

Effectiveness of mindfulness: The evaluation using machine learning algorithm

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Abstract

Mindfulness is a practice that is thousands of years old. This practice is also included in the modern mindfulness-based stress reduction training, and its effects on our cognitive system are supported by extensive literature that comprehend mostly to task-oriented experiments with control groups. In this paper, the problem of testing the effects of mindfulness therapy, with specific regard to the yoga practice, is addressed with a network-oriented modelling approach. The first component of the proposed network simulates the elicitation of an extreme stressful emotion due to a strong stress-inducing event. This was done following the same line of previous papers that proposed simulations of similar processes. A second component represents the role of memory, attention, and self-awareness in coping with the stressful event. This proposed network-oriented modelling, which utilize a standard brain-template was used to model the Electroencephalography (EEG) data and assess connectivity, as indicated by activation levels across scalp regions at baseline and follow-up. The results suggest an increase in activation following mindfulness that was site-specific as a function of the group.

Keywords: cognitive modelling, network-oriented, temporal-causal network, mindfulness, extreme emotions

1. Introduction

Mindfulness is delineated because the application of being attentive within the present and doing it purposely and with non-judgment. Mindfulness meditation practices sit down with the deliberate acts of regulation attention through the observation of thoughts, emotions, and body states. Specific samples of mindfulness meditation interventions, like mindfulness-based stress reduction and mindfulness-based psychological feature medical aid, have already been formally studied and applied the clinical conditions practices [1]. However, the proof for

consciousness isn't definitively concluded [2,3]. Some issues such as inadequate controls, inappropriate and extremely variable outcome measures, lack of measures for intervention adherence, and lack of a live that evaluates the practitioner's ability to interact within the mind-body drugs are the included. This latter downside is very vital. There's presently no objective live which will assess meditation quality of the professional. Thus, creating conclusions regarding mediation intervention efficaciousness while not knowing whether or not the participant is truly meditating is problematic. Having an objective live of meditation ability would greatly

improve our understanding of mind-body drugs intervention trial information. Objectively, it is important to assess the meditation ability that may additionally shed lightweight on answering the basis on why meditation trials succeed or fail.

2. Materials and Methods

2.1 EEG and mindfulness

EEG signals may additionally be potential objectives live of meditation ability as a result of it inform the neural correlates related to meditation. About to this moment has neural correlates however it's unsure however specific these neural correlates square measure to the meditation state. About to the present moment in an exceedingly non-judgmental method, i.e., not generating any emotional associations to what's being attended to, conjointly presumptively has neural correlates.

The neural correlates of those 2millimeter elements are also delicate and also the definition of meditation can improve as we have a tendency to learn a lot of regarding the neural correlates' mistreatment objective physiological markers.

Table 1. EEG signal and corresponding frequencies

Frequency band	Frequency zero in Hz	Characterization
Delta	0.5 – 3.5 Hz	Deep Sleep
Theta	3.5 – 7.5 Hz	Sleep and Dream
Alpha	7.5 – 12.5	Relaxed awake, closed eyes
Beta	12.5 – 30 Hz	Inner restlessness, stress, concentration
Gamma	30hz	Extreme concentration

3. Result and Discussion

The mindfulness audio file consisted of a 5 (five) minute mindfulness body scan, within which participants were asked to use their breath as an anchor to assist target this moment, adapted from the other research [40]. Participants were target-hunting through that specialize in the sensations in their body consecutive from foot to move. As an example, "shifting attention up from their currently into the trunk, being conscious of the rear region, the chest, the abdomen". Similar body scan mindfulness techniques are utilized in previous

analysis as a part of a six to eight weeks mindfulness course [5] and in one off laboratory sessions [6]. The body scan practices utilized in previous analysis have generally ranged long from ten to forty-five minutes.

Here, a 5-minute version was developed for 2 reasons. First, we tend to were inquisitive about whether or not as very little as 5-minutes of mindfulness apply has any impact on levels of state heedfulness. Second, we tend to were inquisitive about developing an apply that might be applied as much as attainable to everyday settings like the schoolroom or geographical point, wherever pausing to apply mindfulness for extended periods might not be possible [7].

The audio was purposefully developed excluding any mention of mindfulness. This was to do and avoid any demand characteristics in participants of the United Nations agency might have some information of the helpful effects of mindfulness apply, as on other study.

In the standard, participants were asked to require some deep breaths and look any directions, there was then a 4-minute silence before these directions were perennial and participants were able to continue the form. This standard was chosen since it allowed North American nation to regulate the length of the audio files that participants were taking note of, and keep the temporal order as similar as attainable for all participants. Though other study, counsel that people don't wish to be left with their own thoughts, even for brief periods of your time, the authors do conjointly indicate that those that were left with nothing to try to rumor a so much bigger quantity of mind-wandering, which can even be reciprocally associated with mindfulness [8-9]. Additionally, when compare a 5-minute mindfulness apply to an equivalent form of standard and to an attention to detail task and located that the mindfulness condition considerably reduced the extent that participants committed the correspondence bias, however that the management and a spotlight condition failed to dissent considerably [9]. This demonstrates that state heedfulness isn't an equivalent as attention to detail. Alternative analysis has used taking note of audiobook excerpts as an impression condition 32, forty-two however these square measure for extended periods of your time than 5-minutes. We have a tendency to were conjointly significantly inquisitive about sensible applications of the temporary heedfulness apply, and then tried to use

an impression condition that might be like individuals' daily experience- as an example, being at work and losing target this task for a brief amount might involve doing nothing, however not essentially taking note of an audio book. Refer the figure meditation frequency and mindfulness.

To ensure that each one participant skilled as similar conditions as attainable, the form software system was programmed so the audio files compete for the total 5 minutes and participants weren't able to move off from this page till the audio was finished. Additionally, the audio files for each the heedfulness and management conditions altogether studies were recorded mistreatment an equivalent male voice to make sure consistency [7], as presented on Fig. 1.

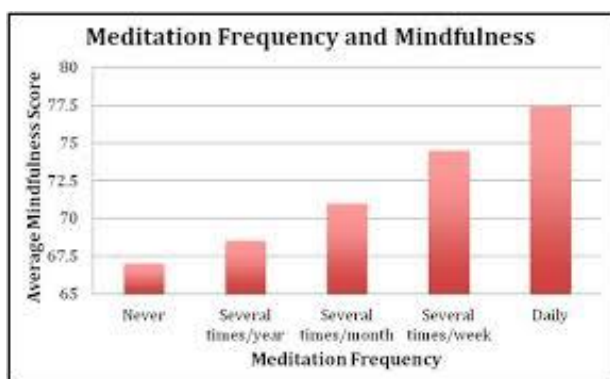


Figure 1. Meditation frequency and mindfulness

Mindfulness coaching effects on the attention and may be as the key modulator of psychological feature, process, sanctionative [9]. In the United States of America, to pick the task-relevant stimuli and inhibit inapplicable info, sustain concentrate on psychological feature performance, divide attention, and keep wakeful once required. One theory of attention that's ordinarily utilized in attentiveness analysis proposes that there are unit 3 for the most part freelance attention networks The dimensioning network supports choosing relevant sensory input and shifting attention toward a goal-related stimulant (disengaging and reengaging attention) [10].

The alerting network refers to tier of arousal and vigilance—that is, the flexibility to take care of sensitivity to external stimuli. This will be additional separated into phasic alertness, that is task-specific, and intrinsic alertness, that refers to a lot of general attribute levels of arousal. Finally, govt attention monitors and resolves any conflicts

arising between thought, emotion, and govt attention are often measured by victimization tasks involving an incompatibility between totally different aspects of a task. Otherwise it may be called “conflict,” like within the classic Stroop task, within which a personal should ignore the word (e.g., red) and instead establish the color that the word is written in the conflict observation is believed to be one key side of govt attention, in conjunction with computing task parameters, evaluating conflict, change new or unlearned responses, regulation thoughts and emotions, and block habitual responding [9,10].

Though the body of analysis supports each practical and neural separation of those networks, there's conjointly proof that it is often troublesome to methodologically separate the eye networks, as a result of they typically operate in parallel the bulk of studies concerning attention performance and attentiveness follow have mentioned enhancements in terms of the 3 attention networks and so as to judge the past literature systematically, we'll conjointly apply this approach. However, there are units of different frameworks among the broader attention literature, with the integrated competition hypothesis being another common clarification supported by neurocognitive findings [10].

The machine learning technique includes the subsequent 3 steps: two.3.1. Spectral Analysis and have Extractions. To rework the cleansed EEG knowledge set from statistic knowledge into frequency vary knowledge, the EEG spectral analysis is conducted [10,11]. An acceptable approach is that the quick Fourier Transformation (FFT), that decomposes the EEG signals as a perform of frequencies.

The spectral analysis is provided victimization EEG kits. The simplified method of the FFT is shown in Fig. 2. 1) 1st the initial signal is lessened into several curved oscillations. 2) Then the strength of every frequency, among the initial signal, is calculated. During this work, the ordinarily used division of frequency bands into alpha, beta, theta, delta and gamma bands, as shown in table one, wasn't used as a feature extraction criterion [11].

As on the other study, there are some tendencies to determine to use technique on EEG knowledge of attentiveness practitioners and non-practitioners' persons. To require the higher gamma frequency bands under consideration, we tend to in addition

determined to increase the frequency vary up to a hundred cps. Thus, two hundred frequency bands from a similar breadth area unit thought-about during this work. Alpha 7.5–12.5 cps; relaxed awake, closed eyes Beta twelve.5–30 cps; Inner restlessness, stress, concentration of Gamma; thirty cps Extreme concentration, as presented on Table 1.

This study tends to use the random forest classifier. This category shows substantial enhancements in classification accuracy that results from growing collections of trees and material possession them vote for the foremost in style class. The method works as illustrated in figure three and is represented as follows: 1) n tree bootstrap coaching samples area unit indiscriminately made from the initial knowledge; and 2) every coaching sample generates the corresponding call tree [12].

For every leaf node, the try of the predictors' area unit indiscriminately sampled and therefore the best split among all variables is chosen. Every tree expands unpruned, and 4) The corresponding class is decided by victimization every take a look at sample call for testing. 5) per majority vote, the category is picked. Figure 2 shows the comparison between non-practitioners versus mindfulness practitioners.

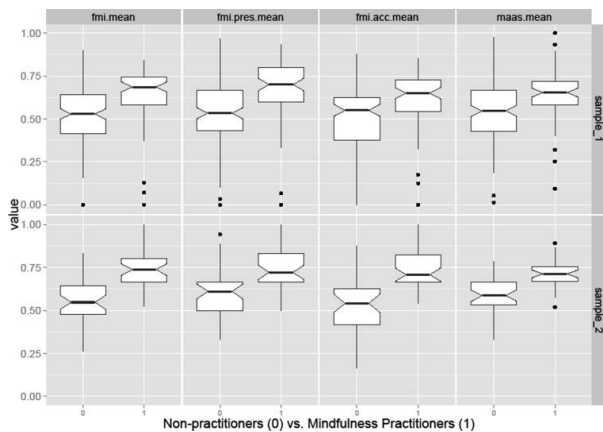


Figure 2. Non-Practitioners versus Mindfulness Practitioners

To classify the dataset of attentiveness practitioners and non-practitioners' persons, the Random Forest of the mark package was chosen. The dataset was divided during a seventy-five the educational set (375 recordings) and a twenty-five to check set (124 recordings). The quantity of trees is n tree = five hundred. To validate and improve the random forest classifier we tend to create a k-fold cross validation with ten iterations. This

methodology is especially appropriate because it provides data concerning the huskiness of a model [12]. Among this operation, the coaching set is split into ten haphazardly chosen folds. 9 of them area unit wont to train the model, whereby the remaining one is employed to check it. The results of the 10-fold cross validation is that the mean of all trials. For the random forest algorithmic rule, we have a tendency to apply the mark package v.6.0.82 among an R x64 three.5.3 setting.

To train and value the model, we have a tendency to split the 499 recordings into a coaching partition (nT = 375) associated an analysis partition (nE = 124). The classifier was designed five hundred option trees. Information from nineteen sensors in every recording were summarized. Afterwards, we tend to 1st designed ninety-nine power bands with a spread of zero.5 cycles/second every and gained a balanced accuracy of ninety-six.01 percent. By continuation the method, increasing the spectrum up to a hundred cycles/second, we have a tendency to improve our result to a balanced accuracy of ninety-six.77 percent. The validity of our classifier is ensured by the 10-fold cross validation. Solely 2 non-practitioner's samples were misclassified as attentiveness practitioner's samples were misclassified as non-practitioner's victimization the extended methodology.

The remaining a hundred and twenty samples were classified properly. We tend to evaluate our classifier in terms of accuracy, positive prognostic worth, negative prognostic worth and balanced accuracy. Additionally, we tend to detect that, on the far side the present state of our data, specific frequency sub bands within the high. We tend to know the four most significant frequencies for prediction. The foremost prognostic band is 50-50.5 Hz, that is scaled to a worth of a hundred and is a basis for the calculation of the importance of the remaining bands.

The subsequent results area unit obtained for the individual necessary frequency bands: 96-96.5 cycles/second contains a worth of sixty-five.35, 8.5-9 cycles/second contains a worth of fifty-eight,64 and 96.5-97 cycles/second contains a worth of fifty-six.10. Overall, 196 frequency bands area unit below associate importance of fifty. Compared to the classical frequency divisions the foremost necessary sub bands may be assigned to the subsequent bands: 3 sub bands area unit within

the gamma vary, and one sub band is within the alpha vary. 4.

Our artifact for characteristic attentiveness practitioners from non-practitioners persons other datasets achieved accuracies between eighty.5 and 90.48. Our approach outperforms this with a balanced accuracy of ninety-six.77 p.c in terms of other classification that used the AdaBoost [12]. Supported a dataset with thirteen attentiveness practitioners associated eighteen age-matched management participants they achieved an accuracy of eighty-five.41 p.c (AdaBoost) and eighty-seven.51 p.c (BDLDA). Supported samples of 780 encephalogram recordings as also presented by other [13].

4. Conclusion

The mindfulness and mediation intervention efficaciousness are now can be implemented by the practitioners. The objective meditation ability would greatly improve our understanding of mind-body drugs intervention trial information. It is important to assess the meditation ability using the engineering devices and system analysis, to answer the successful meditation for human mindfulness.

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