

Entrainment: Transcendental Condition that Affected with Musical

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ABSTRACT

This research examines the phenomenon of entrainment, which is associated with atmospheric phenomenon in meteorology, and is now also used in a person's psychological and neurological state that leads to a state of brainwave synchronization (neural entrainment). In the most extreme conditions, this neural oscillation process will make a person enter the transcendental phase. This research is examined through a qualitative method by conducting a literature study of a number of studies on the phenomenon of entrainment. The findings obtained by researchers and academics related to entrainment can be a source of evidence for this research. The results of the research conducted found that entrainment can be the most logical explanation to explain a number of transcendental phenomenon associated with traditional or modern music. Entrainment is also a scientific explanation for the phenomenon of being possessed by spirit in a number of traditional arts in Indonesia and entrainment also affects human behavior which can reach the most extreme phase when affected by music to the subconscious level. This article is not sufficient to provide a significant explanation for the phenomenon of trance in some traditional Indonesian arts. More proofs, experiments, and literature studies are needed to strengthen the explanation of the phenomenon scientifically.

Keywords: Entrainment, Neural Oscillation, Transcendental Phenomena, Musical, Bio-Music

INTRODUCTION

Entrainment is a phenomenon when two or more objects that have independent rhythm get into a synchronization process (Clayton, et al, 2004). This process is termed by Clayton as oscillation process, and objects that synchronize themselves are called oscillator. Object that contains independent rhythm is defined as an object that's capable of emitting music constantly and continuously. To achieve phenomenon entrainment, a human body has to follow certain beat or rhythm outside of the body itself that's affected with bio-musical. In the

context of bio-musicology, as an animalia kingdom creature, man is considered to have independent rhythm in his body (Clayton, 2012). Discourse and conception of entrainment have been discussed since 1665 by Christian Huygens, ultimately used as term at several branches of science such as biology, physics, linguistics, chronobiology, engineering, until eventually used in bio-musicology.

Entrainment condition is identified from several phenomena. The name Christian Huygens is famous for explaining phenomenon in several pendulum clocks that emit sounds from their respective

pendulum movements. Even the movement of the pendulums is not simultaneously, and the sounds that are emitted are not at the same beat, but eventually, the sounds are heard at the same level (Pikovsky, in Clayton, 2012). Such similar condition is found when several bees, mosquito, and flies at large number, fly simultaneously. Sound emitted from their wings is actually come with several different beats. But after it has been listened for awhile, the buzzing sound will be heard at the same level. It's the condition where entrainment made many sounds as they're synchronized. As such, entrainment is defined as rhythmic synchronization between an object that's capable of producing independent rhythm, with another object that has the same property.

This article will be more focused on the discussion of entrainment in human, which is happening in the context of human body's musical (bio-music), when being synchronized with music that comes outside from their body. The discussion will be taken from several journals, research papers, articles, and writings that discuss entrainment in human to the most extreme limitation, that is transcendental phase. Human body as an object that has independent rhythmic will be very potential to be exposed to the entrainment process, whenever it meets with another "independent rhythmic object". In light case, human will be at the same level with music that comes outside from his body and moves his body accordingly to the music beat. However in more heavy case, human that has become one level with music that comes from outside of his body, will lose control of his body and will keep following the music beat. Or, in another words, that particular human is entering transcendental phase.

It's not just one factor that influence the presence of entrainment phenomenon. Several other processes such as circumstance, time, place, connection between biological body and mechanical system, suggestion, belief, and others will be very connected to the birth of the entrainment process, so far even to the transcendental phase. Contradictory to the transcendental phenomenon in performance show, especially Indonesian traditional music performance that's always associated with the term D.T.D. (Dissociative Trance Disorder), but in reality it is absolutely different with what is achieved in this research.

In the perspective of existentialism, human is susceptible and easily persuaded by his surrounding. This is termed by Sartre (2021) as a gift and also a flaw of human kind. The connection with entrainment is that influence and persuasion that most easily affect human are things that are auditive (Shahidullah, Hepper, 1993). The influence of sound, in this case, music will be able to influence a human's behavior. Not just adult, even when still in the womb, human perceive firstly what they hear. Hearing is among the first senses to work in a human body (DeCasper, et all, 2015). A baby in its womb has been listening and perceiving since the first week (Djohan, 2020), eventually make hearing senses as the most dominant senses to perceive anything.

The dominance of hearing senses as a tool to perceive the environment makes human susceptible and easily persuaded whenever a suggestion comes as a sound. Music with certain beat will be very potential to influence and persuade a man. The entrainment process that takes place in between that, whenever music wave from the outside and the inside of the body

starts to synchronize in a long and constant time. This is what happen whenever a human body meets music. Entrainment process will make that human shake his body accordingly to the respective song. As for several cases of traditional music that have something believed to be mystical, then abundant number of suggestions will infiltrate and will influence the mind of its listener. This is what makes entrainment able to make one of the two independent rhythm producers gets into transcendental phase. As theatrical show *Kuda Kepang* or *Kuda Lumping*, *Bambu Gila*, and several transcendental cases after listening to Indonesian tradition music, it can be explained with entrainment conception.

Entrainment has tight connenction with psychology, music, neurology, music, and belief. Because of that, deeper discussion regarding entrainment process, conception, the process and other several things which could cause human to reach transcendental phase will be discussed in this article.

METHOD

This article will explain several literally sources regarding entrainment with all its supports. The design of this research is literature review. In general, literature review can be defined as a process of analyzing, reading, and examining a number of literary sources (books, journals, articles, and so on) that have connection with the respective topic on the research, as an exploration and research process (Marzali in Firsty, et all 2023).

Several keywords that are used to look up literally sources are: entrainment, neural oscillation, transcendental phenomenon, and musical. The database gathering process is committed on several sites such as Mendeley, Google Scholar, Research Gate, and Academia including articles or

English and Indonesian books containing entrainment and regarding with bio-musicology. Those articles then selected with discourse proximity that's brought up in this writing. From that selection, 2 books and 4 articles have been selected that have the most relevancy with the upcoming discussion.

The procedure of conducting this literary-based research is started with general idea exploration or research premise, continued with information searching regarding said premise. The next step is to emphasize the focus with organizing correct material, continued with seeking relevant data sources, be it books or scientific article. After that is to reorganize materials and notes from data sources, creating review from information that will be analyzed according to researchers' requirement. Data analysis process is enforced by enriching data sources, then closed with assembling the research result (Tahmidaten and Krismanto, 2019). In a brief, that process can be simplified as data gathering, presenting, and extracting summary (Amalia and Sa'adah, 2020).

RESEARCH AND DISCUSSION

A. The Difference of Entrainment with D.T.D.

With certain condition, this entrainment is often associated with D.T.D. (Dissociative Trance Disorder) disturbance or particular condition whenever a man entering transcendental phase without consent. Possessed condition is always associated with D.T.D., even though fundamentally speaking entrainment condition with D.T.D. are two different matters. D.T.D. is a kind of a psychological behavior disorder in a form of mental status change that is associated with identity and memory. D.T.D. condition is grouped with D.I.D. (Dissociative

Identity Disorder), D.A. (Dissociative Amnesia), D.P.R.D. (Depersonalization-Derealization), O.S.D.D. (Other Specified Dissociative Disorder) and U.D.D. (Unspecified Dissociative Disorder) (Loewenstein 2018). As stated by Ginting and Effendy (2019), that a certain mental illness is caused by many matters, such as hallucination, illusion, delusion, and so on. But for one case in Tiga Binanga, North Sumatera, when a young woman whom doesn't have a history of mental illness, has to be admitted into medical care because of D.T.D. disturbance, that is caused by cultural tradition *Nini Pagar* in that specific region. In the condition of D.T.D., the patient has to had psychotherapy and pharmacotherapy care before the said patient becomes a nuisance to its living environment.

Entrainment condition differs from D.T.D. condition. Entrainment will be occurred temporarily, and slowly dissipates whenever synchronization condition between human body's bio-rhythm and external rhythm has been ceased, as for D.T.D. is a kind of illness that requires intensive medical care. This matter can be harmful to the psychological condition of the victim. Moreover, entrainment also involves believe, fear, loss of self-confidence, and many more. Nevertheless, the main stimulus is music. As for D.T.D. is a psychological abnormality condition that is affected with several other things that are not directed to that certain musical.

B. Entrainment Phenomenon

Entrainment or phenomenon of getting carried over, previously used as a term in the discipline of meteorology. This particular condition marked with flow turbulence that caught non-turbulence flow, as in tropical cyclone, whenever more humid air caught with the flow of

more dry air to engage with the same flow and then be mixed altogether (Knight, et all, 2007). Entrainment terminology in bio-musicology refers to the definition of bio-logical synchronization between external rhythm from music and dance, with organic body. In general, man is not the only species that is able to experience entrainment. Several researches such as one that is conducted by Patel proves that animal like sea lions, parrots, and many more can also experience this phenomenon (Patel, et all, 2009).

When exposed to external music, man will listen in auditive. That condition will make human pulse that is isochronous inside the body will be active. This condition that makes human body move in synchronization with the external music (Clayton, et all, 2004). According to Patel, this induction process is a rhythmical process that is based on beat. This is the explanation to why a man will move around, dance, and jiggle whenever listening to music that came externally from outside its own body. In general, it can be concluded that biological synchronization has took event with external music, with inside-body musical (bio-rhythmic). However, entrainment condition that got to the transcendental phase is not affected with only music. Music is the only early stimulus, and the individual is also affected with collective identity such as fear, belief of certain things, loss of self-identity, and several other things that make an individual experience Altered State of Consciousness (A.S.C.) or the process of mind changing because of debate in its consciousness (Jordania, 2015).

C. Entrainment Process Requirement

Entrainment will truly happen whenever two independent rhythm producers as two basics components meet

certain requirement. First condition, both are emitter or rhythmical processor that are autonomous. In another words, as oscillators (Clayton, Sager, and Will, 2016). The regarded autonomous is that both objects are separated and while they are not interacting with each other, they are still be able to perform oscillation process. The said oscillation is a process that involves internal resource as an energy to produce rhythmic process. And so, the resonance in this case is not included in the rhythmical process. That means entrainment process will not happen between a musician with his own instrument. Since, the instrument will not be autonomous, because it depends on the musician.

Oscillator has a circadian system, meaning a rhythmic cycle keeps taking place endlessly. And so entrainment process might easily happen in several tools that are capable of emitting music (rhythmic and beat) on a long period of time autonomously (Roenneberg, et all. 2003). Musician, in this case is a part of his instrument. Both are not separated oscillators. As for the listener it's different, whom susceptible to experience entrainment whenever situated in a auditive experience from music that comes from a musician and his own instrument. With condition that the music is continuous and constant.

Entrainment has a difference with basic synchronization. Every system can be easily synchronized with another system. Synchronization can be easily influenced by another matters outside music, such as temperature, brightness, and so on. Entrainment is a different process, it's because the engaging system is required to be an oscillator and each of it will be influenced with stimulation (or suggestion) that comes externally outside the body of the said oscillator (Roenneberg, 2003).

The second condition for entrainment is that the two oscillators have to interact with each other. In another words, both oscillators have to have a strong influence to another. Stronger influence will bring weaker system to be in its level. From those two conditions, it's known that this rhythmic processor or oscillation have an influence to interact. This is the main tendency from an entrainment process. For a simple example, human conversation with another human will involve a rhythmic process and then, the conversation will go in one level that's decided from the speaker that has the most stable and rhythmic beat.

Entrainment influence aims to brainwaves that influence to each other, and then synchronized and one of it is streamed to a stronger current. That influence is not limited to come from a (living) organism or a non-living organism, as long as both have a chance to be an oscillator.

It needs to be underlined that an entrainment process cannot take place from a single physical (Clayton, Sager, and Will, 2016). Previously, it has been discussed that a musician and his instrument are not two oscillators, and so the process can be defined as a single physical. Entrainment will not happen to a process that just involve single physical. Entrainment is more like a tendency spread to a bigger space, and involve more biological bodies, even non-biological oscillator body. For example, pendulum clock, etc.

D. Entrainment in Bio-Musicology Perspective

Musicality differs from music. Musicality, in perspective of bio-musicology, is a capacity and tendency of a living organism that produces, and also enjoys music that comes from different shapes and genres. Still in bio-musicology perspective, human is a species that has

certain musical characteristic that becomes part of its life complexity (Parmadi, 2021). It means, human body is able to produce music, as well as embody across different genres of music using instrument and sound. The tendency of human to enjoy music is caused by hearing senses as the utmost senses and the easiest to use to influence mind and behavior. Because of that, entrainment is very well possible happen to a human. Moreover, with biomusicology principal, musical-influenced behavior also common to be found across different culture, from traditional culture up until post-modern (Fitch, 2015).

Entrainment will begin with synchronization process. Basic synchronization will make a man shake his body, or dance, following beat and rhythm of the music. This basic synchronization process will open a great opportunity for entrainment to a man. Aside from music, man will be more susceptible to what another man that has more enchanting "tone". The research that's conducted by Blain and McKeever (2011) says a very powerful link between communicative capability in one's interaction with biomusic synchronization in his body. Biomusic in a human body will interact with each other as an oscillator, whereas one that has interactive and communicative capability will be at stronger level. That condition causes the one with "lesser" communicative skill will be brought up to that more strong level. This is also an entrainment phenomenon that can change mindset and behavior in a lesser degree.

Body movement in context of dance is also a strong affection to the event of entrainment phenomenon, factors that make a human body deep inside of affection of musical rhythm that is rising and falling and the tempo that is quite static, are able

to construct human subconsciousness (Salim, 2018). Motoric coordination that is inherent with mind is also postulated as a cause of entrainment symptom in ecology perspective. The stimulus comes from a rhythm and beat signal from one individual to another individual. A dialog process between two individuals is also a form of rhythmic procession that takes place between two autonomous oscillators. Sensory feedback that comes from both of those is a form of non-verbal interaction, and whenever one of it starts to follow the level (be it tempo or rhythm) from his interlocutor, then the entrainment phenomenon has taken place. This is what is termed as social entrainment (Phillips-Silver, et all, 2010).

The aforementioned forms are basic form of entrainment that still has level above basic synchronization. It can be sorted such as this:

1. A dancer with rhythmical movement, following beat and music intentionally is a **basic synchronization** process.
2. A dancer with rhythmical movement, following beat absolutely freely, without putting a thought to the movement anymore is an **advanced synchronization**.
3. The dancer with rhythmical movement has been united with music and nearly most of the movement comes from reflex is an **early entrainment** process.
4. The dancer loses control (knowingly) and still moving following the music in transcendental phase is an **extreme entrainment**.

It can be seen from that order, whenever two oscillators (in this case dancer and his music) moving constantly and stimulate continuously, it can reach a transcendental phase, that is entrainment in an extreme degree.

E. Entrainment Experiment

Entrainment is defined as rhythmic procession of two oscillators. Therefore, in bio-musicology perspective, not just human kind as a species that has a possibility to experience entrainment process. Because of that, several experiments conducted to test out such hypothesis. The experiment is conducted on an eleonora cockatoo namely Snowball. The experiment that's conducted by Patel and his team (Patel, et all, 2009) involves a cockatoo as a constant sound emitter and qualifying as an oscillator, as to the requirement of entrainment proposed by Clayton (2004). Not just that, the hypothesis that will be proven in this experiment also predict that entrainment is possible in another species besides human.

Snowball was made to listen to popular music that's being changed in tempo constantly from the original. The result, Snowball performed continuous dance following the tempo from the song. The tempo in the song was then changed, slowed by 2.5% from its original tempo, and then 5%, 10%, 15%, up until reduced to 20% from its original. The result, utilized involving test of Monte Carlo with more than 22 times attempt, Snowball was noted to nod its head 101 times according to the beat of song that has been changed 5 times (from the first tempo at 130.4 bpm).

Patel and his company (2009) stated that the synchronization that took place in Snowball is similar to what happens in human child. From that whole experiment, 25% of Snowball's movement followed the beat that has been changed several times. This matter proved that Snowball not performed continuous movement, but it was influenced or synchronized with the music. Considering the tempo was changed several times up to five times, but was still followed well by Snowball, proves that

there was entrainment phenomenon in the experiment. So then the hypothesis that tries to be proved, which is early entrainment prediction can happen to any species that's able to produce vocal sound such as bird, cetacean, mammal, and primates, can be proven through the experiment.

Lots and Stone (2008) explain that neural synchronization will happen from two paired oscillators. Although it's not explicitly mentioned as an entrainment, according to the research and experiment that has been conducted before, that process is a form of entrainment that's proposed by Clayton and Patel. The term used by Lots and Stone is beating effect, or a process of beat equalization from two oscillators. Research that's conducted by Lots and Stone is tried out to varying living things, including human up until Andrew Rose's experiment to sea lion. The point is, beat holds important influence in this entrainment process, compared to melody. In mathematical language, this beating effect is considered as an addition of two sinus tones (without harmony) that is linear, but has an almost similar frequency, and so the amplitude.

The calculation is the first sinus is added with the second sinus, will produce $2\cos$ sinus. Whereas the mean frequency is the first sinus added with the second sinus divided by two. The result of that equation will decide the impression of the hearer, will be acquired from two different frequencies, but only one sinus tone will be heard as the result of the beating. Despite using mathematical perspective, it proves that two oscillators meeting at two different frequencies and tempos, will be at one level in the same frequency and tempo. In mathematical language, it's what termed as pure sinus tones (Ibid, 2008).

F. Connection with Transcendental Phenomenon

The next writing will attempt to connect entrainment phenomenon with several metaphysics. A number of tradition arts in Indonesia such as *Kuda Lumping*, *Bambu Gila*, and so on are very close with transcendental phenomenon. The previously used term is possessed, and the most logical explanation to explain the possessed phenomenon is entrainment (Suryajaya, 2021 and Irianto, 2022).

Suryajaya sees several “possessed by ghost” phenomenons from a handful of traditional dance and music show, such as *Tambur*, *Kuda Lumping*, until dance that comes from several places in Indonesia. The similarity from all those dances is that there’s an interaction between human bio-rhythm with music level outside his body. Irianto (2022) says such phenomenon as an entrainment.

Sebenarnya yang terjadi adalah entrainment, yakni ketika bioritme di dalam tubuh manusia menangkap aras musik yang ada di luar tubuhnya, kemudian tersinkronisasi. Hal ini bisa membuat seseorang masuk dalam fase trasendental, yang kemudian membuat dirinya lepas kendali atas dirinya sendiri. Akhirnya, tubuhnya akan mengikuti musik tanpa ia sadari.

Transated:

What is truly happening is entrainment, that is when bio-rhythm inside human body is able to receive music level outside his body, then synchronized. This condition is able to make one to enter transcendental phase, which will make himself lose control over himself. Ultimately, the body will follow music without him knowing so.

Entrainment in the most extreme phase makes an individual (as an oscillator) follow external music level with beat and rhythm form, up until losing control and entering into transcendental phase. This condition at first is started with basic synchronization, showed with head nod, foot tap, or body movement. The synchronization keeps increasing its level, whenever the beat and rhythm from the outside constantly stimulate (and suggestion). This condition is what is believed as scientific explanation to the entranced phenomenon which common to take place in traditional show.

This process will keep involve the existence of two waves that interact with each other, that is rhythmic wave from music with brainwaves as the result of bio-rhythmic of the human body. Several other factors outside music, such as environment, temperature, and so on also contribute to the early synchronization. Referencing to the order of rhythmic that ends in entrainment, then everything began when early synchronization starts. Music also gives mystic stimulation, such as *gamelan* sound, *tambur* (skin percussion), flute, and so on that speed up the process of entering into the most extreme entrainment process.

Pavlov’s perspective (in Mulyadi, et all, 2016), music comes as a natural stimulation that will cause natural response and also improvisational. The stimulation that comes constantly as a requirement of entrainment phenomenon will surface natural responses. As to Skinner’s perspective (Ibid, 2016), this matter is termed as superstitious or metaphysics behavior. This behavior happens because of interaction response from “enforcer” and said response doesn’t show clear causality. Even it doesn’t show clearly, but the connection will be very strong that’s capable of surfacing movement or uncontrollable gesture.

CONCLUSION AND SUGGESTION

1. Conclusion

In general, entrainment is a result or musical influence to one's mind and behavior. Several researches and experiments that have been conducted by previous researchers also show that entrainment doesn't only take place in human, but also to living creature that has bio-rhythm in its body, as previously stated. The influence of music psychology, creating a new branch of science, that is music psychology. As to the phenomenon of human capability to produce music (rhythm) from inside his body presents science branch of bio-musicology. Entrainment is a bridge to clarify that these two sciences are connected and are able to explain each other. Entrainment will be more easy to understand regarding transcendental phenomenon, especially in performance show that's correlated with music than D.T.D.

Entrainment is also a scientific explanation to several phenomenon that's considered as possessed by ghost in several tradition arts in Indonesia. The movement and behavior outside one's control from music influence also serves as a real proof of entrainment that could reach the most extreme phase. To differentiate entranced phenomenon that's not directly influenced from music, then entranced phenomenon that's caused or the result from entrainment can be considered as musical entranced.

2. Suggestion

The writing in this article is not complete enough to give logical explanation to the entranced phenomenon that takes place in several kinds of Indonesian tradition arts. It needs more add up, experiment, and literary study to further enrich and able to explain the phenomenon scientifically.

Indonesia as of now is still influenced from metaphysics perspective and also

mythological to explain some event that's considered psychological. And so, next research and writing related to entrainment will be able to support scientific explanation to the entranced phenomenon, and to put aside conceptual statement regarding the existence of ghost that dances along and enter a human's body. Replaced with observational statement regarding psychological phenomenon that influences behavior, and bodily response of a human to the future. Also it is added that the writer feels there are missing links from explanation regarding entrainment to explain entranced phenomenon at its extreme form. Therefore critique and suggestion, also more intensive research regarding entrainment is still needed to perfect this writing in the future.

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