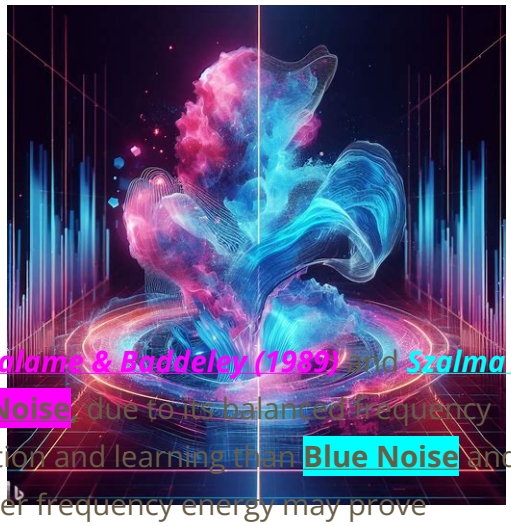
The Frequency of Memory: Assessing Cognitive Effects of Pink and Blue Noise During Study Sessions

Research Methods in Psychology **10/15/23 > *Project Proposal By* :**
Jack Burleson & Nick Kitelinger > Group #3

- **ABSTRACT**
- Exploring the subtle intricacies between distinct acoustic phenomena (pink and blue noise) and cognitive performance, this inquiry peeks into their influence on memory's multiple phases: encoding, consolidation, and retrieval. We meld neurocognitive models and attentional frameworks to examine how these auditory waves might sway neural activations in crucial cerebral locales, thereby altering memory efficacy. Initial revelations propose that these specific sonic frequencies

could sculpt neural plasticity and attention, embedding a unique resonance in our emotional and cognitive tapestry, thus etching depths into memory processing and offering substantial implications for both educational and therapeutic environments.



Overview, Justification,& Hypothesis

Overview/Intoduction

- Drawing upon the findings and research of ***Salame & Baddeley (1989)*** and ***Szalma & Hancock (2011)***, it's hypothesized that **Pink Noise**, due to its balanced frequency distribution, will foster better memory retention and learning than **Blue Noise** and No Noise conditions. Blue Noise with its higher frequency energy may prove distracting, while the No Noise condition may lead to mind-wandering, thus potentially hindering **optimal learning** and **memory retention**.

Justification For Research:

1. The significance of this niche research lies in its potential to unveil the optimal auditory conditions for studying, thereby guiding educational setting facilitators in creating conducive learning environments. By understanding the impact of different noise conditions, educational institutions and individuals can better design study rooms and personal areas to enhance learning outcomes. This also extends to online learning environments where individual students have complete choice in controlling their learning environment and can choose to play certain types of noise to aid their studying, as a majority of their instruction may occur online, and the ability to focus for extended periods can vary substantially from student to student.

Research Question(s)

- **Neural Activation and Noise:** How do pink and blue noise frequencies differentially activate the brain's hippocampal region, influencing the consolidation and recall of declarative memories?
- **Cognitive Load and Noise Interference:** How do pink and blue noise interact with the brain's cognitive load, and what implications does this have for the depth of processing and subsequent memory recall?
- **Emotional States and Auditory Influence:** How do pink and blue noise influence the brain's limbic system, and can this auditory stimulation evoke specific emotional states that enhance or inhibit memory recall?

Hypothesis:

1. Exposure to pink noise during study sessions will lead to significantly higher recall accuracy compared to blue noise or no noise conditions.
    a. Secondary Hypothesis: The effectiveness of pink and blue noise on recall abilities will vary depending on the complexity of the information studied.

Specifications:

Experimental Design:

Participants: A total of at least 30 college students,(could be expanded to include anywhere from 30 students to 300 students due to simplicity of selection & dividing of experimental groups) but this stands in as a simple divisible total. Students may be of any background, major of study, or year in college, with no prerequisites or qualifications required besides basic good health, functioning auditory intake channels, and confirmed consent to take part in our experiment. After this, participants are randomly assigned to one of the three noise conditions (Pink Noise, Blue Noise, No Noise), with at least 10

participants in each group. (Groups are decided by a random number generator to minimize any human interference.)

Materials:

- Pre-test to establish a control baseline for the participant,
- High-quality headphones,
- sound systems for noise generation,
- A standardized reading material, a post-study assessment to evaluate learning retention and memory,
- An exit screening to analyze other implications and questions, as well as gather participant feedback and experience.

Audiological Software: To generate Pink and Blue Noise, a high-fidelity audiological tool will be employed, ensuring the purity and consistency of the auditory stimuli. Utilizing either Audacity[1] or Similar Online Counterparts, this frequency and consistent output of

[1] Using Software, Audacity & Web Based **Audacity**:

- **Platform**: Windows, macOS, Linux
- **Cost**: Free

Steps:

1. Download and install Audacity.
2. Open the program.
3. Go to the `Generate` menu.
4. Select `Noise...`.
5. In the pop-up window, choose either `Pink` or `Blue` from the dropdown menu.
6. Specify the duration (e.g., 45 minutes).
7. Click `OK`.
8. To save, go to `File > Export` and choose your preferred format.

2. Online Generators:

There are websites like myNoise and SimplyNoise where you can generate and customize Pink or Blue noise. Though there might be limitations regarding the length and download options, it can be an easy and fast solution.

sound will be very easily achievable through a simple Python script or utilizing the simple user interface of Audacity.

Online Specific Materials

- Google Surveys (Surveys)
- Website to operate assessment securely from & store encrypted data concerning participant's name, email, DOB, etc..
    - Due to the flexibility and minimalistic requirements that are in place to begin and effectively execute the experiment, an option to facilitate the experiment in person, or online independently could be easily implemented and swapped out with the current material requirements. Depending upon any limiting factors or constraints that might be encountered at a later unforeseen date.
    - In the case of swapping the in-person experimental method with an online-based independent experiment, the aforementioned tools can be applied to the structure and execution of our experiment with tweaks around the deployment of the surveys & assessments to be digitally answered and cataloged. In addition, a heightened descriptive and explicit nature of instructions would be required in order to ensure the highest probability of exact accordance with the procedure as outlined.

Operational Definitions:

Independent Variable (Type of Noise)

Pink Noise: The designation “pink” sometimes referred to as 1/f noise is a reflection of the noise’s frequency spectrum. In terms of physics, as the frequency (or wavelength) of light increases, it moves from red to pink shades. Similarly, pink noise decreases in power as the frequency increases, leading to the name. Pink noise spans the entire range of audible frequencies, but its power density decreases by 3 dB/octave (or 10 dB/decade).It will be electronically generated and delivered through high-quality headphones at a relatively consistent volume level, with slight variations of (±5 decibels) interspersed throughout the audio to simulate a slightly more immersive environmental audio experience.

Blue Noise: This noise is defined in relation to the color spectrum, similar to pink noise. As you progress from violet to blue light in the visible spectrum, the frequency of light increases. This increase aligns with blue noise’s characteristic of increasing power as frequency goes up. The power density of Blue Noise increases by 3 dB/octave (or 10 dB/decade). This noise will also be electronically generated and delivered through high-quality headphones at a relatively consistent volume level, with slight variations of (±5 decibels) interspersed throughout the audio to simulate a slightly more immersive environmental audio experience.

No Noise: This condition will entail a silent environment within a soundproof booth, with no auditory stimuli provided, acting as the ‘control’.

Decibel Levels & Considerations for Various Noises:

Ethical Considerations

1. Comfort & Safety: The World Health Organization recommends that under headphones, the level should not exceed 85 decibels, which is around the loudness of city traffic from inside a car.
2. Typical Study Environments: Common study environments such as **libraries** and **cafes** usually have background noise levels ranging from ***40 to 70 decibels.***

- Considering the above information and typical decibel setting, it could be safe to assume that operating the unique independent sound profiles within this range would be both safe, and environmentally cohesive to the typical perceived sound experience and idle noise present while studying, reading, or attempting tasks that avoid concentration in a myriad of different locations.

Noise Profile & Decibel Level

•Pink Noise: Set it around ***50-60 decibels***. This level is audible without being overbearing, often compared to light rainfall or a soft hum. Due to its balanced and equal frequency across the noise spectrums, it provides an interesting element

•Blue Noise: Given its high-frequency energy, it might be perceived as slightly louder. Commonly utilized in digital media, it's higher frequency is likened to a "hiss" sound, but also has been compared to sounds of water from a distance, such as rain and waterfalls. Thus, a slightly lower level, around ***48-58 decibels***, could be ideal to ensure comfort.

•No Noise: Ensure the soundproof booth minimizes external noises to ***below 30 decibels***, akin to a quiet rural area. Very heavy importance on absolute control of this no-noise room, as it represents the controlled scenario in comparison to the unique noise profiles.

Dependent Variable (Learning Retention and Memory):

Post-Study Assessment: The post-study assessment will consist of multiple-choice questions and recall-centered tasks related to the standardized reading material. The total score obtained will serve as the quantifiable & measurable value to base a majority of the conclusions of the experiment from the assumptions surrounding learning retention and memory. Following all trials and experiments conducted, participants are given a debriefing form, as well as a post-test experiment survey/ included in the experiment, a debriefing survey will be administered to inform the participant of the research goal, context, availability and access to test results and conclusions, as well as inform them on the process to remove themselves from the experiment data & being included in the research any further if desired. A brief exit

Multiple-Choice Section: A set of multiple-choice questions evaluating the understanding and retention of key concepts from the reading material.

Recall-Centered Tasks: Participants will be asked to recall specific information, facts, or concepts from the reading material.

- *Multiple Choice* *and* *Recall Centered Tasks* are focused explicitly upon the academically approved, reviewed, and appropriate study session-centered text(s) both on a general knowledge level, but also in consideration of the 'average' Lexile level for college-bound students is roughly estimated to be between 1185L to 1385L.
    - The content that will be utilized for the assessments will be randomly selected from an assortment of scholarly scientific, psychological, or sociological articles, magazines, and scholarly article excerpts.
    - Intend to have either one or two reading materials selected, to add a potential additional level of observable variance from the main focus of the experiment, specifically to analyze whether the difference in topic studied had any effect or trend that could be identified from the possibly slim variance between observed scenarios and the accompanying results in the worst case statistical scenario. (Possible Contrasting Topics, Contrasting density & complexity within same length of reading)

Prior Scholarly Research Conducted In the Same Field of Study:

I. Salame & Baddeley (1989)

- This study primarily dealt with the role of the phonological loop in working memory, specifically focusing on the interference effects of background music on verbal reasoning tasks.

II. Szalma & Hancock (2011)

- "Mixed evidence was obtained for the traditional arousal and masking explanations for noise effects. The overall pattern of findings was most consistent with the maximal adaptability theory, a mental resource-based explanation of stress and performance variation." (Szalma & Hancock 2011)

III. **Klatte, M., Bergström, K., & Lachmann, T. (2013).**

- A focused review on how noise impacts learning, specifically in children. However, many of the findings can be extrapolated to older populations.

IV. **Bridgett, R. & Cuevas, H. M. (2016)**

- This study explores the impacts of background music on reading comprehension, which can be extrapolated to understand the effects of studying.

CONCEPT ART

APA REFERENCES TO UTILIZED SOURCES

1. Klatte, M., Bergström, K., & Lachmann, T. (2013). Does noise affect learning? A short review on noise effects on cognitive performance in children. Frontiers in Psychology, 4, 578. https://doi.org/10.3389/fpsyg.2013.00578
2. Smith A. (1989). A review of the effects of noise on human performance. Scandinavian journal of psychology, 30(3), 185–206. https://doi.org/10.1111/j.1467-9450.1989.tb01082.x
3. Jäncke, L., & Sandmann, P. (2010). Music listening while you learn: no influence of background music on verbal learning. *Behavioral and brain functions : BBF*, *6*, 3. https://doi.org/10.1186/1744-9081-6-3
4. Szalma, J. L., & Hancock, P. A. (2011). Noise effects on human performance: a meta-analytic synthesis. *Psychological bulletin*, *137*(4), 682–707. https://doi.org/10.1037/a0023987
5. **Lu, Y., Huang, H., & Lin, Y. (2020)**. Spectral Content (colour) of Noise Exposure Affects Work Efficiency. *Noise & Health*, *22*(104), 19-27. https://doi.org/10.4103/nah.NAH_61_18
6. Lehmann, J. A., & Seufert, T. (2017). The Influence of Background Music on Learning in the Light of Different Theoretical Perspectives and the Role of Working Memory Capacity. *Frontiers in Psychology*, *8*, 297754. https://doi.org/10.3389/fpsyg.2017.01902
7. Szalma, J. L., & Hancock, P. A. (2011). Noise effects on human performance: a meta-analytic synthesis. *Psychological bulletin*, *137*(4), 682–707. https://doi.org/10.1037/a0023987
8. Salamé, P., & Baddeley, A. D. (1989). Effects of background music on phonological short-term memory. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology*, *41*(1-A), 107–122. https://doi.org/10.1080/14640748908402355