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ORIGINAL ARTICLE

The effectiveness of Mozart's Rondo for piano in D major and participant-selected music assessed in relation to a placebo. Variations in P300 amplitude and latency studied

Eficacia del Rondó para piano en re mayor de Mozart y de la música seleccionada por los participantes evaluada en relación con un placebo. Variaciones en la amplitud y latencia de P300 estudiadas

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Abstract

Background: *The P300 wave is an action potential that, depending on the stimuli, attention, and alertness levels, peaks at 300 ms or longer.* **Objective:** *Evaluate the effectiveness of the Rondo for piano in D major K 485 by Wolfgang Amadeus Mozart and music chosen by the participant compared to placebo (white noise).* **Methods:** *Prospective, longitudinal, and experimental investigation. A paired t test was used to examine the differences between each group for parametric variables. An ANOVA test for parametric variables and a non-parametric ANOVA when necessary will be used to compare the groups. A significance level of p < 0.05 will be applied.* **Results:** *In terms of age, group 1's mean was 36.4 years, group 2's was 34.1 years, group 3's was 10.74 years, and p was 0.168. Group 1 mean +12.19, SD (-3.25 – 27.63) for latency (paired t). Mean +11.29, SD (-2.03 – 24.61) for Group 2. Mean +1.39, SD (-31.02 – 33.80) for group 3. Breadth: mean -2.18 SD (-6.03 – 1.67) for group 1. Mean -0.90 SD (-0.47 – 2.92) for group 2. Group 3 mean (-4.60 – 0.20) = -2.20 SD.* **Conclusion:** *Contrary to what was predicted by the hypothesis, an increase in latency and a decrease in amplitude were seen in the three groups.*

Keywords: *P300. White noise. Mozart. Latency. Amplitude.*

Resumen

Antecedentes: *La onda P300 es un potencial de acción que, dependiendo de los estímulos, la atención y los niveles de alerta, alcanza su máximo a los 300 ms o más.* **Objetivo:** *Evaluar la eficacia del Rondó para piano en Re mayor K 485 de Wolfgang Amadeus Mozart y música elegida por el participante en comparación con placebo (ruido blanco).* **Métodos:** *Investigación prospectiva, longitudinal y experimental. Se utilizó una prueba t pareada para examinar las diferencias entre cada grupo para las variables paramétricas. Para comparar los grupos se utilizará una prueba ANOVA para las variables paramétricas y una ANOVA no paramétrica cuando sea necesario. Se aplicará un nivel de significación de p < 0,05.* **Resultados:** *En cuanto a la edad, la media del grupo 1 fue de 36,4 años, la del grupo 2 fue de 34,1 años, la del grupo 3 fue de 10,74 años, y la p fue de 0,168. Media del grupo 1 +12,19, DE (-3,25 - 27,63) para la latencia (t emparejada).*

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Media +11,29, DE (-2,03 - 24,61) para el Grupo 2. Media +1,39, DE (-31,02 - 33,80) para el grupo 3. Amplitud: media -2,18 DE (-6,03 - 1,67) para el grupo 1. Media -0,90 DE (-0,47 - 2,92) para el grupo 2. Media del grupo 3 (-4,60 - 0,20) = -2,20 DE. **Conclusiones:** *Contrariamente a lo predicho por la hipótesis, se observó un aumento de la latencia y una disminución de la amplitud en los tres grupos.*

Palabras clave: *P300. Ruido blanco. Mozart. Latencia. Amplitud.*

Introduction

The P300 wave is an event-related action potential with a 300 ms peak or more after a stimulus[1], it is considered an endogenous component since it depends on the processing of the stimulus, as well as the levels of attention and alertness[2].

Two N200 components can be evaluated, which are associated with the perception, discrimination, recognition and classification of an auditory stimulus[3]; and P300 which occurs when an individual recognizes the presence of a change in the auditory stimulus[4]. Neuroscience is using music as a study aid to examine from emotions to motor abilities[5]. A variety of cognitive processes are involved in both creating and listening to music[6]. At this point, it is recognized how both brief and long-term musical training affect cognition[7]. Additionally, it is understood that the Mozart effect affects not only spatial-temporal reasoning but also other cognitive processes in both good and negative ways[8]. The neural representation of particular cognitive tasks has been identified as the event-related potential, which has enabled us to stereotypy the electrophysiological response during music listening[9]. Given that P300 changes when listening to classical music (Mozart), it's critical to ascertain whether further alterations take place following the chosen musical selection[10]. Our goal is to determine how well Wolfgang Amadeus Mozart's Rondo for piano in D major, K 485, and participant-selected music work to reduce latency and boost amplitude of P300 in healthy people as compared to a placebo (white noise).

Methods

Study: Experimental, Longitudinal (controlled, non-blinded), Prospective. A sample of 27 subjects was included and 9 subjects were assigned to each of the 3 research groups. The sample was not randomized. A series of consecutive cases organized by blocks of 9 subjects was carried out, considering that there are 3 study arms. This process will be generated with the R software, with a command line created for this purpose. The inclusion criteria included: healthy subjects (No-known medical condition), aged 18 to 65 year-old patients (men and woman indistintibly), lack of psychostimulants consumption, availability for the study and signed consent form regarding participation. The exclusion criteria were the following: subjects with a neurological or psychiatric diagnosis (Depression, Anxiety, Addictions, Dementia), Hearing Loss, Sleep Disorders, Sleep Restriction and Deprivation. Elimination Criteria: Lack of test completion.

After being input into an Excel spreadsheet, the variables were exported to the R statistical program. The numerical variables were subjected to Shapirowilk normality testing. Every variable was distributed normally. Categorical variables are presented as absolute frequency (%), while numerical variables are reported as mean (SD - standard deviation). A one-way ANOVA test was used to compare the three groups, and a t-test was used for paired samples to assess changes in neurophysiological values (both baseline and subsequent). The change values' 95% confidence interval was computed. Statistical significance was defined as a p value of 0.05 or less.The patients signed an informed consent form, the study was authorized by the ABC Medical Center ethics committee, and the data were used for research. Present study consisted in a session of approximately one hour in duration, carried out during business days within the Department of Neurophysiology of the ABC Medical Center, Observatory Campus and Santa Fe Campus.

Results

Since there are no published studies regarding this population and research focus 27 subjects were included in three arms (9 per unit).

Sample

The mean for age variable was 28.22 years (SD 5.64) in group 1; 36.44 years (SD 10.22) in group 2 and 34.11 years (SD 10.74) in group 3, respectively; with a non-significant p of 0.168.

Table 1. Sample characteristics

Characteristic	Group 1 – Mozart	Group 2 – Preferred music	Group 3 – White noise	p*
Age	28.22 (5.65)	34.44 (10.22)	34.11 (10.74)	0.168*
Sex Female Male	 4 (44.4%) 5 (55.6%)	 7 (77.8%) 2 (22.2%)	 5 (55.6%) 4 (44.4%)	0.342**

Values expressed in: mean (standard deviation), absolute frequencies (%).
*One-way ANOVA.
**Chi square test.

Table 2. P300 general values

Variable P300	Group 1 – Mozart	Group 2 – Preferred music	Group 3 – White noise	p*
Basal latency	276.19 (37.58)	290.28 (35.13)	285.77 (30.51)	0.681
Basal amplitude	7.26 (5.00)	5.80 (3.52)	9.16 (6.17)	0.377
Post-test latency	288.38 (47.80)	301.57 (34.77)	287.16 (42.85)	0.727
Post-test amplitude	5.08 (2.18)	4.90 (3.08)	6.96 (5.09)	0.430

Values expressed in: mean (standard deviation).
*One-way ANOVA.

Regarding sex differences, the results were reported as absolute frequencies, obtaining for group 1, 44.4% in female, 55.6% for the male; for group 2, 77.8% females, 22.2% males; group 3, 55.6% for females and 44.4% for males, respectively as well. Chi square test was performed with a non-significant p of 0.342 (Table 1).

General P300 values

Considering group 1: latency with a mean of 276.19 ms (SD of 37.58) and amplitude with a mean of 7.26 microvolts (SD of 5.00). For group 2: latency with a mean of 290.28 ms (SD 35.13) and amplitude of 5.80 (SD 3.52). For group 3: latency with a mean of 285.77. ms (SD 30.51) and amplitude of 9.16 (SD 6.17).

With a non-significant p of 0.681 for latency and a non-significant p = 0.377 for amplitude.

After listening to Mozart, preferred music and white noise. For group 1: Latency with a mean of 288.38 (SD 47.80) and amplitude of 5.08 (SD 2.18). For group 2: Latency with a mean of 301.57 (SD 34.77) and amplitude of 4.90 (SD 3.08). For group 3: Latency with a mean of 287.16 (SD 42.85) and amplitude of 6.96 (SD 5.09). With a non-significant p = 0.727 for latency and a non-significant p of 0.430 for amplitude (Table 2).

Group´s latency vary

Analyzed with a paired t-test; for group 1 a mean + 12.19 SD (-3.25 – 27.63) with a non-significant p of 0.106. Group 2 a mean + 11.29 SD (-2.03 – 24.61) with a non-significant p = 0.086. Group 3 a mean + 1.39 SD (-31.02 – 33.80) with a non-significant p = 0.924 (Table 3).

Group´s amplitudes vary

Analyzed with a paired t-test; for group 1 a mean -2.18 SD (-6.03 – 1.67) with a non-significant p = 0.106. Group 2 a mean -0.90 SD (-0.47 – 2.92) with a non-significant p = 0.603. Group 3 a mean -2.20 SD (-4.60 – 0.20) with a non-significant p = 0.068 (Table 4).

Discussion

The neural representation of particular cognitive tasks has been identified as the event-related potential, which has enabled us to stereotypy the electrophysiological response through music listening. Where P300 is one of these potentials[11].

Jausovec and Habe examined the electroencephalogram and event-related potentials in participants who listened to Mozart, Brahms, and Haydn compositions[12]. These authors demonstrated a potential impact on the

Table 3. Group's latency vary

Group	Basal latency	Post-test latency	Vary	p*
Group 1 – Mozart	276.19 (37.58)	288 (47.80)	+12.19 (–3.25 - 27.63)	0.106
Group 2 – Preferred music	290.28 (35.13)	301.57 (34.77)	+11.29 (–2.03 - 33.80)	0.086
Group 3 – White noise	285.77 (30.51)	287.16 (42.85)	+1.39 (–31.02 - 33.30)	0.924

Values expressed in: mean (standard deviation).
*Related samples t test.

Table 4. Group's amplitudes vary

Group	Basal amplitude	Post-test amplitude	Vary	p*
Group 1 – Mozart	7.26 (5.00)	5.08 (2.18)	–2.18 (–6.03 - 1.67)	0.106
Group 2 – Preferred music	5.80 (3.25)	4.90 (3.08)	–0.90 (–0.47 - 2.92)	0.603
Group 3 – White noise	9.16 (6.17)	6.96 (5.09)	–2.20 (–4.60 - 0.20)	0-068

Values expressed in: mean (standard deviation).
*Related samples t test.

conscious state as well as the potential to enhance cognitive functions[13].

According to Zhu et al., P300 changed when listening to Mozart as opposed to quiet in a study on the impact of Mozart's K488 sonata on visual attention[14]. In other words, voluntary attention was negatively impacted, and the sound effect had a greater impact on P300 amplitude than the Mozart effect[15]. However, the researchers also noted that sound, which is a distractor, altered involuntary attention by reducing P300 amplitude[16]. The neurophysiological variations observed were consistent with a more sophisticated process under musical situations than under silence conditions[17].

Our study was directed towards P300 with the auditory paradigm, and it was found that there were changes in both the Mozart sonata, with preferred music comparing both groups with those who listened to white noise; all groups exhibited an amplitude decrease and latency increase that deviated from our hypothesis. Since other research have used an auditory paradigm, our experiment used a visual paradigm because the patients had some sort of pathology, including Alzheimer's, various dementias, epilepsy, ADHD, and Alzheimer's disease.

It is important to mention that, although no statistical significance was observed in the results, this could be due to a betta mistake. This implies that there may be a true association between Mozart's music or preferred music and the modification of P300 that was not detected due to limitations in the sample size or the study's power. Therefore, these results should be interpreted with caution, considering the possibility of a betta mistake.

Conclusión

Our study concludes that there was an increase in latency and a drop in amplitude, but no significant difference, after listening to Mozart music (preferred music) as opposed to white noise and repeating P300. Considering that the subjects who performed the test were healthy and many of the studies previously described in the literature are in subjects with neurological or psyquiatric diagnosis.

One significant finding was that the subjects from the three groups became distracted when told they would be listening to Mozart's Rondo, their favorite music, or white noise. When the P300 was repeated, the subjects' responses differed from what was anticipated, which created bias in our study.

This was a pilot research where important data had been gathered to control biases that can affect the possible P300 outcomes in larger sample size studies in the future. In addition, certain age groups that are pathologically or medically known to modify P300 potential should be studied. All of the participants in this study were in good health and had no illnesses. However, it is crucial to take into account previously evaluating hearing

using tonal audiometry, logo-audiometry, and, if necessary, augmenting with potentials in future studies of P300 potential with an auditory paradigm. brainstem auditory. By doing this, we could be sure that the research participants' hearing is normal and won't affect their ability to grow their P300 potential.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of humans and animals. The authors declare that the procedures followed conformed to the ethical standards of the responsible human experimentation committee and in accordance with the World Medical Association and the Declaration of Helsinki.

Confidentiality of data. The authors declare that they have followed their institution's protocols on the publication of patient data.

Right to privacy and informed consent. The authors have obtained Ethics Committee approval for the analysis and publication of routinely collected clinical data. Informed consent from patients was not required as this was a retrospective observational study.

Use of artificial intelligence to generate text. The authors declare that they have not used any type of generative artificial intelligence in the writing of this manuscript or for the creation of figures, graphs, tables or their corresponding captions or legends.

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