The study of the effect of the trigonometric pattern of the music chords on human relaxation: Electroencephalogram (EEG)

Mr. T-touch Pattaravarodom[1]*, Miss Jantrarat Jun-a-nun[1], Miss Chaweewan Arunthaworn[1], Miss Sunisa Kongkalai and Mr.Somyote Noipailom**

[1]Princess Chulabhorn Science High School Pathum Thani 51 M.6 Bhorngurn Ladlumkaou Pathum Thani

E-mail: tone.7610@gmail.com*, ajvee_math@hotmail.com**

Abstract

This objective of this research is for study of the effect of the trigonometric pattern of all of the music chords and study about the relationship of class in Moonlight Sonata. Furthermore, we compared the effect on human relaxation in the different type of the chords to explain the music that lead to human relaxation in mathematics and biology. The different type of the music is Major chords, Minor chords and mix. We use Geogebra program to search for the trigonometric relationship and the intersection on the frequency wave of the note in different chords. Moreover, we recorded and analyzed the result from EEG for 10 persons from Princess Chulabhorn Science High School Pathum Thani at the laboratory, Mahidol University. The variable is the change of Alpha wave in each area in human brain. For the result, there is the intersection of the three different waves in the same point. When we count for the length of the Major chords in each wave, we can find that there is the pattern in 2, 2.5 and 3 cycles, respectively. However, in Minor chords, we can find that there is the pattern in 8, 9.5 and 12 cycles, respectively. Also, for the music in each class, there are some relationship in music and mathematics. Lastly, for the hypothesis, the most of music that is a big change of alpha wave is Moonlight Sonata.

Keywords: music chords, *the pattern of trigonometric*, relaxation and brain wave

1. Introduction

Music is the significant thing in our life. It can make the sound that is effect to human emotion in various way. For instance, develop preference, popularity and human personality. When we heard them, we will feel like sadly, lovely and enjoyable. This is kind of science integrate with art. So, we cannot separate them out because music is abstract that cannot touch or see them. We can just hear and feel. This would mean that music is the science which is very beautiful and highest.

The benefits of the music are not just about the human emotion or human feeling but also can treat you from many diseases and rehabilitate your health. There are many researcher studies about the effect on human when they are listening to music. For example, Ms. Udomluk mongkol was found that music can affect to human body, mind, temper, and spirit, directly. Also, type of the music is the important function that effect to the brain wave in different way. Many researches said that the alpha wave would happen when human is relaxing or happy. This would mean that the change of human brain wave was depend on the kind of the music which lead to human emotion.

The different feeling when we listen to music is depended on the basic element, such as, melody, media, note, rhythm, musician and chords. The music that we are listening nowadays, human has changing many times for many years.

Music have a pattern and specific structure. There are use theory of Major chords and Minor chords. Moreover, many musicians create a new theory of how to make the sound of music more confident and fluently. Also, in each musician create many different ways to make audience remembered them. For instance, they were use notes more than 3 in classic era. Classic music is the most significant music in the world because the basic of the music nowadays, they are also made from classic music. There is numerous research study about the relationship of music and mathematics for 2000 years. Many music theorists use basic of mathematics to develop and support their opinion because mathematics can explain phenomenon and many ideas of music. Also, it can explain the vibration of the sound spectrum. (Bilal Ahmad Bhat, 2015)

Relationship of mathematics and music are complicated. The history of music and mathematics are also dispute for a long time. Music is definitely link with mathematics continuously. So, the question and the issue that happen in music theory was edit by the research of mathematics and physics. Furthermore, the history has many samples of musician that use technical of math support their idea, such as, Pythagoras who create trigonometric theory. (Muhammad Ashraf Wani, 2015)

Therefore, we interested to study the pattern of frequency in music chord in classic era. In each chord has a different write and emotion that can explain in trigonometric and study the most effect in human relaxation type of music progression by human brain wave. Moreover, we use the different pattern of chord to explain why we feel in many ways when we listen to music.

2. Objective

2.1 To study about the pattern of trigonometric in Major chord, Minor chord and mix

2.2 To study about the relationship of music progression in each class of music

2.3 To compared the change of brain wave that effect to human relaxation when listen to different type of the music

3. Hypothesis

3.1 There are different pattern in each chord

3.2 There are the relationship in each class of music

3.3 Moonlight Sonata is the most relax music

4. Variables studied

4.1 The study of relationship of trigonometric in Major chords and Minor chords

Independent Variable is the frequency of notes that different in Major chords and Minor chords

Dependent Variable is the pattern of wave that intersection in the same point at amplitude 0 with time

Controlled Variable is the GeoGebra program and the equation of $y(t) = \sin(2\pi ft)$

4.2 The study about the relationship of music progression in each class of music

Independent Variable is the time where intersection in each chord

Dependent Variable is the relationship of intersection in each chord

Controlled Variable is Microsoft Excel 2013

4.3 The study of compared the change of brain wave that effect to human relaxation when listen to different type of the music

Independent Variable is the type of the music that include A Little Night in G major which is the music that have more major chords than minor chords, Nocturne No.20 in C-sharp minor which is the music that have more minor chords than major chords and Moonlight Sonata (1st Movement) which is the music that have major chords equal with minor chords

Dependent Variable is the change of brain wave that effect to human relaxation

Controlled Variable is Laboratory, secondary high school students, times and EEG

5. Scope of study

Area Scope

Princess Chulabhorn Science High School Pathum Thani 51 M.6 Bhorngurn Ladlumkaou Pathum Thani, Institute of Molecular Biosciences at Mahidol University and Faculty of Information Technology at King Mongkut's Institute of Technology Ladkraban

Time Scope

Between November, 2017 and February, 2019

6. Operation definition

6.1 The pattern of trigonometric is the pattern of intersection when count for the length of the Major chords and Minor chords in each wave from the intersection in the same point at amplitude 0 with time

6.2 Human relaxation is the rising of alpha waves from the human feeling and the environment in each situation.

6.3 Alpha wave is the brain wave while participants close their eyes, do meditation or relax.

6.4 Mix is the music which have major chords equal with minor chords.

7. Equipment and tools used in the experiment

1) Tools include A Little Night in G major, Nocturne No.20 in C-sharp minor and Moonlight Sonata

2) Electroencephalogram; EEG

3) Cross word and quiz

4) EmotivPRO license program

5) GeoGebra program

8. Methods and process

8.1 The study of relationship of trigonometric in Major chords and Minor chords

1) Transcribe a chord into various note along with the frequency

2) Determine the trigonometric pattern with the wave equation $y(t) = \sin(2\pi ft)$ using GeoGebra.

3) Count the period of the intercept point in each frequency.

8.2 The study about the relationship of music progression in each class of music

1) Transcribe a lyrics into various chords in each scale

2) Summary of results in the form of a pie charts

8.3 The study of compared the change of brain wave that effect to human relaxation when listen to different type of the music

Type of Minor chords	Section point	X	y	period
C Minor	A	0.030541	0.000011	8
	B	0.030583	-0.000071	9.5
	C	0.030769	0.000377	12
	X bar	0.030631	0.000106	
	SD	0.000099	0.000195	
D Minor	A	0.027216	0.000010	8
	B	0.027250	-0.000064	9.5
	C	0.027397	0.000338	12
	X bar	0.027288	0.000095	
	SD	0.000079	0.000174	
E Minor	A	0.024238	-0.000009	8
	B	0.024266	-0.000078	9.5
	C	0.024390	0.000302	12
	X bar	0.024298	0.000072	
	SD	0.000066	0.000165	
F Minor	A	0.022897	-0.000013	8
	B	-0.227094	-0.000999	9.5
	C	0.022857	-0.000143	12
	X bar	-0.060447	-0.000385	
	SD	0.117838	0.000437	
G Minor	A	0.020398	-0.000036	8
	B	0.020396	-0.000029	9.5
	C	0.020408	0.000000	12
	X bar	0.020401	-0.000022	
	SD	0.000005	0.000016	
A Minor	A	0.018159	-0.000095	8
	B	0.018154	-0.000078	9.5
	C	0.018182	0.000000	12
	X bar	0.018165	-0.000058	
	SD	0.000012	0.000041	
B Minor	A	0.016190	-0.000123	8
	B	0.016144	0.000046	9.5
	C	0.016393	0.000734	12
	X bar	0.016242	0.000219	
	SD	0.000108	0.000370	

1) Selection of samples in the experiment

2) Each sample group listened to the first song and measured the changes in the brain wave by EEG.

3) Resting activities to reduce symptoms (Ear worm)

4) Complete all 3 songs in this experiment

5) Observe changes and analyze data

9. Result

1) The study of relationship of trigonometric in Major chords and Minor chords

Pattern as a period of the intersection of the frequency of each note in various music chords of Major and Minor chords will intersection at the intercept point. But there are different number of rounds in the pattern because three notes that made up a triad or a chord in chord Major have a gap less than a gap from notes in the Minor chord which made the pattern of the Major chords are different form Minor chord.

Type of major chords	Section point	x	y	period
C Major	A	0.007601	-0.000053	2
	B	0.007618	-0.000087	2.5
	C	0.007692	0.000097	3
	X bar	0.007637	-0.000014	
	SD	0.000040	0.000080	
D Major	A	0.006777	-0.000047	2
	B	0.006790	-0.000077	2.5
	C	0.006849	0.000086	3
	X bar	0.006806	-0.000013	
	SD	0.000031	0.000071	
E Major	A	0.006040	-0.000042	2
	B	0.006037	-0.000034	2.5
	C	0.006024	-0.000076	3
	X bar	0.006034	-0.000051	
	SD	0.000007	0.000018	
F Major	A	0.005703	-0.000060	2
	B	0.005705	-0.000065	2.5
	C	0.005714	-0.000036	3
	X bar	0.005708	-0.000054	
	SD	0.000005	0.000013	
G Major	A	0.005068	-0.000085	2
	B	0.005074	-0.000104	2.5
	C	0.005102	0.000000	3
	X bar	0.005081	-0.000063	
	SD	0.000015	0.000045	
A Major	A	0.004527	-0.000051	2
	B	0.004534	-0.000075	2.5
	C	0.004566	0.000057	3
	X bar	0.004543	-0.000023	
	SD	0.000017	0.000058	
B Major	A	0.004032	-0.000051	2
	B	0.004038	-0.000074	2.5
	C	0.004065	0.000051	3
	X bar	0.004045	-0.000024	
	SD	0.000014	0.000054	

Table 2 Show amplitude, time and intersection of all Minor chords

10. Conclusion

1) The study of relationship of trigonometric in Major chords and Minor chords

Pattern as a period of the intersection of the frequency of each note in various music chords of Major and Minor chords will intersection at the intercept point. But there are different number of rounds in the pattern because three notes that made up a triad or a chord in chord Major have a gap less than a gap from notes in the Minor chord which made the pattern of the Major chords are different form Minor chord.

2) The study about the relationship of music progression in each class of music

Songs that have a ratio of major chords higher than minor chords or minor higher than that depends on the composers and the era of the composers, found that the song that have a ratio of major chords higher than minor chord as "A little night music in G Major". And Wolfgang Amadeus Mozart is the composer for this song in the classic era, Therefore the Songs that have a ratio of minor chords higher than as "Moonlight Sonata in C sharp minor" and "Nocturne in C sharp Minor", And Ludwig van Beethoven and Frédéric François Chopin is the composers of these songs respectively Which is a composer in the late classical era until the romantic era. And the romantic era, respectively, that made the ratio of these music to have a different aspect of the music chord.

3) The study of compared the change of brain wave that effect to human relaxation when listen to different type of the music

Due to the experimental that study of the trigonometric pattern of the Major Chord and Minor chord indicates that Major and Minor chords are different pattern, and each song has a different ratio and when considered, found that The relaxation value will change. According to the ratio of the song to the Minor chords. That is, the more the ratio of the chord to the song, the Minor extension, when listening will be more relaxed.

11. Discussion

1) The study of relationship of trigonometric in Major chords and Minor chords

Pattern as a period of the intersection of the frequency of each note in various music chords of Major and Minor chords will intersection at the intercept point. But there are different number of rounds in the pattern because three notes that made up a triad or a chord in chord Major have a gap less than a gap from notes in the Minor chord which made the pattern of the Major chords are different form Minor chord.

2) The study about the relationship of music progression in each class of music

Songs that have a ratio of major chords higher than minor chords or minor higher than that depends on the composers and the era of the composers, Found that the song that have a ratio of major chords higher than minor chord as "A little night music in G Major". And Wolfgang Amadeus Mozart is the composer for this song in the classic era, Therefore the Songs that have a ratio of minor chords higher than as "Moonlight Sonata in C sharp minor" and "Nocturne in C sharp Minor", And Ludwig van Beethoven and Frédéric François Chopin is the composers of these songs respectively Which is a composer in the late classical era until the romantic era. And the romantic era, respectively, that made the ratio of these music to have a different aspect of the music chord.

3) The study of compared the change of brain wave that effect to human relaxation when listen to different type of the music

Due to the experimental that study of the trigonometric pattern of the Major Chord and Minor chord indicates that Major and Minor chords are different pattern, and each song has a different ratio and when considered, found that The relaxation value will change. According to the ratio of the song to the Minor chords. That is, the more the ratio of the chord to the song, the Minor extension, when listening will be more relaxed.

12. Suggestion

1) Can be added to find trigonometric relationships of chords, minor7 minor7 and more

2) can find many other forms of relationships, not just trigonometric relations

3) To find the relationship between the music room and the ratio of chords in each song Should search for things that can be used to explain why there is such a ratio

13. Acknowledgment

Researchers, thank you teacher Chaweewan Arunthaworn, Lecturer in Mathematics, teacher Sunisa Kongkalai, professor of biology And Teacher Somyote NoiPhaiLom, professor of international music Princess Chulabhorn Science High School, Pathumthani, who gave advice and provide various knowledge about this research Encouragement in the operation Help coordinate Performing various experiments in the project throughout Finally, the research team wishes to thank the parents.

who gave a valuable educational opportunity to the research team

14. Bibliography

Ashby, F. G., Isen, A. M., & Turken, A.U. (1999). **A neuropsychological theory of positive affect and its influence on cognition**. Psychological Review, 106(3), 529-550.

Koelsch, S. (2010).**Towards a neural basis of music evoked emotions.Trends in Cognitive Sciences** , 14(3), 131-137.

Bilal Ahmad Bhat. (2015). **A STUDY ON RELATIONSHIP BETWEEN MATHEMATICS AND MUSIC**, 1(2), 100-108.

Saloni Shah. (2010). **An Exploration of the Relationship between Mathematics and Music**, Manchester Institute for Mathematical Sciences School of Mathematics,

Janelle K. Hammond. (2011). **Mathematics of Music**, UW-L Journal of Undergraduate Research XIV.