

EEG Responses to Shamanic Drumming. Does the Suggestion of Trance State Moderate The Strength of Frequency Components?

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Abstract

One of the techniques used to induce trance state in shamanic ceremonies is monotonous drumming. According to previous EEG research, certain patterns of drumming cause an increase in power of alpha and theta frequencies of the listener. Present study aimed to determine, if suggestion to experience trance state could increase the relative alpha and theta amplitude and the intensity of experienced state. A group of twenty-four subjects participated in the study. Suggestion to experience trance state decreased alpha frequency power during the drumming condition. No other significant effects of suggestion or drumming were found.

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The key concept in shamanism is the ceremonial use of the state of trance [7]. Altered consciousness may be achieved in various ways, either ascetic - like meditation or sensory deprivation, or ecstatic such as dancing, chanting or use of entheogenic substances. A very popular instrument used in ceremonies is the drum, and monotonous patterns of drumming are often used to induce a state of trance. During ceremonies, unusual perceptions and hallucinations were reported, as well as twitching of the body and generalized convulsions [10].

Subjective response to shamanic trance

Although the topic of shamanic trance states was extensively covered in the field of anthropology, only a few researchers set out to examine its behavioral aspects in an experimental setting.

[8] compared the trance state induced by shamanic drumming with that induced by hypnosis. After listening to a 15 min recording of monotonous drumming the participants (N=206) rated their subjective experience. Forty participants reported experiencing shamanic trance state while listening to drumming. Those participants for whom the trance induction was successful came largely from the groups of medium or high hypnotic susceptibility scores [8], which indicates a link between hypnotic susceptibility and the ability to experience trance state while listening to shamanic drumming.

[9] examined the subjective experience of participants (N=12) who listened to different patterns of monotonous drumming. Written descriptions of participants' subjective experiences were categorized according to common themes and topics. Among the experienced described were shamanic imagery, feeling of becoming energized, mental or physical discomfort, sensations of movement, flying or distorted body image and losing track of time. All participants experienced visionary experiences during at least one condition. The experiment supports the hypothesis that rhythmic drumming can induce state of trance [9].

The use of EEG in trance research

A more direct way to assess trance or altered states of consciousness is to measure patterns in the electrical activity of the brain. The electroencephalograph (EEG) provides information about neural oscillations. The frequency components of the neural oscillations spectrum allows to detect for

example states of alertness, relaxation or drowsiness. According to frequency brainwaves are categorized into following main types [15]:

- beta 13-40 Hz – active, strongly engaged mind
- alpha 8-12 Hz – relaxed wakefulness, sometimes also alertness
- theta 5-7 Hz - occurs in a range of different mind states: drowsiness, threshold between wakefulness and sleep but also meditation or solving mathematical tasks
- delta 1-4 Hz, associated with sleep and drowsiness

EEG can be used to discern between various altered states of consciousness, such as hypnosis, meditation or states resulting from yoga practices [9]. Especially, the presence of alpha and theta frequency has been associated with states of meditation [5]. Although research on EEG activity in shamanic trance is limited, higher alpha and theta activity were registered in participants who claimed to have experienced trance state in experiments by [9,10]. Basing on this research, EEG may be useful in detecting trance experience during shamanic drumming.

Photic driving

Since 1934 [11,12] it was known that rhythmic visual stimulation in the form of flashing light with a frequency close to the alpha rhythm of the brain can produce two effects in the EEG: (1) increase in EEG amplitude and (2) if the frequency of the light flashes changes, the brain wave rhythms follows that frequency. This phenomenon is called photic driving [10].

[10] claimed that a beat of a drum contains a wider spectrum of frequencies than a single tone or a click used in previous experiments. Different sound frequencies are transmitted along different nerve pathways in the brain, therefore a larger area of the brain can be stimulated. Using drumming patterns based on those used during shamanic ceremonies in Africa or in the Vodoun cult in Haiti, [10] measured the physiological EEG response of participants (N=10) [10]. recorded driving responses similar to photic driving in all subjects. The main area of driving was the auditory cortex, with some recruitment in other areas, particularly the occipital cortex.

[9] compared different patterns of drumming in terms of their effect on cortical EEG. Different patterns of drumming lead to different changes in brainwaves. The drumming pattern with 4.5 beats per second elicited a strong increase in the theta component, as well as in alpha and beta. This may be due to the phenomenon of photic driving that mirrors theta frequency of 4 to 7 cycles per second.

Expectancy of trance state

It is reasonable to believe that certain patterns of drumming may induce states of trance due to the brainwave entrainment (photic driving) mechanism. However, a shamanic ceremony is a complex phenomenon. An important factor is the ritual structure itself. In *Deep Listeners* [2], emphasizes the ceremonial character and the group processes present in ritual, and suggests that it is not possible to isolate the experience of a singular participant from the cultural background of his experience. Pollak-Eltz describes shamanic trance as "a mixture of autosuggestion and conditioned reflex" (as cited by [4]).

Therefore, the individual's response to shamanic drumming may be moderated by expecting the trance state to happen. Expectancies can shape the ability to resist suggestion and can influence hypnotic suggestions, such as arm catalepsy, or spontaneous amnesia [1,14] demonstrated that both positive and negative suggestions may mediate the effect of short meditation on executive brain functions.

Research objectives

Out of the very limited scientific literature about shamanic drumming, only two studies used EEG to examine the trance state induced by monotonous drumming [9,10].

Hence, the aim of the present experiment was to contribute to the existing scientific knowledge about shamanic drumming. Specifically, the first aim of the experiment was to determine if the results obtained by Neher and Maxfield by could be replicated. The second aim was to examine the possible role of expectation in experiencing trance state during listening to monotonous drumming. Verbal suggestions can mediate the effect of meditation on executive brain functions [14]. Similarly, it was expected that the suggestion may influence participants ability to experience trance state during drumming stimulus.

Two research questions were derived:

- 1) Does shamanic drumming induce a change in EEG frequency components?
- 2) Does the suggestion to experience trance state increase the relative amplitude of EEG frequency components?

Method

Participants

A group of 24 people participated in the experiment consisting of 13 males and 11 females (mean age=28.8 SD=8.05). The group was recruited in Sweden mainly among Umeå university students and members of Yogasällskapet yoga center. All participants lived in Umeå, twenty of them were of Swedish origin and all of them were fluent in English. The inclusion criteria were normal hearing and no prior experience with shamanic drumming. Exclusion criteria was epilepsy and psychosis. To ensure a normal state for the EEG procedure, all participants were asked not to drink alcohol or use drugs the day of the session and the day before. They were also advised not to come on empty stomach and not after a big meal.

Sound recording

To produce a recording for the experiment an accurate replica of shamanic frame drum was constructed, with wooden frame and deer hide membrane. Samples of drumming with the pattern of approximately 4 beats/s were recorded. According to previous research this pattern was likely to induce the strongest physiological and behavioral response due to the mechanism of photic driving [9,10].

Using Ableton Live 9 software, the chosen sample of 1.5 min was looped to produce a recording of steady 15 min of drumming. Beginning and end of the each sample repetition were adjusted to make the transition unnoticeable. A small reverb effect was added to the the recording to create the feeling of listening to the drum played in a room. The samples were not corrected to achieve a metronomically perfect 4 beats/second speed, to simulate a live performance during a shamanic ceremony. The beginning and end of the recording were faded to create a smooth transition between the drumming and the control conditions: in the beginning the sound level increased up to the basic level for 10 s, and in the end the sound decreased for

the last 10 s. Intensity of the sound was the same for all the participants. Recordings similar to the one used in present experiment can be found on Youtube, as seen in a video by [3,6].

EEG recording

An AD Instruments Powerlab 8/35 device with a Dual BioAmp amplifier was used to collect the EEG data, together with five Ag electrodes (impedance < 5k Ω) [16] and AD Instruments LabChart 8 software. Two balanced input channels were utilized:

Channel 1 gathered signal from the occipital lobe. The first electrode in this channel was placed on the occipital lobe (OZ), and the reference electrode was placed on the parietal lobe (PZ). Alpha rhythm is distributed maximally in the occipital regions [15], therefore placing the electrode of the Channel 1 on the occipital lobe ensured that a strong signal in alpha frequency.

Channel 2 gathered signal from the temporal lobe, with the first electrode placed on the left temporal lobe (T3), and the reference electrode placed on the

right temporal lobe (T4). This setting of the channel 2 was chosen in order to detect theta signal if it would occur.

An additional grounding electrode was placed on the forehead. The sampling frequency was 1000 Hz and the time resolution 1 cm/s. A mains filter was applied to exclude 50 Hz interference and a 50 HZ low pass notch to cut off high frequency noise. No means of correction for eye movement artifacts were needed because Channel 1 and Channel 2 electrodes were placed away from the forehead. Figure 1 shows the placement of the electrodes.

The Phenomenology of Consciousness Inventory

The Phenomenology of Consciousness Inventory (PCI) is a self-rating instrument developed to measure subjective experience during altered states of consciousness, such as hypnosis or various types of meditation. PCI questionnaire is a reliable and valid instrument and testing of its dimensions and subdimensions proved them to be stable construct [8,13] used the PCI to measure the subjective

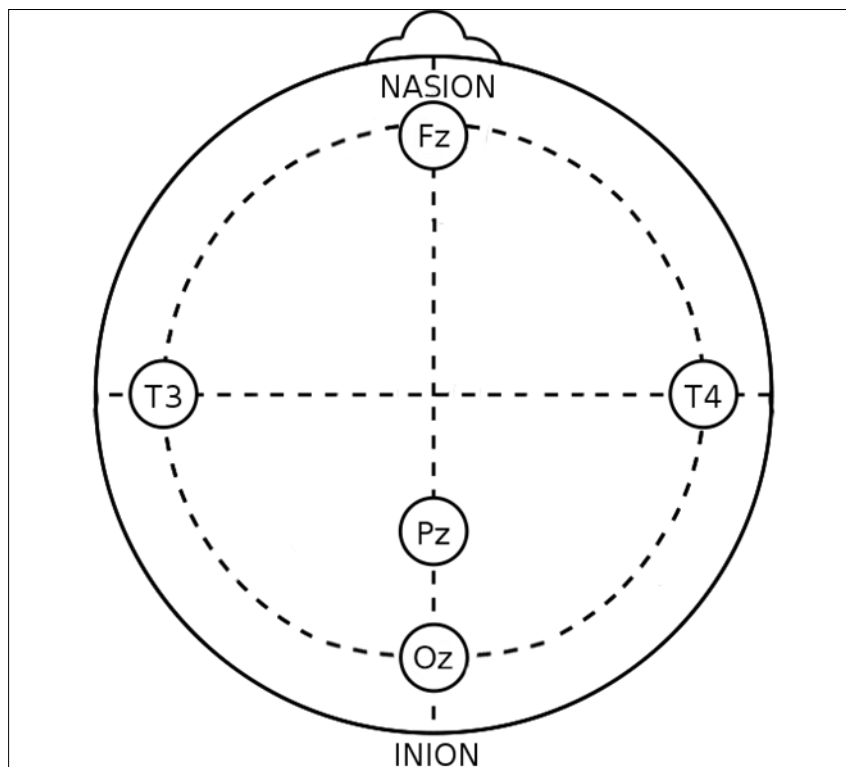


Figure 1. Placement of the EEG electrodes

experience of listening to shamanic drumming. The PCI is designed to be completed after a short stimulus condition and contains 53 items that cover 12 major and 14 minor dimensions. These include: internal dialogue, self-awareness, altered state of awareness, imagery, positive affect, sexual excitement, love, negative affect (anger, fear, sadness), altered experience, body image, perceptions, unusual meanings, attention (absorption, direction), memory, rationality, volitional control and arousal (relaxation).

Procedure

Prior to the session, participants were informed that they will take part in a non-invasive experiment that involves listening to drumming. All experimental sessions were conducted in the afternoon to control for the time of the day. During two weeks, two experimental sessions were conducted at 16.00 and 17.30, one participant at a time. All sessions took place in a calm, quiet laboratory, and the time of the day was chosen to limit the amount of possible outside noises.

Upon arrival in the laboratory, participants were advised to use the toilet if needed before the session. Every session started with signing the consent form and reading the informational text – neutral for Group 1, and a text containing suggestion for Group 2. After signing consent and reading the text, participants were informed about the procedure of the experiment. They were asked to keep their eyes closed throughout the recording, and to move as little as possible, but also to adjust their position whenever they feel uncomfortable. They were also instructed to continue lying still and relaxing after the drumming track will end, until the experimenter informs them that the recording is over. Subsequently, EEG electrodes were glued onto the chosen places on their scalp (Fig. 1), and sample recordings were performed to ensure the quality of the signal and adjust the placement of the electrodes if necessary. After obtaining steady signal, participants lied down on a bed, and put on a headphone set. The headphones were not removed until the end of the recording, to shield the background noise. After the participants got a comfortable position and stopped moving, the recording started.

First, 10 min of baseline control condition was recorded. An EEG procedure requires an adaptation period of approx. 5 min for the participants to settle in

and calm down. Data from the first five min of the control recording were treated as an adaptation period and excluded from the analysis.

After the first control condition, the 15 min drumming track was played through the headphones.

Subsequent to the drumming condition, second control recording was taken. Because of the structure of the experiment which involved lying in supine position for a prolonged period of time, second baseline recording was needed to determine if any observed response in EEG signal could be due to the time passing.

After the end of the recording, the electrodes and headphones were removed, and the participants completed the PCI questionnaire.

Experimental groups

Participants were randomly assigned to two groups. Group 2 received a suggestion in form of a written text before the experiment, whereas Group 1 received no suggestion (they were given a neutral text).

Group 1 (N=12) received a neutral text. It referred to the drumming, but no trance state effects were mentioned.

"Drumming is often used in native ceremonies. It is sometimes combined with singing or playing other instruments, like rattles or flutes. During the experiment, you will hear drumming on an exact replica of the drum typically used during such ceremonies, with a deer rawhide membrane mounted on a wooden frame using traditional methods. The drum is usually beaten with a stick with a steady, monotonous pattern. No other instruments were used in the recording."

Group 2 (N=12) received a text containing a suggestion that they may experience a trance state during the drumming.

"Rhythmic drumming is used in shamanic ceremonies to induce a state of trance. During the altered state of consciousness caused by drumming you may feel either energized or relaxed. Your body experience often becomes distorted, and you may feel pressure, expansion or vibration in various parts of your body. It is also common to experience sensations of movement: flying, falling, or spiraling. Usually, your imagination gets very vivid, and you may experience visions or a dreamlike state of mind. Participants of shamanic drumming ceremonies often describe their

experience as a “journey” emphasizing the sensation of distorted time and space, and a feeling of leaving the body and traveling.”

Data analysis

Statistical analyses were conducted using AD Instruments LabChart 8 and LibreOffice Calc software. The structure of the present experiment was derived from the research by [9], hence from each control condition a number of five 1 min epochs were chosen:

- From the first control condition, the first 5 min were ignored as adaptation time, and the epochs starting 5, 6, 7, 8, and 9 min into the recording were chosen for further analysis.
- From the drumming condition, epochs starting 8, 10, 12, 13, and 14 min after the drumming begun were chosen. The choice of epochs was determined by the observations from the previous research. According to [9] the optimal physiological response to shamanic drumming occurs between 8 and 15 min of listening.

- From the second control, epochs starting 2, 4, 6, 8 and 9 min into the recording were chosen.

No movement artifacts were present in the chosen epochs. For each epoch, LabChart software was used to derive the power of each frequency component from the raw EEG signal. Alpha peak was the highest amplitude density in the 8-12 Hz frequency range, theta peak was the highest amplitude density in the 5-7 Hz frequency range and delta peak was the highest amplitude density in the 0-4 Hz frequency range. For each chosen epoch, the mean peak values of alpha and delta amplitude density in $\mu\text{V}/\sqrt{\text{Hz}}$ were derived for the further analysis.

The experiment used one between subjects factor: suggestion and neutral text groups and two within-subjects factors: three conditions and five epochs in each condition. Therefore, to determine if suggestion increases the relative amplitude of frequency components a two groups x 3 conditions x 5 epochs repeated measures ANOVA test was used.

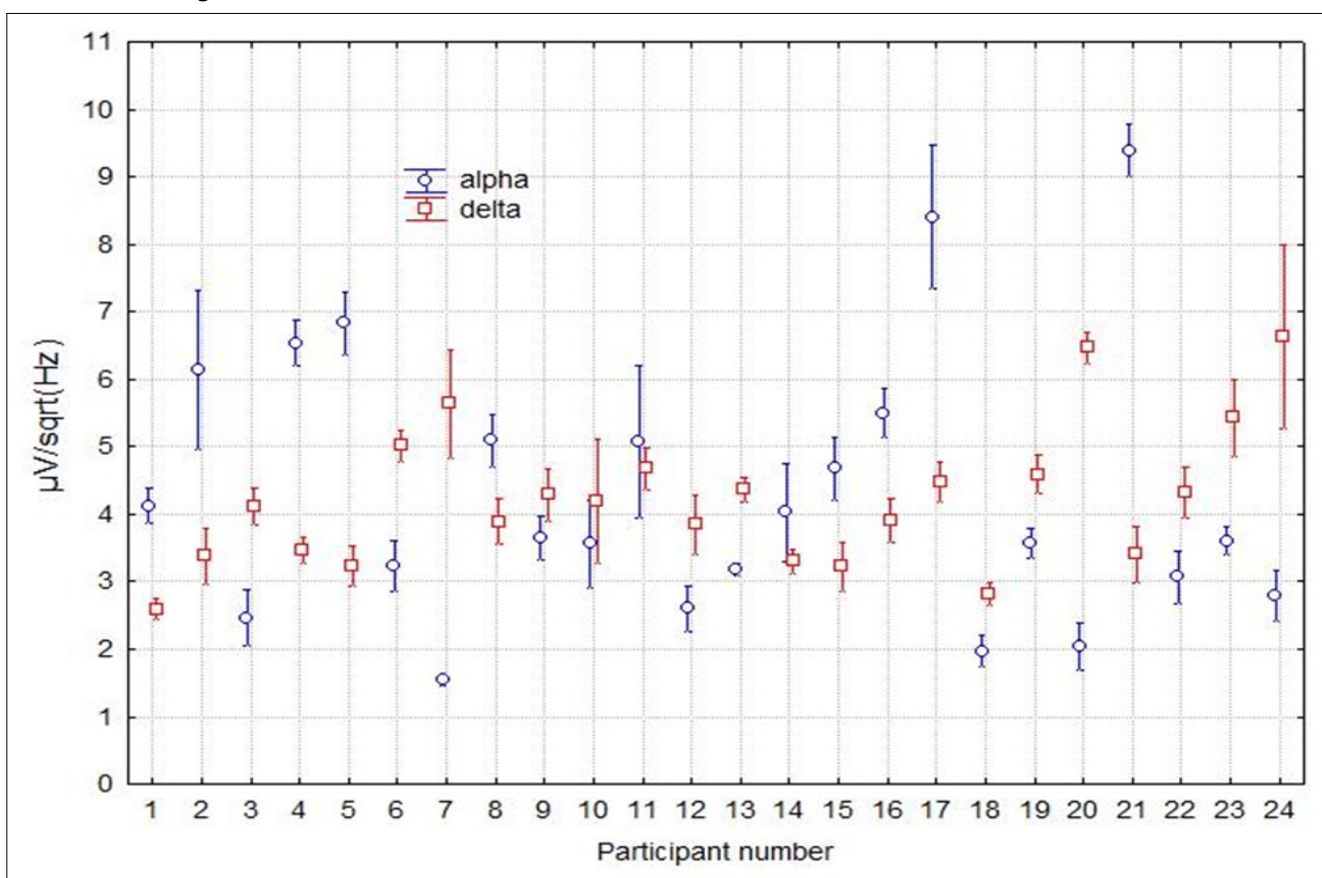


Figure 2. Mean amplitude ($\mu\text{V}/\sqrt{\text{Hz}}$) for alpha and delta for each participant. Error bars depict 0.95 confidence intervals.

Results

Preliminary observations of the EEG spectrum revealed that there were almost no theta components in the EEG signals. Two peaks corresponding to alpha and delta bandwidth were clearly noticeable for all participants, and the subsequent analyses were therefore conducted on these.

Examining the mean amplitude values from both channels led to the observation that the power of the alpha component was stronger in Channel 1 (occipital lobe), whereas the power of the delta component was stronger in Channel 2 (temporal lobes). Therefore, Channel 1 was chosen as the source of alpha data and Channel 2 was chosen as the main source of delta data.

Figure 2 presents means and confidence intervals for all the participants. Differences between the participants were very large, indicating a highly heterogeneous group.

Firstly, the question of whether the suggestion to experience trance state increases the relative amplitude of EEG frequency components was addressed. Two 2 group x 3 condition x 5 epochs repeated measures ANOVA was performed to reveal any significant differences in mean alpha and delta amplitudes as a function of suggestion and condition. There was a significant main effect of epoch ($F_{4, 24} = 11.67, p < .01$), but there was no significant main effect of suggestion ($F_{1, 24} = 0.81, p > .05$), and no significant main effect of condition ($F_{2, 24} = 2.71, p > .05$). There were no significant two-way interactions. However, there was a significant three way interaction between condition, suggestion, and epoch ($F_{8, 24} = 2.19, p = .031$). For delta, no significant main or interaction effects were found (suggestion $F_{1, 24} = .01, p > .05$, condition ($F_{2, 24} = .74, p > .05$), epoch ($F_{4, 24} = 1.72, p > .05$).

Secondly, the question of whether the suggestion to experience trance state during drumming increases the intensity of subjective experience (measured by the PCI instrument) was addressed. An independent t-test found no statistically significant difference between suggestion and neutral group in the Altered Experience (AE) scores ($p > .5$). Mean value on AE scale for the whole group was 2.45 (on a 0-6 scale).

Discussion

Treating PCI questionnaire Altered Experience score as an indicator of experienced trance state it can be doubted whether the drumming stimulus and suggestion succeeded in inducing the altered experience reported by previous research [8,9,10]. The AE is a major scale of the PCI questionnaire measuring to what extent the experience was different from ordinary state, therefore allowing the assessment of the intensity of trance state. The mean score for the whole group was 2.45 on a 0-6 scale, which represents a medium response. For comparison, in [8] experiment using shamanic drumming the mean AE score of those participants who claimed to have experienced shamanic trance state was 3.05.

It is also possible that the cultural differences could be accounted for different scores in PCI questionnaire. Many participants expressed difficulties with understanding some of the questions connected for example with expanding of the body or visionary states and imagery. It may mean that they are not used to describing their experience in such terms. Cultural differences may also limit the effectiveness of suggestion. In other words, Swedish people may be unlikely to believe that they will experience a state of trance. For future research on shamanic drumming it would be reasonable to adjust the used instruments to the cultural background of the participants.

A surprising finding of the present experiment was registering the decreased alpha frequency during the drumming condition in the suggestion group. This observation is in variance with the results of [9], who noted an increase in alpha activity. In present study many participants reported that the drumming had a very relaxing effect, which is additionally supported by low scores on the Arousal (AR) scale of the PCI questionnaire. The decreased alpha in the suggestion group may be connected to the greater relaxation of those participants.

Another possible reason for the differences in alpha activity between the present and the Maxfield study may be different placement of the electrodes. In the present study, the occipital location for Channel 1 electrode was chosen due to the fact that the occipital lobe is the main source of alpha activity [15]. The electrodes in the Maxfield study were placed at the left

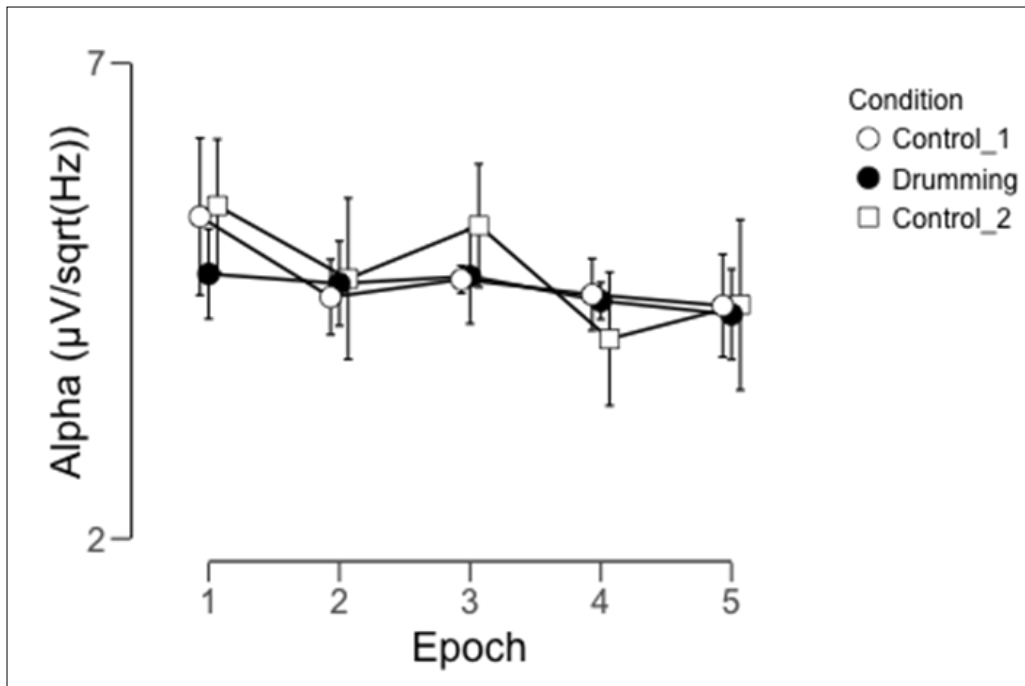


Figure 3. Mean alpha amplitude values across the conditions and epochs for no suggestion group.

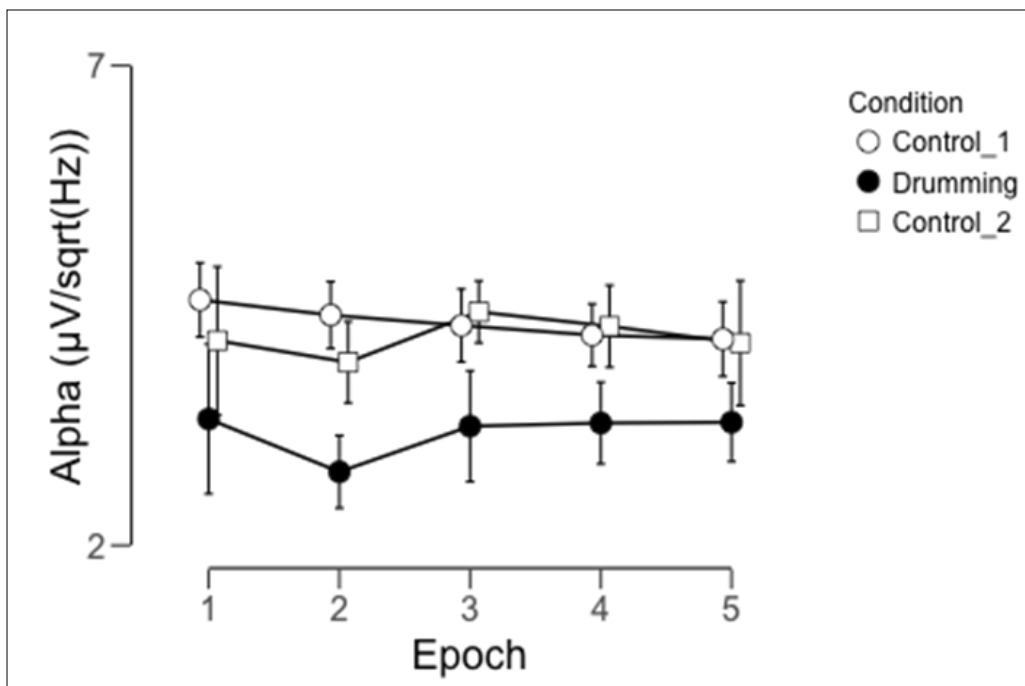


Figure 4. Mean alpha amplitude values across the conditions and epochs for suggestion group.

parieto-central, right parieto-central, left parieto-temporal and the right parieto-central areas, which means that the main source of alpha signal was not monitored.

One other unexpected result was that theta rhythm was not registered neither during baseline nor during stimulus conditions. Together with decreased alpha and increased delta frequencies, the absence of theta may indicate deep relaxation and drowsiness of participants.

One of the goals of present experiment was to replicate the results of the previous EEG research on shamanic drumming, at the same time avoiding their methodological problems. The number of participants (N=24) was twice bigger than Maxfield's (N=12) or Neher's (N=10). One of the biggest drawbacks of Neher (1962) experiment was very short stimulus condition (T= 4 min). In [9] study mean values of frequency components were computed and subtracted from baseline means, but no methods of statistical analysis were used to compare baseline and stimulus condition. Although the time of day may influence EEG signal, neither [9] nor [10] controlled for this factor in their experiments. In light of the facts presented above it is possible that the results obtained by [9,10] could not be replicated with a scrupulous examination.

This situation of the use of similar stimuli yielding different physiological and behavioral responses indicates that shamanic drumming is a complex phenomenon requiring further scientific investigation. It is possible that there are other variables than merely the amount of beats per second that determine the trance-inducing character of the drumming. Typically, different combinations of strong and weak drum strokes are used during drumming. Future research would benefit from comparing patterns of drumming with the same speed of beats per second, but different combinations of accents.

Another aspect of the present experiment was the horizontal position of the participants. Although some shamanic ceremonies require the participants to lie down, most of the indigenous rites involve movement and dance. The original ritual context provides a richer and much more stimulating atmosphere than a sterile and rigid laboratory setting. Unfortunately, due to the problem of movement artifacts replicating such conditions is not possible in EEG study.

Remaining in horizontal position throughout the session allowed obtaining steady EEG signal from the participants, but might have increased their drowsiness.

Limitations

The differences between participants in terms of mean values of alpha and delta were very large. This may stem from a highly heterogeneous group of participants. The age span was very wide, ranging from 20 years for the youngest participant to 43 for the oldest one, which may have increased the individual differences in EEG signal between the participants. EEG signal is very sensitive to specific state of the participant, and older people may respond differently to remaining in horizontal position for a prolonged time. The increased variance in EEG signals may be the cause of reduced statistical power, and therefore insignificant results.

Moreover, nine of the participants were recruited from the Yoga studio where the present author used to teach. Some of the participants recruited from this source had experience with meditation practice, which tends to be associated with higher baseline alpha activity [5]. People practicing meditation are more likely to enter a meditative state during the experiment, which would yield different EEG responses during both drumming and control conditions. This would decrease the difference in EEG signal between drumming and control conditions, therefore making it statistically insignificant. Finally, even not having prior experience with shamanic drumming, they are more proficient in controlling their state of awareness, which may make them respond to drumming differently. It may be reasonable for the further research on shamanic drumming to control for the meditative practice.

In conclusion, suggestion about experiencing a state of trance might decrease alpha frequency brainwave activity when listening to shamanic drumming, which indicates a deeper state of relaxation, rather than the predicted trance state. The present experiment did not replicate the results of the previous studies, which demonstrates that the phenomenon of trance induced by shamanic drumming required careful scientific examination.

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