MUSIC AND MEDICINE

Honors Senior Project
Tom Zink
INSPIRATION

- Pre-Med Student
- Trombone Player at WWU
- Bridge Interests

The big question: How will I incorporate music into my future practice?
SOUND PATHWAY

1. External auditory canal
2. Malleus
3. Incus
4. Stapes vibrating in oval window
5. Helicotrema
6. Cochlea
7. Scala tympani
8. Scala vestibuli
9. Basilar membrane
10. Perilymph
11. Middle ear
12. Auditory tube
13. Tympanic membrane
14. Secondary tympanic membrane vibrating in round window

Forebrain:
- Longitudinal fissure
- Lateral fissure
- Primary auditory cortex
- Medial geniculate nucleus (thalamus)
- Inferior colliculus (tectum)

Midbrain:
- Lateral lemniscus
- Cochlear nuclei

Hindbrain:
- Superior olives
- Auditory nerve
- Cochlea

Figure 17.22: Tortora - PAP 13/e
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MUSIC AS A POSSIBLE MODALITY

The brain at rest

The brain’s reaction to music
WIDELY ACCEPTED MEDICAL APPLICATIONS OF MUSIC

• Music Therapy
  • Uses music to help address individual therapeutic needs
  • Sing, create, listen
  • Music Therapist

• Dementia and TBI Rehabilitation
  • Alternate, unaffected pathways
  • Learning to speak again by singing

• Cognitive Disorders
  • Tomatis Method
    • Specific Resonant Frequencies
    • Increased Cerebral Blood Flow
    • More nutrients and oxygen
    • Dendritic Branching
    • More Connections
WIDELY ACCEPTED **ASTERISK**

- Widely Accepted does not mean implemented in the clinic
- Ignored in Allopathic Medicine despite:
  - Wealth of Anecdotal Evidence
  - Proven music interventions
- Still termed alternative medicine
  - Bad connotation
- Lack Of Empirical Evidence

- Potential Benefits of Music using Music in the clinic
  - Synergistic effect with other therapies
  - Cheap, easy to access
  - No side effects
  - Less dependent on other drugs
MUSIC, PAIN, AND ANXIETY

• Surgery (Pre/Intra/Post)
  • Anesthesiologists monitor vitals
  • Reduced analgesic and sedative requirements in music groups
    • Self administered pain medication

• Sympathetic vs Parasympathetic response
  • Music produced parasympathetic activation
    • Vagus nerve
  • ICU showed reduced HR, BP, RR with music
  • Retts Syndrome = “no bias”

• Key Notes
  • Music Better than white noise, no conditioning effect = not placebo
  • Familiar, deactivating music was best
    • Slow = entrainment, calming
    • Familiar = emotional response
      • Limbic system is very powerful!

= why I used self selected music under 120 bpm
PHYSIOLOGY OF MUSIC

• Biological Entrainment
  • Tendency for body rhythms to synchronize to an external forcing function
  • Nerve Firing
  • Parkinson’s

• Psychology
  • Evoke positive memories
  • Distraction
  • Positive emotions
PHYSIOLOGY OF MUSIC ANALGESIA

• Activation of the Limbic System
  • Limbic System Responsible for Emotional/Physiological Responses to Stimuli
    • i.e. fear and sympathetic activation
  • Would allow for excitation or relaxation based on type of music
  • Dopamine Release
    • Stim of VTA by LS
  • Endogenous Opioid Release
    • NA
      • endorphins
    • Inhibition of nociception

• Structures Affected
  • Thalamus
    • Switchboard of brain
  • Amygdala
    • Less active
    • Decreased negative reaction
  • Hypothalamus
    • Hypothalamic-hypophyseal axis
    • Endocrine system
Opioids

Hyperpolarization (open K⁺ gates)
Inhibit Ca²⁺ influx at presynaptic cleft
Block neurotransmitter release
• PAG modulates ascending nociceptive stimuli

• Opioids
  • Hyperpolarization (open $K^+$ gates)
  • Inhibit $Ca^{2+}$ influx at presynaptic cleft
  • Block neurotransmitter release
MUSIC AND EXERCISE RECOVERY

• Similar Physiological Response to Stress and Exercise
  • Sympathetic Activation
  • Parasympathetic withdrawal
    • Increased BP, HR
  • Soreness
• Hypothesis: Music will expedite recovery of HR and BP after exercise and decrease perceived pain and fatigue.

• Supporting Literature:
  • Desai, 2015:
    • Significant greater decrease in HR, SBP, DBP after 3 min step test
  • Savitha, 2005:
    • Music improves recovery times of HR and BP after exercise
    • Slow music was more effective
  • Eliakim, 2012:
    • Fast Music improved lactate clearance, not HR recovery
    • Increased recovery activity, decreased RPE
PROTOCOL AND HUMAN SUBJECTS

- Required to complete NIH “Protecting Human Study Participants”
- Submit Protocol illustrating:
  - Methods
  - Safety
  - Risks/Benefits
  - Supporting Literature
  - Consent Form
  - Maintenance of Confidentiality
- Reviewed by IRB

- The take away:
  - Writing protocols
  - Experience with regulations
  - Submitting to IRB
  - NIH certification
  = Helpful for future job search or clinical research
METHODS

• Variables
  • HR, SBP, DBP, RPF, RPP
  • Pulse Oximeter, Automated BP Cuff

• Pre-Test
  • Consent
  • Resting Variables
  • Screened Music Selection

• Test
  • Run 600m as fast as possible
  • Measure variables every 2 min for 16 min
  • With or without music
    • Under 120 BPM, screened
ANALYSIS

- Mean Decrease from time 0 - t
  - \( MD = \frac{1}{n} \sum ([x_0 - x_t]_1 + \cdots + [x_0 - x_t]_n) \)
  - No Recovery Time
  - Not enough recovery

- Standard Error
  - \( SE = \frac{SD}{\sqrt{n}} \)
  - Error Bars

- ANOVA (single variable)
  - Statistical significance
  - Excel
RPF AND RPP

• RPF adapted from Borg’s RPE
  • Recovery not exercise
  • 1-10 scale
• RPP on a 10 point scale is common
<table>
<thead>
<tr>
<th>Table 1. Subject Characteristics</th>
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<tbody>
<tr>
<td>Age (yrs)</td>
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<tr>
<td>Height (in)</td>
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<tr>
<td>Weight (lbs)</td>
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<tr>
<td>HR (bpm)</td>
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<tr>
<td>SBP (mmHg)</td>
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<tr>
<td>DBP (mmHg)</td>
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<tr>
<td>Run Time (sec)</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Table 2. Subject Demographics</th>
</tr>
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<tbody>
<tr>
<td>Subjects</td>
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<tr>
<td>Males</td>
</tr>
<tr>
<td>Females</td>
</tr>
<tr>
<td>Music Background</td>
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<tr>
<td>Physically Active</td>
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</tbody>
</table>
HR Example

HR During Post-Exercise Recovery

Subject 3

Music
No Music
Post-Exercise Recovery of SBP

Mean Decrease in SBP

SYSTOLIC BLOOD PRESSURE

Mean SBP (mmHg)

0-4 0-8 0-16 Hi-Low

Time Interval (min)

SBP (mmHg)

Music
No Music
DIASTOLIC BLOOD PRESSURE

Post-Exercise Recovery of DBP

Mean Decrease in DPB (mmHg)

Time Interval (min)

Music
No Music

Post-Exercise Recovery of DBP

Mean DPB (mmHg)

Time (min)

MUSIC
NO Music
RATINGS OF PERCEIVED FATIGUE

Post-Exercise Recovery and RPF

RPF During Exercise Recovery

Mean Decrease in RFP

Time Interval (min)

<table>
<thead>
<tr>
<th>Time Interval (min)</th>
<th>Mean Decrease in RFP</th>
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<tbody>
<tr>
<td>0-2</td>
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<td>0-4</td>
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<tr>
<td>Hi-Low</td>
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</tbody>
</table>

Music
No Music

Mean RPF

Time (min)

Music
No Music
RATINGS OF PERCEIVED PAIN

Mean Decrease in RPP

Time Interval (min)

Music
No Music

Post-Exercise Recovery and RPP

Post-Exercise Recovery and Pain

Mean RPF

Time (min)
EXPLANATIONS

• Experimental Control
  • Motivation of subjects
  • Temperature
  • Speed
  • Music Selection

• Physiological
  • HR varies with age, temp, caffeine, emotions
  • Duration/Intensity of Test

• Subject Variability
  • Different amounts of exercise
    • PA and on test day
  • May have been more focused on pain when rating it than during interim time
  • Music may have made sleepy or “less energetic”

• Limitations
  • Sample Size
  • Equipment Sensitivity
LOOKING TO THE FUTURE

• I will incorporate music into practice by:
  • Using music in treatment of pain, anxiety, and cognitive disorders
  • Using pre/intra/post-operatively
    • Made my own Emergency Surgery Playlist
  • Continuing to play
    • Musicianship and laparoscopic technique
  • Continued Research
    • Music and the immune system
  • Using Music to connect with patients

• Experience has been invaluable!
THANKS!

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