NEUROSCIENCE JUNIOR THESIS PROPOSAL FORM

For 6th semester students (typically junior spring) considering writing a thesis

PLEASE READ THE INSTRUCTIONS CAREFULLY

*** NOTE: DO NOT USE THIS FORM IF YOU ARE ENROLLED IN NEURO 91 ***

Please complete this form and attach your thesis proposal as described on page two. Email your form and proposal to the Advising Office (undergraduate_neuroscience@fas.harvard.edu) by **11:59 PM** on **Saturday, December 9th, 2023 (March 2025 grads)** or **Tuesday, April 30th, 2024 (May 2025 grads)**. You must also send a copy of your proposal to your lab director.

The Head Tutor and the Concentration Advisor will review your proposal, and you will be notified over the summer with feedback. This form should be submitted if you are considering writing a thesis, but does **not** obligate you to do so.

If you have any questions, contact Dr. Laura Magnotti (magnotti@fas.harvard.edu), Dr. Ryan Draft (draft@fas.harvard.edu), or Dr. Kristina Penikis (kpenikis@fas.harvard.edu), Neuroscience Concentration Advisors.

Part A. Complete the following sections:

Student Name: Fahim Ahmed	**HUID**: 11534872
Thesis Title: (May be tentative – Be sure to review title with your research director before submitting.) Investigating the role of music in emotional granularity and emotion regulation	
Harvard email: fahmed@college.harvard.edu	

Research Lab Director: (*GRADUATE STUDENTS OR POST-DOCTORAL MENTORS SHOULD NOT BE LISTED HERE.*) (Please print) Dr. Lisa Wong	
Address: Milton Pediatrics 340 Wood Road Braintree MA 02184	
Telephone: 617 947-2884 cell	**Email**: lmwong@fas.harvard.edu
Director's Signature: (*GRADUATE STUDENTS OR POST-DOCTORAL MENTORS SHOULD NOT SIGN HERE.*) L M W MD	

Daily lab supervisor (if not Research Lab Director): (Please print) Psyche Loui, Phd
Email: p.loui@northeastern.edu

* if you research director cannot provide an electronic signature, please have her/him email us the ompleted form directly to acknowledge her/his approval of your thesis project.

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Part B. Attach your thesis proposal to this form (as a .docx file if possible). Do not exceed **4-5 pages (double spaced).** Include the following:

- Background & Rationale: In approximately 2-3 pages (double spaced), introduce your broad topic and provide a background for your research project. You should read the relevant literature and provide a brief context for the question(s) you plan to address. Be sure to include in-text citations of all relevant published work. Begin this section by broadly introducing your topic, then focus in on any pertinent background studies (not just from your own lab but others as well), and eventually end with a statement of your specific research question(s). A reader should be able understand why you are asking your question(s), based on what you describe in this background section about earlier work, current debates in the field, etc. You can think of this section as eventually being developed into your thesis introduction.

- Experimental Approach: In approximately 1-2 pages (double spaced), describe the experiments you plan to complete in the coming year. Describe the specific methods you will use and explain how they will provide mechanistic insight into how the brain works. Provide enough detail so that the reader will have a clear idea about what you plan to do in the lab. We will use this section to make sure that your project will be appropriate for a thesis in Neuroscience. Do not just describe the overall research plan of your host laboratory; rather, try to be specific about the work you plan to do. Your research director and your mentor should help you to define your specific role in the project. Also, make sure that your mentors read a draft of your proposal for suggestions and revisions.

- References: *(not included in page count)* Provide key references regarding the background and experimental design of your project. Provide complete reference information (authors, year, title, journal, volume, pages numbers, etc).

- Joint Concentrators**:** If you are a joint concentrator, your thesis proposal must demonstrate how you will integrate both of your concentrations into an interdisciplinary thesis. This means you must show how approaches from both fields will be applied to your work and how both provide essential contributions to further your central thesis question. Your proposal will be reviewed by the Neuroscience Standing Committee (and also your joint concentration) to determine if it meets the standards for a coherent and integrated project. This checkpoint is a requirement to continue to pursue a joint concentration.

    - *Joint concentrators must submit the Joint Concentration Information Form along with their junior thesis proposal.*

* *

PLEASE SUBMIT THIS FORM WITH SIGNATURE AND ATTACHED PROPOSAL BY:

11:59 PM on **Saturday, December 9th, 2023 (March 2025 grads)** or **Tuesday, April 30th, 2024 (May 2025 grads)**

Email your report to your lab director and return these completed forms to undergraduate_neuroscience@fas.harvard.edu

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Investigating the role of music in emotional granularity and emotion regulation

Background & Rationale

Emotional granularity refers to the ability to differentiate and label discrete emotional experiences with precision and specificity (Barrett, 2004). It involves recognizing and distinguishing between subtle variations within a particular emotional category, such as differentiating between feeling mildly annoyed versus intensely frustrated. Individuals with greater emotional granularity tend to be more capable of accurately identifying and articulating their emotions, which enhances their emotional regulation skills and coping strategies. This concept suggests that the richness and complexity of one's emotions contribute to a more nuanced understanding and management of emotions.

Understanding individuals' abilities to differentiate between specific emotions is essential for understanding methods of emotion regulation and the long-term behavioral and mental outcomes thereof. Tugade, Fredrickson, and Barrett (2004) highlight several studies that indicate that high positive emotional granularity is linked to better mental health outcomes after negative events, as individuals with high emotional granularity specific for positive emotions are more capable of identifying positive elements within different experiences, helping them to cope and recover after stressful events. Given that music listening is a popular method of emotion regulation for coping with stress, this suggests that music might play an important role in affecting individuals' ability to regulate their emotions (Thoma et al., 2012). Therefore, investigating this role of music may improve methods of measuring and understanding emotional granularity.

This proposal presents a novel approach to measuring emotional granularity. Previous studies tend to use visual stimuli and require participants to report the extent to which they feel different emotions after being exposed to sets of normed and verified visual stimuli. When reported on a numerical scale, the values for different emotions experienced by an individual across the different stimuli can be used to calculate an intraclass correlation (ICC) of the individual's emotions. A high correlation between different emotions across stimuli suggests lower emotional granularity, as it suggests that the individual more frequently experiences different emotions together rather than being able to pinpoint and differentiate their emotions based on the type of stimulus. The effects of emotional granularity are often also studied through EEG measurements of event-related potentials (ERPs) and event-related desynchronization and synchronization (ERD/ERS) in response to affective images (Lee et al., 2017). EEG alpha-power density is inversely related to neural electrical activity and can be used to study emotional experiences (Baumgartner et al., 2006). Variation in resting state functional connectivity of brain networks has also been associated with differences in emotion processing (Canu et al., 2022).

However, using stagnant visual stimuli may limit participants' experiences of nuanced emotions, given that these stimuli (such as the International Affective Picture System (IAPS) and Open Affective Standardized Image Set (OASIS) do not evolve over time (Coan & Allen, 2007; Kurdi et al., 2017). Musical stimuli, on the other hand, *do* unfold over time and evoke different nuanced emotions due to their emotionally dynamic nature, allowing for more nuanced emotional experiences. This may mimic real-life emotional experiences more accurately and could therefore provide more ecologically valid measures of emotional granularity than what is currently observed with visual stimuli.

I propose investigating the role music plays in individuals' abilities to differentiate emotions. I will compare self-reports of experienced emotional granularity in response to original music and visual stimuli and relate this to mental health outcomes. I will be conducting this research through Dr. Psyche Loui's Music, Imaging, and Neural Dynamics (MIND) Lab at Northeastern University, with Dr. Lisa Wong as my faculty advisor, exploring music as a means for measuring emotional granularity and determining whether music can provide more nuanced data than the stagnant visual stimuli that are typically used for determining emotional granularity.

Experimental Approach

The pilot data that we recently collected from a sample of 125 adults aged 18-65 show promising results. In the online pilot study, participants rated six musical stimuli from the Musical Emotional Bursts (MEB) set which varied in emotional valence (Paquette et al., 2013). The participants also rated four IAPS images, which also varied in emotional valence. For all ten stimuli, participants rated ten different emotional experiences, five of which were negative and five of which were positive: anger, disgust, sadness, scared, upset, happiness, pride, excitement, joy, and satisfaction, on a 0-100 scale, with 0 standing for "I did not experience this emotion." These ratings are done directly after each stimulus is shown/played. ICC analysis of the dataset showed that, on average, individuals had higher emotion granularity with musical stimuli, both for positive and negative emotions, suggesting that music may elicit more granular emotional experiences. Musical stimuli showed greater granularity than visual stimuli on average, suggesting that the musical stimuli may be inherently more emotionally nuanced.

Building off of this, I will be using original musical stimuli from Matthew Sachs, PhD (Harvard College '12, Sachs et al., 2023). I have met with Dr. Sachs regarding using his stimuli, which are four original compositions, composed by two film score composers (two pieces each), with each piece containing 16 emotional events. These events were composed to correspond to one emotion, either joyful, sad, anxious, calm, or dreamy, and be at least 30 seconds in length. I will be using shortened excerpts of these stimuli in an experiment with a design similar to that of our pilot study. Specifically, I will be using the time series emotion rating data of the stimuli to isolate sections that consistently remain within either positive or negative valence and are 8 seconds in length. We will be selecting an equal number of visual stimuli from OASIS that are of comparable emotional valence in order to compare the strength of the musical stimuli against the visual stimuli, computing emotional granularity scores as outlined above and comparing the average emotional granularity scores between types of stimuli.

Each participant will also complete the Range and Differentiation of Emotional Experience Scale (RDEES), which is a validated measure of emotional differentiation (granularity), and we will check the correlation between RDEES scores and the experimental granularity scores. To explore whether or not this relates to individual differences in musical training, participants will also complete the Goldsmiths Musical Sophistication Index (Gold-MSI). Additionally, to consider correlations with music exposure at home throughout development, participants will complete the Music@Home–Retrospective Scale developed in the PINE and MIND Labs at Northeastern.

To relate these results to mental health outcomes further along the research process, we will also have participants complete the Connor-Davidson Resilience Scale (CD-RISC) for resilience, Beck Depression Inventory (BDI) for depression, and State-Trait Anxiety Inventory (STAI) for anxiety. Once we extend the study into a developmental population, the study will be conducted in person with children, and we will be using the PINE and MIND Lab's non-retrospective Music@Home Scale to collect data about music exposure at home, which we may then use to determine correlations between music exposure in development and emotional granularity.

My role in this process involves analyzing the valence and arousal of the existing stimuli from Dr. Sachs to select shorter clips, selecting visual stimuli from OASIS, scoring the data collected from piloting the new stimuli, determining correlations between RDEES, Gold-MSI, and experimental emotional granularity scores (for both musical and visual stimuli), and doing the same for a formal version of the study. I will also continue to adapt our adult paradigm to work with developmental populations. Once we start conducting the study in person, I will be working directly with participants to collect data. We will prepare and formally run an online study in adults, using the musical stimuli and visual stimuli that we select. I will then pilot the study with children and adolescents to determine what changes need to be made for a developmental, in-person version of the study. I will be recruiting children for the in-person study and administering the experiment.

I will be helping with administering the fMRI component of the study, analyzing resting state fMRIs to see if there are differences in neural activity that are related to emotional granularity. Recent studies have related resting state functional connectivity to frontotemporal lobar degeneration and changes associated with emotion processing, highlighting the value of considering resting state activity and not just activity during emotional experiences (Canu et al., 2022). However, given the significant use of EEGs in emotional experience studies, I may also help administer EEGs to analyze neural activity during presentation of affective stimuli. This may be dependent on how much data we're able to get from the fMRI component. The combination of neuroimaging data, affective stimulus presentation results, and mental health self-report scales should allow me to understand the role that music plays in emotional granularity more deeply than what is currently known.

Citations

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