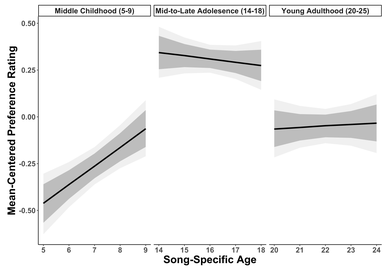
# Leveraging novel music to examine age-related reward responses across development

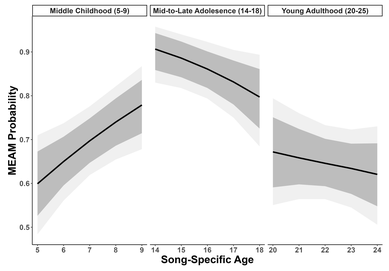
Nicholas Kathios, Kelsie L. Lopez, Juliet Y. Davidow, Laurel Gabard-Durnam, Psyche Loui
Northeastern University, Boston, MA

PINE LAB
MIND Lab
THE LEARNING & BRAIN DEVELOPMENT LAB
kathios.n@northeastern.edu

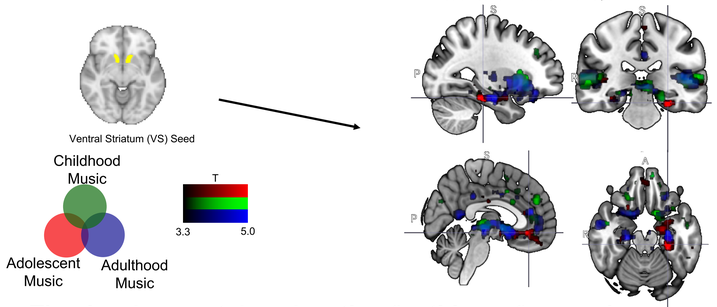
## Introduction

- Listening to music is regarded as one of the most pleasurable experiences across the lifespan[1]
- Pleasurable music listening experiences involve interactions between auditory and reward neural systems[2]
- Music accrues implicit reward value by exploiting reward-prediction mechanisms: listeners tend to prefer music with predictable acoustic and structural features[3]
- There are also lifespan differences in which music is most preferred: Older adults (ages 55+) show lifelong preference for music from adolescence, which also elicits the most spontaneous music-evoked autobiographical memories (MEAMs) in this population (the "reminiscence bump" effect[4]):




Music Year of Release – Participant Year of Birth




Music Year of Release – Participant Year of Birth



- **The developmental explanation for this preference bump remains unclear.** Here we test a candidate mechanism:
- Adolescents show heightened sensitivity to non-music reward-predictive cues and rewarding outcomes[5], attributed to peak levels of dopamine signaling and reward system responsivity during this time[6]
- Corticostriatal functional connectivity also shows positive age-related changes during adolescence[7]

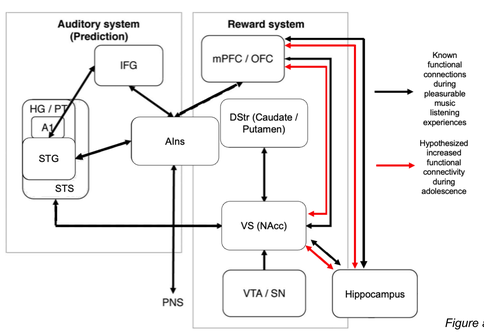



*Figure adapted from (2)*

## Research Questions:

1. Does heightened reward sensitivity in adolescence contribute to an increase in music reward valuation during adolescence?
2. How does developmental maturation of the reward system relate to changes in music preference in adolescence?

## Study Aim 1

**Aim 1**: To characterize differences in behavioral reward responses (i.e. liking ratings) to music across children, adolescents, and young adults.

## Behavioral Task

• Using a novel behavioral[8] and music-listening task fMRI[9] paradigm developed in our lab, we propose to test the relationship between participants' liking and familiarity of novel melodies while manipulating exposure and prediction error, in a cross-sectional cohort aged 8-24
•Studying how predictions relate to learning and reward is often challenging because most music that we encounter contains acoustic features listeners have been exposed to throughout their lives[10]
• To overcome this issue, music stimuli used in this task will be written in the Bohlen-Pierce scale, a musical system acoustically different from existing scales across cultures[11]

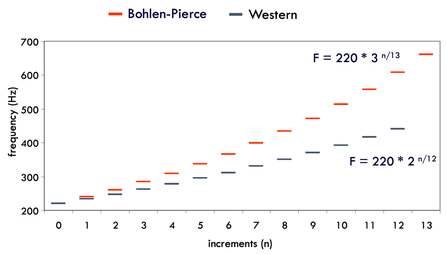
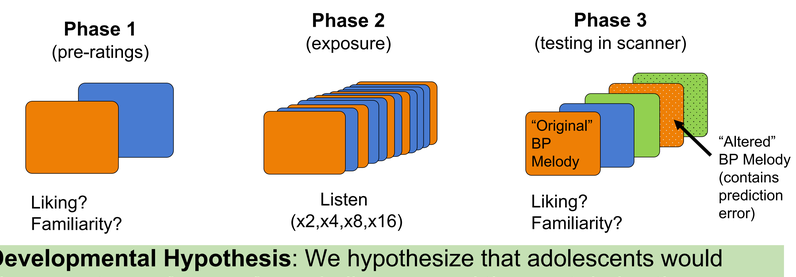
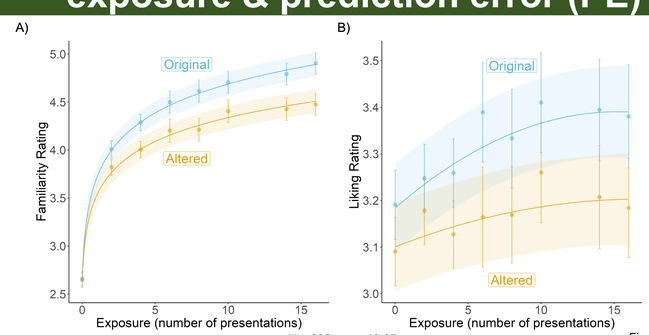



*Figure from (9)*




**Developmental Hypothesis**: We hypothesize that adolescents would show greater preference for melodies exposed the most during the exposure phase and greater disliking for melodies that contain a prediction error. The age-related trajectory of the fit between number of presentations and liking ratings will be best characterized by an inverse-U curve, peaking in adolescence. In contrast, there should be no age-related differences in the strength of the relationship between familiarity and number of presentations.

## Liking & familiarity ratings sensitive to both exposure & prediction error (PE)




N = 665; ages 18-65

*Figure from (8)*

Power analyses from adult data indicate that a sample size of N=68 will have 80% power in detecting an effect of number of presentations on subsequent liking ratings. To account for data loss, we will recruit 78 participants, evenly distributed across age, to meet this sample size. We are exploring ways to ensure we are powered to detect age-related effects, which may increase planned sample size.

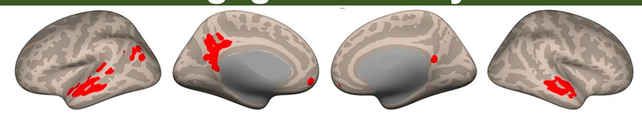
## Study Aim 2

**Aim 2**: To compare functional connectivity during music listening across children, adolescents, and young adults, using fMRI

## Music listening fMRI task


**Developmental Hypothesis**: Adolescents will show greater fronto-striatal connectivity while listening to liked music & greater hippocampal-striatal/prefrontal connectivity while listening to melodies presented more often during the behavioral task.

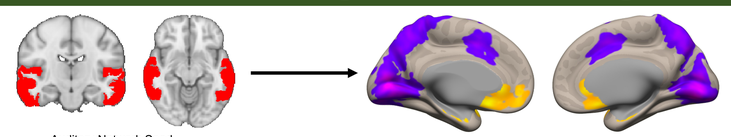
## Liked music engages auditory areas & mPFC



**Parametric Effect of Liking**
N = 16; ages 55-90

Voxel Threshold: $p < 0.05$ (FDR-corrected)
Cluster Threshold: $p < 0.05$ (FDR-corrected)
*Figure from (9)*

## Auditory network & mPFC more functionally connected for younger compared to older adults during music listening



Auditory Network Seed

YA (N = 24; $age_{mean}$ = 18.6) > OA (N = 24; $age_{mean}$ = 66.7)

Voxel Threshold: $p < 0.05$ (FDR-corrected)
Cluster Threshold: $p < 0.05$ (FDR-corrected)
*Figure from (12)*

## Auditory cortex sensitive to PE; FC with mPFC tracks with both exposure & PE

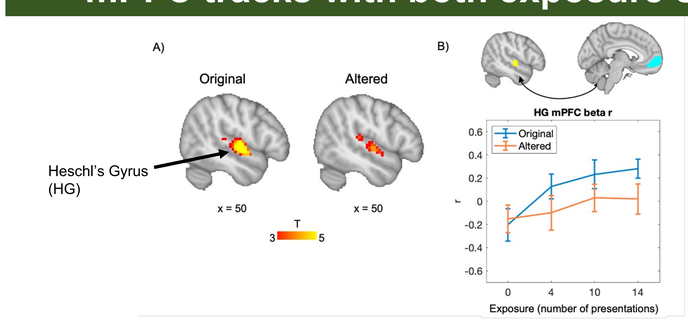



*Figure from (4)*

## Discussion

- Music provides a powerful, yet relatively underutilized, perspective into the neurocognitive developmental trajectory of reward responses
- Music-based interventions may be particularly effective in developmental populations that experience heightened musical reward
- Can age-related changes in music valuation explain lifelong increases in preference and memory associations for music from adolescence?

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We acknowledge support from NSF-GRFP awarded to NK and seed grant funding from Northeastern University's Center for Cognitive and Brain Health awarded to PL, JYD, and LGD.

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@nickkathios