Biomedical music therapy as procedural support: Understanding the effects of music therapy on pain and anxiety from a neurological perspective

Olivia Swedberg Yinger, MME, MT-BC
The Florida State University
Tallahassee Memorial HealthCare Foundation
Procedure

Any physiological task a patient must perform or submit to which:

• Provides information regarding the patient’s physical state, or

• Aids in the patient’s healing process.

Philp, 2012
Procedural Support Music Therapy

• “The use of music and aspects of the therapeutic relationship to promote healthy coping and decrease distress in individuals undergoing medical procedures.”

Ghetti, 2011, p. 4

While waiting for an IV start, a man and his wife reminisce with music therapist Olivia Swedberg about the music that was played on the couple’s wedding day.
Music Therapy Goals: Patients

• Decrease anxiety before, during, and after.

• Decrease perception of pain during procedure.

• Serve as an adjunct to sedative and analgesic medications and attempt to decrease their use.
Music Therapy Goals: Patients

- Teach and reinforce coping strategies that can be used with or without direct intervention from the music therapist.
- Promote completion of tasks needed for a specific procedure and timely completion of the procedure.
Music Therapy Goals: Family and Staff

- Provide family members with creative and effective ways to support their child.
- Model child-friendly techniques for healthcare staff.

Philp, 2012
Pain

- “An unpleasant sensory and emotional experience associated with actual or potential tissue damage.”

International Association for the Study of Pain, 2011, para. 1
Anxiety

• “The apprehensive anticipation of future danger or misfortune accompanied by a feeling of dysphoria or somatic symptoms of tension.”

American Psychological Association, 2000, p. 820
Gate Control Theory of Pain

• Physical damage occurs to nerve endings in the peripheral nervous system (PNS)
• Awareness and interpretation of pain occurs in central nervous system (CNS)

Melzack & Wall, 1965 (in Davis, Gfeller, & Thaut, 1999)
Gate Control Theory of Pain

Neural gates open or close to various degrees, modulating the severity of pain signals. Factors that determine the degree to which gates are open:

- Amount of noxious stimulus (pain)
- Competing sensations
- Messages from the brain (emotional)

Melzack & Wall, 1965, in Davis, Gfeller, & Thaut, 1999
Neuromatrix Theory of Pain

Inputs:
- Cognitive-evaluative
- Sensory-discriminative
- Motivational-affective

Outputs:
- Pain perception
- Action programs
- Stress-regulation programs

Melzack, 2001
Neurophysiology of Pain and Anxiety

- Reticular activating system: Circuit of neurons in the brainstem that regulate attention, sleep, and wakefulness.
- Thalamus: Relay center between sensory input from the PNS to the CNS.
- Anterior cingulate cortex: Cognitive center for interpretation and evaluation of pain and emotion.

Bernatzky et al., 2011; Philp, 2012; Taylor, 1997
Neurophysiology of Pain and Anxiety

- Amygdala: Integrates physiological and hormonal responses to fear and anger. Responds to stressful stimuli by sending signals to the brainstem, which increase heart rate and blood pressure, and to the hypothalamus.

- Hypothalamus: Signals secretion of stress-related hormones (cortisol, epinephrine, and norepinephrine).
Median section of the brain

- Frontal lobe
- Corpus callosum
- Parietal lobe
- Parieto-occipital sulcus
- Occipital lobe
- Central sulcus
- Lateral ventricle
- Thalamus
- Hypothalamus
- Midbrain
- Pons
- Temporal lobe
- Medulla oblongata
- Spinal cord
- Cerebellum
Neurophysiology of Pain and Anxiety

- Cortisol: Helps break down protein into glucose, needed to provide energy.
- Epinephrine (adrenaline): Increases heart rate, constricts blood vessels, dilates air passages. Leads to increase blood glucose and fatty acids for energy.
- Norepinephrine (noradrenaline): Increases blood pressure, triggers release of glucose from energy stores.
Neurophysiology of Pain and Anxiety

- Endogenous opioids (aka endogenous morphine or endorphins): Reduce pain awareness. Disinhibit dopamine pathways.
- Bind with opioid receptors in the periaqueductal gray matter of the midbrain.
Effects of Music on Pain

- Induces production of endogenous opioids (endorphins).
- Inhibits activity of neurons bringing pain information to the central nervous system.
- Music therapists can help bring awareness to musical stimulus rather than painful stimulus, engaging the reticular activating system.

Taylor, 1997
Neuroimaging Research on Music

- College music majors ($N = 10$) underwent PET scans while listening to music that gave them chills.
- Cerebral blood flow increases were observed in brain regions thought to be involved in reward, motivation, emotion, and arousal (ventral striatum, midbrain, and orbitofrontal cortex).
- These brain structures are known to be active in response to other euphoria inducing stimuli, such as food, sex, and drugs.

Blood & Zatorre, 2001
Measuring Blood Levels of Hormones after Music Listening/Music Therapy

• Decreases in production of cortisol, a stress hormone. ¹

• Increases in production of melatonin, which promotes relaxation. ²

¹ Nilsson et al., 2005
² Kumar et al., 1999
Adult Procedural Support: Labor and Delivery

Participants: Women ($n = 20$) who received live music therapy for 20 minutes during childbirth and women ($n = 20$) who received standard care during childbirth.

Results: Participants who received live music therapy reported:

- significantly less pain
- significantly less fatigue

Fulton, 2005
Adult Procedural Support: Magnetic Resonance Imaging

Participants: Teens and adults who received live music therapy \((n = 44)\) or standard care \((n = 44)\) during MRI.

Results: Participants in the music therapy group:

- reported significantly better perceptions of the procedure
- requested fewer breaks
- had shorter procedures (lumbar and brain scans)

Walworth, 2010
Adult Procedural Support: Chemotherapy

Participants: Adults who received live music therapy for 20-30 minutes \((n = 25)\) or standard care \((n = 25)\) during chemotherapy.

Results: Participants who received music therapy reported:

- significantly less fear, anxiety, and fatigue
- significantly greater relaxation

Ferrer, 2005
Pediatric Procedural Support: Needle Insertions

Participants: Children under age seven who received live music therapy ($n = 20$) or standard care ($n = 20$) during an IV start, venipuncture, injection, or heel stick.

Results: Children who received music therapy showed:

- significantly less behavioral distress during pre-needle and post-needle phases

Malone, 1996
## Research on Music Listening/Music Therapy and Heart Rate

<table>
<thead>
<tr>
<th>Medical specialty</th>
<th>k (number of studies)</th>
<th>N (total sample size)</th>
<th>$r_u$ (effect size)</th>
<th>p (level of significance)</th>
<th>Q (homogeneity, * indicates heterogeneity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Across specializations</td>
<td>42</td>
<td>1805</td>
<td>0.24</td>
<td>.00</td>
<td>138.93 *</td>
</tr>
<tr>
<td>Neonatology</td>
<td>5</td>
<td>240</td>
<td>0.30</td>
<td>.01</td>
<td>5.56</td>
</tr>
<tr>
<td>Surgery</td>
<td>15</td>
<td>763</td>
<td>0.24</td>
<td>.00</td>
<td>63.93 *</td>
</tr>
<tr>
<td>Cardiology/ICU</td>
<td>11</td>
<td>579</td>
<td>0.13</td>
<td>.04</td>
<td>18.76 *</td>
</tr>
</tbody>
</table>

Dileo & Bradt, 2005
## Research on Music Medicine/Music Therapy and Blood Pressure

<table>
<thead>
<tr>
<th>Measure</th>
<th>Medical specialty</th>
<th>$k$</th>
<th>$N$</th>
<th>$r_u$</th>
<th>$p$</th>
<th>$Q$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean arterial pressure</td>
<td>Across specializations</td>
<td>4</td>
<td>192</td>
<td>0.31</td>
<td>.02</td>
<td>8.54</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>Surgery</td>
<td>9</td>
<td>450</td>
<td>0.26</td>
<td>.00</td>
<td>8.93</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>Across specializations</td>
<td>21</td>
<td>1055</td>
<td>0.19</td>
<td>.00</td>
<td>27.62</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>Cardiology/ICU</td>
<td>8</td>
<td>475</td>
<td>0.10</td>
<td>.04</td>
<td>5.27</td>
</tr>
</tbody>
</table>

Dileo & Bradt, 2005
### Research on Music Medicine/Music Therapy and Pain/Anxiety

<table>
<thead>
<tr>
<th>Measure</th>
<th>k</th>
<th>N</th>
<th>$r_u$</th>
<th>p</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedative drug intake</td>
<td>5</td>
<td>355</td>
<td>0.35</td>
<td>.00</td>
<td>8.77</td>
</tr>
<tr>
<td>Anxiety (STAI)</td>
<td>40</td>
<td>1921</td>
<td>0.30</td>
<td>.00</td>
<td>161.97 *</td>
</tr>
<tr>
<td>Pain</td>
<td>49</td>
<td>2872</td>
<td>0.23</td>
<td>.00</td>
<td>137.09 *</td>
</tr>
<tr>
<td>Anxiety (non-STAI)</td>
<td>17</td>
<td>780</td>
<td>0.2</td>
<td>.00</td>
<td>20.35</td>
</tr>
<tr>
<td>Analgesic drug intake</td>
<td>11</td>
<td>571</td>
<td>0.16</td>
<td>.01</td>
<td>17.83</td>
</tr>
</tbody>
</table>

Dileo & Bradt, 2005
Pain: Effect sizes were significantly greater in studies which used music therapy ($r_u = .62$) compared to studies which used music medicine ($r_u = .18$).

Dileo & Bradt, 2005
Moderators of Effects of Music on Anxiety

• Anxiety (STAI): Effect sizes were greater for music therapy ($r_u = .50$) compared to music medicine ($r_u = .30$), though not significantly.

• Anxiety (Non-STAI): Effect sizes were greater for music therapy ($r_u = .30$) compared to music medicine ($r_u = .16$), though not significantly.

Dileo & Bradt, 2005
Biomedical Theory of Procedural Support
Music Therapy

• Listening to music has the potential to decrease pain and anxiety during medical procedures by affecting the way the brain processes aversive stimuli at both the cortical and sub-cortical level.

• Music therapists promote coping by increasing focus on musical and interpersonal stimuli, affecting the reticular activating system, and influencing decision-making at the cortical level.
Implications for Practice

• Recorded music beneficial at alleviating pain and anxiety, live music therapy frequently better.

• Preferred/familiar music frequently better.

• Sedative or stimulative music—depends

• Passive or active music therapy—depends
Areas for Future Research

• Multiple dependent measures
• Compare interventions
• Design protocols specific to procedures and populations
• Measure distal factors, regression analysis
• Long-term effects: “Clockwork Orange”
• Effects on caregivers/staff
Music Therapy Techniques

• Music Alternate Engagement
• Music Assisted Relaxation
• Integration
Music Alternate Engagement (MAE)

- Participation in musical interventions including songwriting, playing musical instruments, singing, or active listening.
- Override pain and anxiety signals by serving as competing sensory stimuli.
Music Assisted Relaxation (MAR)

- Uses the elements of music (tempo, timbre, melodic contour) to match the patient’s level of arousal and help them transition to a more relaxed state.

- Encourage the patient to actively attend to musical stimulus over other environmental stimuli.
• Alternative to distraction.

• “Calls upon the child to come into the body by focusing on the breath, heart rate, emotional intention, and resonance, i.e. the feeling of pain itself.”

Loewy, 1997, as cited in Ghetti, 2011, p. 5
Considerations

- Understand the procedure
- Facilitate caregiver involvement
- Facilitate interdisciplinary involvement
- Evaluate success

Philp, 2012
Considerations

• Pediatric vs. adult
• Non-invasive vs. invasive
• First time vs. repeat procedure
• History of medical experiences
Elements of the Therapeutic Relationship: Distal Factors

- Child psychosocial factors: Fear, coping style, behavior problems, temperament, previous experience
- Parent psychosocial factors: Negative affectivity, coping style
- Family factors: Marital quality, family environment, parent relationship with child, social support, stress

Blount, Bunke, & Zaff, 1999, 2000
Elements of the Therapeutic Relationship: Proximal Factors

In-session coping-promoting or distress-promoting behaviors of:

- Parents
- Staff

Blount, Bunke, & Zaff, 1999, 2000
Proximal-Distal Model of Child Coping and Distress During Acute Medical Procedures

Blount, Bunke, & Zaff, 1999, 2000

**Proximal Factors**

**PARENT IN-SESSION BEHAVIOR**
- Distress Promoting
- Coping Promoting

**STAFF IN-SESSION BEHAVIOR**
- Distress Promoting
- Coping Promoting

**CHILD IN-SESSION BEHAVIOR**
- Coping
- Distress

**Distal Factors**

**CHILD PSYCHOSOCIAL FACTORS**
- Fear
- Coping Style
- Behavior Problems
- Temperament
- Previous Experience

**PARENT PSYCHOSOCIAL FACTORS**
- Negative Affectivity
- Coping Style

**FAMILY FACTORS**
- Marital Quality
- Family Environment
- Parent Relationship with Child
- Social Support
- Stress
Coping-promoting behaviors: What to Say...

- Non-procedural talk/singing: “What kind of animal did Old MacDonald have on his farm?”
- Humor directed at the child: “The cow says, ‘oink’!”
- Commands to use coping strategies (deep breathing): “Take a deep breath.”

Blount et al., 1989
Distress-promoting behaviors: What NOT to Say...

- Reassuring comments: “It will be over soon.”
- Apologizing: “I’m sorry.”
- Empathic statements: “I know it hurts.”
- Giving control to the child: “Tell me when you’re ready to start.”
- Criticizing: “Don’t be such a baby.”

Blount et al., 1989