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Short Communication

Association between Sense of Coherence and Heart Rate Variability in Healthy Subjects

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Abstract

Objectives: This report investigates whether there is any association between sense of coherence (SOC), as a coping measure in confronting stressful conditions, and heart rate variability (HRV), as a measure of the cardiac autonomic nervous system during the daily life pattern.

Methods: Sixteen healthy university students (14 males and 2 females) filled in the validated Japanese version of the SOC-13 questionnaire before being informed about the study protocol. For each participant, we calculated 5-minute HRV indices using logarithmically transformed data on frequency domains for HRV derived by 24-hour Holter monitoring. Frequency domains for HRV recordings were investigated for the 24-hour time periods.

Results: The correlation coefficient between the SOC scores and the high frequency power of HRV (0.15–0.40) was positively significant during the resting sitting position ($r \geq 0.60$, $P<0.05$). After grouping SOC scores by the median, the high frequency domain of HRV was higher in high SOC subjects for most of the 24-hour time period.

Conclusion: A higher SOC could modulate the parasympathetic tone of cardiac autonomic activity, especially during the resting sitting position.

Key words: sense of coherence, heart rate variability, holter monitoring

Introduction

The contribution of psychological characteristics to pathophysiological functions has been the focus of decades of research. While numerous studies indicating that psychological characteristics such as anxiety, depression and hostility are associated with increased risk of diseases (1–3), there is a need for studies in which the physiological mechanisms are investigated in healthy individuals prior to the occurrence of diseases.

Sense of coherence (SOC) has been proposed (4, 5) as a construct for predicting effective coping measures in confronting stressful conditions. SOC has been defined as a global orientation that expresses the extent to which one has a dynamic feeling of confidence that the stimuli derived from one's internal and external environments in the course of living are structured, predictable and explicable.

We have already shown that a high SOC may attenuate the adverse impact of job strain on sleep quality in public service workers (6). Furthermore, Poppius (7) reported from the Helsinki heart study that in the follow-up of eight years, high SOC white collar workers had a lower incidence of CHD than low SOC workers. However, the pathophysiological pathway through which SOC might be beneficial to health has not been well addressed. Nakamura et al. (8) found that a higher SOC and never smoking significantly contributed to a higher level of natural killer cell activity. In this study, we investigated whether the salutogenic (health-promoting) effect of SOC could also be regulated through the autonomic nervous system, by measuring heart rate variability (HRV). We predicted that a high SOC individual would have higher cardiac parasympathetic reactivity.

Methods

Subjects:

The Japanese version of the SOC-13 questionnaire (9) was distributed among grade four and five medical students (n=190), from which 16 (14 men and 2 women) were accepted as participants by means of their consent. The protocol of the study was revealed after the questionnaire survey. The participants were healthy university students with an age range of 22

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to 43 years [mean±standard deviation (SD) of 26.2±6.5 years]. Mean±SD of body mass index (BMI), systolic blood pressure and diastolic blood pressure were 22.0±2.9 (kg/m^2), 114±6.0 (mmHg) and 68±4.1 (mmHg), respectively.

Study protocol:

All measurements were performed from 1:00 pm on the experiment day until 1:00 pm the next day. The participants were asked to eat lunch at 12:00 pm and were asked not to drink coffee or alcoholic beverages on the experiment day. The first part of the experiment was conducted in an air-conditioned room, with temperature and humidity being set to 25°C and 50%, respectively. A Holter electrocardiograph (RAC1202, Nihon Coden Co., Japan) was attached during the 15-minute period before starting the experiment. The timetable of the study (Table 1) started with 15 minutes of rest in a sitting position followed by 15 minutes of an arithmetic test. The arithmetic test was done by subtractions of one- or two-digit numbers from a four-digit number. Every five minutes the subjects were instructed to perform the procedure faster. Polysomnographical recording (Alice 3, Respironics, Georgia, USA) of brain waves was then performed to precisely determine the sleep period during the afternoon nap (at most, 1 hour and 30 minutes). Sleep recordings were visually scored at 30-second intervals. After detachment of the electroencephalogrph (EEG) cables in the supine position, the subjects got up from bed, and for the next 10 minutes were checked for orthostatic changes. The subjects took a short time off, and from 17:00 pm started 15 minutes of rest in the sitting position followed by 15 minutes of exercise on a stationary bicycle (workload of 7 watts at a rate of at least 60 pedals per minute). After 15 minutes of rest the subjects departed the laboratory and were asked to follow their everyday sleeping and eating habits and record their bedtime and wake-up time.

For frequency domain analysis of RR intervals, data were interpolated using a cubic-spline interpolation method, and re-sampled at 2 Hz. The re-sampled 512-point equidistant data were treated with a Hanning window function and transformed into power spectral data using a Fast Fourier Transform method (10). Low frequency power (LF; 0.04–0.15 Hz) and high frequency power (HF; 0.15–0.4 Hz) were calculated. These indices were transformed into a natural logarithm (ln), because the indices were skewed. The low/high frequency ratio (LHR) was calculated as LF divided by HF. HF and LF waves were considered to arise from cardiac parasympathetic nerve activity and combined sympathetic and parasympathetic nerve function, respectively. The consensus was that LHR reflects cardiac sympathetic nerve activity.

Statistical analysis:

The Pearson product-moment correlation coefficient was

Table 1 Timetable of the experiment

Schedule	Time
1) Rest before experiment starts	13:00~13:15
2) Mental arithmetic test	13:15~13:30
3) Electroencephalograph attachment	13:30~14:00
4) Afternoon nap	Recognized by polysomnography
5) Getting up from bed after nap	Recognized from EEG detachment through the next 10 minutes
6) Rest before exercise	17:00~17:15
7) Exercise (stationary bicycle)	17:15~17:30
8) Rest after exercise	17:30~17:45
9) Nighttime sleep	From bedtime until waking up
10) Morning getting up until detachment	From waking up until 13:00 the next day

Table 2 Correlation coefficients between SOC score and HRV components by time periods of experiment

	LFln	HFln	LHR
1) Rest in sitting position	0.45	0.63*	–0.38
2) Arithmetic test	0.45	0.36	0.001
3) Electroencephalograph attachment	0.43	0.60*	–0.62*
4) Afternoon nap	0.02	0.21	–0.05
5) Getting up from bed after nap	0.34	0.15	0.04
6) Rest before exercise	0.40	0.30	0.16
7) Exercise (stationary bicycle)	0.23	0.23	–0.02
8) Rest after exercise	–0.05	–0.07	0.16
9) Nighttime sleep	0.26	0.15	0.26
10) Morning getting up until detachment	0.22	0.25	–0.08

* $p<0.05$.

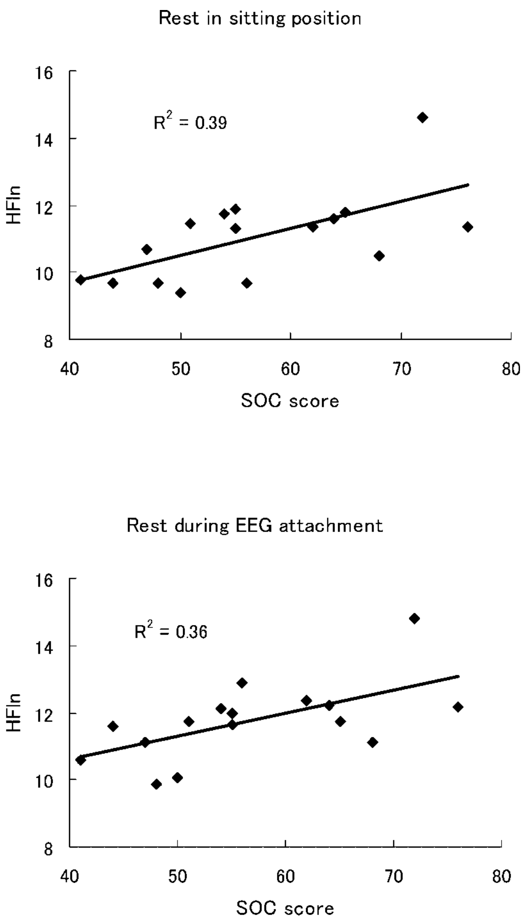

Fig. 1 Correlation coefficients between high frequency (HFln) power of heart rate variability and sense of coherence (SOC) score during rest in the sitting position at the start of the experiment, and during rest during EEG attachment.

used for the analysis. Mann-Whitney U test was used to check the differences in HFln during different time periods after categorizing SOC scores into two groups of below or equal to the median, and above the median.

Results

Table 2 shows the correlation coefficients between the SOC scores and frequency domain components of HRV. The SOC score was correlated significantly with the HF domain of HRV during the resting sitting position in the first 15 minutes of the experiment ($r=0.63$, $p<0.05$), and also during the period in which subjects were in the sitting position for connection of the electroencephalograph cables ($r=0.60$, $p<0.05$) (Figure 1). Frequency domains of HRV in other time periods (described in the Table 1) were not correlated significantly to the SOC score. Controlling for age and BMI in a partial correlation analysis did not change the magnitude of the correlation coefficients or their significance level.

After categorizing SOC into below or equal to the median and above the median, HFln was higher in high SOC subjects for all of the time periods except for rest after exercise (results not shown), but the association was only significant during the sitting position in which EEG cables were attached. The mean±SD of HFln for those with SOC$\leq$ median and SOC$>$ median was 11.2±0.83 and 12.5±1.17, respectively (p for Mann-Whitney U test=0.01). Age and BMI were not remarkably different between those with SOC below or equal to the median and those with SOC above the median.

Discussion

There is substantial evidence that the HF power of HRV represents a noninvasive index of cardiac vagal modulation (11). There have also been reports concluding that enhanced cardiac parasympathetic tone explains an important mechanism underlying the beneficial effects of the relaxation response (12–14). Our findings showed that the personality trait of SOC was positively correlated to parasympathetic cardiac autonomic responses in the resting sitting position, which may indicate that in subjects with a higher SOC there is more potential to feel relaxed.

The salutogenic effect of SOC was also observed during mental and physical loads, for which those with a higher SOC tended to have a higher HFln, but not significantly.

The limitations of our study are mainly the small number of subjects and not acquiring ECG signals under controlled respiration, which should be taken into consideration when interpreting the results.

An individual with a high SOC sees his or her future as predictable, and considers that things will work out as well as can reasonably be expected, and in cases of surprises like failure, death or unemployment, such an individual can make sense of them. In addition, a high SOC individual is confident of his/her own resources and can trust others. These findings suggest that higher SOC could modulate the cardiac parasympathetic activity, especially in a resting position, and to a lesser extent during mental and physical loads. Further investigations with a larger number of subjects are required to reveal whether the current associations are spurious or causal.

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