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Does Schumann resonance affect our blood pressure?

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Abstract

Objectives—To investigate whether Schumann resonance (SR) affects blood pressure (BP), heart rate (HR), and depression and, if so, whether the putative BP reactivity to SR (BPR-SR) is associated with health-related lifestyle (HLS), disease-related illnesses (DRI), and depression.

Methods—A sample of 56 adults in Urausu, Hokkaido, Japan, wore an ambulatory BP monitor, except for the time in the shower, for seven consecutive days. They completed the Geriatric Depression Scale-Short Form and a health survey questionnaire on HLS and DRI. Group mean differences and within-individual differences in systolic (S) and diastolic (D) BP, mean arterial pressure (MAP), double product (DP), and HR were, respectively, compared between normal and enhanced SR days, using Student's t-test. Correlations between BPR-SR and other characteristics (i.e. age, gender, HLS, DRI, subjective health, and depression) were analyzed, using Pearson's product moment correlation.

Results and discussion—Group mean SBP, DBP, MAP, and DP for enhanced SR days were lower than those for normal days (P = 0.005-0.036). DRI was negatively associated with BPR-SR in SBP, DBP, MAP, and DP (P = 0.003-0.024), suggesting a better health status for those who showed lower BP on enhanced SR days. HLS was negatively associated with BPR-SR in DBP and MAP (P = 0.016-0.029). Males showed higher BPR-SR in DBP and MAP than females (P = 0.0044-0.016). Neither subjective health nor depression was significantly associated with BPR-SR. Future studies based on larger sample sizes are planned to see whether possible health effects can be generalized.

Keywords

Schumann resonance; Geomagnetic; Blood pressure; Depression; ELF

1. Introduction

Cases for linking changes in the ambient magnetic field to observable changes in higher life form can be found in the scientific literature. For instance, geomagnetic storms have been found to be accompanied by degradation and destruction of mitochondria and loss of the circadian rhythmicity in the heart rate of rabbits [7]. Because the magnetoreception of neural structures should be evolutionarily adjusted to these magnetic fields, humans may also have a special sensitivity to geomagnetic fields [22]. In fact, scientific literature suggests that ambient electromagnetic fluctuations, such as geomagnetic activity, may affect our physiology, psychology, and behavior [1–8,10–13,19–22,30]. For instance, Ghione et al. [13] found

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significant, positive associations between geomagnetic activity and (daytime and 24-h) systolic (S) and (daytime, nighttime, and 24-h) diastolic (D) blood pressure (BP). Although the possible dynamics of electromagnetic activity affecting physiology, psychology, and behavior is still unknown, studies of the blood system of rats exposed to magnetic fields in the frequency band of 0.01-100 Hz (with magnitudes 5, 50, and 5000 nT) revealed that magnetic fields at the frequencies 0.02, 0.5–0.6, 5–6, and 8–11 Hz were the most bio-effective [19,22]. Moreover, transcranial applications of 5 Hz electromagnetic fields in picotesla (pT) range to patients with Parkinson's disease were found to increase alpha and beta activities as well as the resolution of theta activity in EEG and to improve gait, postural reflexes, mood, anxiety, cognitive, and autonomic functions [23–26]. Sandyk [23] insists that the rapid improvement of the syndrome may be related to the augmentation of dopaminergic and serotonergic neurotransmission that is reduced in chronic patients with Parkinsonian syndrome.

Cherry [6] suspects Schumann resonance (SR), which is globally propagating ELF waves, to be "the possible biological mechanism" that explains biological and human health effects of geomagnetic activity. The aim of the current study was to investigate whether SR affects blood pressure (BP), heart rate (HR), and depression and, if so, whether the putative BP reactivity to SR (BPR-SR) is associated with age, gender, health-related lifestyle (HLS), subjective health, disease-related illnesses (DRI), and depression.

1.1. Schumann resonance

SR is a background stationary electromagnetic noise that propagates in the cavity between the earth surface and the lower boundary of the ionosphere at altitudes of 45–50 km, in the frequency range between 5 and 50 Hz [3,14,27–29]. The phenomenon was named after W.O. Schumann who first predicted and discussed it in 1950s [29]. Its peak intensity can be detected at ~8 Hz, along with its harmonics with lower intensity at 14, 20, 26, 33, 39, and 45 Hz due to frequency-related, ionospheric propagation loss [3,14,27–29]. The peak SR frequencies undergo a moderate diurnal variation of approximately ± 0.5 Hz [29]. Interestingly, the first four SR modes happen to be within the frequency range of the first four EEG bands (i.e. delta 0.5–3.5 Hz, theta 4–7 Hz, alpha 8–13 Hz, and beta 14 to 30 Hz) [6].

The amplitude of 8 ± 0.5 Hz SR background signals ranges between 0.5 and 1.0 pT $Hz^{-1/2}$, and shows diumal and seasonal variations in response to stochastic redistribution of electric activity over the globe and resultant changes in the local height of the ionosphere at the respective observing sites [29].

Principal excitation source of SR is cloud-to-ground discharges, with the peak currents on the order of 20,000–30,000 A and the discharge rates of 100 times per s [29]. Because of such high discharge rates and remarkably small propagation loss, the associated electromagnetic radiations from individual lightning overlap to form a stationary background electromagnetic noise [14,29]. However, once in a while, middle atmospheric electrical current between the cloud tops and the ionosphere causes sufficiently large transients, called ELF transients, and excites the earth-ionosphere cavity to amplitude that may exceed the background by factors of 10–20 or more [29]. ELF transients have been found to be coincident with transient optical events (TLEs), such as red sprites (i.e. a transient luminous event at 55–80 km with the life time of few tens of ms) and elves (i.e. a transient luminous event in the altitude range between 70–90 km with the life time shorter than 1 ms) [14]. Other sources of SR include: (1) the vertical component of intercloud and intracloud discharges; (2) a fluctuating auroral electrojet that flows horizontally within the upper boundary of the cavity at altitudes of approximately 100 km; and (3) ELF whistlers, which are narrow signals believed to originate as plasma drift waves in the dayside magnetosheath and to enter the earth-ionosphere cavity through the polar cusp [14].

There are three noise sources that interferes with SR: (1) Pc 1 geomagnetic pulsations, which have much larger amplitudes than those of SR and can bleed into the lowest frequency 7.5 Hz resonance; (2) medium-scale power line radiation and relatively nearby lightning; and (3) smallscale local or mechanically induced electromagnetic signals [29]. Such noise data can be integrated as part of ELF data in the SR band because their occurrence rates are quite low.

2. Methods

2.1. Participants

As part of a cross-sectional study of life satisfaction, a sample of 56 residents (30 males and 26 females) of Urausu, Hokkaido, Japan, in age from 24 to 73 with a mean age of 51.7 years, agreed to participate in the study. The study was approved by the Tokyo Women's Medical University Research Ethics Board, and the participants were informed of the procedures and signed a consent form, which guaranteed their anonymity and freedom to withdraw at any time.

2.2. Procedure

2.2.1. Ambulatory blood pressure measurement—The participants wore a commercially available ambulatory BP monitor (TM-2431, A&D Company, Tokyo, Japan) around the clock for 7 days, except for the time in the shower. They also completed a health survey questionnaire on HLS and DRI [18] and the Geriatric Depression Scale-Short Form (GDS-SF) [9]. The monitors were programmed in advance to measure BP at 30-min intervals between 07:00 and 22:00h, and at 60-min intervals between 22:00 and 07:00 h, on a personal computer with software commercially available for the device (TM-2430-15, A&D Company). The monitor was fit snugly around each participant's dominant arm on the first morning, usually between 10:00 and 11:30 h. They were encouraged to maintain normal daily routines during the monitoring, and were instructed to remain motionless while their blood pressure was being read, and then to record their activity in a diary [19].

2.2.2. Measurement of HLS and depression—At the beginning of the study, participants were asked to complete a health survey questionnaire on living environment, family history, non-occupational history, past history, and depression [18]. Because the GDS-SF [9] was reported to have high concurrent validity with the Beck Depression Inventory ($r = 0.84$, $P < 0.01$) in a young adult sample [12], the scale was used to assess depression in our sample population of adults.

2.2.3. Measurement of Schumann resonance—SR signals were recorded at Moshiri station (geographic latitude 44.37°N; longitude 142.27°E), which is currently the only permanent ELF station in Asia region [15] and its geographic location happens to be within a distance of 0.8° in longitude and 1.1° in latitude from Urausu, the town where the study was carried out. Moshiri station is equipped with a three-component wide-band ($1 \text{ Hz} < f < 1 \text{ kHz}$) ELF/VLF electromagnetic measurement system, which detects background signals of both SR and ELF transient events from local and distant sources [15]. The system consists of three orthogonal sensors (i.e. two induction type antennas for the north-south and east-west horizontal magnetic field components and one capacitor type antenna for the vertical electric field component), preamplifier, main amplifier, and data acquisition system [15]. The SR intensity was calculated as 10-min mean spectra of 1-min sampled continuous background signals of 30 s (60,000 pt) [15]. The intensity of 8 ± 0.5 Hz Moshiri SR typically ranges from 0.3 to 0.6 pT $Hz^{-1/2}$ [15]. In the current study, the 8 ± 0.5 Hz SR data for the horizontal north-south component for the study span of 4 months (April to July of 2001) were used. The intensity of 8 ± 0.5 Hz ELF data in the SR band including ELF transient data recorded at Moshiri station for April to July, 2001 ranges from 0.3 to 1.46 pT $Hz^{-1/2}$, with a mean of 0.67 ± 0.13 pT $Hz^{-1/2}$.

2.2.4. Classification of study measurement days—In order to compare BP on daily basis, we classified the study measurement days into two groups—normal and enhanced SR days, based on the distribution of the X-component of primary SR signals (8 ± 0.5 Hz). Since we do not know whether there is a threshold for the putative biological effects of SR, we used the 64th percentile (0.697 pT $Hz^{-1/2}$ = 1.97 pT) of the distribution of the SR signal intensity as a cut-off point.

2.2.5. BP, DRL HLS, and depression score calculation—For each participant's systolic (S) and diastolic (D) BP, mean arterial pressure (MAP), double product (DP), and HR, the daily mean value and the circadian variation (standard deviation) were calculated. DRI score was calculated as the sum of raw scores for questionnaire items on living environment, family history, non-occupational history, and past history [18]. For instance, if the answer to Item 1 ("Are you healthy now?") is *Yes*, the raw score for the item is 0. If it is *No*, the raw score is 1. HLS score was calculated as the sum of raw scores for questionnaire items on lifestyle and dietary intake [18]. For example, if the answers to Item 1 ("Do you take a good care of what you eat?") is *Yes*, the raw score for the item is 1. If it is *No*, the raw score is 0. Depression score was calculated as the sum of the number of *No* answered to positive questions and the number of *Yes* answered to negative questions [18].

2.2.6. Data reduction and classification—Data trimming on each BP variable for each participant was first performed, by excluding values with three standard deviations above and below each variable mean. For the purpose of correlational analysis, participants were divided at the median into high and low groups, based on their scores on HLS, DRI, and depression (GDS-SF), respectively. Age and gender were also coded as dichotomous variables.

2.3. Analyses

Group mean differences and within-individual differences in SBP, DBP, MAP, DP, and HR were, respectively, compared between normal and enhanced SR days, using Student's *t*-test, with a significance level of 0.05 (two-tailed). Correlations between BPR-SR and other characteristics (i.e. age, gender, HLS, DRI, subjective health, and depression) were analyzed, using Pearson's product moment correlation, with a significance level of 0.05 (two-tailed). All the statistical tests were performed with the SAS system version 8 (SAS Institute, Cary, NC) and SPSS version 11.5 for Windows.

3. Results

3.1. Group mean differences in BP between normal and enhanced SR days

The mean score of SBP variable for the enhanced SR days, as seen in Table 1, was statistically significantly lower than that for normal SR days (t = 2.691, P = 0.008). Likewise, DBP (t = 2.691, P = 0.008), MAP (t = −2.86, P = 0.005), and DP (t = 2.127, P = 0.036) for enhanced SR days were also lower than those for normal SR days. The standard deviations of both HR (t = 2.127, P = 0.036) and DP (t = 2.127, P = 0.036) on enhanced SR days were significantly higher than those on normal SR days, respectively. As a result, four BP variables (i.e. SBP, DBP, MAP, and DP) showed statistically significant group mean differences between normal and enhanced SR days.

3.2. Distribution of individual BPR-SR

As shown in Table 2, the results of individual comparisons between normal and enhanced SR days (for each participant) suggests that more participants showed lower BP on enhanced SR days. Namely, 32.1% of the 56 showed lower SBP on days with enhanced SR, whereas only 3.6% showed higher SBP on those days. As to DBP, 26.8% of the participants showed lower DBP on days with enhanced SR, whereas only 3.6% showed higher DBP on those days.

Likewise, 30.4% and 19.6% of the participants showed lower MAP and DP on enhanced SR days.

3.3. Classification of BPR-SR

For each of the four BP variables mentioned above (i.e. SBP, DBP, MAP, and DP), BPR-SR was coded as a dichotomous variable, based on the results of Student's *t*-tests on within-individual differences between normal and enhanced SR days. For example, participants whose SBP on enhanced SR days was statistically and significantly lower than that on normal SR days was coded as "1", whereas those who showed no significant difference between highs and lows was coded as "0." Likewise, for DBP, MAP. and DP. each participant was assigned either "1" or "0", depending on the results of the *t*-tests.

3.4. Intercorrelations between BPR-SR and other characteristics

As shown in Table 3. DRI showed statistically significant negative intercorrelations with BPR-SR in SBP ($r = -0.375$. $P = 0.004$), DBP ($r = -0.302$. $P = 0.024$), MAP ($r = -0.351$, $P = 0.008$), and DP ($r = -0.290$. $P = 0.03$), suggesting better health for those who showed lower BP on enhanced SR days. Age was significantly associated with DP ($r = -0.28$, $P = 0.037$). Gender also showed statistically significant negative correlations with DBP ($r = -0.32$, $P = 0.016$) and MAP ($r = -0.38$, $P = 0.04$), suggesting that significantly lower DBP and MAP on enhanced SR days were more frequently seen in males compared to females. Although neither depression nor subjective health showed statistically significant association with the putative BPR-SR, HLS showed statistically significant negative correlations with DBP ($r = -0.32$, $P = 0.016$) and with MAP ($r = -0.29$, $P = 0.029$), suggesting that significantly lower DBP and/or MAP on enhanced SR days were less likely seen in those with better HLS.

4. Discussion

It is noteworthy that, in the current study, disease-related syndrome was signifcantly associated with SBP, DBP, MAP, and DP, respectively. Disease-related illnesses were reported to be significantly associated with BP, health-related illnesses, quality of life, body mass index, and depression [18]. Health-related lifestyle, on the other hand, was reported to show no significant association with either BP or quality of life and may need further modification and validation [18]. The current results that those with good health-related lifestyle showed low BP reactivity to enhanced Schumann resonance may be due to the possible low validity of the index. Although typical amplitude of Schumann resonance signals is in the picotesla range and seems to be negligible compared to some man-made fields surrounding us, it has been acknowledged by the international scientific community that exposure to low-frequency, low-intensity electromagnetic fields can produce biological effects [22]. Should our brain be sensitive enough to discern those natural signals or artificially generated 8-Hz electromagnetic fields from the background noise, BP reactivity to Schumann resonance would make a good health indicator. Future study will explore the possible health effects of Schumann resonance at 8. 14. 20, and 26 Hz with a bigger sample size, and should the results remain statistically significant, further analysis of the wave structure and a series of experiments would follow.

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Table 1

Group mean differences in the BP variables between high and normal SR days

Variable	Enhanced SR Days[m]			Normal SR Days[n]			Student's t-test		
	Mean	SD[o]	N	Mean	SD	N	t	df	p
SBP[a]	128.7	17.0	112	131.6	17.8	112	−2.691	111	.008
DBP[b]	79.3	10.4	112	81.2	11.1	112	−2.788	111	.006
HR[c]	71.5	8.0	112	72.1	8.2	112	−1.095	111	*NS*
MAP[d]	95.8	12.2	112	98.0	12.9	112	−2.860	111	.005
LOG_PP[e]	1.7	0.1	112	1.7	0.1	112	−1.564	111	*NS*
DP[f]	92.9	16.3	112	95.3	17.3	112	−2.127	111	.036
SBP_SD[g]	18.5	5.3	112	17.5	5.1	112	1.688	111	*NS*
DBP_SD[h]	14.5	4.5	112	14.3	4.4	112	.540	111	*NS*
HR_SD[i]	11.4	3.3	112	9.9	3.2	112	4.406	111	<.001
MAP_SD[j]	14.6	4.2	112	14.2	4.2	112	1.027	111	*NS*
PP_SD[k]	13.5	5.4	112	13.1	4.7	112	.746	111	*NS*
DP_SD[l]	22.9	6.5	112	20.2	5.6	112	3.954	111	<.001

[a] Note. Systolic blood pressure.

[b] Diastolic blood pressure.

[c] Heart rate.

[d] Mean arterial pressure.

[e] Log-transformed power pressure.

[f] Double product.

[g] Circadian variation (standard deviation) in systolic blood pressure.

[h] Circadian variation (standard deviation) in diastolic blood pressure.

[i] Circadian variation (standard deviation) in heart rate.

[j] Circadian variation (standard deviation) in mean arterial pressure.

[k] Circadian variation (standard deviation) in pulse pressure.

[l] Circadian variation (standard deviation) in double product.

[m] Days with enhanced Schumann resonance signals (SR>0.697 pT).

[n] Days with normal Schumann resonance signals (SR = <0.697 pT).

[o] Standard deviation.

Table 2

Number and percentage of participants who showed significantly higher or lower BP levels on enhanced SR days

Condition	SBP[d]		DBP[e]		MAP[f]		Dp[g]	
	n	%	n	%	n	%	n	%
Higher BP on enhanced SR days[a]	2	3.6	2	3.6	3	5.4	3	5.4
Lower BP on enhanced SR days[b]	18	32.1	15	26.8	17	30.4	11	19.6
No significant difference in BP[c]	36	64.3	39	69.6	36	64.3	42	75

[a] Note. Participants who showed a significantly higher daily mean BP value on days with enhanced Schumann resonance signals (SR>0.697 pT).

[b] Participants who showed a significantly lower daily mean BP value on days with enhanced Schumann resonance signals (SR = <0.697 pT).

[c] Participants who showed no significant difference in the daily mean BP value between normal and enhanced Schumann resonance days.

[d] Systolic blood pressure.

[e] Diastolic blood pressure.

[f] Mean arterial pressure.

[g] Double product.

Table 3

Intercorrelations of BP reactivity to enh]anced Schumann resonance (BPR-SR) with other characteristics

Variable		BPR-SR[e]			
		SBP[f]	DBp[g]	MAP[h]	Dp[i]
Age	r	−.027	−.078*	.008**	−.280*
	P	.841	.568	.951	.037
	N	56	56	56	56
Gender	r	−.181	−.321*	−.381**	−.100
	P	.183	.016	.004	.464
	N	56	56	56	56
Subective Health[a]	r	.074	.184	.231	.212
	P	.597	.188	.097	.127
	N	53	53	53	53
HLS[b]	r	−.162	−.321*	−.293*	−.122
	P	.232	.016	.029	.372
	N	56	56	56	56
DRI[c]	r	−.375**	−.302*	−.351**	−.290*
	P	.004	.024	.008	.030
	N	56	56	56	56
Depression[d]	r	−.132	−.035	−.101	−.067
	P	.330	.798	.459	.625
	N	56	56	56	56

[a] Note. Subjective health, based on a questionnaire item “Are you healthy now?”

[b] Health-related lifestyle.

[c] Disease-related illnesses.

[d] Depression rated on the Geriatric Depression Scale-Short Form (GDS-SF).

[e] Bp reactivity to Schumann resonance signals.

[f] Systolic blood pressure.

[g] Diastolic blood pressure.

[h] Mean arterial pressure.

[i] Double product.

* $P < 0.05$.

** $P < 0.01$.