

# Tuning Your Mood with Transcranial Ultrasound

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1. The University of Arizona 2. Center for Consciousness Studies. 3. Berkeley Ultrasound

## Summary

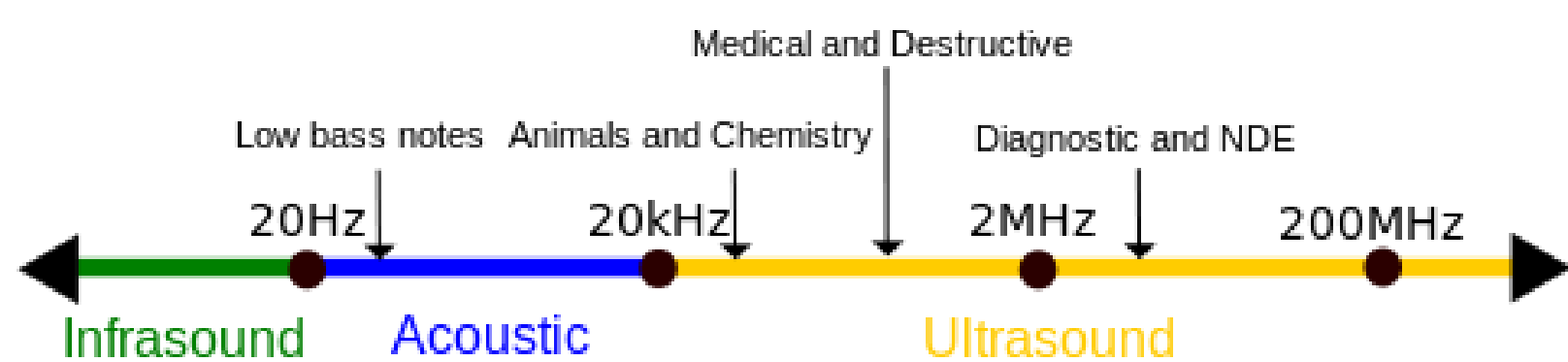
Ultrasound is mechanical vibrations (20 KHz to MHz), safely used in medical imaging.

Low megahertz (< 10 MHz) penetrates the skull and can modulate brain activity [1] – Transcranial Ultrasound (‘TUS’)

At low intensity TUS is a painless and safe noninvasive brain stimulation tool.

In humans, brief (30 seconds) low intensity TUS to right frontal cortex enhances mood [1,2].

We published the first human TUS study, and have studied TUS effects on over 200 subjects without significant side effects [1].



## Background

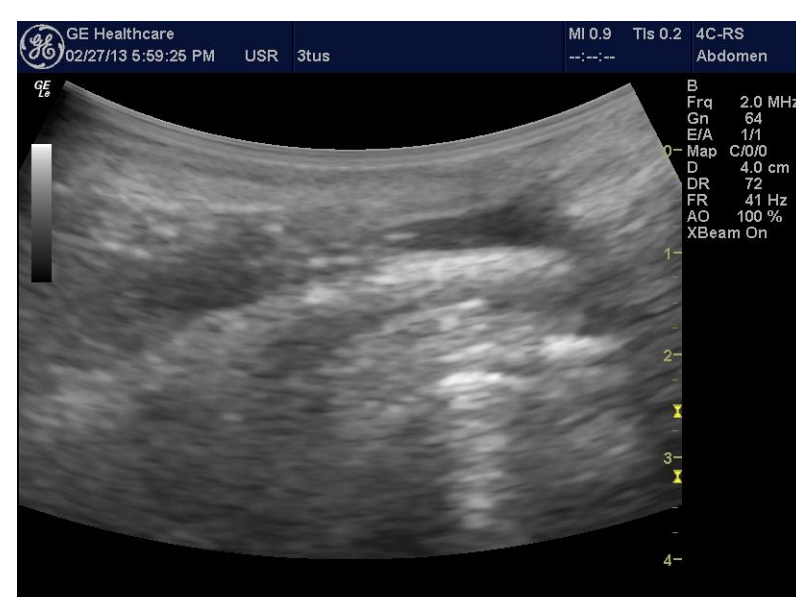
TUS influences neural activity;  
research dating to early 1929 [3].

**Bold signal [4] and electrophysiological potentials [5] can be modulated with TUS in animals.**

Hameroff et. al [1] reported that transcranial ultrasound (TUS) affected pain and mood in chronic pain patients.



**Here, we asked whether TUS with an imaging device can modulate mood by targeting “mood areas” (right prefrontal cortex) in the brain.**



## References

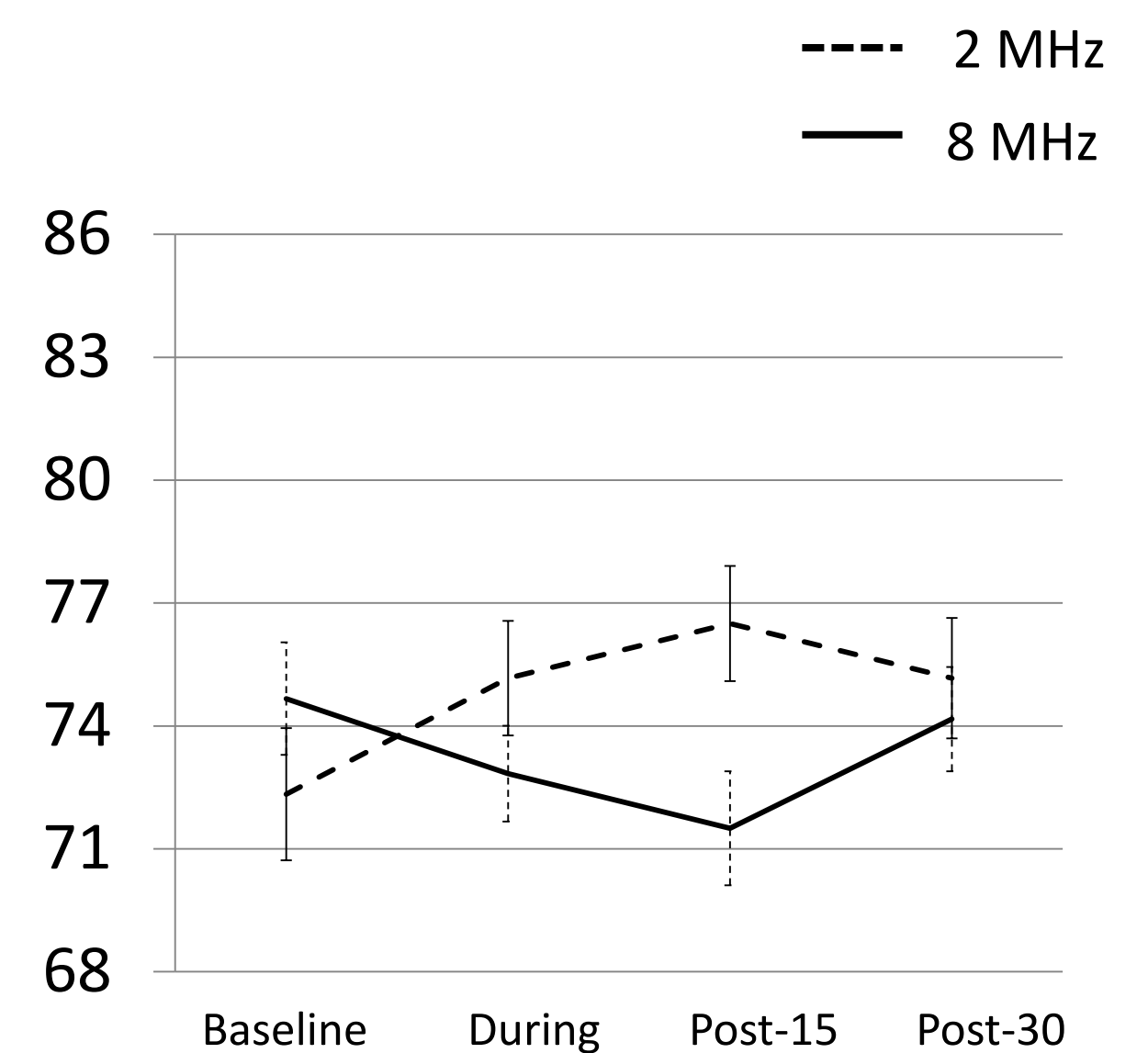
- [1] Hameroff et al., (2012). *Brain Stim*, 6(3):409-415  
 [2] Sanguinetti et al. (2014) Society for Psychophys.  
 [3] Harvey. (1929) *Am J Physiol*, 91(1):284-90.  
 [4] Yoo et al. (2011) *Neuroimage*.56. 1267–1275.

- [5] Legon et al. (2012) PLOS One. 7(12).  
[6] Pascual-Leone et al (1996) *Neurology*, 46(2), 499-502.  
[7] Leinenga & Götz (2015) Sci. Trans. Med.7.  
[8] Sahu et al. (2014) Scientific Reports. 7, 7303.

## Two Experiments

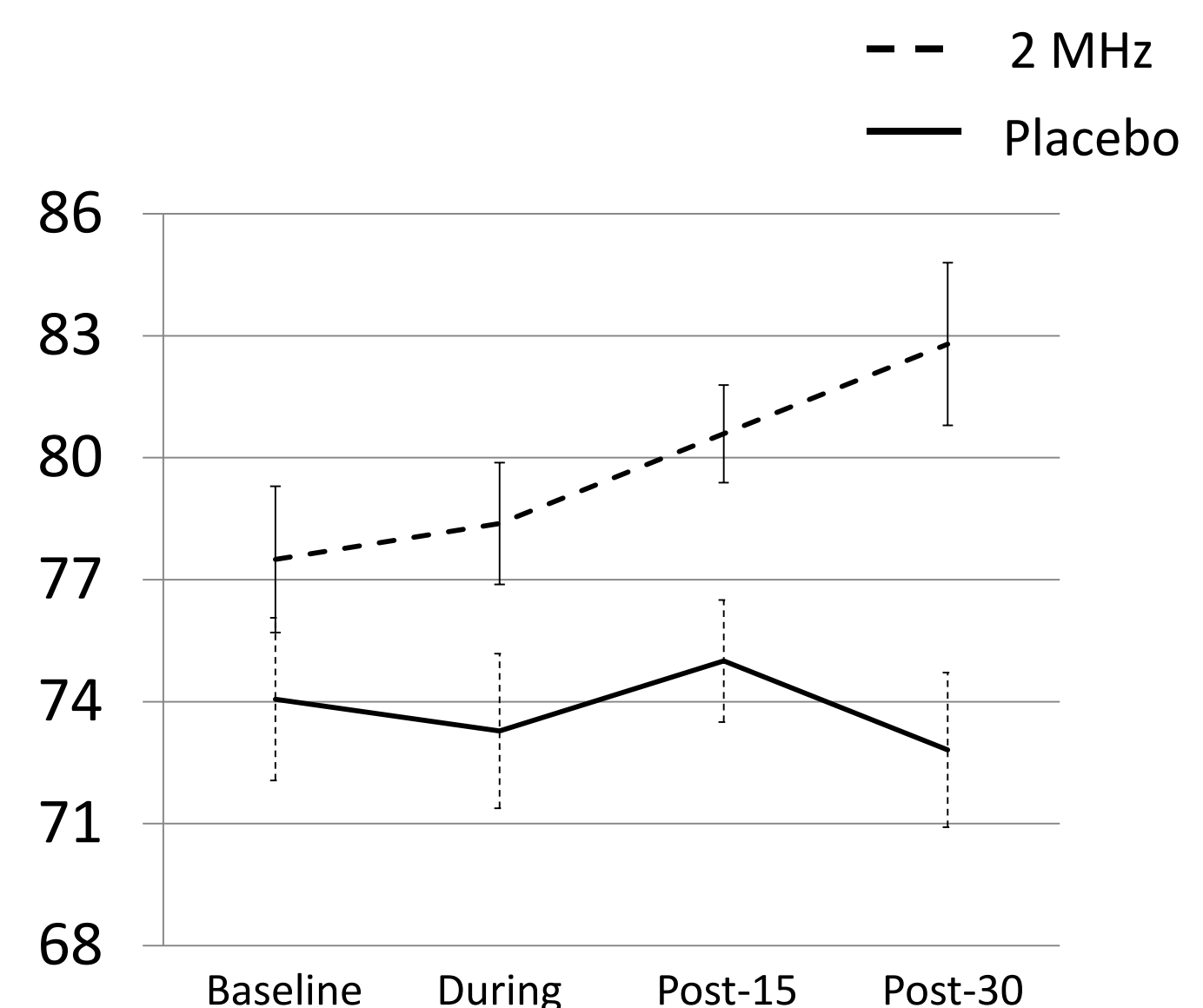
## Experiment 1

- 2 MHz vs 8 MHz; 15 seconds stimulation
- General Electric LOGIQe ultrasound
- Right frontal cortex
- Between subjects,  $n = 29$
- Measured self-reported mood



## Experiment 2

- 2 MHz vs Placebo, 30 sec. stimulation
- General Electric LOGIQe
- Right frontal cortex
- Between subjects, double blind, n = 33
- Measured mood



## Discussion

In over 200 human subjects at the University of Arizona, TUS has proven to be painless and safe.

In double blind studies, we've shown TUS to right frontal cortex for 30 seconds can improve mood for up to an hour or more [1]. (TMS stimulation to right frontal cortex also improves mood [6]).

The mechanism is unknown but might involve stimulating megahertz resonances [7] in microtubules in brain neurons and glial cells.

Ultrasound was recently shown to improve Alzheimer's symptoms and pathology in mice [8].

TUS could be useful for treatment [6] of various mental, cognitive and neurodegenerative disorders [7].