Some Studies Concerning Human Performance Indeces on Visilance Task

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SOME STUDIES CONCERNING HUMAN PERFORMANCE INDECES ON VISILANCE TASK

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Abstract

The present study is undertaken in order to investigate experimentally the effect of physiological functions in visilance task. We use mainly two methods for this purpose. The one is the evaluation of the moving EEG-dominant-frequency-component which is calculated by Fourier Analysis and the another is the evaluation of N_1 wave hight and N_1-P_1 wave fomular, in which the superimposition method suffered by DAWSON is used. The subject is one healthy male aged 22. From the above results we suggest that the moving of EEG dominant frequency have a good possibility to become one of the human performance indeces.

1. Introduction

On the evaluation of effectiveness of Man-Machine-Process System, it is not sufficient to use only an out-put-index, and it is desirable that the effects on human being, that is physiological function, are evaluated simultaneously.

In this report we investigate mainly the effect on psychological and physiological factor.

Recently many kinds of method have been researching and developping to seize the psychological and physiological load.

Especially the methods of checking and measurring the variation on physiological functions have developped and its achievements have become a center of attraction.

By setting a visilance task as an experimental model and observing the variations on physiological functions caused in that task, we investigated the psychological and physiological loads (in this paper).

We have tried mainly to evaluate them by EEG mesurement which is considered to be one of the indeces.

We use two methods for this purpose. The one is the evaluation of the moving EEG-dominant-frequency-component which is calculated by Fourier Analysis and the another is the evaluation of N_1 wave hight and N_1-P_1 wave fomular, in which the superimposition method suffered by DAWSON is used.

In evaluating of Man-Machine-Process-System, this study has fundamental and preparatory character.

2. Method

The Subject was one healthy male aged 22.

The S was no paid an attendance fee. A simply stimulus reaction test was used

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for visilance task, in which equipments consisted of a light stimulus generater and a respons mesurement system. When a randomly switched visilance signal was recognized, the S had to response with a push button as fast as he could. At the begining of experiment, after rest with sitting on an arm chair for half an hour, the detailed explanation of the task was given to the S. The S worked for 90 minutes with sitting on the chair and his face was slightly fixed, and his body motion also was fixed during the practice.

Reaction time (R. T.), Critical Flicker Fusion Frepuency (CFF), Heart Rate (H. R.), Electro-Oculograph (EOG), EEG, and Cortical Evoked Potential were measured in this experiment, and subjective symptoms were checked up at same time.

R. T. is the duration time between a stimulus and its response, which is generated randamly one time per minutes, and is observed with millisec. unit by a cronometer.

H. R. is the sum of R-R interval's countes per minutes from ECG. EEG was recorded monopolarly with indifferent electorodes, one of which was on the chamber and the another was on the parietal passing the regular center line. Silver-ring-cup electrodes were used, and EEG signal were filtered by 7-9 Hz, 9-12 Hz and 12-16 Hz bands. CFF was

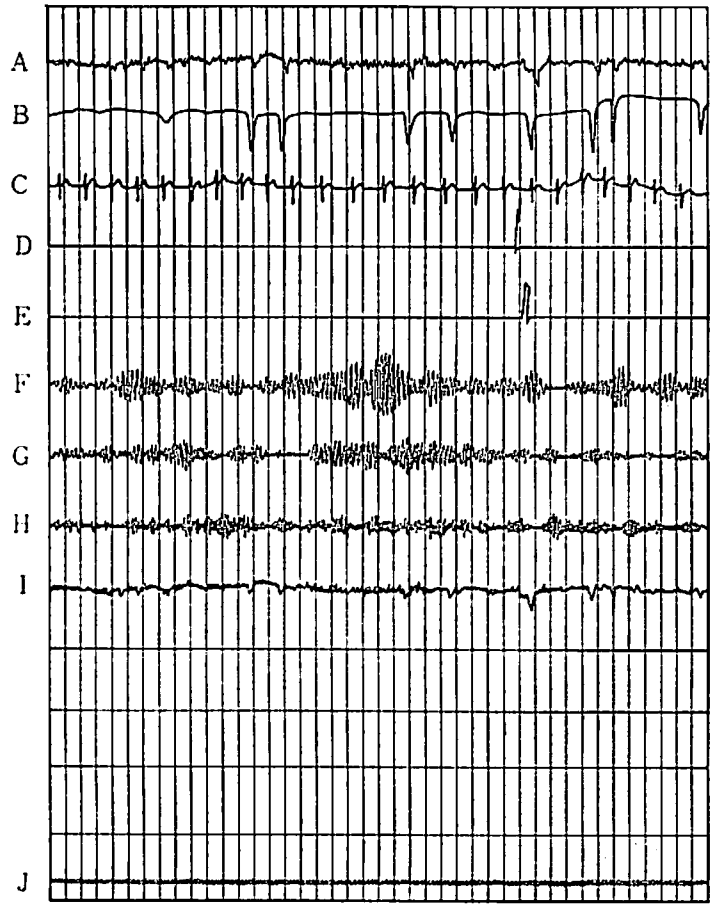

Fig. 1. Record of physiological Function, Response of Subject and Stimulus. From top down ward : EEG (A&I), EOG (B), ECG (C), Stimulus (D), Response of Subject (E), Output of 6-8 Hz (F), 9-12 Hz (G), and 13-16 Hz (H), filterband and Time marker (J). Scanning speed is 15 mm/sec.

given as the mean of five measurements by a decending method.

Cortical Evoked Potential was shown with the superimposition of 50 cycles of Visual Evoked Response by using a signal processer. These responses are induced by regular flush stimulus every 2 sec. Subjective symptoms consist of four question items by a rating scale method for which the S selfrates before and after the practice. These stimulus signals and their responses of the S, ECG, EOG, and EEG were recorded by a penrecorder as shown Fig. 1, and a magnetic tape recorder during the practice. CFF, Cortical Evoked Potential were measured at the start and the end of experiment.

3. Results and Consideration

The hand moter action is caused by responding with push button, but other muscular actions are very few in this practice. Therefore it is considered that the effect was mainly caused in mentaly or psycological one. H. R. is one of the physiological functions which is evaluated as physiological performance indeces.

After 30 minutes from the begining of this practice, H. R. increased by 10% compered with the initial value as shown Fig. 2. This phenomena is considered to be caused by fixing a posture during the practice. It is generally evident that an obvious relation exists between the hardness of task and the increase in H. R., therefore from H. R. point of view, psycholigical or the physiological load considered to be not large in this visual task.

CFF shows the sense threshhold value of time discriminations based on physiological fusion on phenomena which takes place in the central parts of visual system. When the neucortex which controls the complex mental activities becomes vigorously active, CFF value rises, and when it is down, CFF lowered. The CFF value decreesed by 4% compered with the initial value as shown Fig. 3. The fact is consided to correspond with lowering the activation of a cortex, because of generating a smalll number of signal stimulus.

Therefore the answers in subjective symptoms such as, "I feel the brain muddled" "I become to painful." etc. occured as shown Fig. 4. But this CFF value is within the allowance limits according to the criterion by OHOSHIMA.

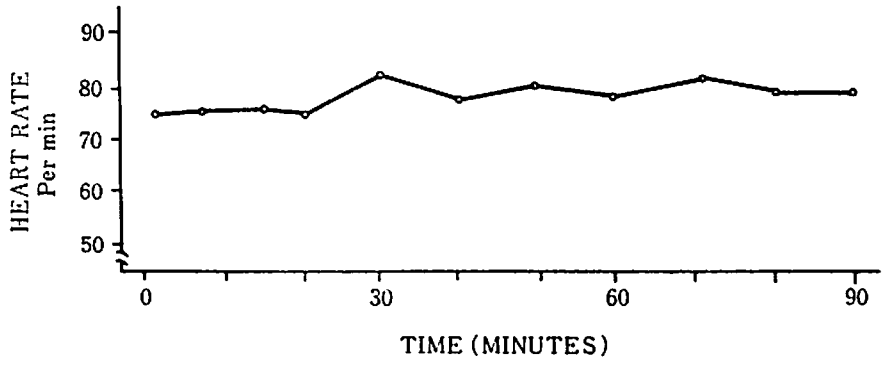

Fig. 2. Change of Heart Rate.

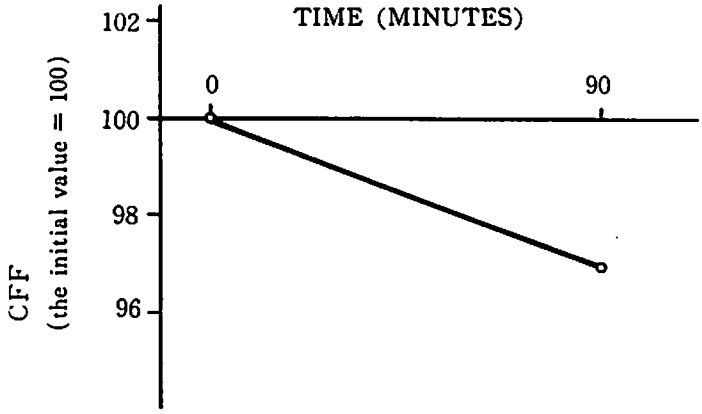

Fig. 3. Change of Critical Flicker Fusion Frequency.

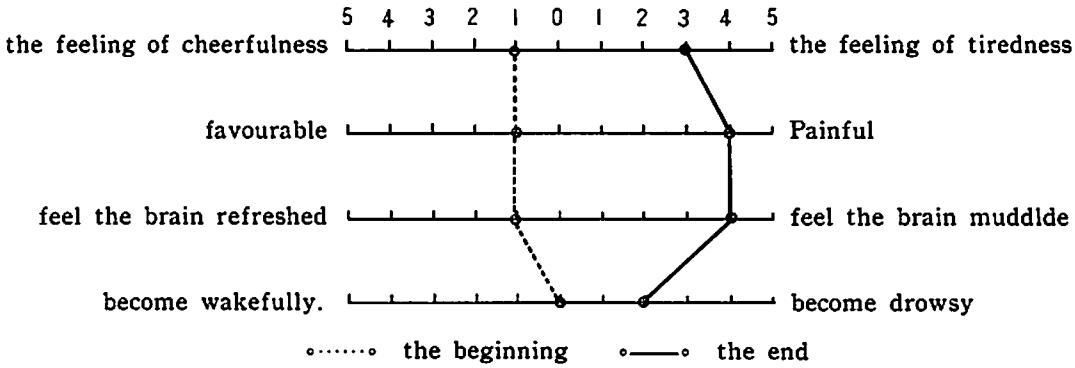

Fig. 4. The Comparison of Subjective Symptoms between the beginning and the end of the Practice.

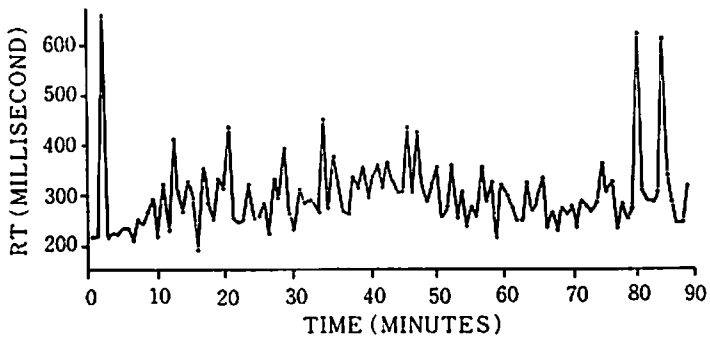

Fig. 5. Change of Reaction Time.

R. T. value consists of the time period which is spent on recepter's excitement and the passing time period on the nervous systems, cerebral systems and muscular tissue etc. It takes constant time period about 50 millisec. to contract muscles in general, then the greater part of R. T. variation is due to the passing time on celebral system because the passing on recepter's excitements and the passing time on nervous system are negligible. The R. T. makes periodic rising in the cycle ranging from 10 to 15 minutes as shown Fig. 5. Such periodic variations shows the strength

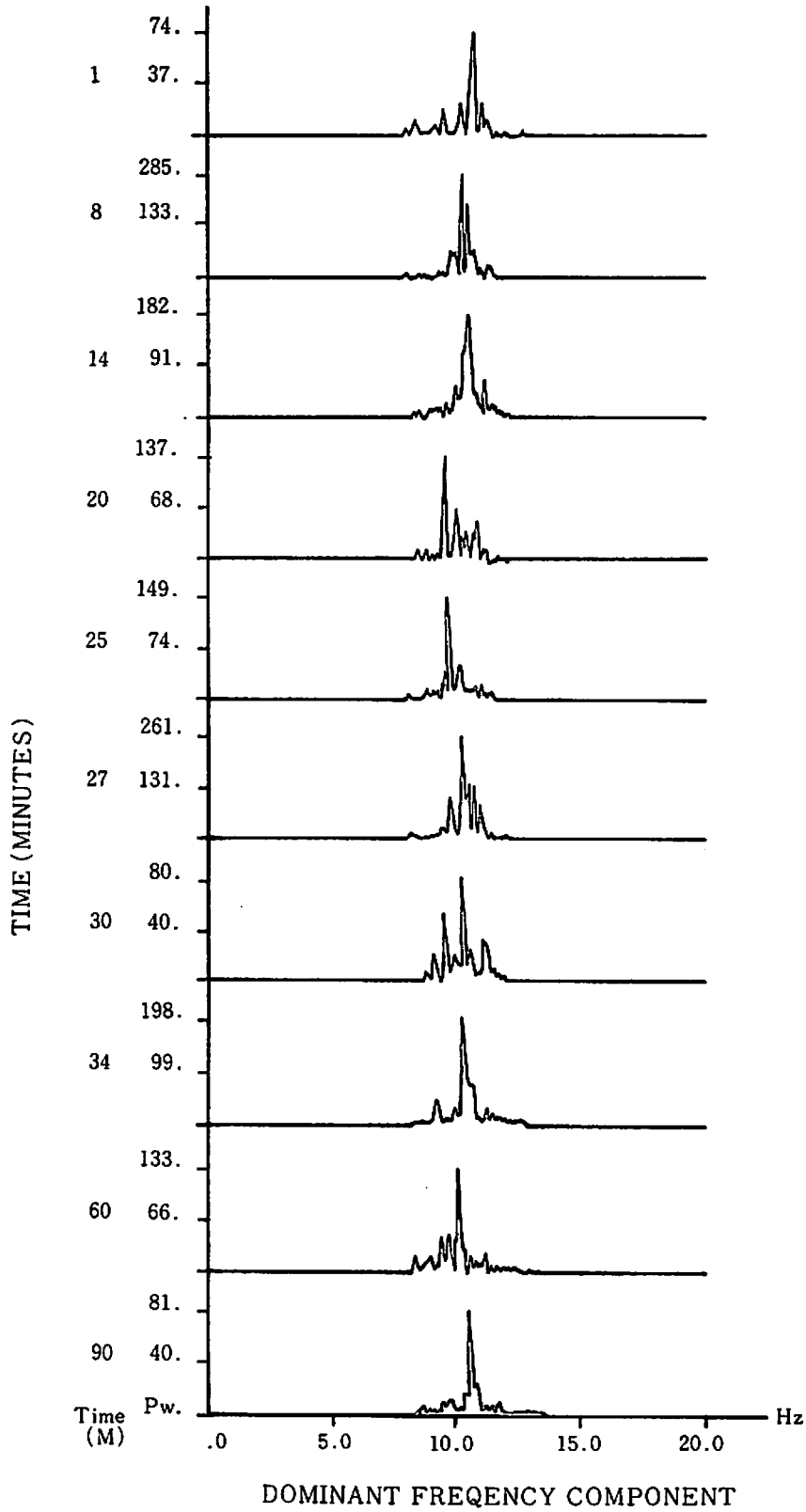

Fig. 6. The Moving of Dominant Frequency Component for 9-12 Hz.

of a mental strain, and the state of attentive concentlation on signal.

Analizing of EEG mesurements with no filter, a very small significant variation is recognized on account of noises, therefore 9-12 Hz band pass filter was used by a FFT method.

Dominant frequency was 11 Hz in early time of the practice, and it moved to 9.5 Hz at about 20 minutes later, then returned to 10 Hz, and at the end it moved to 10.5 Hz to be recovered as shown Fig. 6. Following the statement of DAVIES and KRKOVIC, in such a monotonous task, the movement from 11 Hz to 9.5 Hz can be explained that the S was felt sleepy by causing from low load. Such monotonous limited stimulus invited the lowering arousal level to a brainstem reticular formation and a celebral cortex. It is interesting fact that the answers given by the S after the end of practice, "If the experiment was devided into three parts, I was very sleepy and became to feel the task painful on the first part. On the middle part, I took a crick in my back because of my fixed posture, on the last part I indured myself to the crick and felt to become refresh."

KANO says concerning with a characteristic phenomena on the visilance task as "Work capacity declines after 30 minutes from start of the practice." Those results on our experiment may support his assertions.

The crick on his back made his arousal level in high state, and made the dominant frequency move on the middle part. The same level was keeping till the last part, by the effect of the end spart. There was no significant correspondence between the moving of dominant frequency and lowering of CFF. HASHIMOTO reports that the EEG behavior within 5-9 Hz correlates to CFF. In our study, however, we didn't analyze EEG within θ, and low α band.

In Cortical Evoked Potential, N_1 wave and N_1-P_1 wave fomular have no significant difference between the beginning and the end of experiment.

3. Conclusion

The many Kinds of indeces in the results of this experiment did not always have a significant correlation each other. That means, the sepalate behavior of such indeces can not take hold of physiological functions totaly, therefore it is advisable to evaluate them on using many different kinds of indeces. The moving of EEG dominant frequency have a good possibility to become one of the human performance indeces. But EEG analysis involves many problems to be solved such as the elliminate of the inner or outer artifact, and the limitation on applying to the different condition of task, etc.

Further more research must be continued to solve the difficulties in another time.

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