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Observational Study of Rhythmically Enhanced Music for Chronic Pain

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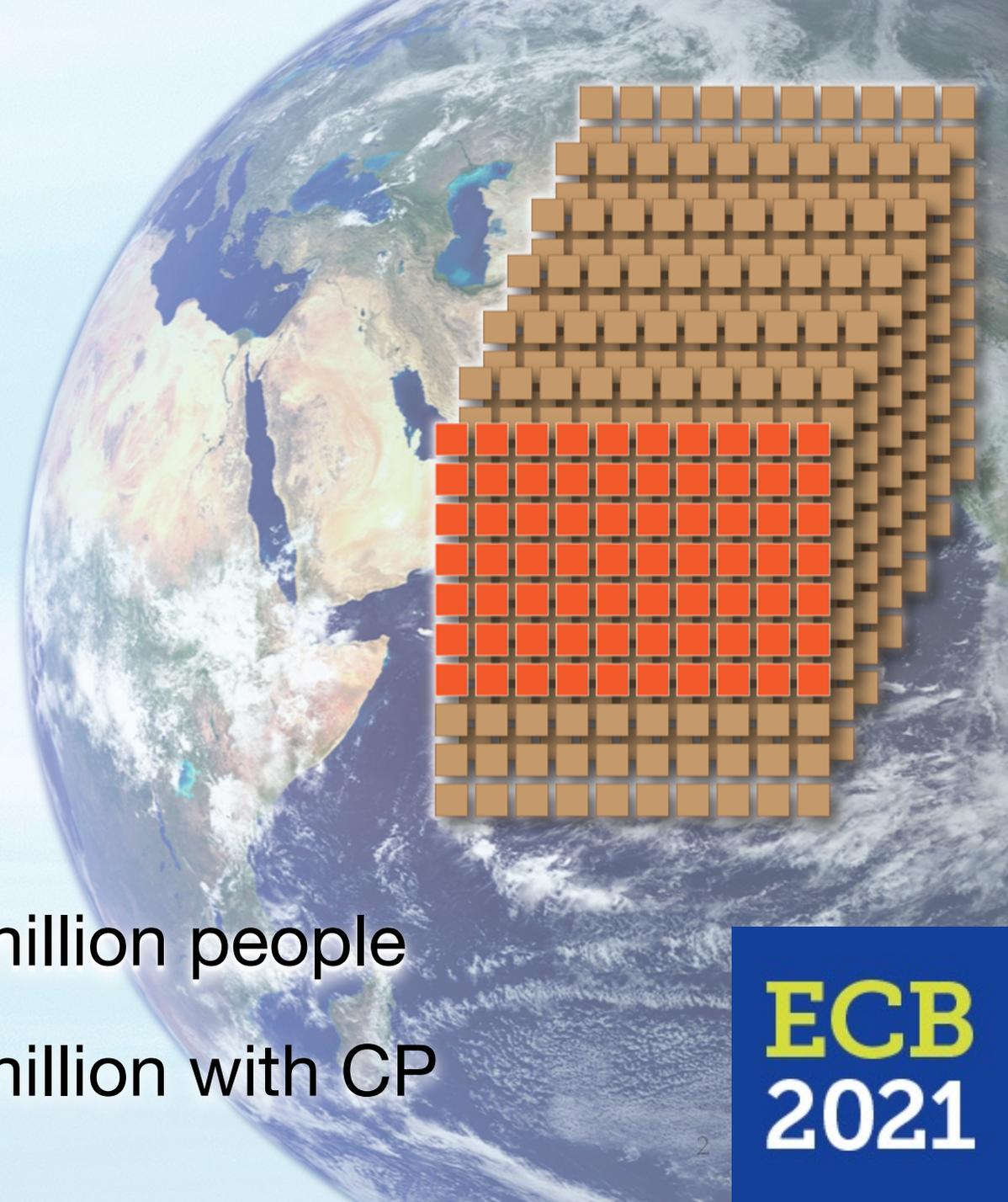
Keywords: chronic pain; music analgesia; brainwaves; isochronic beats

Chronic Pain Is a Silent Global Epidemic

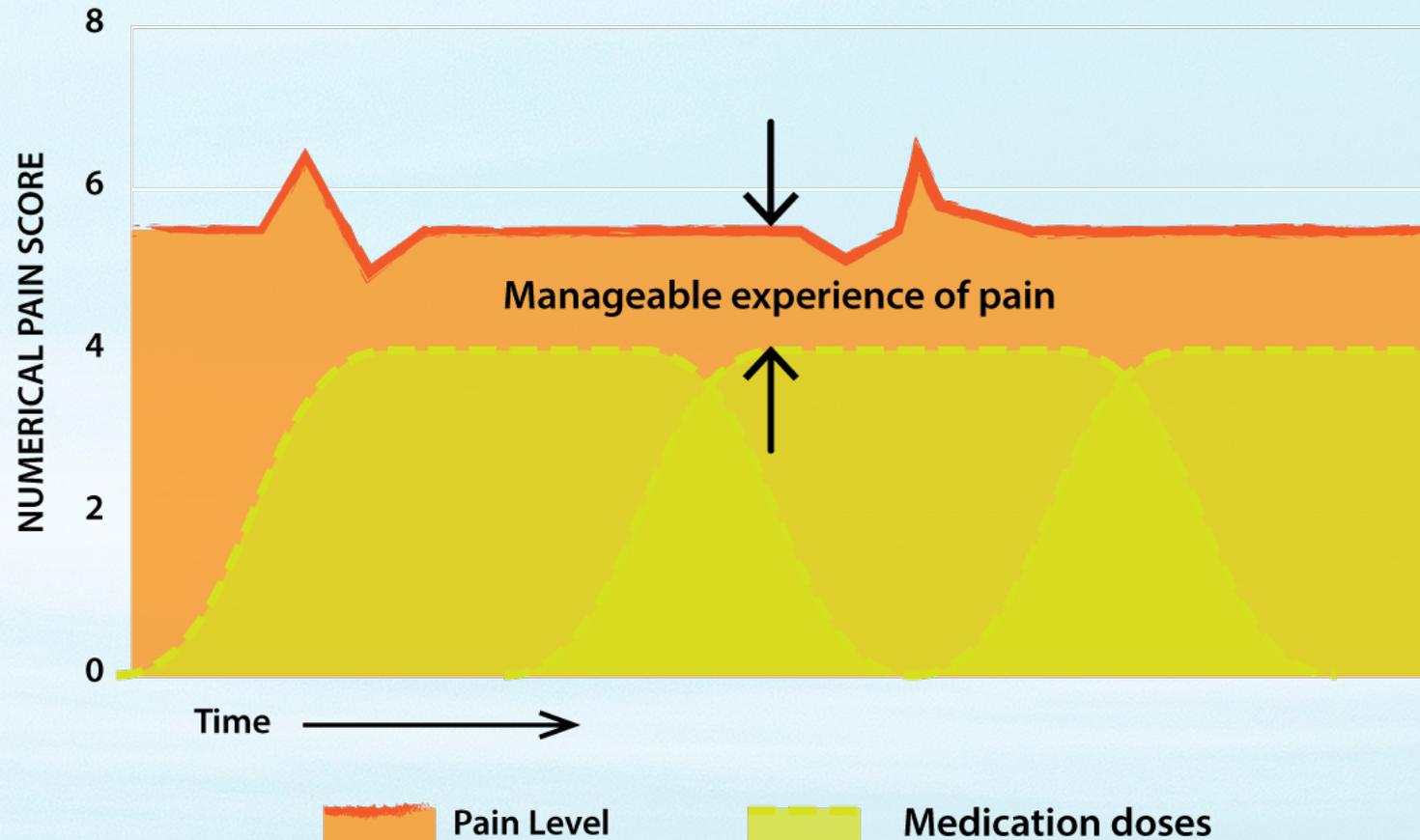
~10% of the world's
population experiences
some form of chronic pain

■ =10 million people

■ =10 million with CP

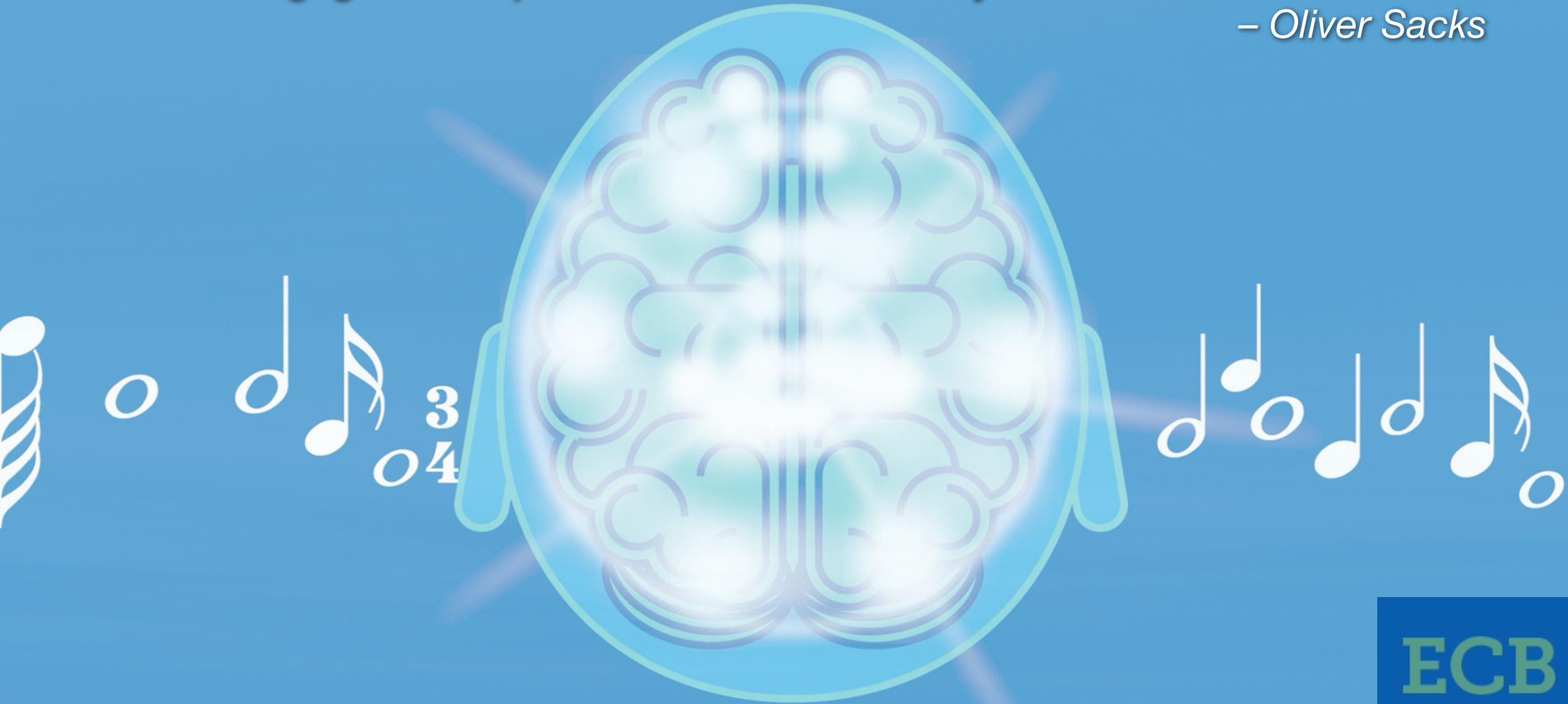


Opioids are common treatment for chronic pain, but have potential for addiction

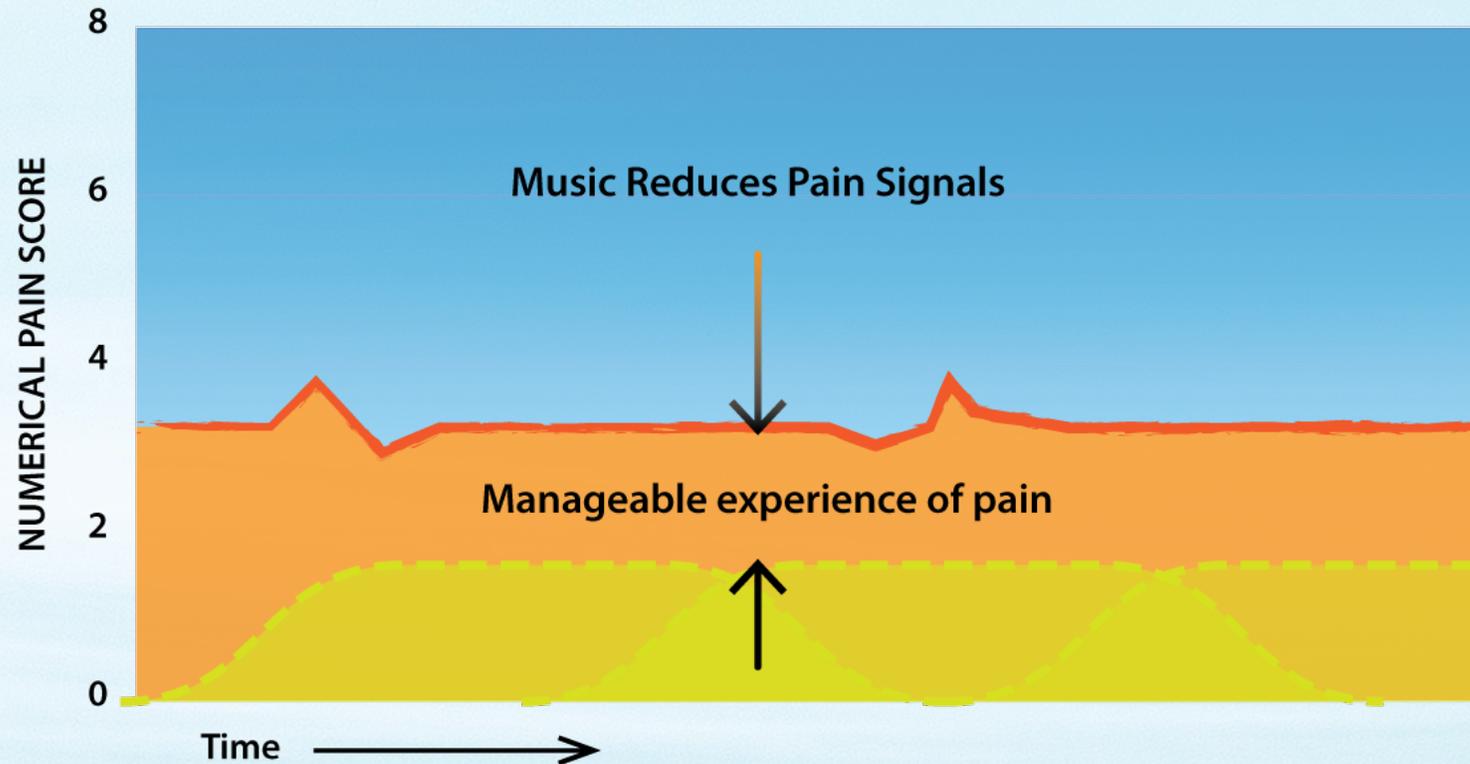


Music engages more parts of the brain than any other stimulus.

– *Oliver Sacks*



Music lowers pain signals, requires less medication to manage pain



Music medicine

Listening guided by practitioners



Less targeted but scalable to large populations.

Music therapy

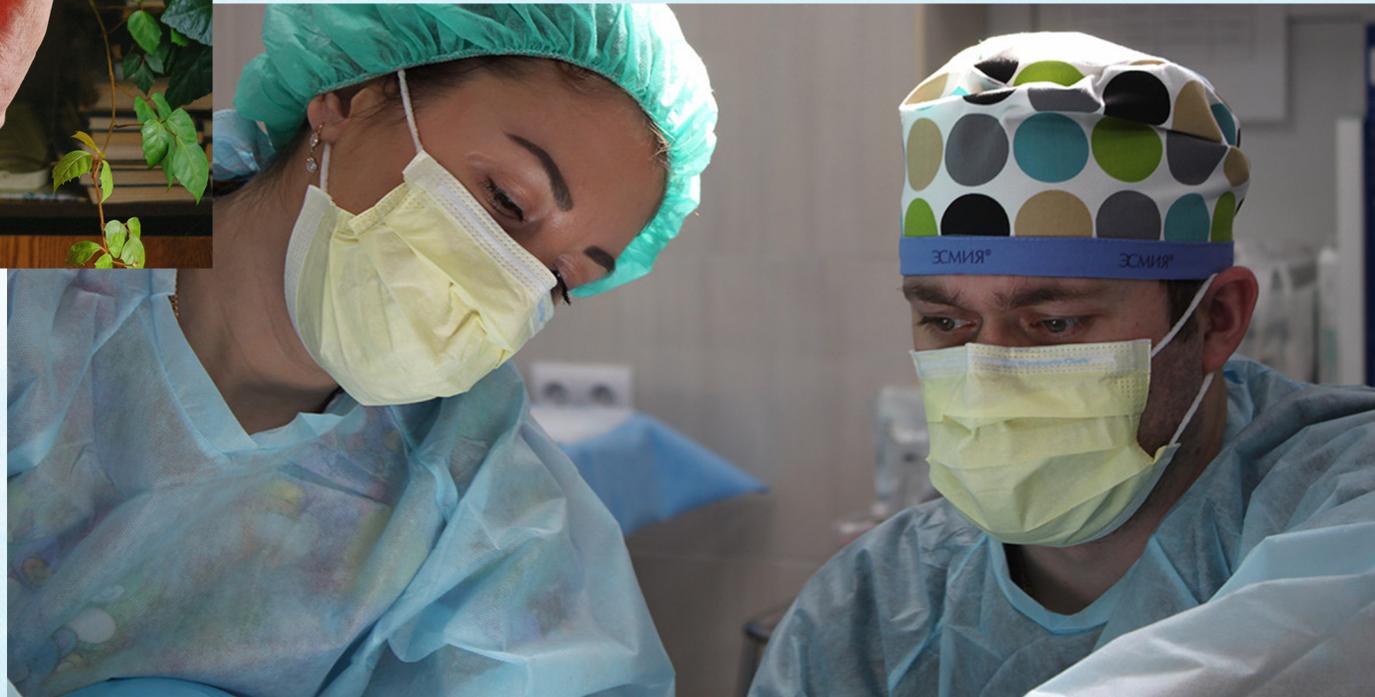
Provided one on one by licensed music therapists

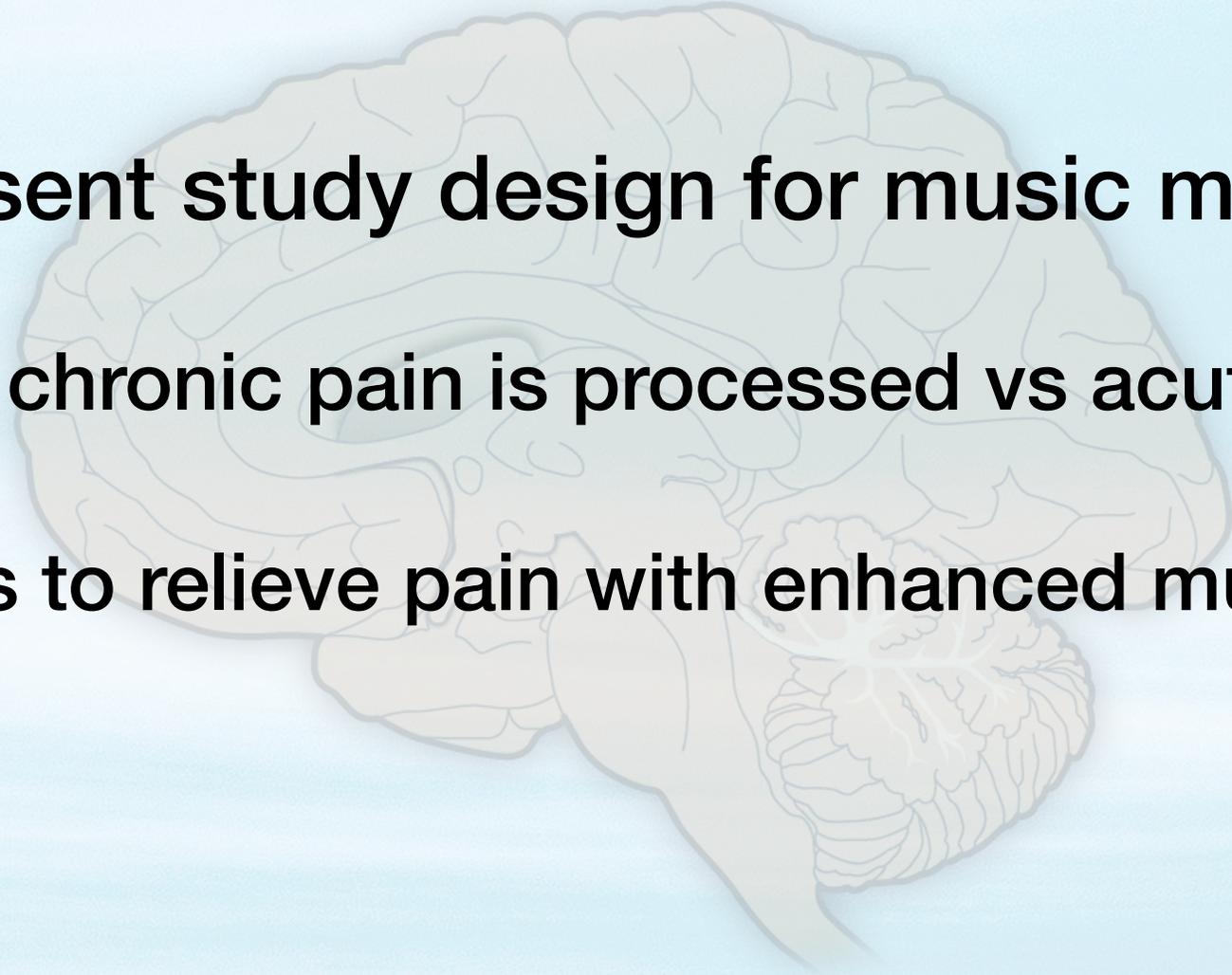


Effective, limited by logistics and economics



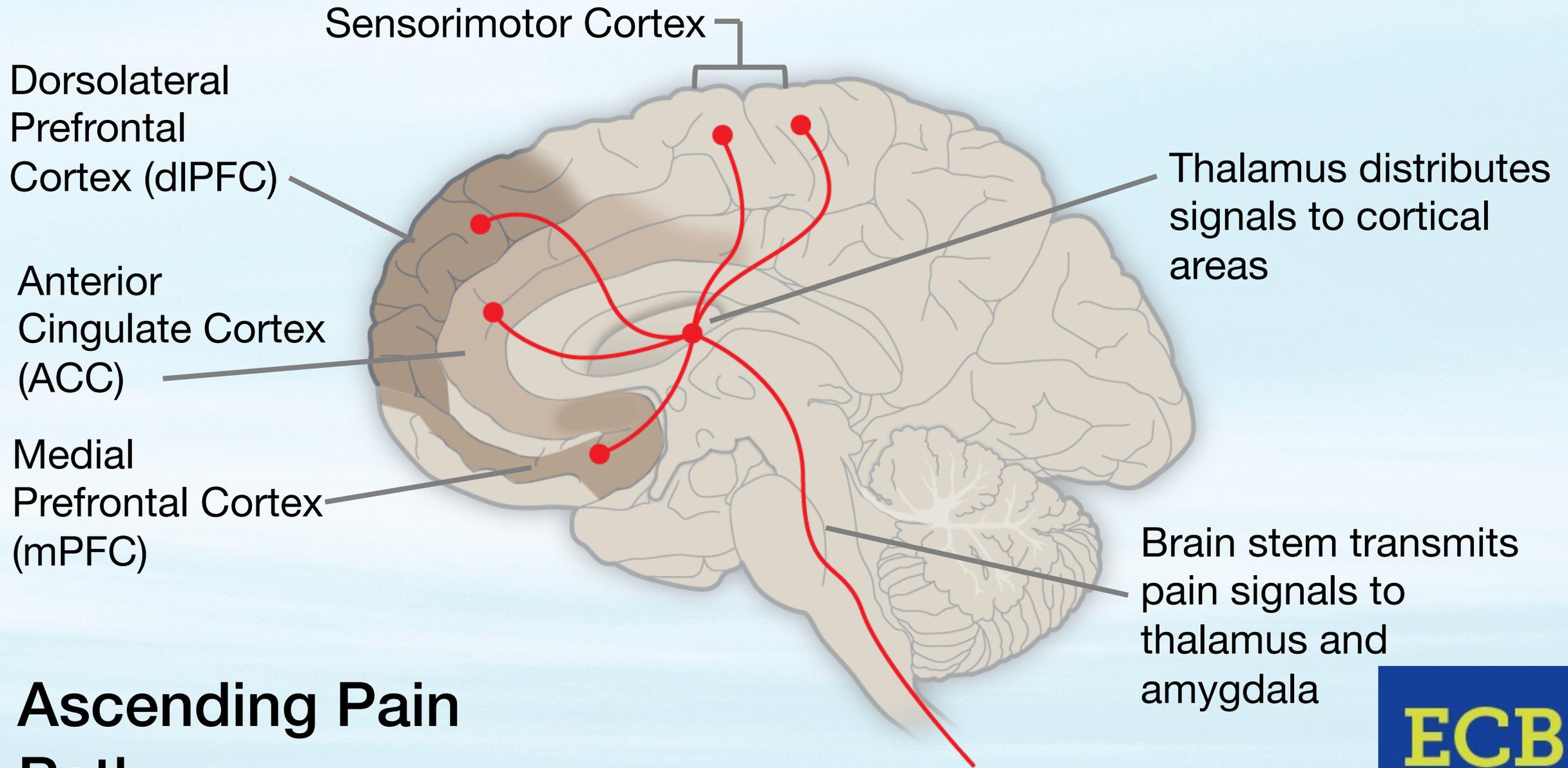
Music medicine can easily be delivered to those who can benefit from it, in many situations.





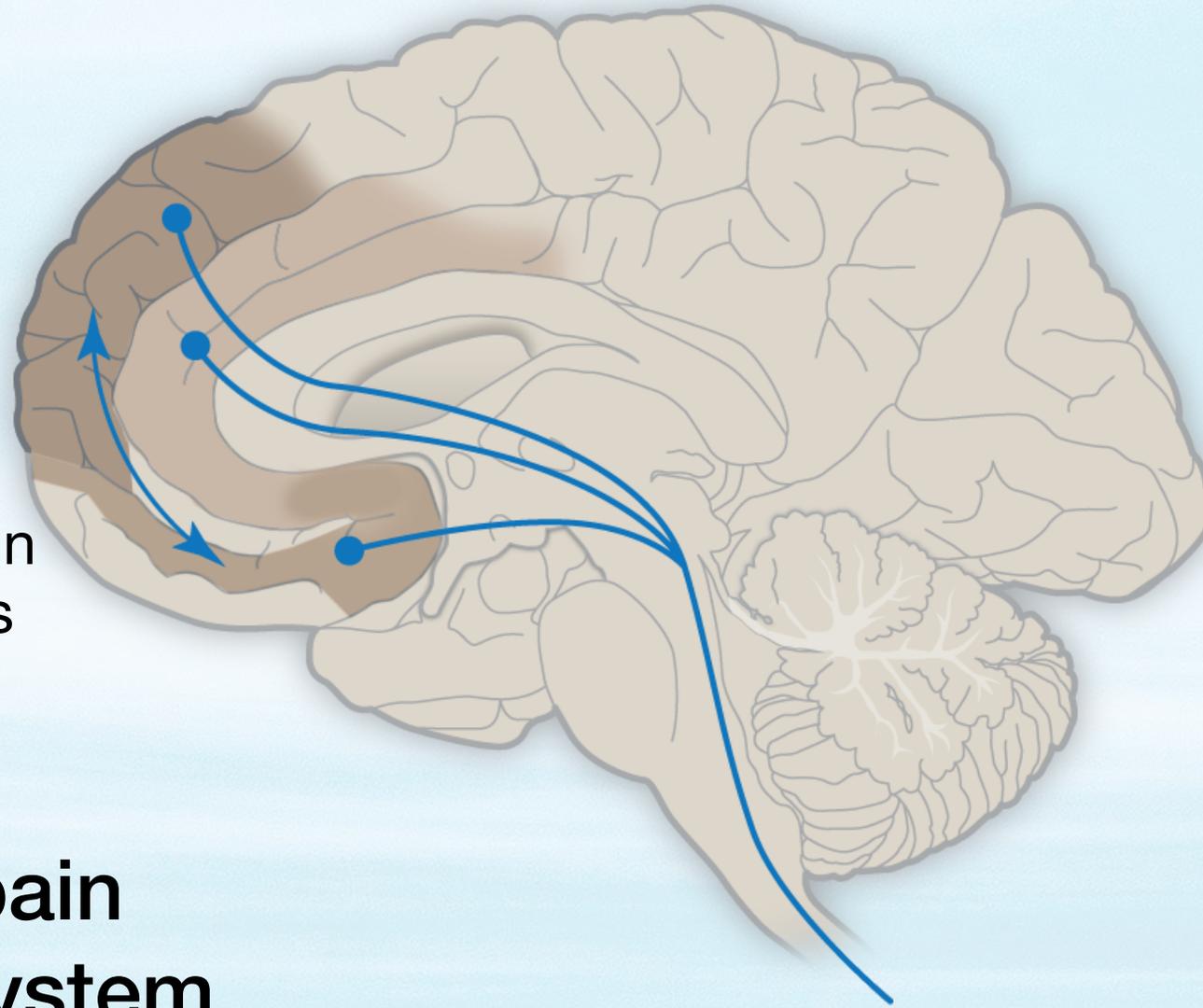
Present study design for music medicine

- 1. how chronic pain is processed vs acute pain**
- 2. ways to relieve pain with enhanced music**



Ascending Pain Pathway (Simplified)

In healthy conditions, dlPFC, mPFC interact to balance each other's activity, ACC modulates pain affect and emotions related to pain



Descending pain modulatory system (Simplified)

dIPFC: less brainwave synchrony, less activity

Loss of dIPFC/
mPFC balance

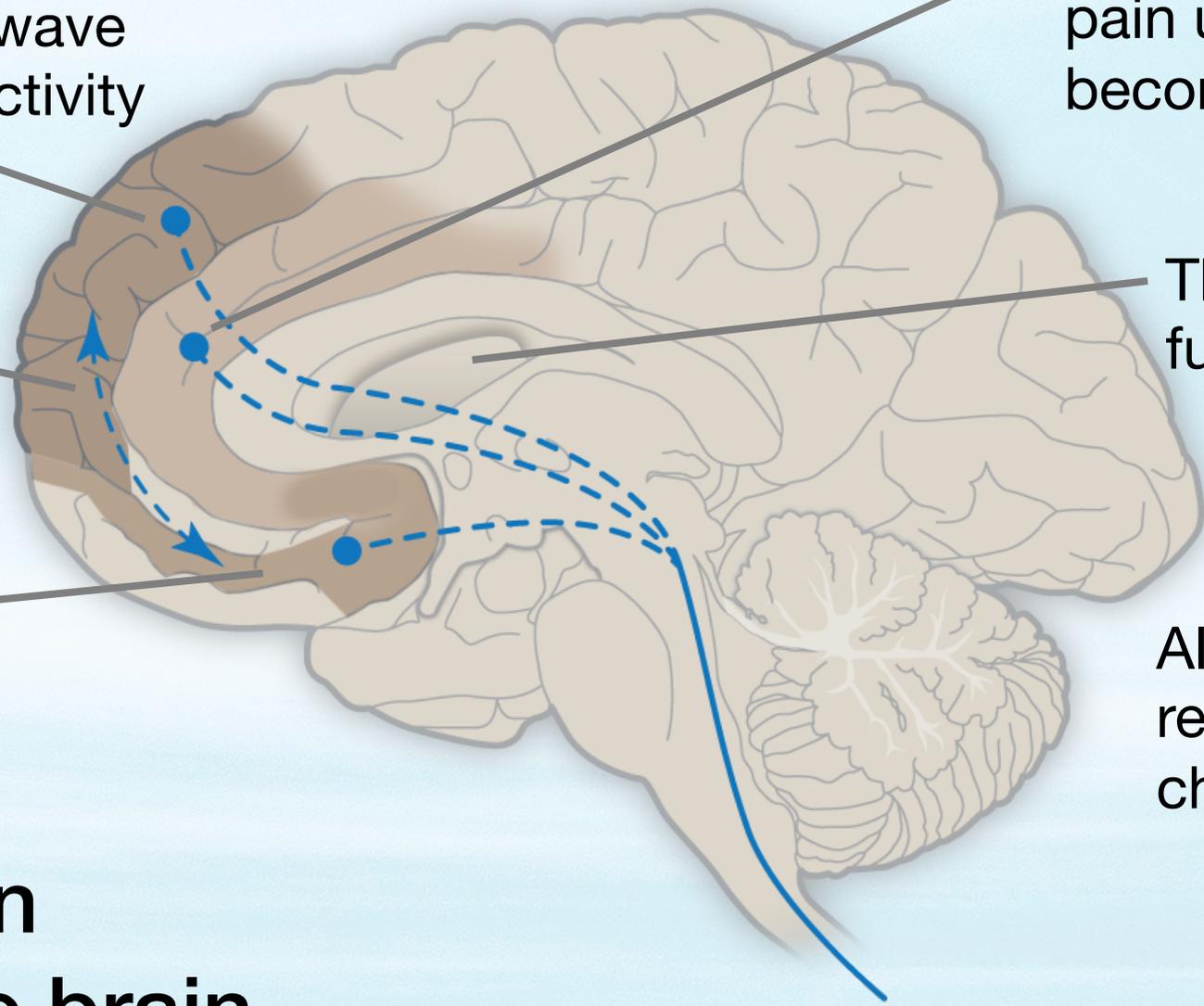
mPFC: more
brainwave
activity

ACC: tends toward more
pain unpleasantness and
becomes more active

Thalamus: reduced
function

All these areas show
reduced volume in
chronic pain.

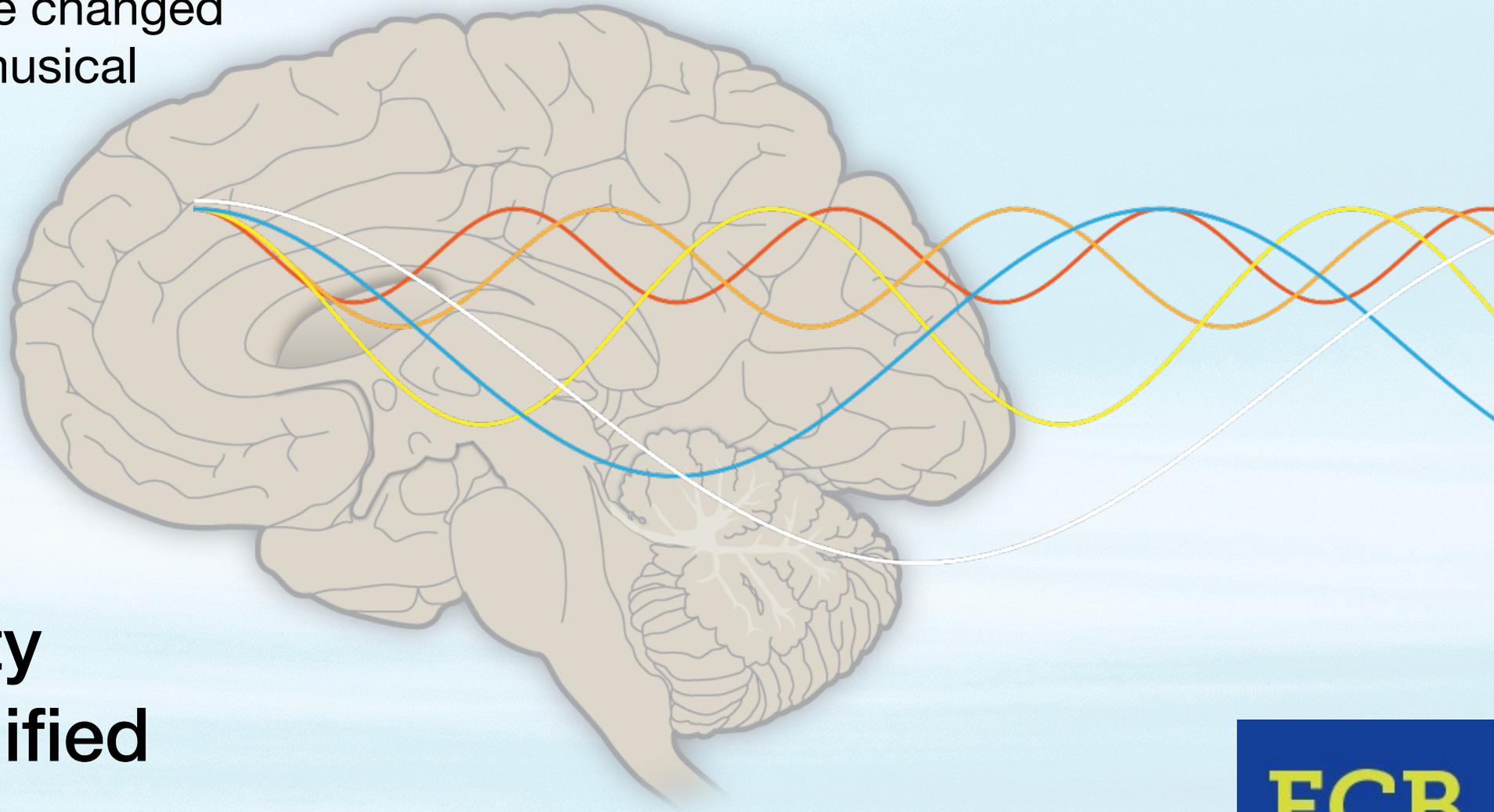
Chronic pain changes the brain

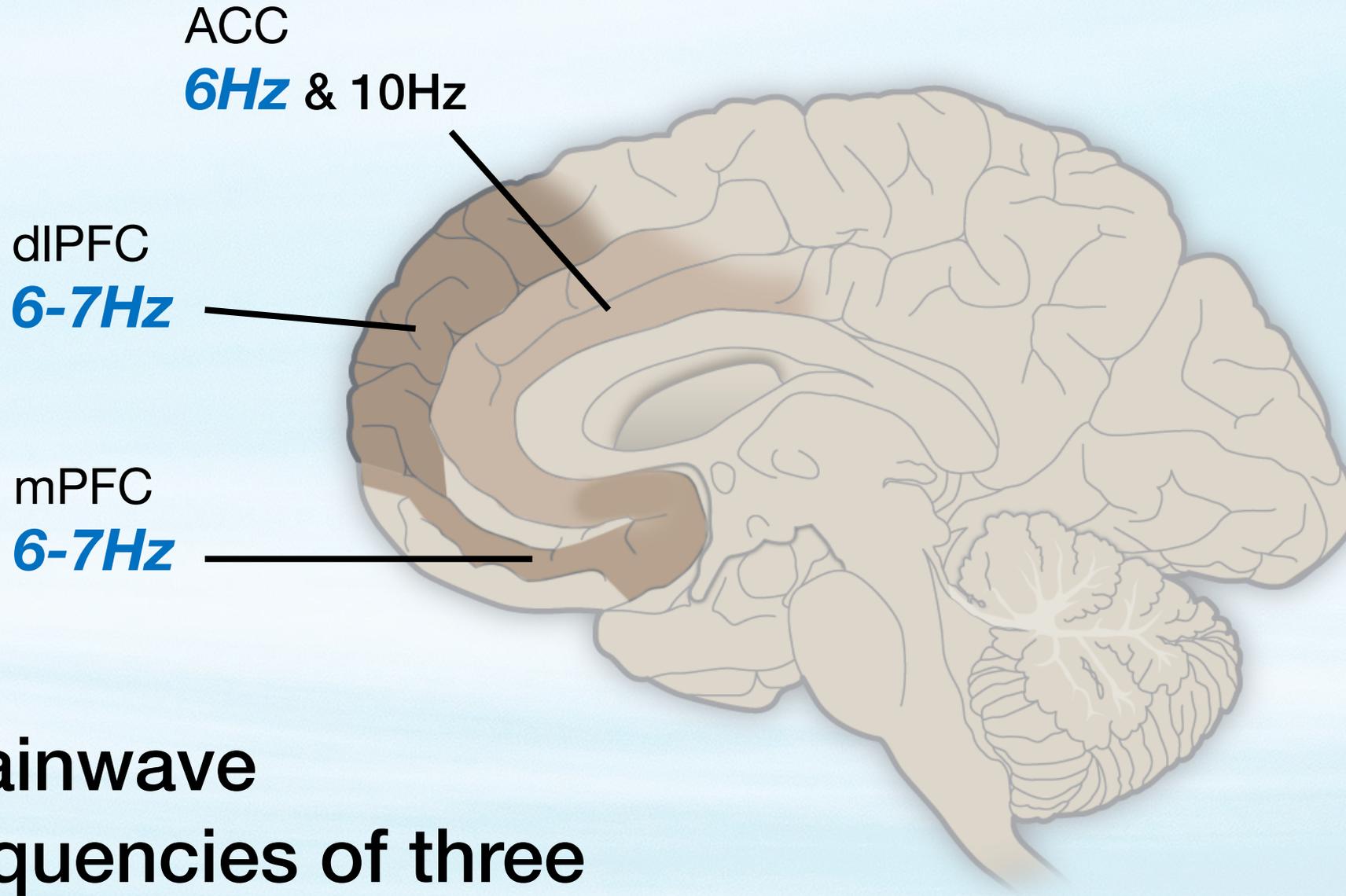


Brainwaves can be changed
by rhythmic and musical
stimuli

Music therapy
uses music to
change the brain

**Brain activity
can be modified
by rhythms**





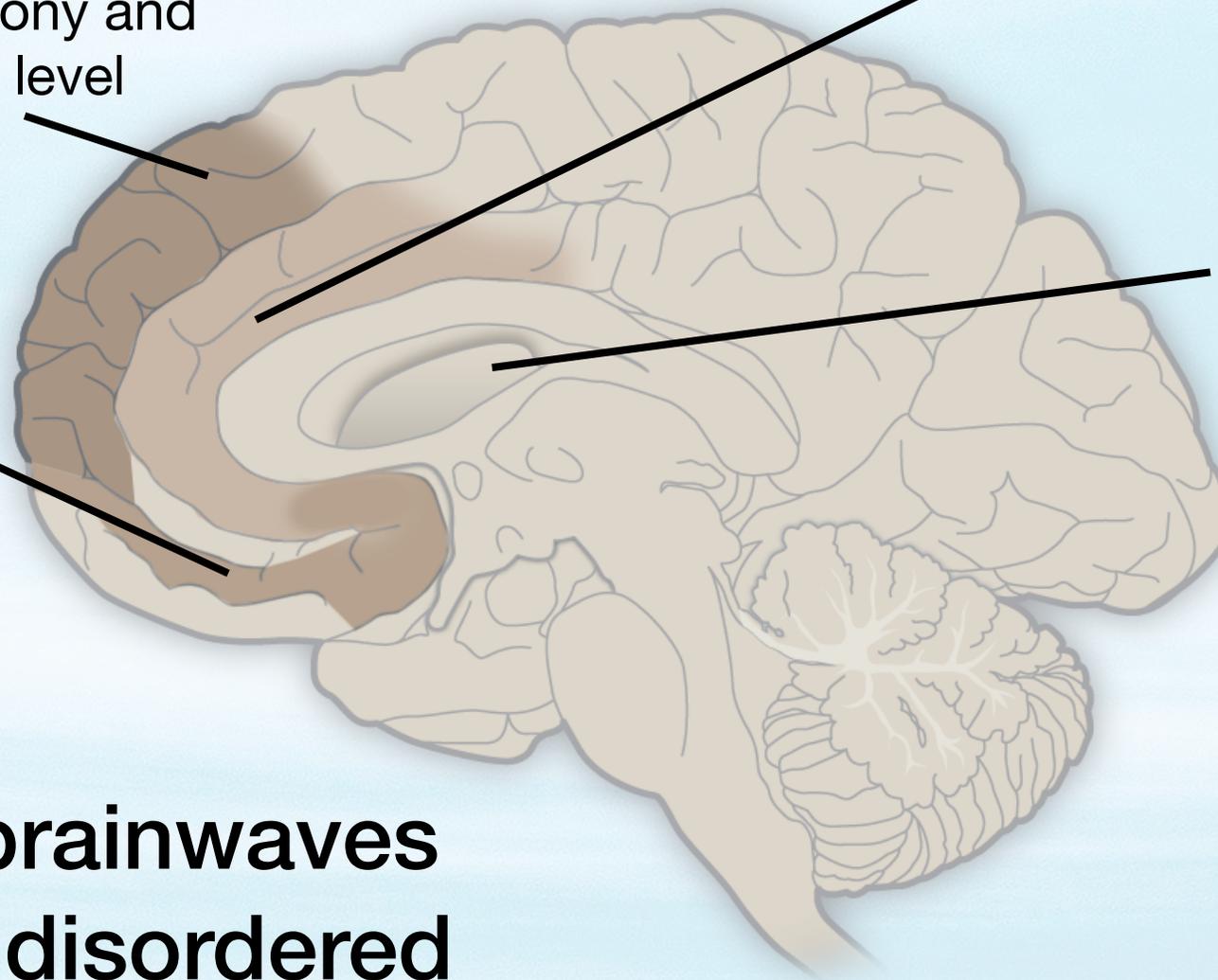
**Brainwave
frequencies of three
areas of DPMS**

Restore dlPFC synchrony and brainwaves to healthy level

Reduce activity in mPFC, reduce brainwave frequency to healthy level

Modify ACC response to more positive affect

Thalamus regains volume when chronic pain is treated



**Music plus brainwaves
may restore disordered
pain modulation**

**Our brains can detect harmonics
of a base rhythm or tone**

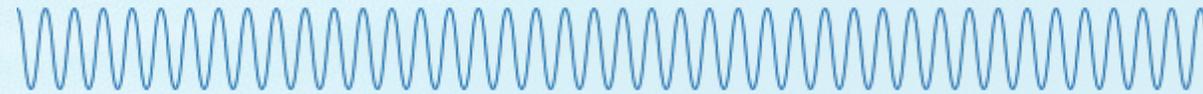
**We created a catalog of music
with 6-7Hz beats embedded as harmonics**



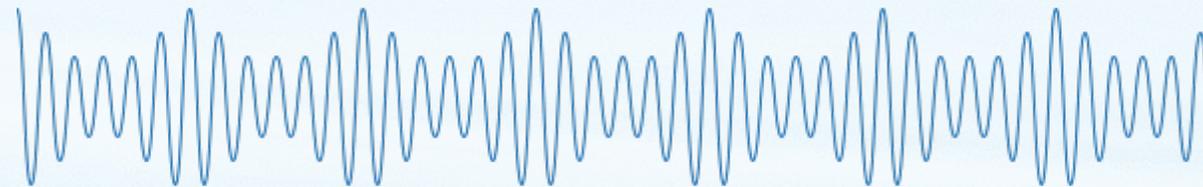
Characteristics of music for the study

- Pleasant, slow tempo
- Self-choice essential
- Familiarity helps
- Selections of ~30 min. to allow time for entrainment

We designed isochronic beats to match brainwaves



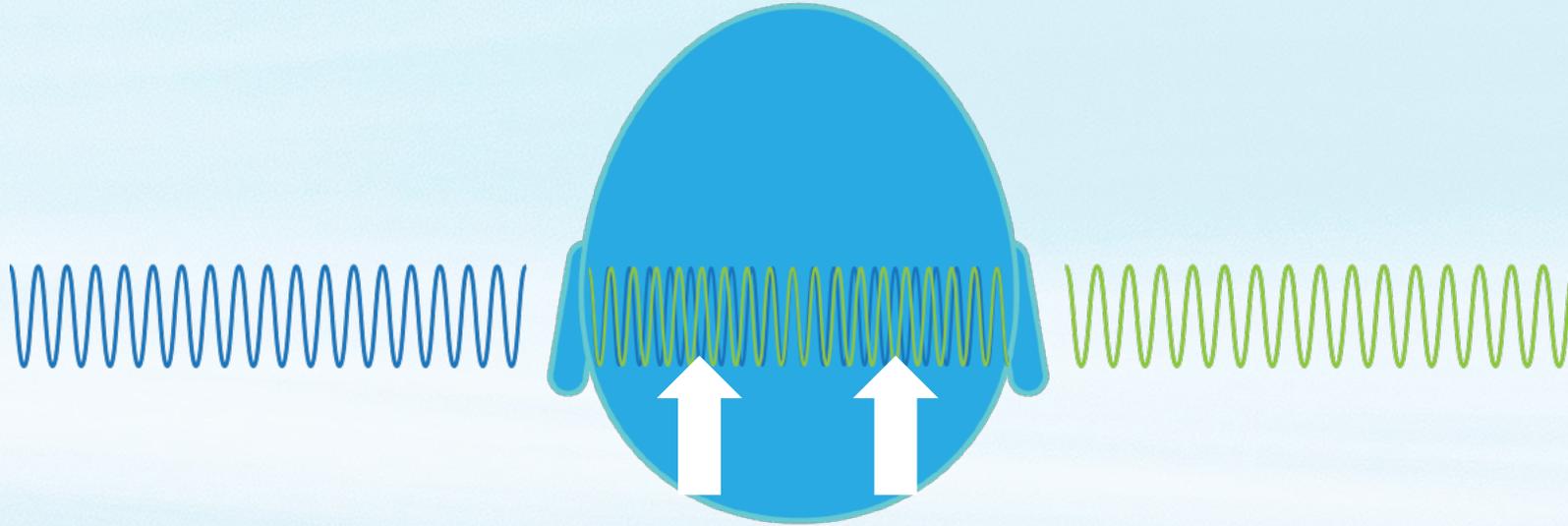
A single tone in the key of the music
pulsed louder and softer at 6-7Hz.



Isochronic tone-beats can be tuned precisely
to the frequency of the music

We considered binaural beats for brainwaves

Play different frequencies in each ear



Result: illusion of pulses created by the brain

Most binaural beats tones are **discordant** and difficult to embed in music.

Method for selecting isochronic tone-beats

Harmonics			
Target Value	82.4069		
Series No	Harmonics	Series No.	Subharmonics, HZ
1	82.4069	1	82.4069
2	164.8138	2	41.2035
3	247.2207	3	27.4690
4	329.6276	4	20.6017
5	412.0345	5	16.4814
6	494.4414	6	13.7345
7	576.8483	7	11.7724
8	659.2552	8	10.3009
9	741.6621	9	9.1563
10	824.0690	10	8.2407
12	988.8828	12	6.8672
14	1153.6966	14	5.8862
16	1318.5104	16	5.1504
20	1648.1380	20	4.1203
24	1977.7656	24	3.4336

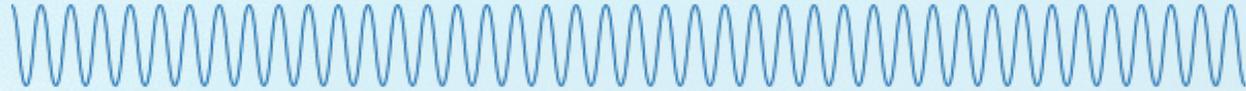
Key of E, **82.4069Hz**

1/12 subharmonic is chosen

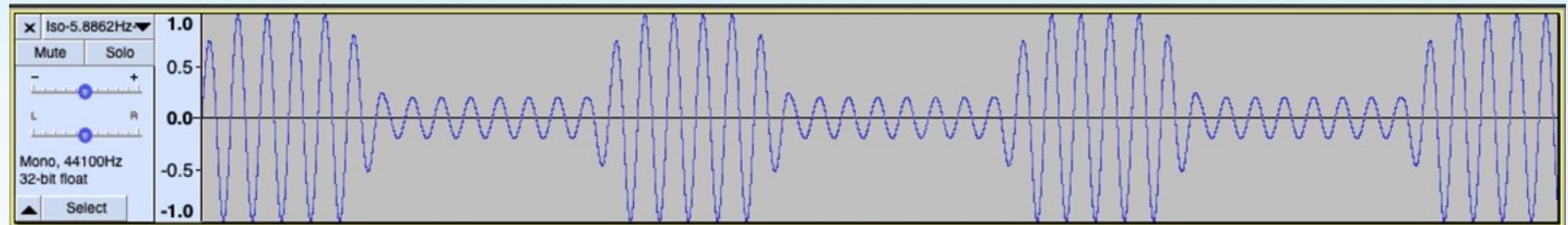
6.8672

Producing isochronic tone-beats in Audacity software

Key of E, **82.4069Hz**
the carrier

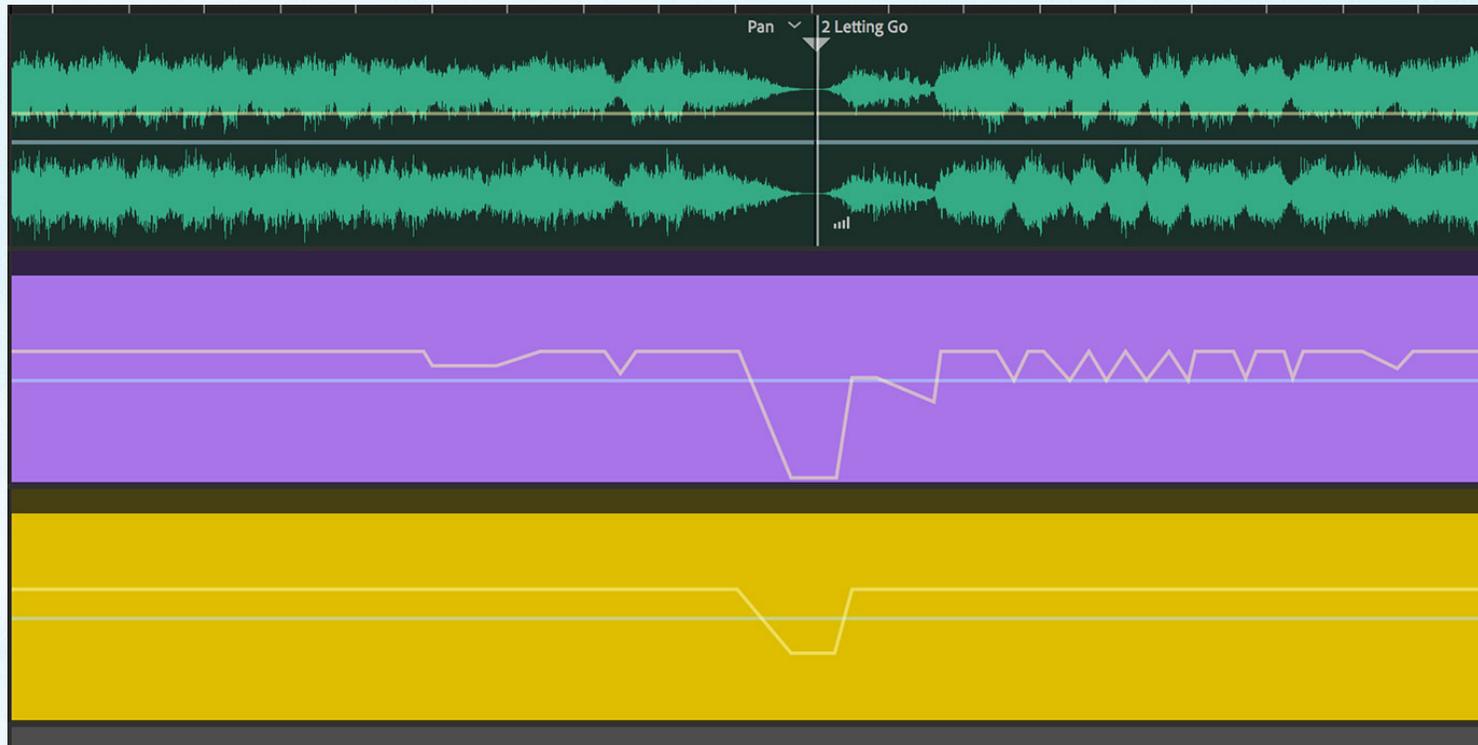


Set to pulse at
harmonic **6.8672Hz**



Generate a file a half hour long to embed in any music in the key of E.

Adding tones to music in Adobe Audition

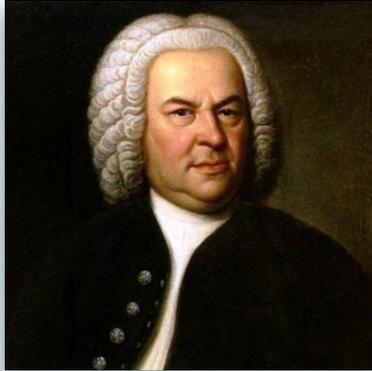


Music track

Isochronic beat volume follows music volume

Low bass aids rhythm tracking

28 Selections Provided



Baroque

Catalog of 28 Selections
with isochronic tone-beats
at 6-7Hz



New Age



Classical



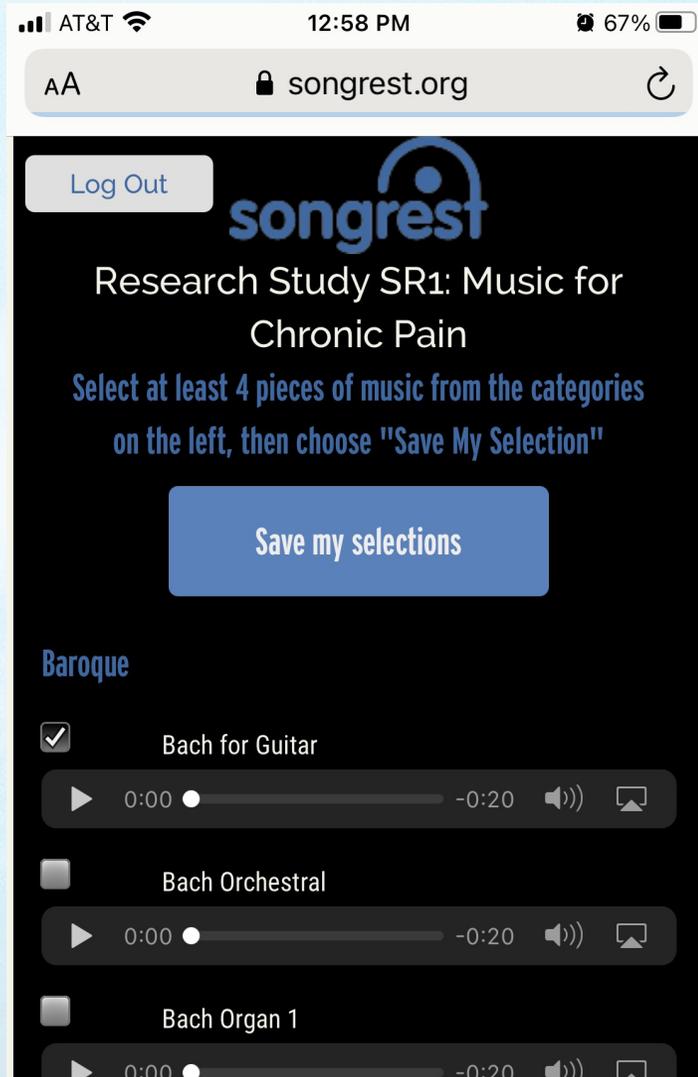
Mozart



Guitar

Mobile App

Select Music with
20-sec. samples



Selections
could be
changed at
any time.

***Listening
selections and
time-tracking
data were tied to
unique logins.***

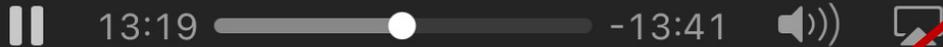
Log Out



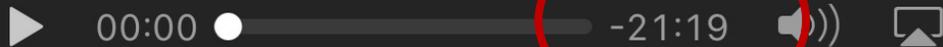
Research Study SR1: Music for Chronic Pain

Change my selections

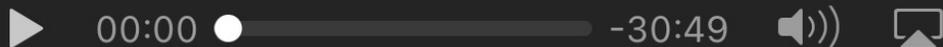
Bach for Guitar



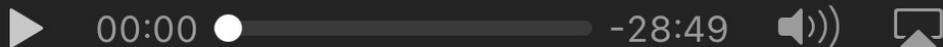
Baroque Harp



Liquid Mind



Rachmaninov Symphony No. 2



Mobile App

Listening time is tracked to the second

Most music research relies on self-reported listening times.

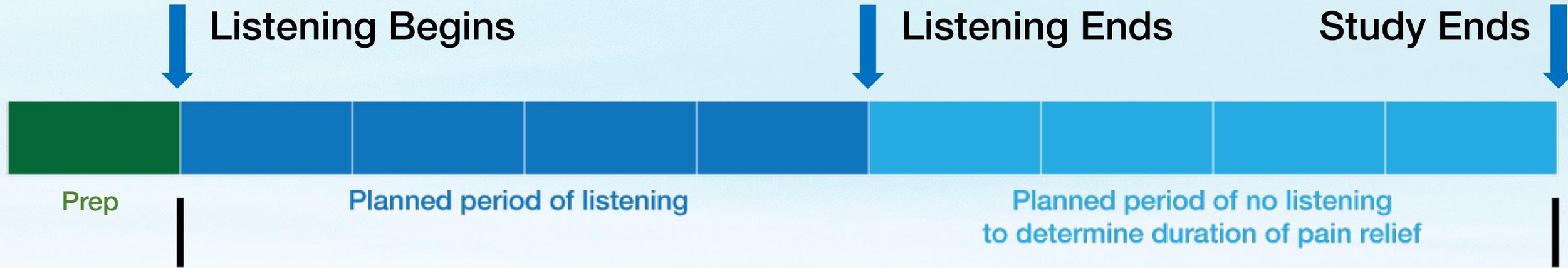
This app provides quantitative data instead.

12 subjects qualified for the study

ID	Age	VAS1	VAS2	VAS3	VAS4	VAS5	NPSNow1	NPSNow2	NPSNow3	NPSNow4	NPSNow5	NPSAvg1	NPSAvg2	NPSAvg3	NPSAvg4	NPSAvg5	NPSHigh1	NPSHigh2	NPSHigh3	NPSHigh4	NPSHigh5	Listing_time	Percent_time_expected	Total_med_start	Total_med_end
5	72	1.90	1.70	1.00	5.20	1.20	5.00	2.00	1.00	5.00	2.00	3.00	2.00	4.00	2.00	7.00	5.00	4.00	6.00	3.00	28.00	1.00	163.00	65.00	
7	78	3.30	3.00	1.60	0.80		6.00	4.00	2.00	1.00		7.00	5.00	6.00	3.00		8.00	7.00	7.00	5.00		23.47	0.84	182.00	91.00
8	64		4.20	5.00	5.50	3.30	6.00	5.00	5.50	6.00	4.00	5.00	6.00	5.00		4.50	9.00	8.00	7.00	7.00	8.50	27.86	0.99	131.00	35.00
9	75	2.00	1.40	1.50	3.80	1.90	2.50	2.00	2.50	3.50	2.00	2.50	2.00		6.00	2.00	3.00	3.00	3.00	7.50	3.00	13.42	0.48	35.00	18.00
10	77	1.50	0.70	0.70	0.80	0.70	2.00	1.00	1.00	1.00	1.00	2.50	1.50		1.00	1.00	4.00	3.00	3.00	3.00	3.00	25.36	0.91	308.00	154.00
11		1.70	3.70	1.10	3.60	1.90	2.00	5.00	2.00	5.50	3.00	2.00	4.00	3.00	5.00	3.00	5.00	8.00		7.00	6.00	26.19	0.94	350.00	88.00
12	39	2.60	8.60	1.60	2.30		3.00	9.00	1.00	2.00		3.00	2.00	2.00	2.00		7.00	10.00	4.00	4.00		28.56	1.02	70.00	20.00
13	54	3.70	2.70	2.70	2.10	2.00	4.00	3.00	4.00	5.00	3.00	4.00	4.00		4.00	5.00	5.00	8.00	6.00	6.00	7.00	11.77	0.42	35.00	20.00
14	66	5.30	5.50	3.20	3.70	3.90	6.50	6.00	4.00	6.00	6.00	6.00	5.00	5.00	5.00	7.00	7.00	6.00	8.00	8.00		17.11	0.61	308.00	22.00
Mean	65.63	2.75	3.50	2.04	3.09	2.13	4.11	4.11	2.56	3.89	3.00	4.00	3.61	3.83	3.89	3.21	6.11	6.56	5.00	5.94	5.50	22.42	0.80	175.78	57.00
SD	12.54	1.21	2.28	1.29	1.62	1.04	1.71	2.33	1.52	1.95	1.51	1.71	1.49	1.57	1.52	1.51	1.85	2.27	1.58	1.57	2.28	6.19	0.22	114.67	44.17

- 1 withdrew before the study
- 2 had compromised data at end
- Final n=9 subjects
- Age range 33-78

Research Timeline



Applications taken online and in person

- Pain for more than 1 year
- Provided informed consent

songrest
SongRest Research

Apply to Participate in the Study of Music for Chronic Pain

This is an informational study, not a treatment. It is not intended to diagnose or treat any condition or disease. Your participation is of great value to this study, and we sincerely appreciate your willingness to explore a new way of relieving pain. This scientific research could contribute to deeper understanding of chronic pain and the role music can play in improving quality of life through long-term relief of pain. For this study to succeed, we need for you to be accurate and fully honest. All information will be kept confidential to SongRest (see our Privacy policy).

Fields labeled "Required" are essential to conducting our study. The form will not submit without information in those fields.

Who should apply?

If you have **epilepsy** you should not apply, because the brainwave frequencies may trigger a reaction.

If you have been diagnosed with a **mental illness** or **substance abuse** requiring treatment, know that this study may not be ideal for you.

Even if you are not selected for this study, we have the greatest respect for the fortitude you show in the face of continuing pain. We will save your contact information if you check the box marked "Save my information", and you may be eligible for future trials.

If you prefer, you may:

[download the form here »](#)
and follow the instructions in the form to send.

First Name Required

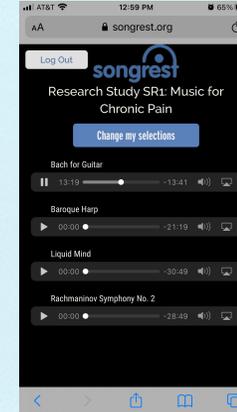
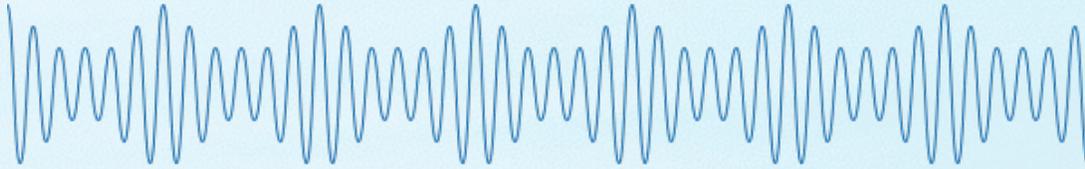
Last Name Required

Email Required

Phone Required

Have answered all questions accurately, and are willing

Subject activities in the study



- Stop all activities and listen 1/2 hr 2x a day
- App tracks actual listening times
- Mail reports on schedule

Email: elissa.nabozny@gmail.com

Phone: 401-829-2856

Please draw a vertical line at your current pain level on the scale below.



If you gave your current pain a number from 0 to 10, with 0 being no pain and 10 being the worst pain imaginable, what would it be right now?

Using numbers, what was your generally average level of pain over the last week?

Using numbers, was the worst pain you experienced in the last week?

What pain medications, amounts and times of day are working for you?

How is the listening going for you? How easy is it to stop everything and listen twice a day?

Do you have any other comments, observations, or questions for us?

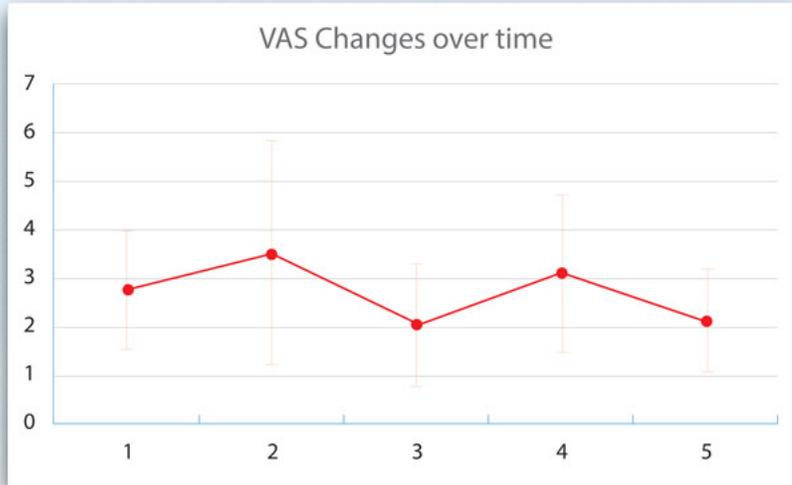
Thank you for sending us this update. Your participation is quite valuable in finding music solutions for chronic pain management.

Mail to: SongRest 1643 Coastal Rd, Brooksville, ME 04617 using the envelopes provided.

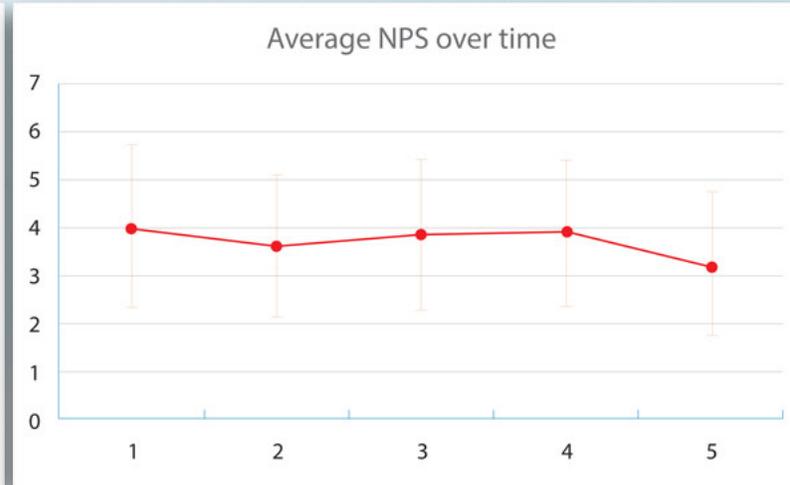
Collected data

- Pain Scores (VAS, NPS)
- Medication type, dose, frequency
- Comments and remarks on subjects' experiences

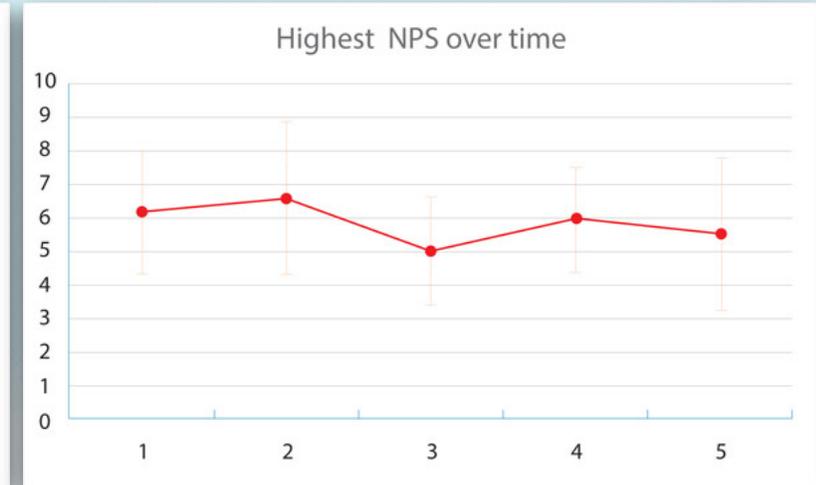
Values with non-significant change over the study



Visual Analog showed modest change over the study due to resurgence of pain for some



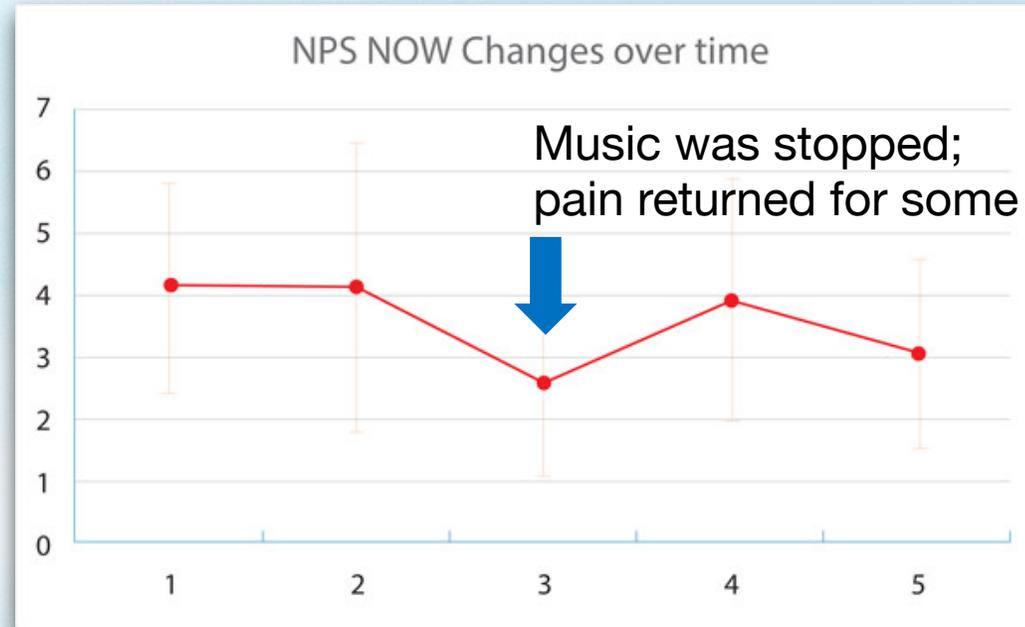
Average Numerical Pain Score was a memory-constructed value recalled by the subject.



Highest Numerical Pain Score was another memory-constructed value.

Significant Results

A reduction in mean NPS at time of report **of 27%**.

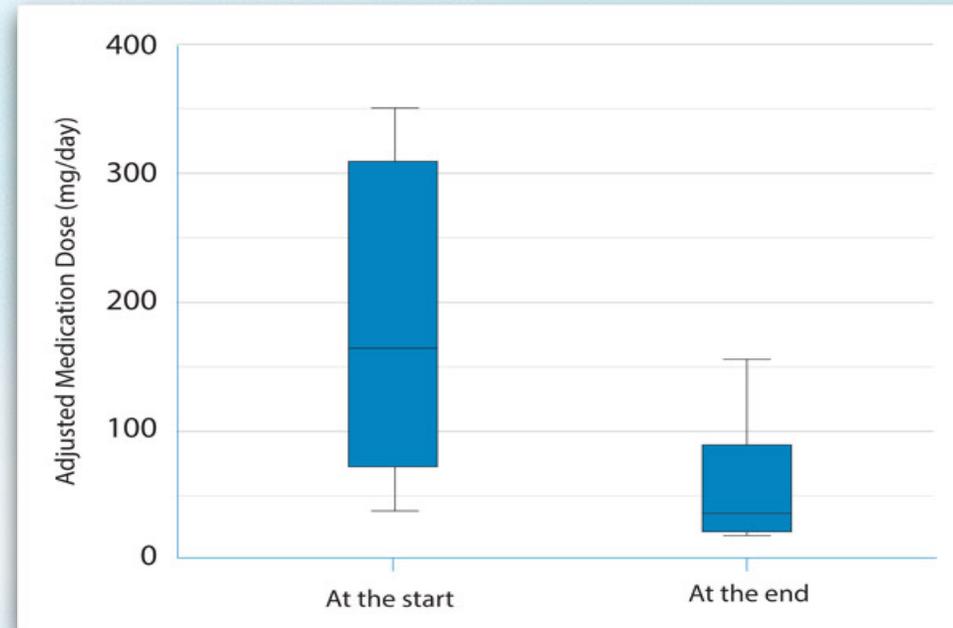


Music was immediately made available again for all subjects

Mean Numerical Pain Scores at time of report reduced from 4.1 to 3.0, $p = 0.015$.

Significant Results

A reduction in mean medication dosage *of 68%*.



Mean medication dosage reduced from 175.8mg/day to 57.0mg/day, $p = .008$.

Conclusions

Listening to long-form music with 6-7Hz isochronic beats showed significant reductions:

- NPS at time of report (27%)
- Pain medication dosage (68%)

175.8 mg/day



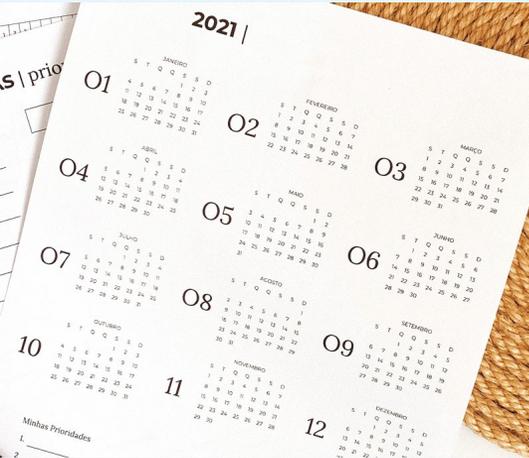
First week

57.0 mg/day



Last week

Discussion



Potential extended analgesic effect

4 subjects did not report return of pain after listening ended, which may indicate extended analgesic effect of the music.

Study will be repeated with a larger population, blinding and controls

Music was Western/European; add music from other musical cultures

We plan to repeat the study with subjects with substance use disorder as a result of chronic pain

Special Thanks to the SongRest Advisory Board

- ❖ [Kate Beever](#), MA, MT-BC, Board-certified Neurologic Music Therapist
- ❖ Sally Kirkpatrick, MD, Neurology and Psychiatry
- ❖ [Ralph Moss](#), PhD, Cancer Research and Treatment
- ❖ Lynn Carroll, LCPC, Psychotherapy/Trauma Therapist
- ❖ Curtis Meadow, MS, Computer Science and Data Analysis
- ❖ App created by [David Merrill](#)

Conclusions

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- NPS at time of report (27%)
- Pain medication dosage (68%)

175.8 mg/day



First week

57.0 mg/day



Last week