TBD

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Abstract

There is a belief that auditory stimulus can create adverse effects on a person's attention and focus. The following experiment was intended to test the aforementioned belief. Students in an upper-division psychology class were going to participate in two different tasks that required their full attention, a simple math task and a simple video game similar; the order in which the tasks were presented would have been random. Secondly, there would have been four types of sound stimulus presented, no sound, a constant sound, an erratic sound, and white noise. The sound stimuli would have also been presented in a random order to all participants of the study. Unfortunately, due to the COVID-19 pandemic the experiment was unable to be carried out and therefore results are unknown.

Introduction

It is widely believed that auditory noise has a detrimental effect on both cognition and attention. In this experiment we attempt to explore the possible positive effects that noise can have on cognitive tasks. One auditory phenomenon that we explore is Stochastic Resonance (SR), the idea that an optimal level of noise added to a system can enhance the performance of a non-linear system. The idea of stochastic resonance has been observed across disciplines and we aim to explore the effects that it may have on cognition. Input Stochastic Resonance in a auditory scenario is called white noise. This is defined as auditory tones being presented with equal intensity at different frequencies.

Evidence of Stochastic Resonance has been found in the nervous system. This effect can be seen as baseline neuronal firing within the brain with no input or outside stimuli. This effect has been viewed in all sorts of perception systems, ranging from audition to visual (Moss et al., 2004). The basic idea of stochastic resonance is that added noise to a system can enhance a signal strength. This can be scaled up to entire pathways present in the brain like the dopaminergic pathway. Recent evidence suggests that the dopaminergic pathway influences attention and cognition (Bellgrove et al., 2007). There is a baseline firing rate dopamine neurons in the brain and the same basic principles of stochastic resonance apply. By adding input noise to the system we believe that we can enhance signal strength, the signal in this case would be memory retrieval. Stochastic resonance has been found specifically in the auditory region. The auditory system overall is nonlinear (Egui'luz et al., 2000). It has been shown that increased noise can increase signal detection of tones (Zeng et al., 2000). It has been found that stochastic noise stimulation via transcranial electric stimulation (tES) both have positive effect on learning (Anna et al., 2011) and general cognitive performance (Mulquiney et al., 2011). We believe that stochastic auditory noise can have the same effect on neuronal firing and thus the same effect on cognitive performance.

An experiment that we draw evidence from is The effects of background white noise on memory performance in inattentive school children, (Göran et al., 2010). This experiment found that inattentive children had an increase of memory performance when listening to white noise. The proposed explanation for this effect was that a hypodopaminergic brain does not have the same baseline dopamine neuronal firing. This neuronal firing can then be increased by input noise and thus increase cognitive performance. We believe that this effect can be replicated with any participant group, even if they have no sign of attention deficit. If the optimal decibel level is reached, there will be increased performance across the board because of an increase in neuronal firing. Another experiment found that white noise increased reaction time on an arithmetical recall task (Usher & Feingold, 2000).

We also aim to explore other possible improvements auditory stimulus could have on performance. There is vast research done on the effect of rhythmic auditory cueing for movement rehabilitation (S, 2014). We seem to have an innate sense to dance to rhythm of music. We would like to explore this as another possible avenue for improved performance in a simple computer game scenario.

Methods

Participants were presented with a total of two tasks. Which task they were assigned first was randomly selected.

Task one: this task was a basic memory retrieval task for single digit multiplication rules. The participants were to answer basic multiplication facts using the keyboard. The stimuli would persist until the participant answered the question presented correctly. Thus the reaction time of the participant answering the question correctly was measured. The variable of interest in this task was the reaction time of the participant. The reaction time was the time from when participant was presented with the multiplication question to when the participant answered the question correctly. The participant must answer the question correctly in order for the next stimuli to be presented.

Task two: this task was a basic computer game. The game was meant to imitate the popular smartphone game flappy bird. The game requires the participant to tap the space bar at a constant rate to keep the bird in the middle of the screen. The obstacles would remain in the middle to require the participant to tap at a constant rate. All stimuli mentioned would be presented to the participant completing this task as well. The variable of interest in task two is the performance on the game. Specifically it is the time from the start of the game to the time of failure in the game. We expect an improvement in performance after more exposure so we first presented the participant with a single practice round before without audio stimuli. The participant is then presented with one of the four stimuli and plays the game one more time with audio until failure. The constant time interval audio stimuli will directly coincide with the requirement to tap the space bar to keep the bird in the middle of the screen.

Stimuli

Each participant was presented with four different stimuli presented in a random order. The first stimuli is no noise presented to the participant. In this condition the participant completed the task with headphones on with no noise presented. The second stimuli was a tone presented at a constant time interval. Everything about the tone was constant, including the frequency of the tone and the loudness of the tone. The time interval between the tones remained a constant 2 seconds. The next stimuli presented was the same tone presented in the previous condition yet with variable time intervals between tone presentation. These intervals varied between .5 second and 4 seconds. The timing of the presentation of the tone was controlled using a built in python random number generator. The last stimuli presented was white noise. This was noise presented at equal intensity with varying frequency tones playing at a time. This was presented at 77 dB which was found to be the optimal decibel level for cognitive performance (Usher & Feingold, 2000). In fact all tones in this experiment were presented at 77 dB to avoid any possible effects on the loudness of the noise causing any impairment on attention.

The dependent variable measured depended on which task was performed. In the arithmetic recall task, the variable was reaction time from presentation of stimulus to correct answer presented by participant. The variable measured on the game task was time until failure. The time from when the game starts to the time of termination of the game (when the participant loses).

Subjects

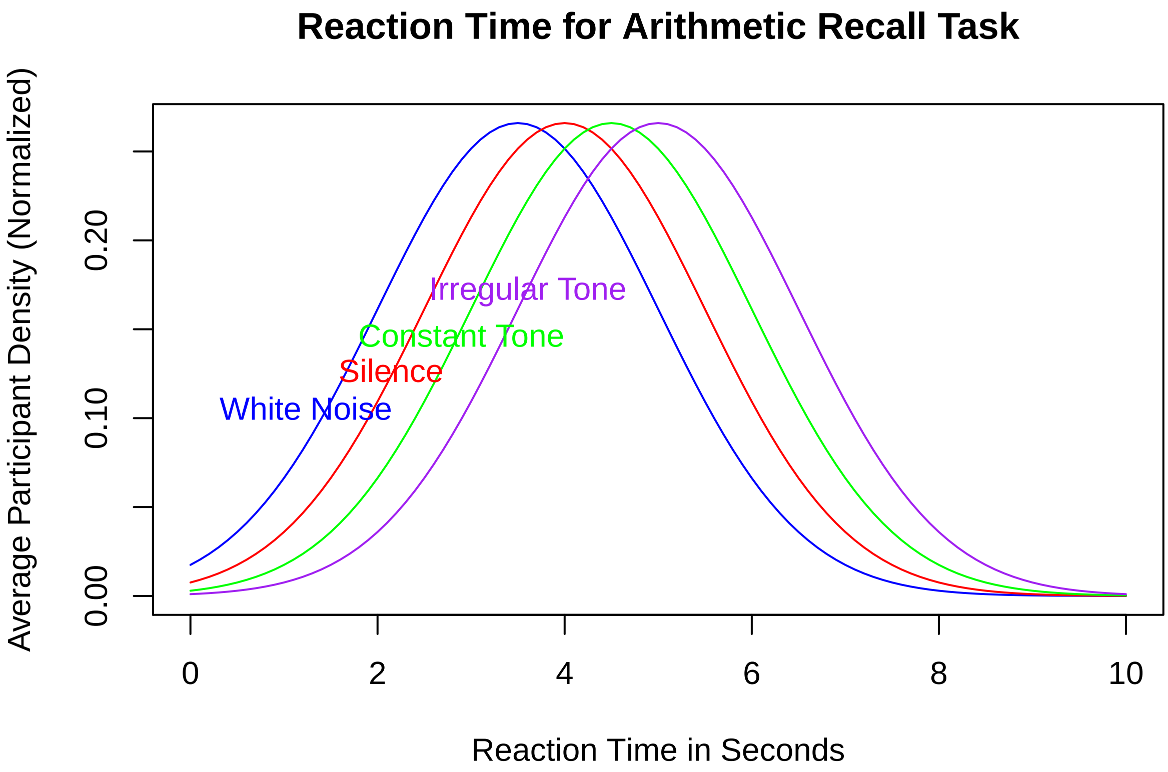
Although the experiment was never actually run. The participants were going to be University of Colorado undergraduate psychology students. They were to be selected from PSYC 4165 11am lecture, and perform the experiment during their allotted lab time.

Procedure

We presented stimuli on nice Macintosh computers running PsychoPy (Peirce, 2009, 2007; Peirce et al., 2019; Peirce & MacAskill, 2018) software. The participant was first briefed on the details of the experiment and told that they would be exposed to both visual and auditory stimuli. The participants were also told they were to complete basic arithmetic questions as well as playing a simple game similar to flappy bird. The participant was then asked if they wished to participate in the experiment. If the participant agreed then the experiment continued. The participant was randomly assigned on which task they would complete first. Then, it was randomly selected on which of the four audio stimuli would be presented to the participant. If the game task was being performed, the participant would have a short practice round to get used to the game. Whether the participant was being exposed to audio stimuli or not, the participant wore headphones through out the entire experiment in order to prevent external audio as much as possible. All stimuli was created with psychopy and standard python3.4. The game was created with pyGame.

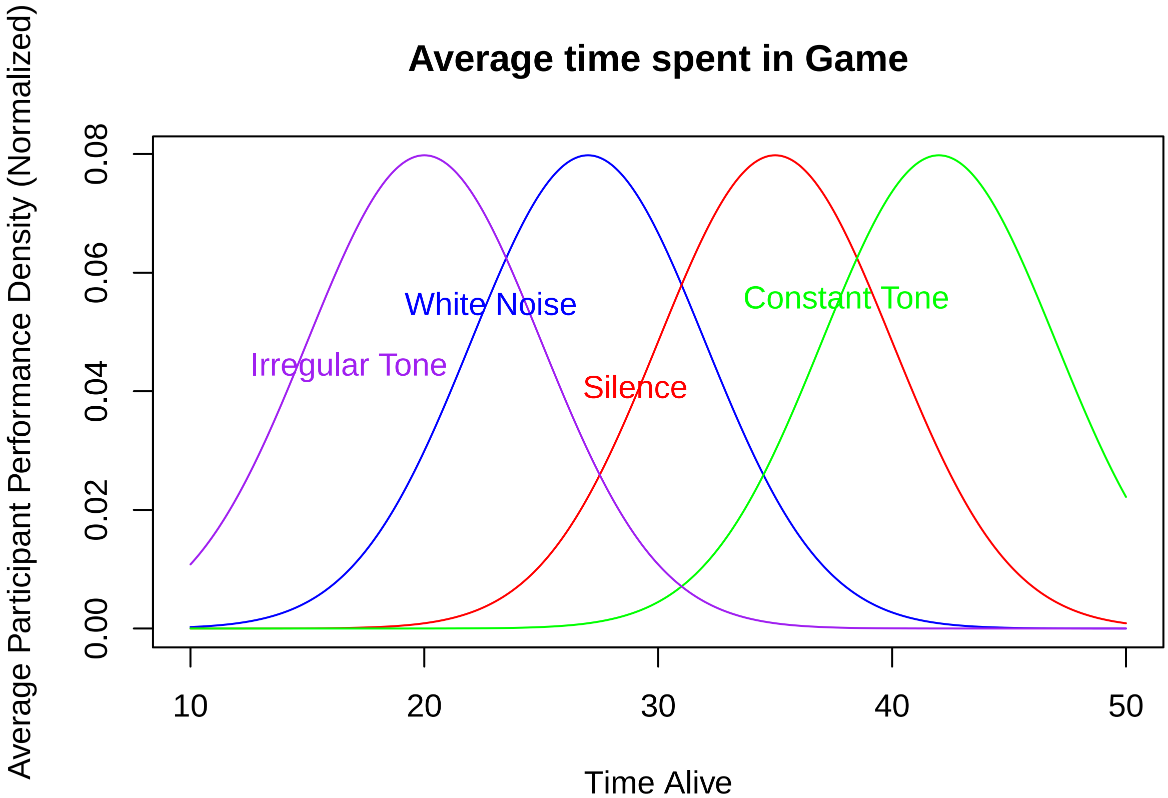
Results

```
## integer(0)
```



Although we couldn't actually execute the experiment, these are the results that may have happened for the arithmetic recall task.

```
## integer(0)
```



These are the results that may have happened if we were to run the experiment of the game with our four groups of different audio stimuli.

`#{r child="my_lab_5.6_Discussion_Lotta.Rmd"} #`

`#{r child="my_lab_5.6_Discussion_Author.Rmd"} #`

`#{r child="my_lab_5.6_Discussion_Susan.Rmd"} #`

Authors Notes

This manuscript was prepared with RStudio (RStudio Team, 2019) using R-Markdown. We used r `cite_r("my_Lab_5.0_additional_files/r-references.bib")` for all our analyses. The experiment was run with PsychoPy3 software (Peirce, 2009, 2007; Peirce et al., 2019; Peirce & MacAskill, 2018). We used r `cite_r("my_Lab_5.0_additional_files/r-references.bib")` for all our analyses.

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