ISSN 2349-7203
IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
HUMAN

Human Journals
Research Article
July 2015 Vol.:3, Issue:4

Study of Event Related Potential (ERP) in Relation to Different Musical Exposure in the Age of 20 – 60 Years, in Gauhati Medical College

ISSN 2349-7203
IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
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Submission: 6 July 2015
Accepted: 12 July 2015
Published: 25 July 2015

HUMAN JOURNALS

www.ijppr.humanjournals.com

Keywords: P300, Event Related Potential, Classical and Rock Music, Mozart effect

ABSTRACT

Objectives: To verify the influence of exposure to different types of music (Classical and Rock Music) on P300 wave measurements & different tempos on P300 wave measurements. **Materials and methods:** The Study was performed on 140 subjects, in the Neurophysiology Laboratory in the Department of Physiology. The P 300 waves were measured for three times during the test. First at starting of the experiment without music to the subject. Again after listening to both music the second and third times P300 was measured. **Results:** The ANOVA one-way test comparing the type of music (Slow Music and Fast Music showed statistically extremely significant differences in P300 Latency (p=0.0001) and N2 Amplitude (p=0.0001). Thus, a comparison of different music speeds and types showed significant electrophysiological differences in groups of slow music and fast music. **Discussion:** Thus, exposure to music could facilitate a reevaluation of the P300 wave. **Conclusion:** Data from this study has demonstrated that Slow music has shown to enhance cognitive performance.

INTRODUCTION

Studies have shown that the right kind of music can help us to relax our mind which enables us to concentrate better and perfect for studying, doing homework or studying for a test or exam. It cuts down distractions and helps us to focus on our work.

The most cited study is the "Mozart effect", which indicates that listening to Mozart's music may induce a short-term improvement on the performance of certain kinds of mental tasks known as "spatial-temporal reasoning", which is the ability to think out long-term and more abstract solutions to logical problems that arise.

Music embodies the spirit of all humanity and provides a powerful way of conveying meaning to the human heart and mind. There is no culture, no people or group that is without some form of musical expression. In fact, music like language is unique to the human species (Blacking, 1973). All genres of music have the power to elicit a multitude of cognitive, affective and motor responses depending on the listener.

It has been suggested that music training improves working memory, but little research has been conducted to investigate this relationship (e.g., Besson, Schön, Moreno, Santos, & Magne. 2007; Lee, Lu, & Ko, 2007; Williamon & Egner, 2004). It is also unclear which domain(s) of working memory might be affected: executive control, auditory, or visual working memory. Event-related potentials (ERPs) provide excellent temporal resolution and the ability to understand complex cognitive processes at the level of milliseconds (e.g., Polich, 2007). The P300 (P3) component of the ERP is sensitive to updates of working memory in oddball paradigms: in a series of standard stimuli, deviant targets elicit more positive responses (P300) than standards.

Review of Literature:

There are studies on the effect of music on our body, as exposure to music activates brain areas related with attention, semantics, music analysis, memory, and motor functions[1]. It also benefits multimode stimulation (hearing, vision, and olfaction) for cognitive and motor rehabilitation[2], and helps to prevent anxiety, depression, and pain[3].

Musical rhythms alter noradrenalin levels, one of the neurotransmitters involved with the state of alertness[4] and memory formation[5]. Estrogen concentration also affects noradrenalin by modifying female behaviors such as mood and cognition[6].

A comparison of performance among groups showed that exposure to music before measuring P300 facilitated attention and sustained attention in testing, which did not occur in women that were not exposed to music before the test, as there was habituation to P300. Thus, exposure to music could facilitate a reevaluation of the P300 wave[7].

Music may have a potential benefit in cardiovascular disease preventive programmes[8]. Classical music significantly increased working memory performance compared with the no-music condition[9].

Exposure to classical music, as in the so-called Mozart effect or Vivaldi effect [10, 11] increased cognitive performance on measures of spatial reasoning.

As noradrenalin concentrations modulate brain activity and are part of the behavioral and physiological responses of the central nervous system, and as musical rhythms may affect attention and memory, there is an interest in studying whether they affect the P300 wave cognitive potential as a response to central nervous system function.

Cognitive change, which is the most commonly reported side effect of dementia, was found to improve following music therapy. In the Bruer et al study, MMSE scores significantly improved by 2.00 points on the same day following therapy and 3.69 points the day after therapy. These findings did not persist into the following week and indicate that music therapy may be beneficial for only a short period of time. While the remaining studies included assessment of MMSE scores from baseline to post-intervention as an additional analysis, neither one found that music therapy had a significant effect on cognition. However, enough evidence exists in current literature to believe that potential effects are possible[12].

Objectives of the Study

1. To verify the influence of exposure to different types of music (Classical and Rock Music) on P300 wave measurements.

2. To verify the influence of exposure to different tempos on P300 wave measurements.

Inclusion Criteria

1. Monolingual, right-handed, no history of language or neurological disorder
2. Participants with normal MMSE Score.
3. Subjects with normal Auditory Function.
4. Subjects between the age group of 20-60 years are considered for the study.

Exclusion Criteria

1. Participants with low MMSE Score.
2. Subjects with Auditory Problems.
3. Person with previous experience with musical instruments and those who had affinity with song styles were excluded.
4. Subjects younger than 20 years of age and more than 60 years are excluded.

MATERIALS AND METHODS

The study was carried out in Dept of Physiology, Guahati Medical College, Guwahati.

- A simple random sampling was done.
- Sample size is 140 subjects.
- Subjects whose age is more than 60 years of age are excluded due to the possibility of any type of senile dementia.

The study was performed on 140 subjects, in the Neurophysiology Laboratory in the Department of Physiology. The test was carried out in comfortable temperature, humidity and light, with subjects supine and wearing headphones. They were asked to listen to two different music with one being slow tempo of 50-60 beats per minute and the other having fast tempo music of 120 to 130 beats per minute for a time period of 10 minutes each. There was a resting period of 5 minutes in between the songs.

The P300 waves were measured for three times during the test. First at starting of the experiment without music to the subject, and again after listening to both music the second and third times P300 was measured.

P300 (P3)

Subjects: An acoustically and electrically shielded room is required for P300 study. The subject was explained the procedure with emphasis on remaining awake and alert during the test. The subject may comfortably sit or lied down supine in a couch with eye fixed to avoid blinking. The subject is asked to mentally count the numbers of the target stimuli by raising the finger which allows the assessment of accuracy of responses[13].

Electrode Placement: Surface recording electrodes are placed at Fz, Cz, Pz and are referred to link mastoid, linked ear, nose or non cephalic reference. The ground electrode is placed at FPz. The electrode impedance should be kept below 5KΩ.

Stimulus: Any stimulus – auditory, visual, olfactory, somatosensory or pain can be used for eliciting P300. The P300 elicited by different stimuli is fairly similar through slight difference in latency and topography may be present. Here auditory stimulus is used. The stimuli were delivered using an oddball paradigm where two types of stimuli target and nontarget are used. The target stimuli comprises of 15-20% of total stimuli, which appear randomly. The patient was asked to count mentally in response to stimulus. The sequence of presentation of target and non target stimuli is important. If the target stimulus appears at fixed interval then it does not remain unexpected and influences the amplitude of P3. It is therefore, important to use a random or pseudorandom sequence (Naatanen, 1970). The pseudorandom sequence was preferred over random sequence because of the effect of local sequence probability. The stimulus intensity of 60-80 db SPL is delivered at rate of 1Hz.

Latencies, expressed in milliseconds (ms), were observed at the peak of waves N1 and P2, and at peak of waves N2 and P300.

Amplitude variations will not be analyzed because of the great variability of the parameter, even in healthy subjects (Fkell and Walhovd, 2001).

Acquisition parameters:

Sensitivity:	50µV/div
Low frequency cut off:	01Hz

High Frequency cut off: 30 Hz

Analysis time: 1sec

Average screening by stimulus type

Trials: From 4 to 32 target trails may be required to elicit a suitable response.

Target Probability: 5-25%

Repetition rate: 0.5 pp

Machine Setup and Running the test:

The low pass filter is kept between 30 Hz and 100 Hz and high pass filter between 0.3 Hz with sweep time of 1s. The EEG is amplified 10000 times and the evoked potential waveforms are computed separately for all rare and frequent stimuli.

The study was self sponsored

RESULTS

Table 1: Mean and Standard Deviation P300 Latency and N2 Amplitude

	Normal P3	Normal N2	Slow Music P3	Slow Music N2	Fast Music P3	Slow Music N2
Mean	302.34	12.24	292.09	9.72	258.88	11.88
Standard Deviation	79.13	5.30	87.13	5.24	84.71	5.17
Sample Size	140	140	140	140	140	140

Table 2: Summary of data for P300 Latency

Group	No. of Subjects	Mean	Standard Deviation	Standard Error of Mean	Median
Normal P3	140	302.35	79.134	9.458	304.92
Slow Music P3	140	292.09	87.130	10.414	219.71
Fast Music P3	140	258.89	84.716	10.125	262.95

Table 3: Summary of data for N2 Amplitude

Group	No. of Subjects	Mean	Standard Deviation	Standard Error of Mean	Median
Normal N2	140	12.24	5.30	0.63	12.11
Slow Music N2	140	9.72	5.24	0.62	9.42
Fast Music N2	140	11.88	5.17	0.61	11.66

Table 4: ANNOVA Table showing intermediate calculations of P300 Latency

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Treatments (Between Columns)	2	144501	72251
Residuals (Within Columns)	417	2902237	6959.8
Total	419	3046739	

F = 10.381 = (MS treatment/MS residual)

The P value is < 0.0001, considered extremely significant. Variation among columns means is significantly greater than expected by chance.

Table 5: ANNOVA Table showing intermediate calculations of N2 Amplitude

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square
Treatments (Between Columns)	2	519.13	259.57
Residuals (Within Columns)	417	11373	27.2752
Total	419	11893	

F = 9.517 = (MS treatment/MS residual)

The P value is < 0.0001, considered extremely significant. Variation among columns means is significantly greater than expected by chance.

The ANNOVA one-way test comparing the type of music (Slow Music and Fast Music showed statistically extremely significant differences in P300 Latency (p=0.0001) and N2 Amplitude (p=0.0001). Thus, a comparison of different music speeds and types showed significant electrophysiological differences in groups of slow music and fast music.

DISCUSSION

Recording the P300 wave after several stimuli may alter neuron network function and result in mental fatigue, which affects the P300 wave amplitude; this is the habituation phenomenon. Even with habituation, reproduction of the P300 wave after several measurements showing latency and amplitude value differences suggests that the P300 wave is a reliable auditory evoked potential, since recorded responses may be tested and confirmed. In most published studies[14,15,16,17], music is presented at the same time as auditory evoked potentials are recorded; music is therefore more of an auditory distraction, rather than a prior condition for recordings. Therefore, we may infer that music stimulation before recording the P300 wave is not so much a distracting factor, but a method for directing the subject's attention to a new P300 task.

The statistical analysis showed a trend towards significance in the Slow Music - increased latency and decreased amplitude. This trend suggests that slow tempos are more beneficial for attention. A study on the effect of different types of music on the P300 wave [15] showed that exposure to familiar music resulted in a positive effect over the cognitive potential, favoring selective attention and memory processes.

Exposure to music at varying pre-established speeds altered P300 in the subjects significantly. A comparison of performance among the subjects showed that exposure to slow music (mean=292) before measuring P300 facilitated attention and sustained attention in testing more than Fast music (mean=258). Thus, exposure to music could facilitate a reevaluation of the P300 wave.

CONCLUSION

The sample size was the major limitation of this study. Large samples could have provided more reliable significances. Due to the limited availability of participants, this study was conducted in a measured design, which could also be a limiting factor. The sequence in which the tests were given was not randomized throughout the experiment; as such, learning effects could account for the improvement in later tests as the study progressed. Future research should strive to change the sequence in which the tests are administered to guarantee that the results obtained are those of the treatment effects and to eliminate or reduce possible learning effects.

The design of the room could also be another limitation to this experiment. Where participants were seated in the room could have had an effect on how the music was heard. Hence, for participants sitting closer to the speakers, the music was louder than those who were sitting on the other side of the room. This variance in volume level may have either positively or negatively affected the results. Although, some of the results from this study showed that the arithmetic problems were a sufficient tool to assess cognitive performance; however, they may have been too simple for students on the collegiate level to perform. Besides, there was no mathematical base level assessments conducted prior to the study. Participants with stronger skills could have had a biased advantage, whereas those with lower mathematical skills would have had a biased disadvantage.

Results from the current study demonstrated how important it is to consider the effects of distracting music on cognitive performance. It was shown that the tempo of music plays a crucial role and could be more important than the type of music played. Data from this study has demonstrated that Slow music has shown to enhance cognitive performance.

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