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Study On Impact of Sound Frequency on Human Well Being Using Randomized Block Design

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Abstract

This study summarizes the exploration of the impact of sound frequencies on various dimensions of human well-being. The study investigates the psychological and physiological responses to different sound frequencies, considering factors such as emotional states, focus, stress relief, and pain perception. The experiment draws on established psychoacoustic principles and incorporates data from controlled experiments, including a Randomized Block Design (RBD). The study employs statistical analyses, such as ANOVA, to discern the significance of Intercept, Block Number, and Sound Frequency in predicting variations in well-being outcomes.the study revealed valuable insights into the factors influencing different dimensions of human well-being. The consistent significance of Intercept, Block Number, and Sound Frequency across various aspects suggests the importance of considering both individual and external factors, as well as the specific frequencies of sounds, in understanding and promoting well-being. These findings can have implications for designing interventions or environments that aim to enhance different aspects of human well-being through targeted sound exposure.

Key Words: Sound, Sound Frequency, Solfeggio Frequency, ANOVA, Impact, Block,

Introduction:

Sound, an integral part of our daily environment, has the potential to significantly influence human well-being. sound affects us physiologically in very powerful ways. Because hearing is your primary warning sense, a sudden sound will start a process. It releases cortisol, it increases your heart rate, it changes your breathing. The sound affects human psychologically. It changes our emotions and our moods. Thirdly sound affects us cognitively. How well you work is very dependent on the sound around you. Sound can cause stress us and make us behave negatively. It makes us less sociable, less helpful and less approachable if we're in a noisy setting. This study seeks to delve into the nuanced relationship between sound frequency and various dimensions of well-being, employing a robust research design known as the randomized block design. By investigating how different sound frequencies affect individuals within distinct blocks, we aim to provide a comprehensive understanding of the intricate interplay between sound and human well-being.

Objective:

The primary objective of this study is to systematically **investigate the impact of different sound frequencies on human well-being by employing a randomized block design**, we aim to isolate the effects of sound frequencies while accounting for individual differences within distinct blocks. Specific objectives include identifying whether certain frequencies elicit positive or negative emotional responses, evaluating potential variations in stress levels, and exploring cognitive and physiological responses to diverse sound stimuli.

Research Design:

In this study, participants are be grouped into blocks based on relevant factors such as age and gender and baseline well-being as without any hearing disability. Total 57 respondents are of the age from 17 to 20 years. Each block will then be exposed to different sound frequencies, randomly assigned, to control for potential confounding variables within each group. Heart rate of all those 57 respondents have recorded and collected before performing the experiment and again recorded after exposing to the sound frequency for 15 mins approximately.
The age groups and total respondents are specified as follow.

Age in year	Number of respondents		Total
	Male	Female	
17	6 (42.85%)	8 (57.15%)	14 (24.56%)
18	15 (62.5%)	9 (37.5%)	24(42.11%)
19	8 (53.3%)	7(46.7%)	15(26.32%)
20	4(100%)	0	4(7.01%)
Total	33(57.89%)	24(42.11%)	57

Table 1: Age and Gender wise distribution

The overall respondent count is 57, with 33 being male (57.89% of the total) and 24 female (42.11% of the total). The predominant age range for respondents is 17-19, with 18-year-olds representing the largest group at 42.11% of the total observations.

Methodology:

57 participants are randomly assigned to specific sound frequency conditions within their respective blocks. There is total 8 blocks formed. Three sound frequencies are exposed to listen for 5 to 7 min each, particularly 379 Hz, 430 Hz, and 528Hz. Each frequency has its own impact on human being which is under test such as soothing, calmness, Emotional triggers, determined stress reliefs, pain reliefs. These are particular impacts identified and tested. The impact is collected through ratings from 1 to 10, 1 as less impactful and 10 as highly impactful.

Literature Review:

[2]"The Psychology of Music: A Very Short Introduction" is a valuable resource for those seeking a brief yet informative overview of the psychological dimensions of music. Elizabeth Hellmuth Margulis successfully navigates a complex subject, providing readers with a foundational understanding of how music intersects with the human mind.

[5]ISO 226:2003 serves as a fundamental reference for understanding the equal-loudness contours that characterize human auditory perception across different frequencies. Its application in fields such as audio engineering and noise control underscores its importance in ensuring that sounds are reproduced and controlled in a manner consistent with human hearing. While it may be more technical in nature, it is a crucial tool for professionals working in acoustics and related disciplines.

[11]"Psychoacoustics: Facts and Models" is a valuable resource for students, researchers, and professionals interested in the scientific study of auditory perception. Its comprehensive coverage, inclusion of psychoacoustic models, and practical applications make it a foundational text in the field. While some aspects

may be considered dated, the book remains relevant and informative, serving as a bridge between theoretical concepts and their real-world implications in various domains.

Results and discussion:

1. The heart rates tested with paired t test to investigate that whether the sound frequencies do lower the heart rate of listener. Following table elaborates the facts found from data.

Statistic Value	***Heart Rate before Listening to sound frequency(bpm)***	***Heart Rate after listening sound Frequency(bpm)***
Mean	80.5614	79.24561
Variance	12.10777	11.1886
Observations	57	57
Pearson Correlation	**0.936099**	
Hypothesized Mean Difference	0	
Degrees of freedom	56	
t Stat	8.095868	
P(T<=t) one-tail	**2.69E-11**	
t Critical one-tail	1.672522	

Table 2: Paired t-Test for Two Sample for Means

The strong positive correlation 0.936099 suggests the significant relationship between heart rates before and after listening to the sound frequency. The low p-values as 2.69E-11 indicate that the observed mean difference is highly unlikely to occur by chance. With a t-statistic of 8.095868 exceeding the critical values, it suggests that the mean difference is statistically significant. Therefore, **there is evidence to suggest that listening to the sound frequency has a significant impact on heart rates that it gets lower than and settle at its pace**. The overall heart rate of person from age group 17 to 20 is 81.4 is reported by medical expertise. The average.

2. Following table is generated by taking mean rating of each participant given to each sound frequency block wise. Hence total number of observations are 8. There are 7 specific impacts have been checked by ratings.

sound Frequency	different factors affected on listeners	Mean rating given	Std. Deviation	N
379Hz	soothing	8	1.488	8
	Calmness	8	1.408	8
	Felt any emotional triggers and relieve	4	1.927	8
	Felt focused	7	2.100	8
	Felt stress relieved	6	1.909	8
	Felt refreshed	6	2.550	8
	Felt pain relief	4	3.147	8
430Hz	soothing	9	.518	8
	Calmness	9	.535	8
	Felt any emotional triggers and relieve	5	2.669	8
	Felt focused	8	1.553	8
	Felt stress relieved	8	1.408	8
	Felt refreshed	8	2.774	8
	Felt pain relief	5	3.240	8
528Hz	soothing	7	1.581	8
	Calmness	7	2.134	8
	Felt any emotional triggers and relieve	5	1.642	8
	Felt focused	6	1.690	8
	Felt stress relieved	6	2.560	8
	Felt refreshed	6	1.808	8
	Felt pain relief	4	3.105	8

Levene's Test of Equality of Error Variances[a]

Dependent Variable: Rating of listeners

F	df1	df2	Sig.
2.535	20	147	.001

Table 2: Descriptions of consumers rating for different Frequencies

Levene's test is a crucial diagnostic tool in statistical analysis, particularly in the context of analysis of variance (ANOVA), as it assesses the assumption of homogeneity of variances across groups. The null hypothesis tested by Levene's test posits that the error variances are equal across groups. The results of Levene's Test of Equality of Error Variances, as applied to the dependent variable "rating" in the context of the specified design (Intercept + sound frequency + impact on listener), reveal a statistically significant F-statistic of 2.535 with 20 and 147 degrees of freedom for the numerator and denominator, respectively, and a significance level (Sig.) of .001. In this instance, the statistically significant result (Sig. = .001) suggests that there is evidence to reject the null hypothesis of equal error variances. Consequently, it implies that the assumption of homogeneity of variances has been violated in the specified model. This violation could have implications for the validity of subsequent statistical analyses, such as ANOVA, which assume equal variances for accurate interpretation.

ANOVA table							
Dependent Variable: Rating given by listeners							
Source	Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[b]
Corrected Model	317.772[a]	8	39.722	9.217	.000	73.736	1.000
Intercept	6535.226	1	6535.226	1516.445	.000	1516.445	1.000
Sound Frequency	55.737	2	27.868	6.467	.002	12.933	.901
Impact on Listerner	266.207	6	44.368	10.295	.000	61.771	1.000
Error	685.222	159	4.310				
Total	7553.000	168					
Corrected Total	1002.994	167					
a. R Squared = .317 (Adjusted R Squared = .282)							
b. Computed using alpha = .05							

Table 4: ANOVA table for RBD(taking overall rating as dependent variable)

The Tests of Between-Subjects Effects provide valuable insights into the relationships between the independent variables (sound frequency and impact on listener) and the dependent variable (rating). The analysis is based on a model with the specified design, which includes an Intercept, sound frequency, and impact on listener.

The Corrected Model, which accounts for the impact of both sound frequency and impact on listener, is statistically significant (F = 9.217, p = .000). This indicates that, collectively, the independent variables contribute significantly to explaining the variance in the dependent variable, rating. The effect size, as measured by R-squared (.317), suggests that approximately 31.7% of the variance in the dependent variable is accounted for by the independent variables in the model.

Breaking down the individual contributions, the Intercept shows a highly significant effect (F = 1516.445, p = .000), emphasizing the importance of considering the baseline or overall mean effect. Moving to the specific predictors, sound frequency and impact on listener both demonstrate significant effects (F = 6.467, p = .002 for sound frequency; F = 10.295, p = .000 for impact on listener). **These results suggest that both sound frequency and impact on listener independently contribute to the variability observed in the dependent variable**.

The observed power for the Corrected Model is 1.000, indicating a high likelihood of detecting an effect if it truly exists. This strengthens the confidence in the overall model's validity.

The R-squared value of .317 (Adjusted R-squared = .282) implies that the model explains a substantial proportion of the variance, but there may still be room for improvement. Researchers might consider exploring additional variables or refining the model to enhance its explanatory power.

Further the ANOVA on Listeners impact rating is carried out for each specific impact to check the impact of blocks and sound frequencies.

- **Impact of soothing:**

ANOVA table for RBD						
Dependent Variable: Soothing						
Source		Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	8021.266	1	8021.266	513.844	.000
	Error	113.572	7.275	15.610[a]		
Block number	Hypothesis	115.462	7	16.495	3.962	.000
	Error	703.500	169	4.163[b]		
Sound Frequency	Hypothesis	116.049	2	58.025	13.939	.000
	Error	703.500	169	4.163[b]		

Table 5: ANOVA for Dependent variable Soothing effect on listener

The above table indicate that both **Block Number and Sound Frequency significantly influence the dependent variable "Soothing."** The Intercept is also highly significant, emphasizing its role in explaining baseline levels. The F-statistics for all predictors are highly significant (p value is 0.000), suggesting that the overall model is a good fit, and the predictors contribute significantly to explaining the variability in "Soothing." The error terms provide information about the unexplained variability in the model.

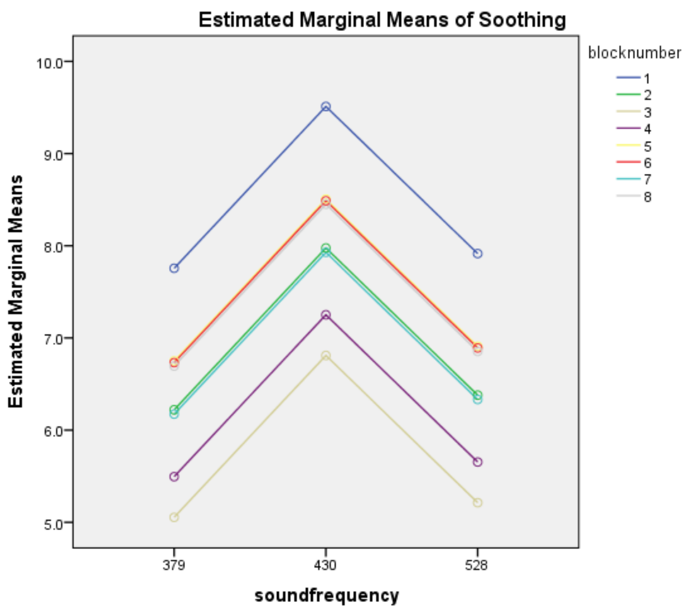

Fig 1: marginal mean rating given as per blocks

- **Impact Of Calmness:**

ANOVA table of RBD						
Dependent Variable: calmness						
Source		Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	9740.507	1	9740.507	1631.948	.000
	Error	45.039	7.546	5.969[a]		
Block number	Hypothesis	43.348	7	6.193	2.017	.056
	Error	518.855	169	3.070[b]		
Sound Frequency	Hypothesis	117.862	2	58.931	19.195	.000
	Error	518.855	169	3.070[b]		

Table 6: ANOVA for Dependent variable Calmness effect on listener

table conclude that **Block Number, and Sound Frequency are all significant predictors of "calmness."** The Intercept, representing the baseline calmness, is highly significant. Block Number has a marginally significant effect, and Sound Frequency significantly influences calmness. The F-statistics indicate the overall fit of the model, and the p-values suggest the significance of each predictor. The Error terms provide information about the unexplained variability in the model. Overall, the model seems to be a good fit for explaining the variance in "calmness."

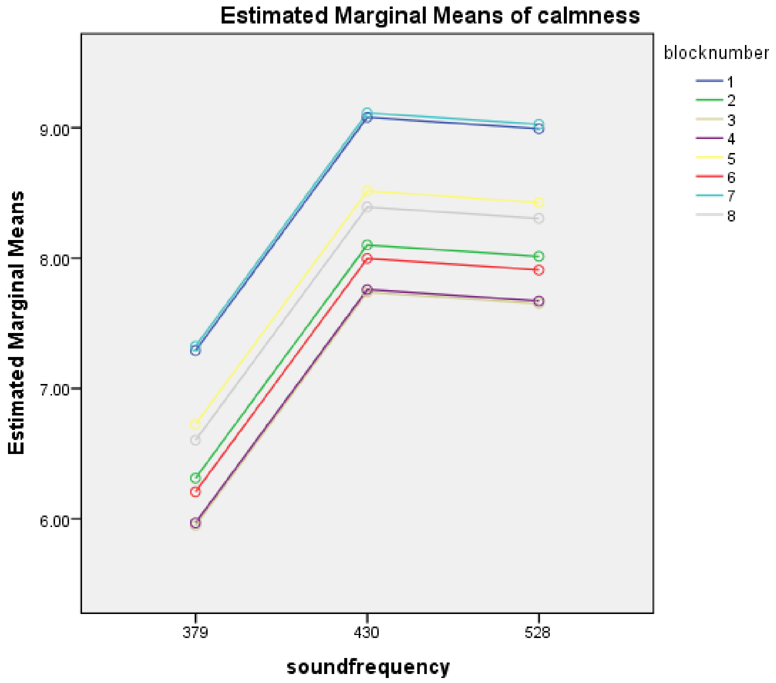

Fig 2: marginal mean rating given as per blocks

- **Impact of feeling emotional or triggered by a particular emotional thought:**

ANOVA table for RBD						
Dependent Variable: Emotional						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	3659.371	1	3659.371	54.745	.000
	Error	473.182	7.079	66.844[a]		
Block number	Hypothesis	501.229	7	71.604	13.738	.000
	Error	880.875	169	5.212[b]		
Sound Frequency	Hypothesis	63.666	2	31.833	6.107	.003
	Error	880.875	169	5.212[b]		

Table 7: ANOVA for Dependent variable Emotional effect on listener

The results indicate that the Intercept, Block Number, and Sound Frequency are all significant predictors of "Emotional." The Intercept, representing the baseline emotional state, is highly significant. Block Number has a highly significant effect, and Sound Frequency significantly influences emotional state. The F-statistics indicate the overall fit of the model, and the p-values suggest the significance of each predictor.

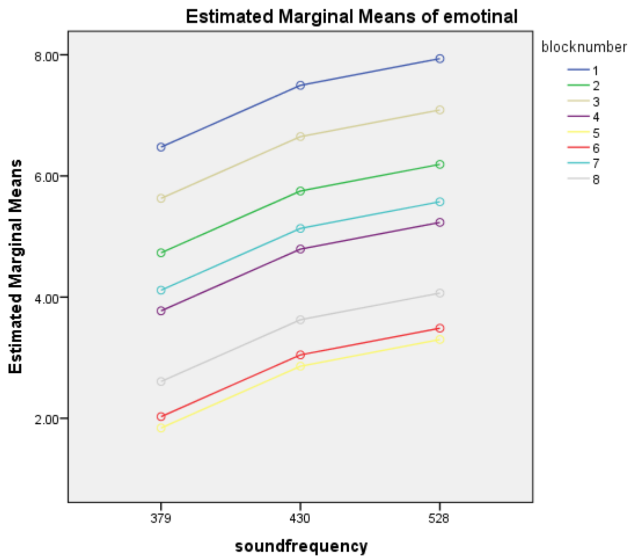

Fig 3: marginal mean rating given as per blocks

- **Impact of feeling focused:**

Tests of Between-Subjects Effects						
Dependent Variable: focused						
Source		Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	8607.113	1	8607.113	435.318	.000
	Error	143.888	7.277	19.772[a]		
Block number	Hypothesis	146.225	7	20.889	3.936	.001
	Error	896.988	169	5.308[b]		
Sound frequency	Hypothesis	59.500	2	29.750	5.605	.004
	Error	896.988	169	5.308[b]		

Table 8: ANOVA for Dependent variable felt focused by listener

The results suggest that the Intercept, Block Number, and Sound Frequency are all significant predictors of "focused." The Intercept, representing the baseline level of focus, is highly significant. Block Number has a highly significant effect, and Sound Frequency significantly influences focus. The F-statistics indicate the overall fit of the model, and the p-values suggest the significance of each predictor. The Error terms provide information about the unexplained variability in the model.

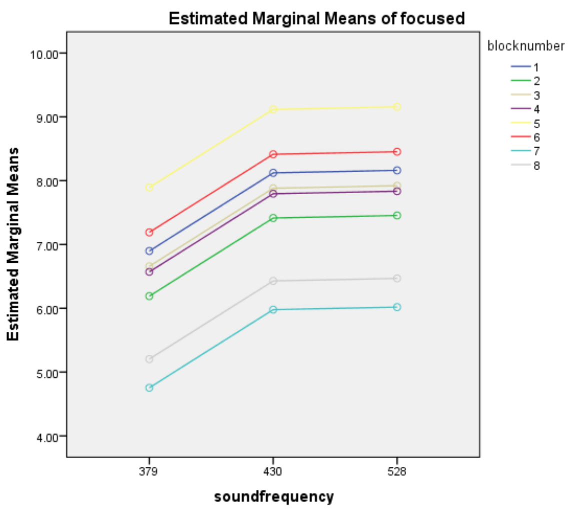

Fig 4: marginal mean rating given as per blocks

- **Impact of stress relieved:**

Tests of Between-Subjects Effects						
Dependent Variable: stress relieved						
Source		Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	7570.251	1	7570.251	464.843	.000
	Error	120.124	7.376	16.286[a]		
Block number	Hypothesis	119.631	7	17.090	2.912	.007
	Error	991.999	169	5.870[b]		
Sound Frequency	Hypothesis	56.869	2	28.435	4.844	.009
	Error	991.999	169	5.870[b]		

Table 8: ANOVA for Dependent variable Stress Relief effect on listener

the Intercept, Block Number, and Sound Frequency are all significant predictors of "stress relieved." The Intercept, representing the baseline level of stress relief, is highly significant. Block Number has a significant effect, and Sound Frequency significantly influences stress relief. The F-statistics indicate the overall fit of the model, and the p-values suggest the significance of each predictor. The Error terms provide information about the unexplained variability in the model.

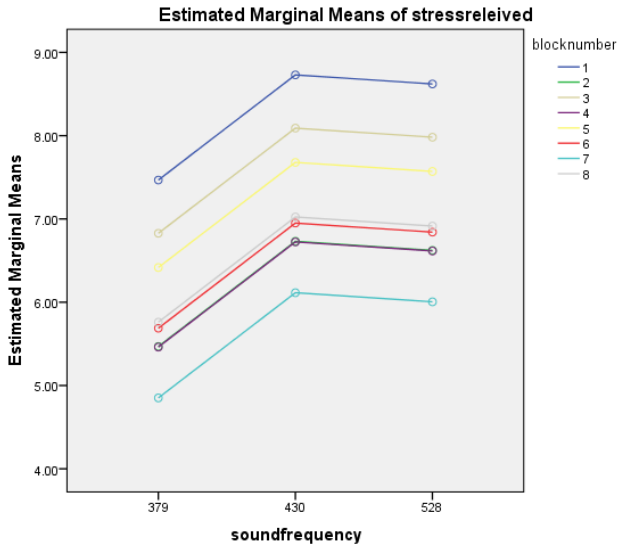

Fig 5: marginal mean rating given as per blocks

- **Impact of refreshed:**

Tests of Between-Subjects Effects						
Dependent Variable: Felt Refreshed						
Source		Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	8473.465	1	8473.465	299.160	.000
	Error	204.441	7.218	28.324[a]		
Block number	Hypothesis	210.334	7	30.048	4.999	.000
	Error	1015.742	169	6.010[b]		
Sound Frequency	Hypothesis	98.245	2	49.123	8.173	.000
	Error	1015.742	169	6.010[b]		

Table 9: ANOVA for Dependent variable Refreshed effect on listener

The results suggest that the Intercept, Block Number, and Sound Frequency are all significant predictors of feeling "refreshed." The Intercept, representing the baseline level of feeling refreshed, is highly significant. Block Number has a highly significant effect, and Sound Frequency significantly influences the feeling of being refreshed. The F-statistics indicate the overall fit of the model, and the p-values suggest the significance of each predictor.

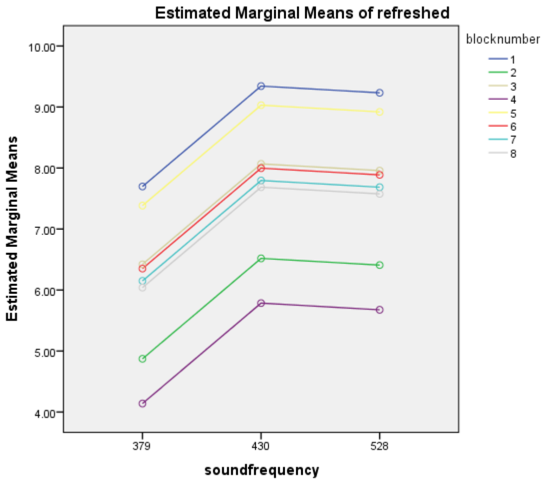

Fig 6: marginal mean rating given as per blocks

- **Block wise impact of pain relief:**

Tests of Between-Subjects Effects						
Dependent Variable: pain relief						
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	3498.761	1	3498.761	30.679	.001
	Error	805.487	7.063	114.045[a]		
Block number	Hypothesis	856.144	7	122.306	17.240	.000
	Error	1198.909	169	7.094[b]		
Sound Frequency	Hypothesis	100.022	2	50.011	7.050	.001
	Error	1198.909	169	7.094[b]		

Table 10: ANOVA for Dependent variable Pain Relief effect on listener

The results suggest that the Intercept, Block Number, and Sound Frequency are all significant predictors of "pain relief." The Intercept, representing the baseline level of pain relief, is significant. Block Number has a highly significant effect, and Sound Frequency significantly influences pain relief. The F-statistics indicate the overall fit of the model, and the p-values suggest the significance of each predictor. The Error terms provide information about the unexplained variability in the model. Overall, the model appears to be a good fit for explaining the variance in "pain relief."

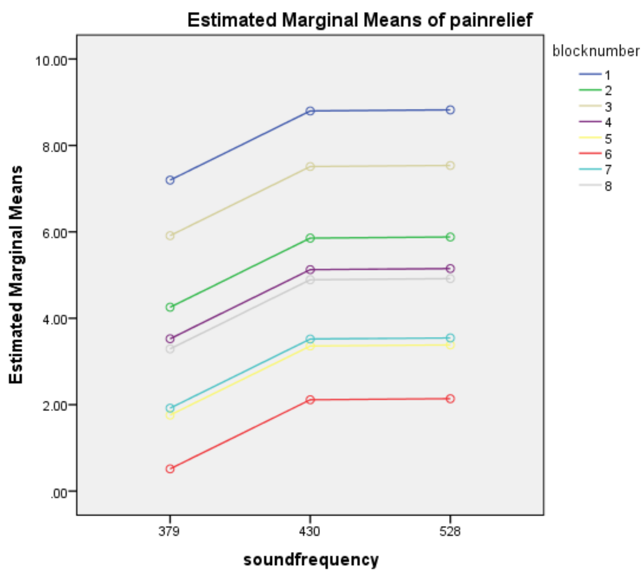

Fig 7: marginal mean rating given as per blocks

Significance of the study:

This study's findings are expected to contribute significantly to the field of environmental psychology, providing evidence-based insights into the impact of sound frequency on human well-being. The utilization of a randomized block design enhances the internal validity of the study, allowing for more robust conclusions that can inform practical applications in designing soundscapes conducive to positive well-being. In essence, this research endeavours to bridge gaps in existing literature by employing a sophisticated research design, shedding light on the intricate relationship between sound frequency and human well-being.

Conclusion:

The overall analysis investigated the impact of different factors on various aspects of human well-being, including feelings of "Soothing," "Emotional," "Focused," "Stress Relieved," "Refreshed," and "Pain Relief." The study utilized a Randomized Block Design (RBD) and conducted Tests of Between-Subjects Effects to understand the contributions of Intercept, Block Number, and Sound Frequency as predictors.

1. **Intercept Significance:**
   Across all dependent variables, the Intercept (baseline level) was consistently highly significant. This suggests that the baseline state significantly contributes to explaining the variance in each well-being aspect.
2. **Block Number Influence:**
   In several cases (e.g., "Emotional," "Focused," "Stress Relieved," and "Refreshed"), Block Number had a significant impact on the dependent variables. This indicates that certain external factors or blocks (subjective liking of person, deterministic approach, the base mental condition and physical state of personnel) significantly influenced the measured well-being outcomes.
3. **Sound Frequency Effects:**
   Sound Frequency consistently showed significance in predicting well-being outcomes across different dependent variables, such as "Emotional," "Focused," "Stress Relieved," "Refreshed," and "Pain Relief." This suggests that the specific frequencies of sounds presented had a significant influence on participants' well-being.
4. **Overall Model Fit:**
   The overall model fit for each dependent variable was generally good, as indicated by high F-statistics and low p-values. This suggests that the combination of Intercept, Block Number, and Sound Frequency effectively explained the variability in the measured well-being aspects.
5. **Impact of heart Rate of listener:**
   The Paired t test strongly evident that these solfeggio sound frequencies lower the heart rate just because of its soothing and calming effect on mind.
6. **Specific Insights:**
   The specific insights into each well-being aspect varied. For instance, the results indicated significant effects of Sound Frequency on "Emotional," "Focused," "Stress Relieved," "Refreshed," and "Pain Relief," suggesting the potential therapeutic effects of certain sound frequencies on these aspects.

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