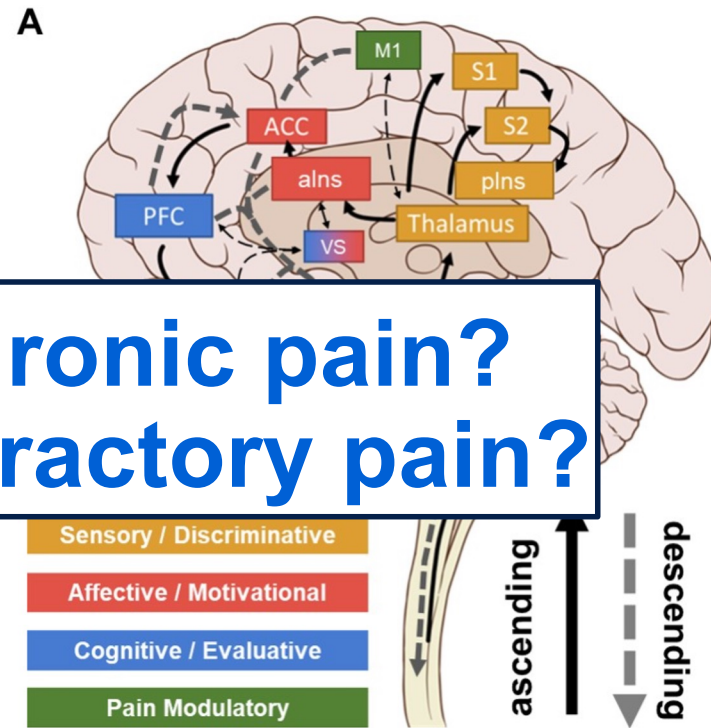
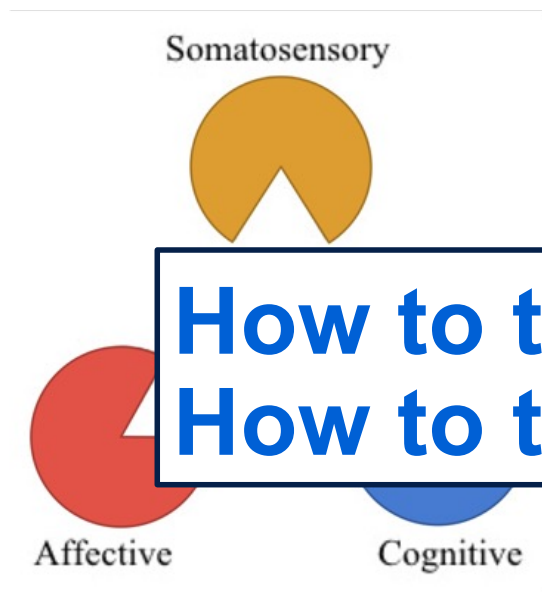


Coghill et al., PNAS 2003



Rainville et al., Science 1997

Chronic Pain Has Multiple Dimensions distributed brain-wide

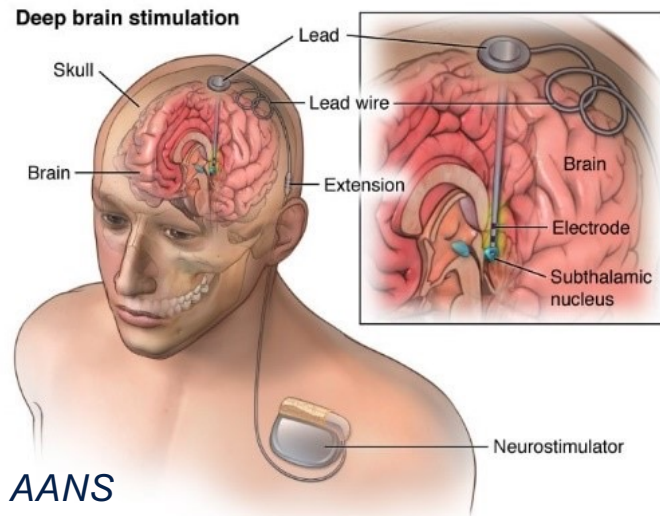


**How to track chronic pain?
How to treat refractory pain?**

Inspired by Melzack and Wall (1965)

Motzkin J, Kanungo I, et. al., *Frontiers in Pain Research*, 2023

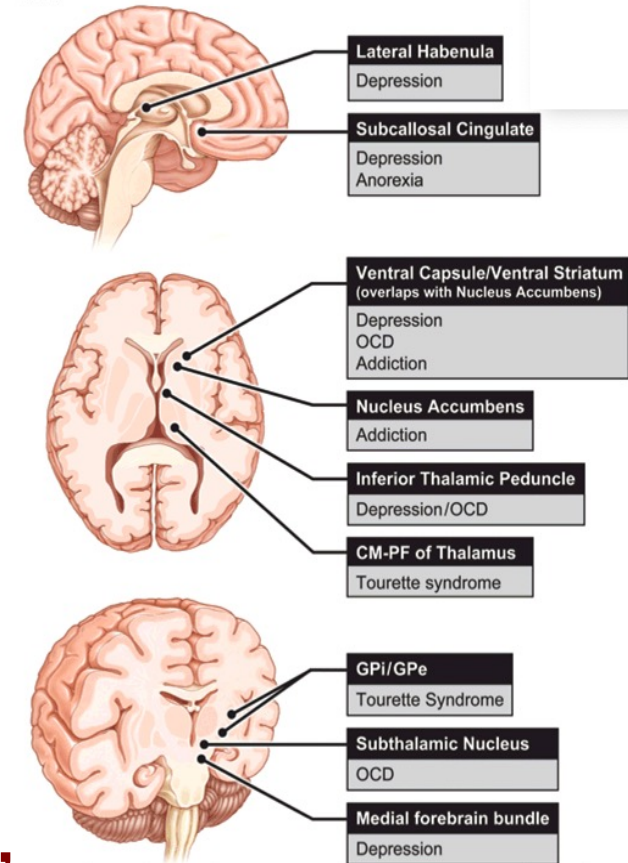
Deep Brain Stimulation is an established tool for other disorders



FDA Approved for

- Parkinson's Disease
- Essential Tremor
- Dystonia
- Epilepsy
- OCD (HUD)

FIG. 1.



Cleary et al., JNS 2015

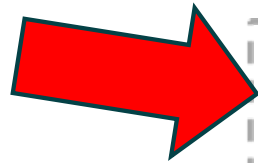
Pain is the oldest studied disease for DBS, but we still lack effective targets.

Main Problems with Pain DBS:

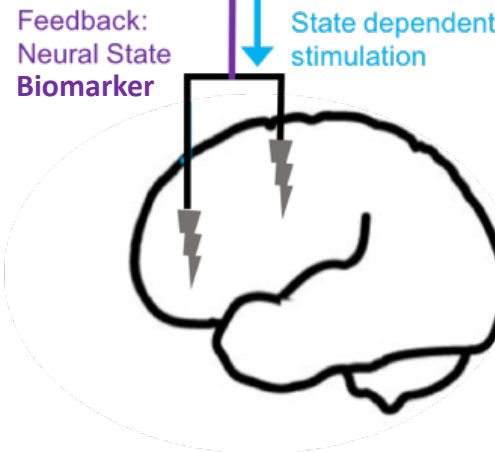
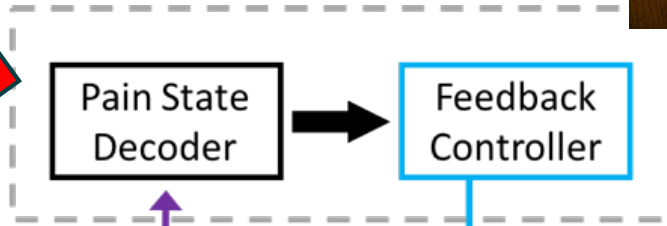
1. Many patients are failed by all available therapies.
2. Effective targets for Pain DBS are unknown.
3. Targets that work for some individuals lose effect over time.

Our Solution / Goal:

Can we identify chronic pain biomarkers?



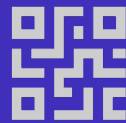
Closed-Loop Controller



OUTLINE



The holy grail of pain is the brain



Decoding Chronic Pain



Closed loop DBS for pain

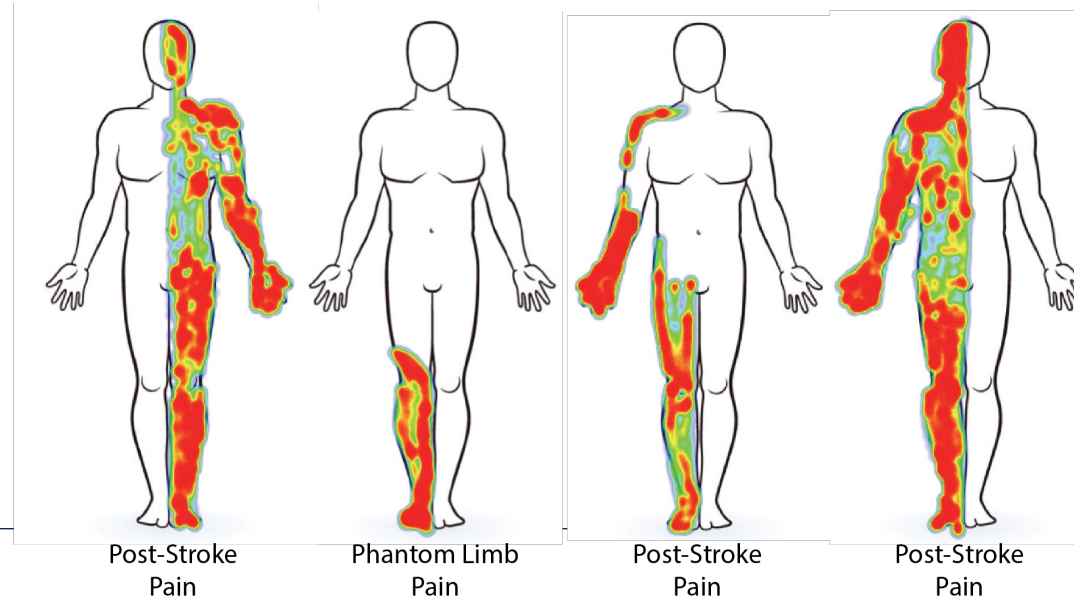
First-in-human prediction of chronic pain state using intracranial neural biomarkers

Received: 13 April 2021

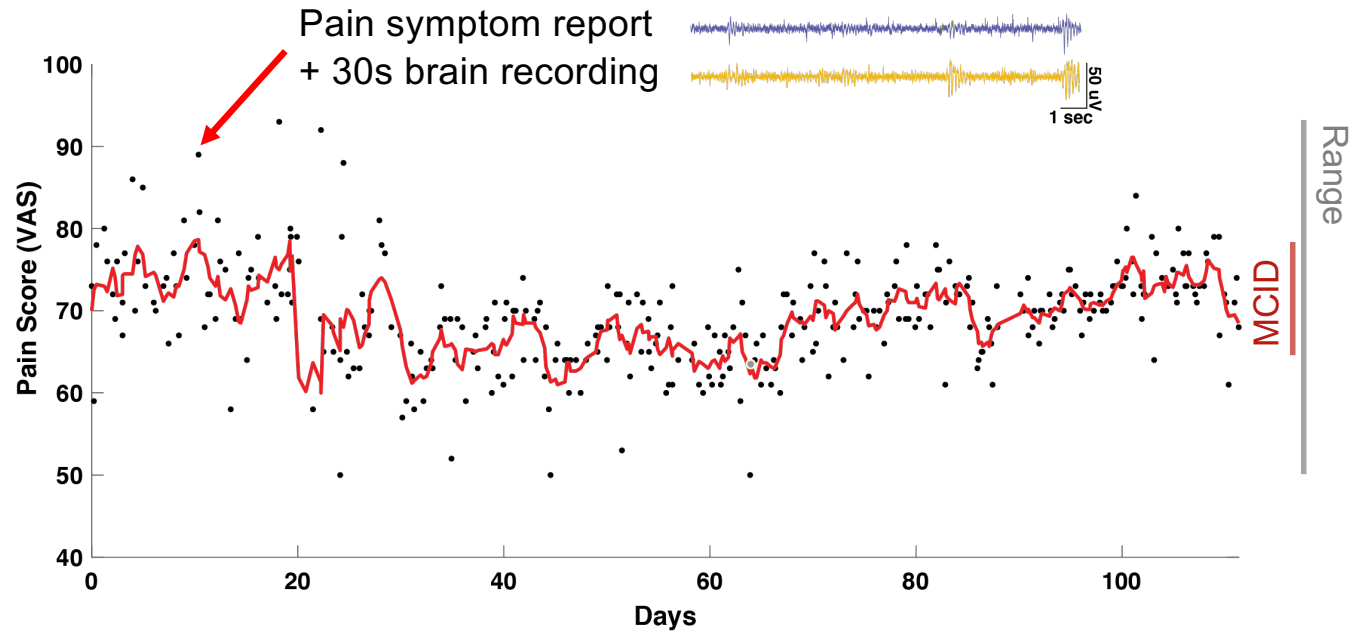
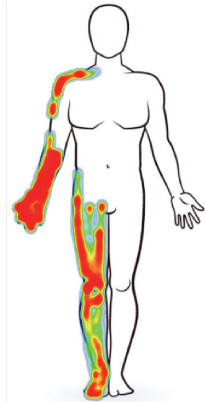
Accepted: 18 April 2023

Published online: 22 May 2023

Prasad Shirvalkar^{1,2,3,4}✉, Jordan Prosky^{3,4}, Gregory Chin³,
Parima Ahmadipour⁵, Omid G. Sani⁵, Maansi Desai⁶, Ashlyn Schmitgen^{3,4},
Heather Dawes^{3,4}, Maryam M. Shanechi⁵, Philip A. Starr^{3,4,7} &
Edward F. Chang^{3,4,7}

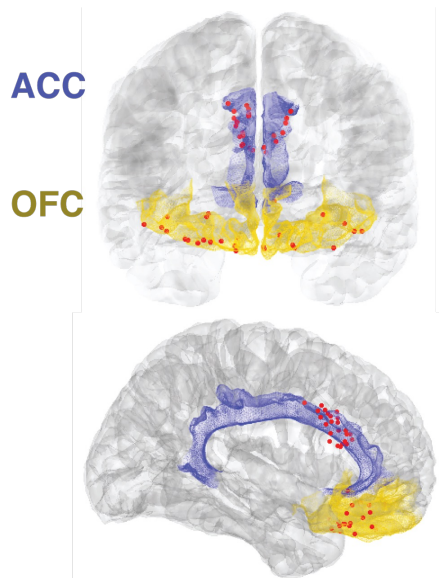


At-home measurements of real-world chronic pain symptoms and brain signals

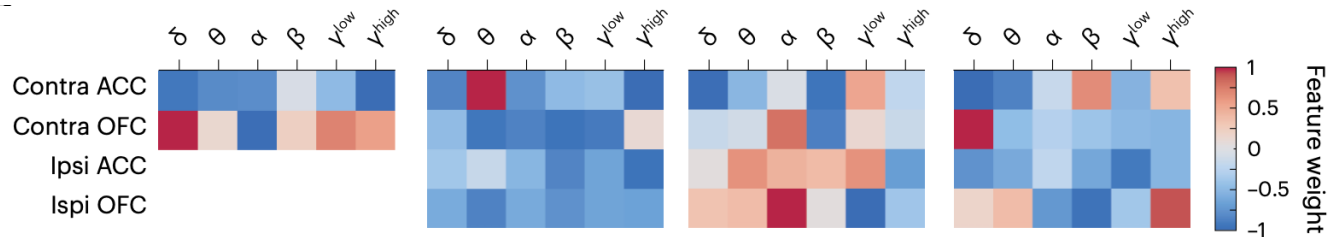
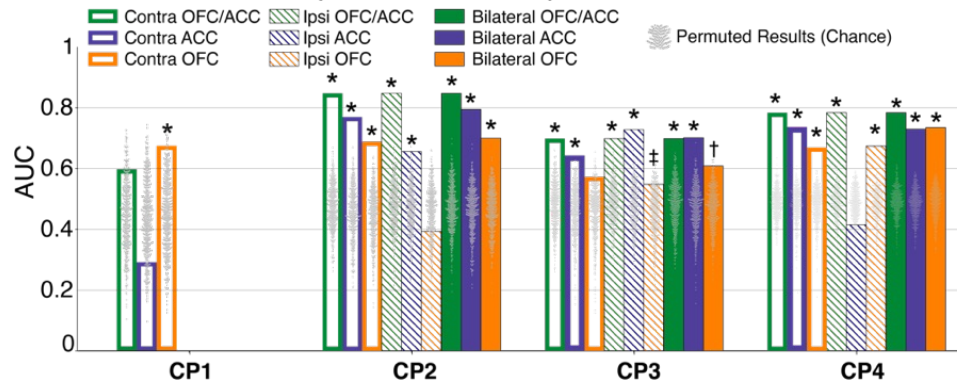


Shirvalkar et al.
2023 *Nat Neuro*

Direct brain measurements track personalized pain severity at-home



D LDA Classification (Chronic Pain NRS)



Biomarkers for chronic pain

- Direct brain signals at home can track clinical, chronic pain state.
-
- Biomarkers should not be used to undermine or confer distrust of the patient's experience. (IASP 2023)
 - "Pain as defined by an individual is their ground truth." (Davis et al., 2020)
 - Instead, they can provide validation to pain that lacks any other objective correlate.

OUTLINE



The holy grail of pain is
the brain



First-in-human decoding
of Chronic Pain State



Next-Generation Closed loop
DBS for pain

Participant Highlight

Edward Mowery
(aka RCS05)

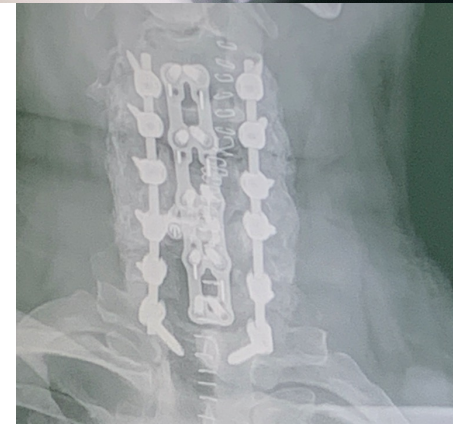
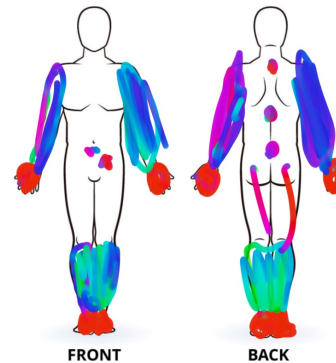
51 y/o man, heavy metal musician from New Mexico with chronic pain since age 15

Pain History:

- Lifetime total 32 surgeries
- Sharp, stabbing, burning over whole body
- Pain worse in 2016, diagnosed with CRPS
- Trouble walking, sleeping, taking care of IADLs.

Treatment history:

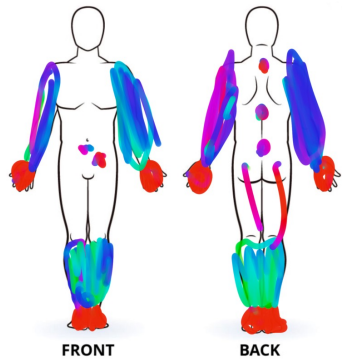
- Failed by >20 different medications across 5 classes
- Steroid Injections
- Physical therapy, intensive pain psychology
- Spinal Cord Stimulation



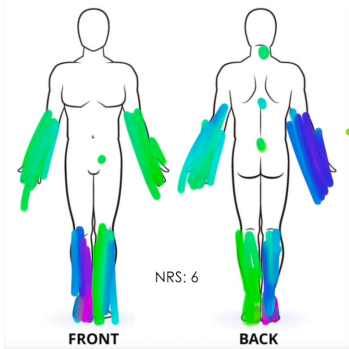
JUNE 2021 – Inpatient Brain Stimulation Mapping



JUNE 2021 – Inpatient Brain Stimulation Mapping



Baseline



Stimulation Testing
over 10 days

Real Time Closed Loop DBS for Pain

RCS05

Real-Time Closed-Loop
Brain Stimulation Responds
to Pain in Toes

February 5, 2024



In his own words...

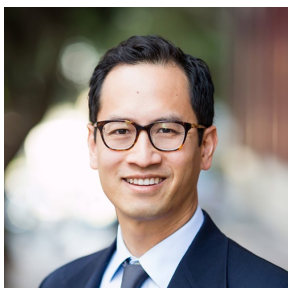


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San Francisco

Thank you!



Prasad Shirvalkar, MD, PhD
Principal Investigator



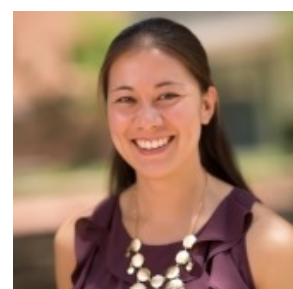
Edward Chang, MD
Co-investigator



Philip Starr, MD, PhD
Co-investigator



Lawrence Poree
MD PhD MPH
Mentor



Kristin Sellers, PhD
Asst Adj Professor

Postdoc / Grad Fellows



Julian Motzkin, MD, PhD



Tom Wozny, MD



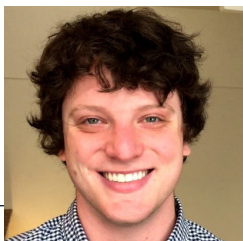
Chad Sitgraves, MS



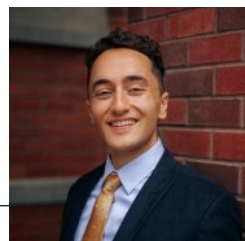
Joanna Lin



Ishan Kanungo
MD candidate



Jeremy Saal
PhD candidate



Ryan Leriche



Andreea Seritan, MD
Psychiatrist

• Patients Living with Chronic Pain

- Heather Dawes, PhD
- Howard Fields, MD, PhD
- Andrew Krystal, MD, PhD
- Niko Schiff, MD
- Vikram Rao, MD PhD
- Daniel Lu MD, PhD
- Cynthia Kubu, PhD
- Joshua Kuluva, MD

UF-Gainesville

- Cora DeHemptinne, PhD
- Jackson Cagle, PhD

USC

- Omid G. Sani, PhD
- Parima Ahmadipour
- Maryam M. Shanechi, PhD

