Receptive Music Intervention in Older Adults: A Multimodal Longitudinal Study

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MIND Lab

Introduction

Background: Music-Based Intervention (MBI) have become a widely adopted non-pharmacological intervention among older adults due to their impact on mood and stress reduction (1). Several randomized controlled trials have shown benefits of listening to familiar music, against other interventions on cognition, mood, perceived stress, and quality of life measures in older adults with Mild Cognitive Impairment (MCI) and Alzheimer's Disease (AD) (2-6), but evidence for their effectiveness is not yet well established due to small sample sizes and large inter-subject variability. This underscores the need for a unified mechanistic understanding to motivate music-based interventions. Studying the effect of MBI at a neural level will not only enable scientists to gain a better understanding of MCI and the effectiveness of our proposed therapy, but also to come up with a possible non-invasive method that could sustainably improve subjects' health and well-being by identifying possible pathways that are affected by musical intervention. Based on our understanding of how music affects the brain and results from the previous literature, we propose the following hypothesis:

Hypothesis: Music therapy would be an effective, non-pharmacological intervention of managing and alleviating symptoms of MCI which could sustainably delay its progression to dementia.

Specific hypothesis 1: Older adults will show increased activity in the reward system following an 8-week receptive music-based intervention.

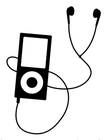
Specific hypothesis 2: Older adults will show reduced stress, anxiety, and loneliness following an 8-week receptive music-based intervention.

Methods

Session 1 & 3

Complete surveys, listening and cognitive tasks, MRI scan, and blood draws

Session 2



Meet with our music therapist to create personalized playlists and listen to them for 8 weeks

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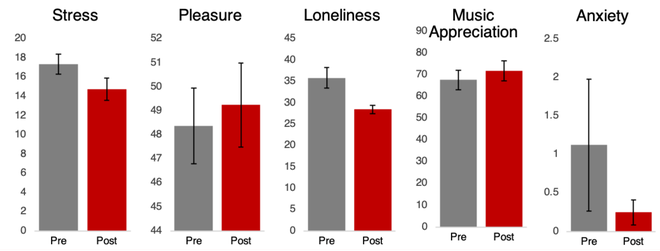
Overview: Adults aged 50+ were recruited from the Greater Boston area to participate in an 8-week music-based intervention. Neuropsychological and neuroimaging data were collected before and after the listening intervention.

- **fMRI acquisition and preprocessing:** MRI data were acquired in a 3T Siemens scanner. T1 Structural data had a voxel resolution was 2 x 2 x 2 mm^3. rsfMRI data: 947 EPI volumes (TR = 475 ms; voxel size= 3 x 3 x 3 mm^3). rsfMRI and task fMRI data were preprocessed using the Conn Toolbox (7). The band pass filter used for rsfMRI data is [0.008, 0.09 Hz], and [0.008, inf] for the task fMRI data.
- **fMRI Mus-Bid Task:** Participants listen to 20-second long clips of music and are asked to rate their enjoyment and familiarity with each clip. There are 4 types of stimuli that participants listen to in a random order: self-selected, familiar-wester, new-western, and Bohlen-Pierce tunes (BP). The liking scale ranges from Love, Like, Neutral, Hate and the familiarity scale ranges from Very Familiar, Familiar, Unfamiliar, Very Unfamiliar (8).
- **Neuropsychological Battery:** During the pre- and post-intervention sessions, participants complete a series of neuropsychological tests. This comprehensive battery of tests includes questionnaires and measures that address areas of cognition such mental health, quality of life, pleasure, music sophistication and reward. Administered tasks that are given by a researcher include measures that test memory, comprehension, and general awareness.
- **Receptive Music Intervention:** The second session of the study involves creating playlists of preferred music for relaxation and enjoyment, and is guided by a music therapist who is able to assess different selections and discuss the significance of different artists and songs as they pertain to the participant's life and personal history. During the 8-week intervention period following the in-person session, the music therapist maintains contact with each participant through a weekly phone call, and the participant continues daily listening for an hour with individual listening logs to fill out and record based on their daily listening experiences.

Behavior and Neuropsychology

Using a paired-sample T test, initial results from the neuropsychological battery in older adults (n = 8) show a significant decrease in loneliness and emotional well-being, an increase in the trends measuring musical enjoyment and hedonic capacity, and a decrease in the trends measuring perceived stress and anxiety after 8-weeks of intervention.

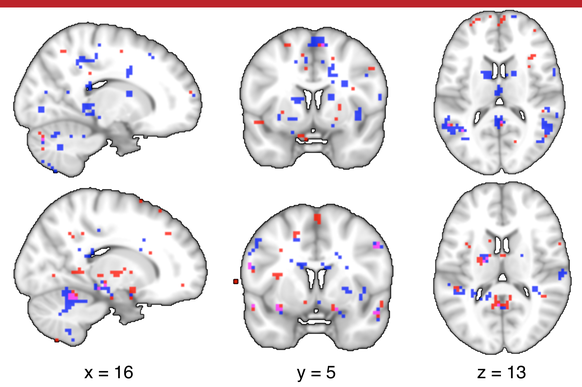
- **Perceived Stress Scale (PSS):** PSS is a 10-item questionnaire that assesses individuals' perception of stress. The questions ask about their feelings and thoughts throughout the last month and are asked to rate how often they felt or thought a certain way (e.g. *In the last month, how often have you felt nervous and "stressed"?*) (9).
- **Geriatric Anxiety Inventory (GAI):** GAI is a 20-item questionnaire that asks how participants have felt in the last week to assess their general anxiety level. Participants can choose "Agree/Disagree" to rate describe how the statement applies to their situation (e.g. *I worry a lot of time)* (10).
- **UCLA Loneliness Scale:** This is a 20-item questionnaire where individuals are asked to rate how often each statement applies to them (e.g. *how often do you feel that you lack companionship?)* (11). Paired t(7)=3.63, p<0.01.
- **Snaith-Hamilton Pleasure Scale (SHAPS):** SHAPS is a 14-item questionnaire that measures participants' ability to feel pleasure in the last few days (e.g. *I have enjoyed my favorite television or radio program*) (12).
- **Goldsmiths Musical Sophistication Index (Gold-MSI):** Gold-MSI is a self-report inventory that measures individual differences in musical sophistication and a person's ability to engage with music. Each statement offers seven responses ranging from Completely Disagree to Completely Agree (e.g. *I spend a lot of my free time doing music-related activities*) (13).



fMRI Task Activations

Pre-intervention (n = 12)

Post-intervention (n = 8)

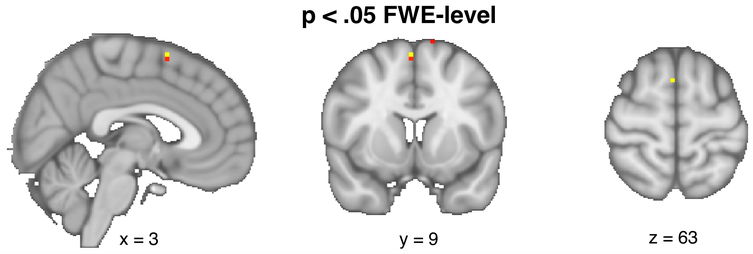


Increased effect of liking, and increased overlap between familiarity and liking after intervention.

T > 4

2nd level analysis (n = 8):

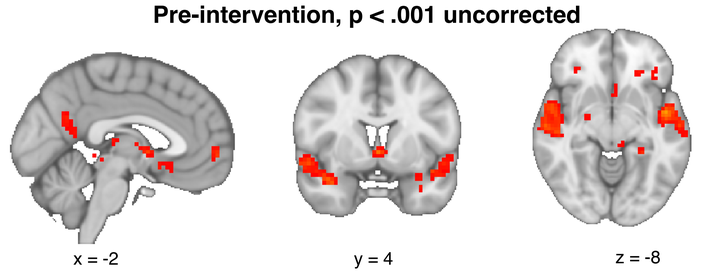
Post > Pre intervention
Linear effect of liking
p < .05 FWE-level



fMRI Functional Connectivity

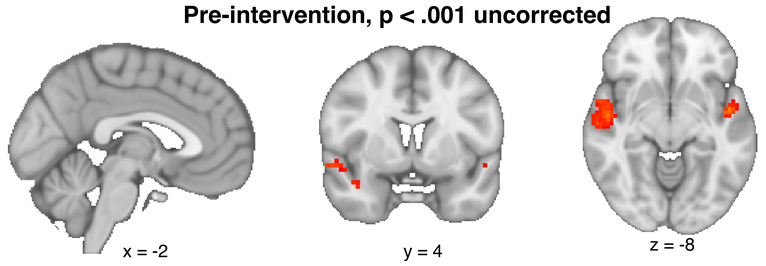
2nd level analysis (n = 12):

Main effect of self-selected music
Pre-intervention, p < .001 uncorrected



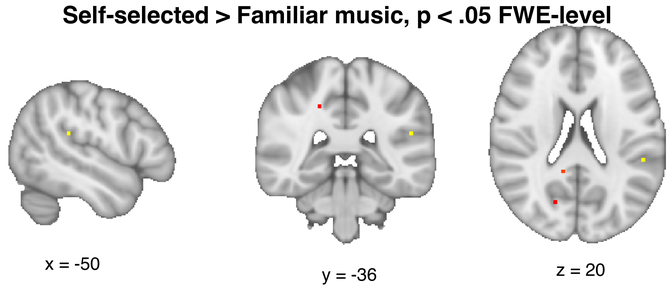
2nd level analysis (n = 12):

Main effect of familiar music
Pre-intervention, p < .001 uncorrected



2nd level analysis (n = 12):

Effect of self-selected music
Self-selected > Familiar music, p < .05 FWE-level



Discussion

1. Neuropsychological results show significant reduction in loneliness, decreased stress and anxiety & increased pleasure and music appreciation after an 8-week music-based intervention. Robust preliminary result suggest that the battery can be effective in capturing sensitivity to musical intervention in older adults.
2. fMRI responses show post-intervention increases in the effect of liking in the SMA, suggesting that repeated listening increases auditory-motor coupling (14).
3. fMRI results when listening to self-selected music, showed higher activity in the auditory network (STG, STS/MTG), and reward/valuation network (striatum, VMPFC). Higher activity for self-selected music than for familiar other-selected music suggests effects of agency and predictability.

Future plans: 1. Larger sample size to correlate behavioral to brain data. 2. Recruit older adults with MCI, Subjective Cognitive Decline (SCD), and varying degrees of early cognitive impairment. 3. Future comparison of MBI vs. other receptive treatment (control intervention).

References & Acknowledgments

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