

Music and the Brain

Ging-Yuek Robin Hsiung
Division of Neurology,
Dept. of Medicine, UBC



Clinic for Alzheimer Disease
and Related Disorders
UBC Hospital



Djavad Mowafaghian
CENTRE FOR BRAIN HEALTH

Brain
Research
Centre



What is music?

“Music is a tonic to the saddened soul.”

Robert Burton (1577-1640), “Anatomy of Melancholy”

“Music is the sound of universal laws promulgated”

Henry Thoreau (1817-1862)

“Music is the universal language of mankind”

Henry Wadsworth Longfellow (1807-82), “Outre-Mer”

The art of arranging sounds in an orderly sequence so as to produce a unified and continuous composition.

Webster Dictionary definition

Earliest evidence of Music

- Earliest archaeological evidence of musical instruments ~ 3000 BC
- Lyres, harps, reed-pipes discovered in Mesopotamia region
- Well developed by 12th Century BC in Egypt as well as in China



Utility of Music ?

Is music the “cheese cake” of language development?

(S. Pinker, 1998)

Evidence shows that historically, music has been around much earlier than speech and language (D. Levitin, 2004)

- Early form of communication in social groups, already apparent in Neanderthals?
 - Hunter’s dance
 - Warrior drums
 - Courtship
- Memory – Gregorian Chants



Why use music for therapy?

- 1.) Music is an universal part of our life
- 2.) Music may produce strong emotions
- 3.) Music entrains us and coordinates motor actions
- 4.) Music promotes social cohesion
- 5.) Music gives us peace and a sense of meaning
- 6.) Music may activate us (emotionally and physically)
- 7.) Music is powerfully linked to memories
- 8.) Music promotes neurophysiological effects in the brain:
 - a.) *auditory-sensory–motor integration via timing*
 - b.) *connectivity between cortical and subcortical areas*
 - c.) *plastic changes in cortical and subcortical structures*
 - d.) *release of dopamine and serotonin*
 - e.) *improvement of immune system (IgA)*

(slide from Dr. E. Altenmuller, IMMM Hannover)

Neurology of music perception

Frontal Lobe

- Harmony/ Key
- Emotion
- Working Memory
- Behaviour output

Temporal Pole

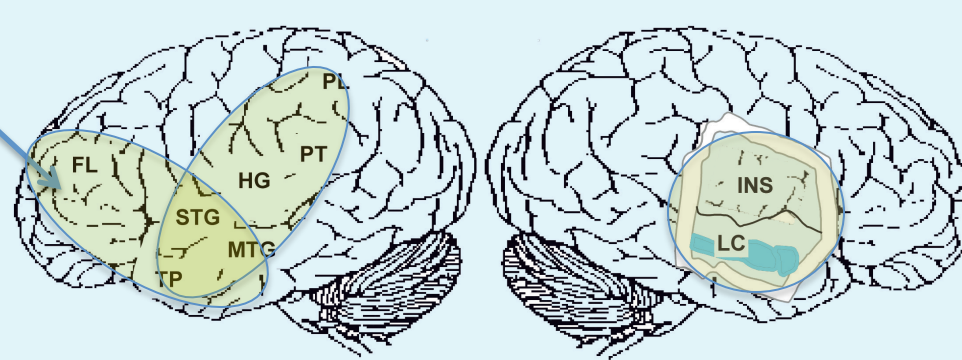
- Recognition
- Cross-modal

Medial Temporal Gyrus

- Recognition
- Cross Modal

Parietal Lobe

- Rhythm
- Spatial location
- Cross modal



Anterior STG

- Pitch interval
- Melody
- Rhythm & timbre recognition

Lateral HG

- Pitch Interval
- Melody

Planum Temporale

- Pitch interval
- Melody
- Rhythm
- Timbre
- Spatial Location

Primary Auditory Cortex Heschl's Gyrus

FL = frontal lobe;
HG = Heschl's gyrus;
INS = insula;
LC = limbic circuit;
MTG = middle temporal gyrus;
PL = parietal lobe;
PT = planum temporale;
STG = superior temporal gyrus;
TP = temporal pole.

Based on Warren, Clin Med 2008

Limbic Circuit

- Emotion

Insula

- Recognition
- Emotion

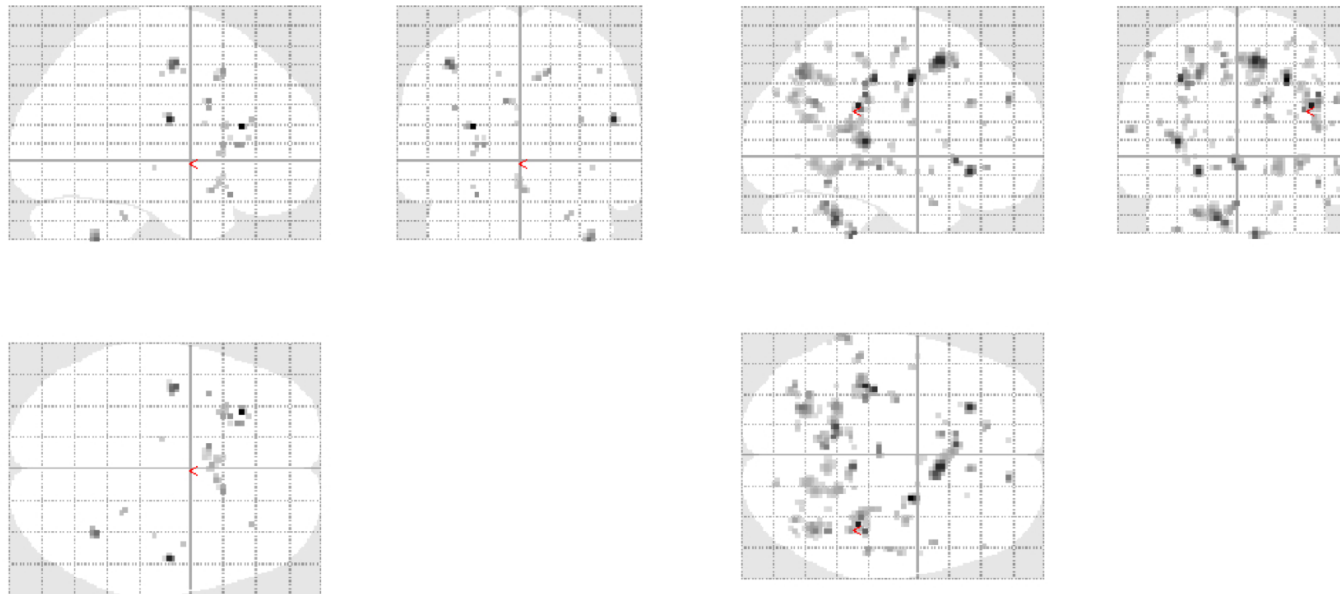
fMRI study on passive listening to music

- Does music therapy alter brain activation pattern?

Figure 1: Greater activation after MT compared to baseline

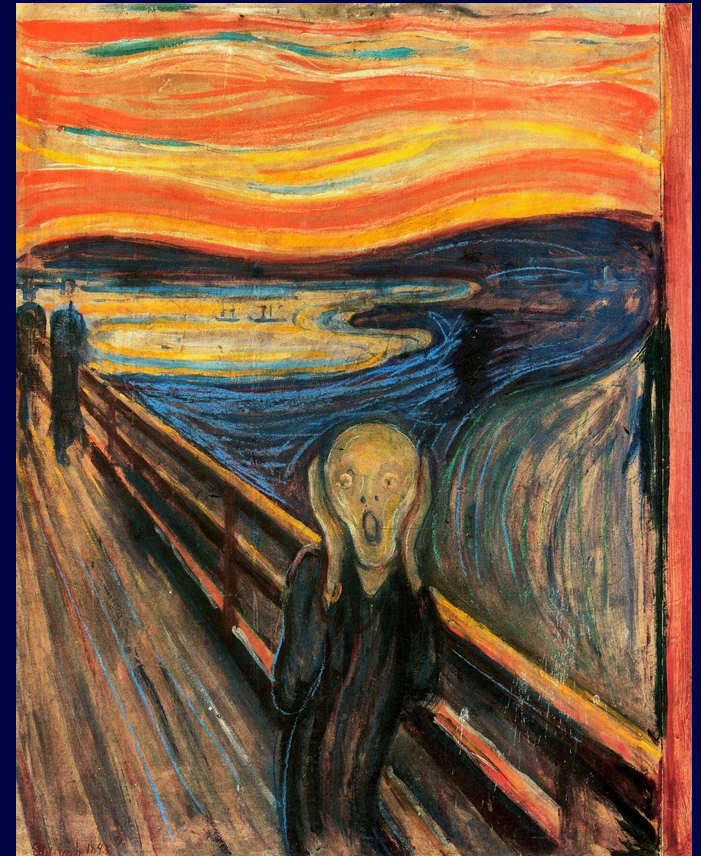
Familiar Music

Unfamiliar Music



Behavioural & Psychological Symptoms of Dementia (BPSD)

- **BPSD in moderate stage of Alzheimer:**
 - Anxiety – 30-50%
 - Agitation – 45-70%
 - Depression – 25-50%
 - Disinhibition – 20-35%
 - Delusions – 15-50%
 - Hallucinations – 10-25%
 - Aggression – 25%
 - Sexual disinhibition – 5-10%



Munch 1893

- BPSD is a strong predictor of nursing home placement

Summary of a systematic review of effects of music therapy (MT) in dementia

- Agitation is the most frequent BPSD symptom targeted in dementia
- Other outcomes assessed include depression, anxiety, global cognition, and overall quality of life
- Most are on subjects with dementia in long-term care facilities
- Usually small groups (largest study has 30 vs. 30; most in the 10-20 range)
- Protocol of Music Therapy are not always clearly described
- Heterogeneous outcome measures were used: but most commonly the Cohen-Mansfield Agitation Inventory (CMAI) or the Neuropsychiatric Inventory (NPI)

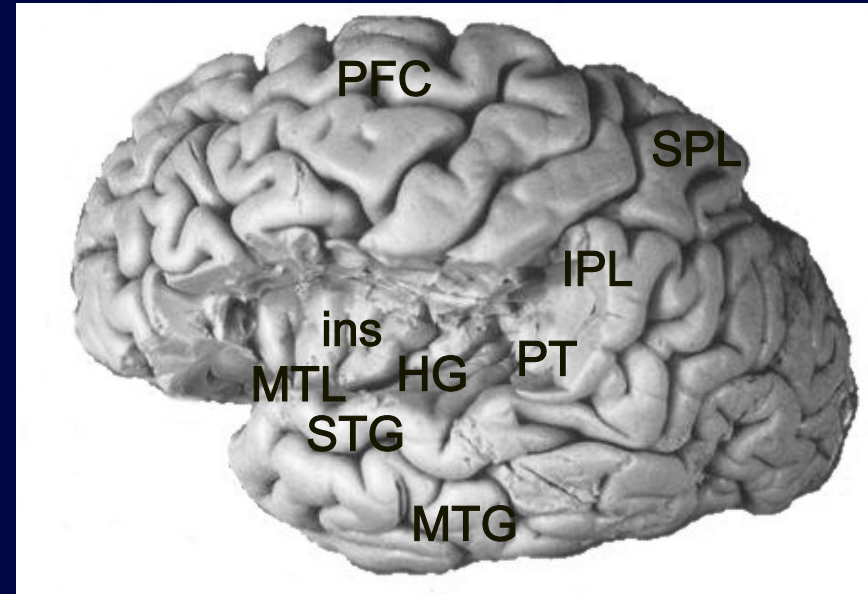
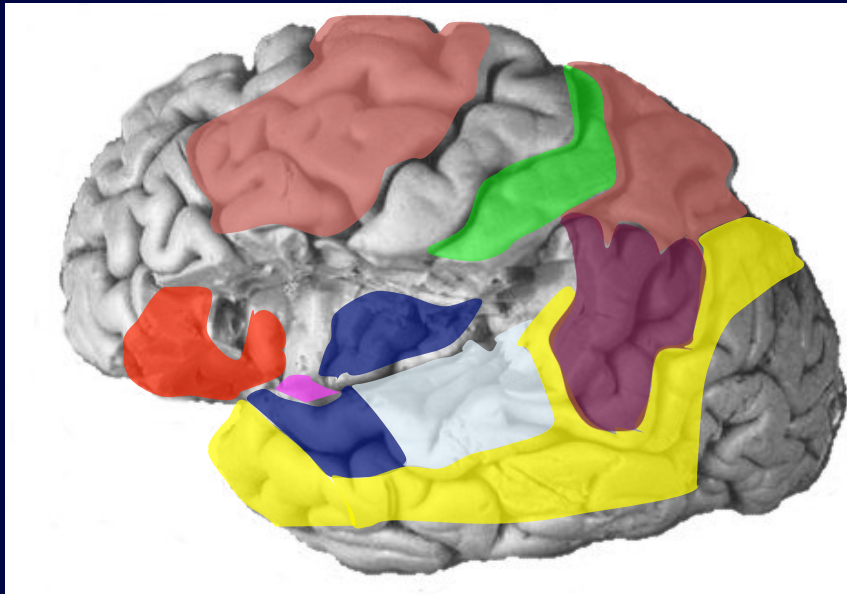
RCT on music therapy in AD








	After MT	After Waiting	P
NPI (Behavioural symptoms)	-2.6	5.9	0.037
CGIC (overall function)	9 improved 9 stable 4 worsened	7 improved 10 stable 6 worsened	Not significant
ADAS-Cog (memory)	1.2	4.4	0.31
QOL-AD-sub	1.6	-0.8	0.25
QOL-AD-CG	1.4	-0.5	0.32
AM Cortisol	-0.15	2.7	0.039

Implications

- Individual or Group MT has beneficial effect on patient with moderate to severe Alzheimer disease with behavioural symptoms
- Our findings are consistent with other Italian and Japanese RCT
- MT for BPSD is a feasible alternative to pharmacological management

Learning to play music or sing opera activates many different parts of the brain !!



- | | | | |
|---|-------------------|---|----------------|
|  | perceptual coding |  | emotion |
|  | recognition |  | music literacy |
|  | episodic memory |  | cross-modal |
|  | procedural memory | | |

HG Heschl's gyrus
ins insula
IPL inf. parietal lobe
MTG mid temporal gyrus
MTL mesial temporal lobe
PFC prefrontal cortex
PT planum temporale
SPL sup parietal lobe
STG sup temporal gyrus