Neural mechanisms supporting mindfulness-based pain relief as compared to placebo analgesia

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Chronic pain: A silent epidemic

- Over 100 million Americans and 1.5 billion people worldwide are affected by chronic pain (Institute of Medicine)
- With 42% of people reporting daily pain
- Costs the U.S ~ $635 billion a year (Gaskin & Richard, 2012)
- Alternative approaches to treating pain are cost-effective without causing side effects
Mindfulness meditation is associated with multiple pain relieving mechanisms:

- Coping strategies (e.g. acceptance) (Grossman, 2004)
- Positive mood (Zeidan et al., 2010)
- Reappraisal (Farb et al., 2009)
- Emotional and cognitive control (Zeidan et al., 2012)
Brief mindfulness-based mental training

- Meditation naïve participants

- Taught basic mindfulness skills (Shamatha/Vipassana)

- Four days of mental training (20m/d)

- Improves anxiety, depression, mood, pain and other health outcomes (Zeidan et al., 2010a, 2010b, 2010c, 2011, 2012; 2013)
Ongoing Project
Methods and Procedures

• Thermal heat (49°C) was used to evoke pain

• Pain intensity/unpleasantness ratings assessed with VAS

• Brain activation was assessed by examining cerebral blood flow with arterial spin labeled (ASL) MRI
Identifying the analgesic mechanisms of mindfulness

Meditation-related pain relief may be related to:

- Relaxation (Kabat-Zinn, 1982)
- Divided attention (Zeidan et al., 2010)
- Placebo analgesia (Kuyci et al., 2011; Zeidan et al., 2013)
- Established beliefs associated with meditation’s health promoting reputation (Zeidan et al., 2010)
Ongoing Project

Mindfulness meditation training (n=17)

Placebo-conditioning (n=19)

Sham mindfulness meditation (n=20)

Book listening (n=19)

Over 600 individually, tailored experimental sessions
Placebo group

- 4 placebo conditioning sessions (Price et al., 1999; Colloca et al., 2010)

- Baseline stimulation (49°C)

- Applied placebo cream on the calf

- Covertly reduced stimulation levels in each session
  - Session 1 = 48°C
  - Session 2 and 3 = 47°C
  - Session 4 = 46.5°C
  - Post-Intervention MRI session = 49°C
Sham mindfulness meditation group

• Aim was to lead participants to believe they were practicing mindfulness meditation (Zeidan et al., 2010)

• Taught to sit with straight posture and eyes closed

• Instructed to “take a deep breath” every 2-3 minutes “as we sit here in mindfulness meditation”

• Matched time spent giving instructions to the mindfulness meditation group
Control group

- Four sessions of listening to the *Natural History of Selborne*
- Employed to control for facilitator attention and time elapsed in the other group’s interventions
Outcome Measures

- Pain intensity and unpleasantness ratings
- Freiburg Mindfulness Inventory (FMI) scores
- Regional brain signals (CBF)
Mindfulness training increased FMI ratings.

- Control: 2% (↑)
- Placebo: 3% (↓)
- Mindfulness: 16% (↑)
- Sham: 0.04% (↑)
Mindfulness meditation was more effective at reducing pain intensity.
Mindfulness meditation was more effective at reducing pain unpleasantness ratings.
Meditation significantly reduces thalamic and PAG activation when compared to placebo.
Mindfulness reduces PAG and thalamic activity when compared to sham meditation
Final Considerations

- Brief Mindfulness-based mental training is more effective at reducing pain than placebo and sham meditation.
- Meditation attenuates pain through multiple mechanisms.
- Placebo likely engages descending control processes.
- Sham meditation-related pain relief likely engages placebo and relaxation-related mechanisms.
- Clinical efficacy.
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Thank you for your time and attention

Questions?

See more details at poster #32
No differences in perceived “meditative” effectiveness ratings between mindfulness and sham meditation groups ($p > .25$)
Neural correlates of mindfulness-based pain relief
Neural correlates of placebo analgesia

Placebo > Rest

Rest > Placebo

Pain Intensity

\[ x = 2 \]

\[ z = 4 \]

\[ x = -14 \]

\[ z = -1 \]

\[ z = 4 \]

\[ z = 67 \]
Main effect of meditation and control comparison

Meditation  | Control  | Med > Con  | Con > Med

\[ z = -5 \]  
\[ z = 13 \]  
\[ z = 32 \]  
\[ z = 50 \]  

Thalamus
mPFC
SI
PCC
S. Frontal Gyrus
mPFC
DLPFC
PCC
Control group pain correlations

Pre > Post  Post > Pre  ↑ Pain Int

↑ Pain Unp
Pain sensitivity decreased after meditation training
Post-Meditation Training

Pain
x=4
ACC
z=-12
F.Parietal operculum
z=3
Posterior/Anterior Insula
z=16
SI
SII/Posterior Insula

Meditation
ACC
OFC
Ventral Striatum
Anterior Insula

Overlap
ACC
R. Anterior Insula
Anterior Insula

Legend:
- Pain
- Meditation
- Overlap

Color Scale:
- Yellow: 9.2
- Orange: 2.3
- Blue: 2.3
- Yellow: 9.2