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Effects of Stimulation by Nostalgic Images on Heart Rate Variability

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Abstract Mental disorders, such as depression, that result from high levels of mental stress are associated with increased cardiovascular morbidity and mortality. In previous studies, symptoms of depression have been associated with reduction of heart rate variability (HRV). The aim of this study was to provide a video for the prevention of depression and to clarify the probability of HRV reduction. Three types of videos were provided: the sea image, the ward image, and the nostalgic image. The nostalgic image consisted of several plays that were enjoyed by the subjects during their own childhood. HRV components, including high-frequency (HF) and low-frequency (LF) components, were evaluated using power spectrum analysis in eight healthy males (57.8 ± 3.8 years of age) while they viewed the three images. These study results showed that subjects viewing the nostalgic image maintained the same level of HF as in the sea image. In contrast, the level of CVRR in the nostalgic image viewing had an increasing trend unlike the sea image. These findings suggest that the nostalgic image seems to result both in relaxation and activation effects of autonomic activity.

Key words: heart rate variability, depression, high-frequency (HF) components, low-frequency (LF) components

Introduction

Mental disorders, such as depression, are common and serious psychiatric conditions. The prevalence in the Unites States is high at 26.4%.[1] This condition is more frequent than other chronic conditions.[1-3] The symptoms of mental disorders, such as dysphoria, resulting from heavy stress, can induce an autonomic imbalance.[4] The condition can become chronic and persistent and can progress to depression.[1] According to current research, depression is associated with higher rates of cardiovascular morbidity and mortality.[5-7] Additionally, the prevalence of mental disorders is generally higher than that of any other chronic conditions.[2,3] Nevertheless, some mental disorders can be underestimated and may progress to serious illnesses if medical attention is not received.[1] Heart rate variability (HRV) is utilized as a convenient evaluation parameter for autonomic activity by recording electrocardiograms or pulse waves, and has been used frequently in psychiatric research.[9-11] In previous studies, symptoms of depression have been associated with reduction of HRV.[12-16] Anxiety and depressed mood in healthy subjects are also related to low levels of HRV and parasympathetic components while the subject is under stress.[17,18] The HRV components respond to environmental stimulation differently depending on emotional circumstances.[19,20] Previously, in the fields of mental health and occupational health, images of nature, such as a forest,[21] the sea,[22] and flowers[23] have been used to promote a state of

relaxation. Lately, some studies in the field of medical care, evaluated the effects of listening to a favorite music or watching a video on pain relief and suffering of patients in the perioperative period.[24,25] The images used as stimuli can activate HRV in patients with depression symptoms, and might even be useful to prevent depression without medication. However, little is known about images that can contribute to decreasing HRV. The final goal of this study was to evaluate the effect of the emotional images on HVR activation, such as nostalgic images that bring back old memories. Given that reactive HRV by the emotional video could be different from a relaxation video, we suggest an application of the activation of autonomic reactivity in dysphoria.

Methods

Subjects

This study began in March 2015. We enrolled eight male health professionals aged between 50 and 61 years of age. None of the subjects had any history of cardiovascular disease or mental illness. They were asked to abstain from ingesting caffeine and alcohol for 12 h and not to perform the strenuous exercise 24 h before the experiment.

VAS

The Visual Analog Scale (VAS) was used to estimate the preference for each image and the sea. Subjects were asked to mark the location on the 10-centimeter line corresponding to the level of preference for each image after viewing all three videos. VAS data of this study was recorded as the number of millimeters from the left of the line within the range from 0 to 100. The higher the number, the mean preference for each image was greater.

Preparation of the videos

We prepared three types of image videos. The sea image was edited from a healing DVD (Nami, Kitajima, 2010). The ward image showed an intensive care unit with the view and alarm sound of the biomedical information monitoring system. The nostalgic image was edited from a DVD with a voice-over (Hokkaido-Hoso, 2008), which consisted of several plays that were enjoyed by the subjects during their own childhood (Syouwajidai). The length of all video's was 10 minutes. The videos were projected onto a 19-inch monitor above the upper visual line of the subject.

Procedure

The experiments were conducted in a room similar to that of the medical ward in Yamaguchi University Graduate School of Medicine. The room temperature was maintained between 20° and 24°C and a relative humidity maintained at 40% to 60%. Upon arrival to the room, the participants read and signed an informed consent form, and completed an interview that provided a profile regarding their age, smoking habits, regular alcohol use, and regular medication and supplement use. Then, each subject was asked to rest in the fowler position with the bed angle adjusted comfortably for each one. The distance from the subject's face to the monitor ranged from 80 cm to 100 cm, and it was adjusted according to the height (t) and the angle of the subjects. We used the Bispectral Index System (BIS) monitor (QE-910P, NIHON KOHDEN, Tokyo, JAPAN), estimated from dual channel brain waves with four electrodes placed on the subject's foreheads, for monitoring the sleep-wake level. The higher the values (close to 100), the higher the subject's awakening level. The ECG was recorded from beginning to end of this experiment with three ECG electrodes attached to the chest for II induction. The image viewing was repeated twice, but the projection order was changed to confirm the possibility that the last image may impact the HRV from the previous image. The subjects watched the videos in order of the first cycle, the sea image, the ward image, and the nostalgic image, and in the 2nd cycle, the order was the sea image, the nostalgic image, and the ward image. Each image was projected at the 3-minute intervals, and 2nd cycle was restarted after the first 20-minute cycle. HRV was continuously measured from the start to the end of the image's presentation by measuring the R-R intervals using a portable electrocardiograph (Activtracer AC-301A, GMS, JAPAN). The HRV was analyzed according to the power levels of the HF

(0.15-0.40 Hz) and LF (0.04-0.15 Hz) using the maximum entropy method (MemCalc, GMS, JAPAN) simultaneously. The LF was a measure for activity of both the parasympathetic and the sympathetic systems, whereas the HF was solely a measure of the parasympathetic activity.[9] The LF/HF ratio was used as an indicator of the balance between sympathetic and parasympathetic activities. Additionally, the coefficient of variance of R-R intervals (CVRR: SD of the R-R interval/mean of the R-R interval × 100) was measured as an indicator of the total HRV power.[26,27]

The study protocol was conducted with the approval of the Ethics Committee of University (No.).

Data analysis

All statistical analyses were performed on a personal computer with the statistical package JMP® 12 (SAS Institute Inc., Cary, NC, USA). To compare the mean, absolute, and relative values between repeated measurements, or among three image groups, we used repeated measures analysis of variance (ANOVA). A P-value of less than 0.05 was considered to indicate statistical significance; all tests were two-tailed.

Results

The BIS measurement did not decrease from eighty for all subjects throughout the image viewing. This result suggested that all subjects were fully awake. The results of VAS are shown in Fig. 1. The preference of the sea image was conspicuously high. On the other hand, the preference of the ward video was significantly lower compared with the sea image and the nostalgic image.

Changes of average HRV components in each image viewing are shown in Fig. 2. The average HF scores among all subjects during the image viewing were 84.1 ± 95.1 msec^2 for the sea image, 94.3 ± 117.5 msec^2 for the ward image, and 89.6 ± 87.0 msec^2 for the nostalgic image during the first cycle. In the second round, the average HF score were 78.8 ± 78.2 msec^2 in the sea image, 88.4 ± 84.3 msec^2 in the nostalgic image and 69.1 ± 46.4 msec^2 in the ward image. There were no differences in the average HF among the three images by the repeated measures ANOVA. The effects of relaxation were not different among three images viewing of both the 1st and 2nd cycle. Although the average LF/HF in the first cycle was no significant changes by repeated measures ANOVA, showed a tendency to increase in the nostalgic image viewing (P = 0.07). The average CVRR of seven of eight subjects showed similar variance in the first and second cycle, a tendency to increase in the nostalgic image viewing (P = 0.56, P = 0.38). To evaluate the impacts on HRV from the last images, when the average HF, LF/HF and CVRR were compared between the first

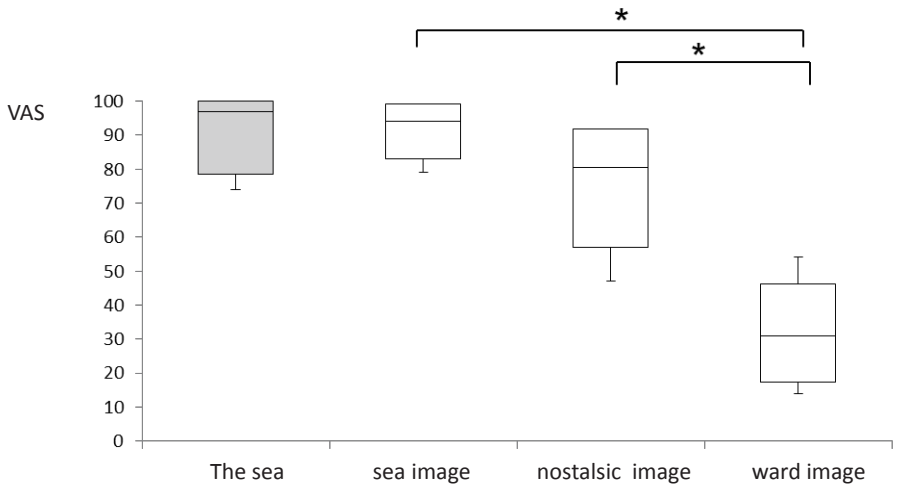

Fig. 1 Comparison of Visual Analogue Scale, representing preference in the sea image, the ward image and nostalgic image, and for the sea as such. *P<0.0001 according to post hoc test.

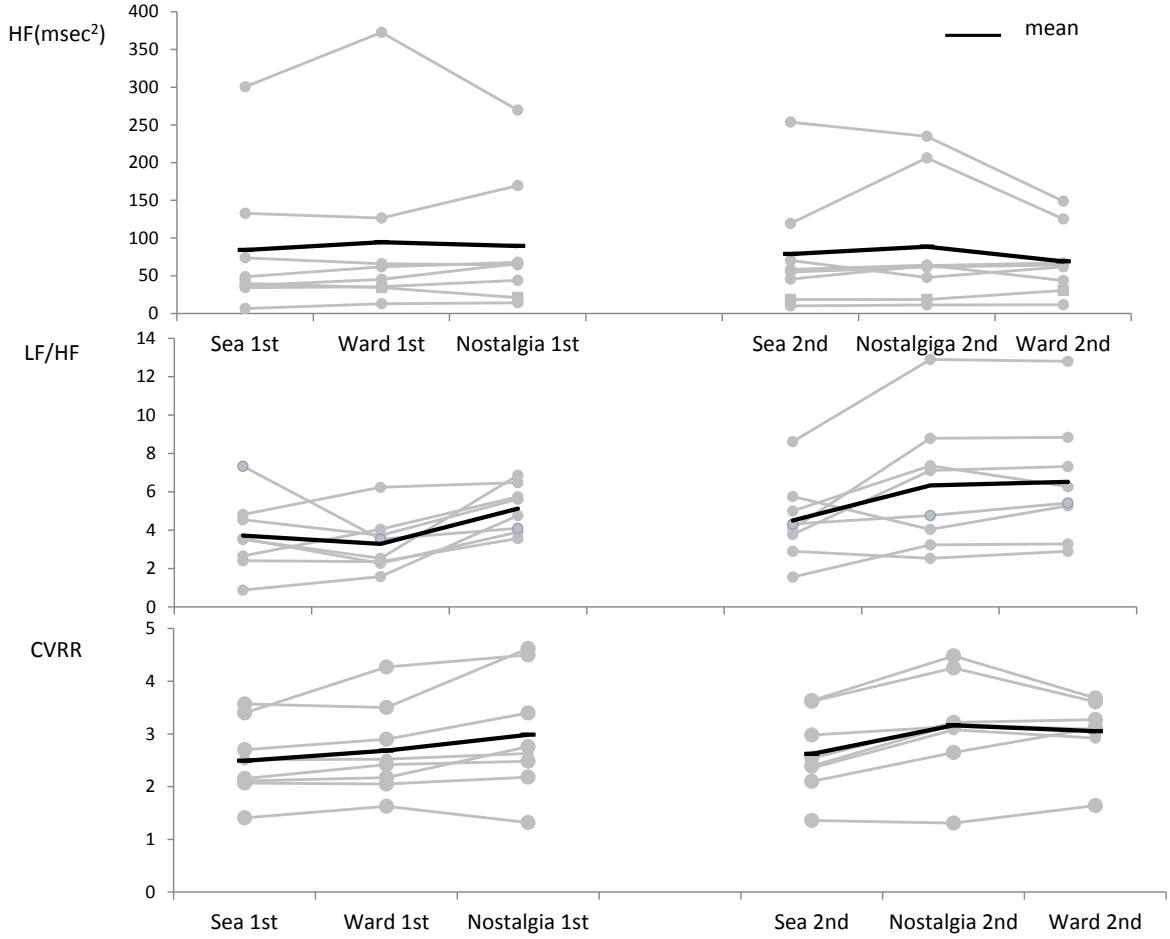

Fig. 2 HRV parameters during the sea image viewing (Sea), the ward image viewing(Ward) and the nostalgic image viewing, in all subjects(n=8). Data from the same subject are connected. The black bold lines represent the mean value of all subjects.

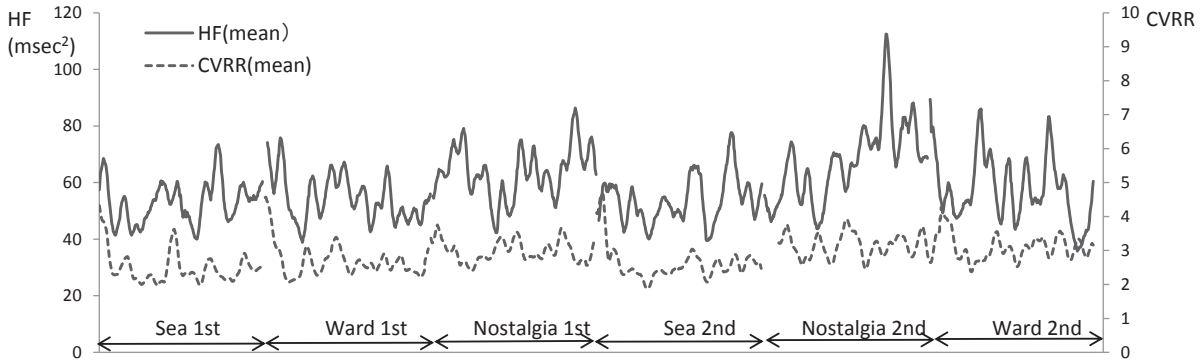

Fig. 3 Changes in mean HF and mean CVRR of all subjects, during the 60 min of viewing the images, the sea, the ward and nostalgia in twice by changing the order of the ward and nostalgia.

and second image viewing, there had been a significant decrease in only LF/HF in the second ward image. However, for both the first and second cycles, the average LF/HF and CVRR on the ward image were similar to those of the previous image in each cycle. Changes of the average HF and CVRR components in each image viewing are shown in Fig. 3. The sea and ward images were similar to changes in HF and CVRR parallel to each other. In contrast, the average HF and CVRR for the nostalgic image viewing decreased and increased, respectively.

Discussion

The current studies have explored the relaxing effect of several materials, such as images of nature and listening to music via reactive HRV analysis. However, few studies have explored the activated autonomic activity in dysphoria and elderly people with reduced HRV. We propose using the nostalgic image as alternate activator to prevent the progression of symptoms of mental disorders, such as dysphoria, particularly in elderly patients with decreased HRV. We have previously reported that viewing a video of the sea or a forest had a relaxation effect, increasing HF and decreasing the heart rate.[22] The results from this study suggest that both the nostalgic image and the ward image exerted a relaxation effect like the sea image, resulting in a similar level of HF. Although there was no significant difference among three images, the nostalgic image in twice revealed increasing trend in LF/HF and CVRR. While the LF/HF and CVRR of the ward image viewing during the second cycle were significantly higher than those in the first cycle, each value was similar to that of the previous image. Although HF and LF/HF in the ward image viewing did no change from the preceding images, it suggests the ward image could not stimulate autonomic reactivity and could be recognized as a background. While the sea and ward image resulted in similar changes in HF and CVRR, the nostalgic image resulted in changes contrary to each other, such as decreased HF, and increased CVRR. Specifically, the results of changes in HF and CVRR showed that the nostalgic image resulted in a different stimulation effect from that of the sea and the ward images. When considering these findings, only the nostalgic image seems to result in both relaxation and activation effects of autonomic activity, increasing HF and CVRR. To our knowledge, this is the first study to assess the activation of the autonomic system by the viewing of emotional images such as the nostalgic image, consisting of varied images, sounds, and environment. Some previous studies assessed the effect of relaxation and stress reduction using HRV components, in the field of health and medical treatment, such as the surgical field. In concordance with previous studies that have shown that depression proceeded mental stress and was associated with reduced HRV, the emotional image might be useful for the prevention of depression. From the different effects on HF and CVRR achieved with the sea image and the nostalgic image, the nostalgic image was suggested to exert activation effects on the autonomic activity, which differed from the relaxation effect. The findings of the previous study indicated that the tilt of autonomic balance toward sympathetic activation, such as the HF component, significantly decreased and LF/HF and HR increased with mild mental stress.[28] Previous studies have shown that depression is associated with reduced HRV and cardiovascular risk.[7,8] However, our study is important for generating hypotheses in that watching videos that elicit emotions and bring back memories might be useful for the treatment and prevention of symptoms associated to mental disorders such as dysphoria and depression. Although the mechanisms that caused these effects are unclear, it is likely that viewing the nostalgic image had a positive effect on the subjects. There are several potential limitations to this study. It was one of the weighty limits that all subjects were males, to avoid the influence of various factors in a menopause woman. The sample size was relatively small, and a large sample would have a significant difference among the three images. All subjects were medical professions, and it is likely that they might express different responses to the ward image. However, it is intriguing to speculate about the reasons why the nostalgic image may have the

Table 1 Comparison between first and second viewing of each video in heart rate variability.

	Sea			Ward			Nostalgia		
	1st	2nd	p value	1st	2nd	p value	1st	2nd	p value
HR	73.0±8.6	71.3±8.3	0.70	71.8±8.7	71.0±8.0	0.85	70.6±8.6	70.1±8.3	0.91
HF	84.1±95.1	78.8±78.2	0.90	94.3±117.5	69.1±46.4	0.58	89.6±87.0	88.4±84.3	0.97
LnHF	3.86±1.13	3.87±1.01	0.99	3.96±1.06	3.90±0.81	0.89	4.02±0.98	4.00±1.06	0.92
LF/HF	3.71±1.93	4.50±2.10	0.45	3.28±1.46	6.51±3.20	0.02	5.13±1.23	6.34±3.43	0.36
LF	173.6±83.8	235.1±130.4	0.28	218.5±+165.3	320.1±115.3	0.18	352.3±264.0	377.6±211.5	0.84
CVRR	2.49±0.72	2.62±0.77	0.76	2.68±0.85	3.16±0.97	0.4	2.99±1.13	3.05±0.63	0.68

potential of promoting a state of relaxation and elicit emotions, which is a different response to the HRV observed with videos for relaxation. In order to reveal the activation effect of autonomic activity to patients with depression or mental stress, the further research for them is required. In conclusion, the image which revives memory and stimulates emotion might have activation effect of autonomic activity. Furthermore, the stimulus images might be able useful to prevention of depression state without medication.

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Conflict of Interest

The authors declare no conflict of interest.

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