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RELATIONSHIP BETWEEN POSITIVE AND NEGATIVE MOODS AND BLOOD PRESSURE IN A CLINICALLY HEALTHY MAN

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A b s t r a c t

This study explored the relation of circadian characteristics of mood to those of blood pressure and heart rate in a longitudinal record kept by a 24-year-old, clinically healthy man. Circadian rhythm characteristics, assessed for consecutive daily spans, were analysed by Pearson's product-moment correlation. A circadian rhythm was demonstrated for all variables. The circadian amplitude of negative mood was found to correlate positively with the MESOR of systolic and diastolic blood pressure.

K e y w o r d s

Psychic affect, Blood pressure monitoring, Clinically healthy man, Circadian variability

INTRODUCTION

A consistent circadian variation in human mood, self-rated along a 7-point scale (*1*) or otherwise, has been most apparent in clinically healthy medical students (*2*) and in patients (*2–7*). It has been suggested that a high-arousal state may be associated with heightened energy and optimism and a low-arousal state with reduced energy, less optimism and increased tension (*8*). The possibility of gauging tension by means of blood pressure has also been considered (*9*). Against this background, this study explored associations between circadian characteristics of mood and those of blood pressure and heart rate longitudinally recorded by a clinically healthy man.

MATERIALS AND METHODS

A clinically healthy, 34-year-old man answered the Positive and Negative Affective Scale (PANAS) questionnaire five-times a day for 82 days (between 3rd May and 27th July 2000). The two 10-item mood scales are reported to be highly internally consistent and largely uncorrelated and

stable (10-14). He also measured his systolic (S) and diastolic (D) blood pressure (BP) and heart rate (HR) at 30-minute intervals, using an automatic, ambulatory monitor (TM-2421, A&D, Tokyo, Japan) from 19 May to 29 June 2000. Each variable was analysed by the Halberg cosinor method (15) to assess circadian characteristics as they change from one day to another. Estimates of MESOR (M) and circadian amplitude (A), obtained on consecutive days, were correlated among variables to assess any association. During the first part of the study, but not thereafter, the subject woke up at 03:00 for data collection. His mood was analysed separately for the first 44 sleep-disturbed days and then for the following 42 days, because the reduced sleep quality due to sleep interruption at 03:00 was taken into account.

RESULTS

A circadian rhythm was demonstrated for each of the variables (*Table 1*). The results were validated by one-way analysis of variance for both positive and negative mood (*Table 2*). A positive association was found between the circadian amplitude of negative mood and the MESOR of both SBP (r=0.363; P=0.029) and DBP (r=0.389; P=0.019), suggesting that BP is raised in the presence of large swings in negative mood. A weak association between the MESOR of negative mood and the circadian amplitude of SBP (r=0.272; P=0.108) was recorded, suggesting a lowering of the circadian SBP amplitude in the presence of a strong negative mood. Of interest was the lack of a statistically significant relation between positive and negative moods, not only in terms of MESOR but also in terms of circadian amplitude.

DISCUSSION

This study corroborates the view that positive and negative moods, as assessed by the PANAS questionnaire, are independent. The circadian amplitude did not correlate with MESOR for a positive mood, but it correlated with MESOR for a negative mood; this correlation was statistically significant, indicating larger mood swings in the presence of a strong negative mood. In another longitudinal record of mood, larger mood swings (gauged by the standard deviation) were also associated with lower mood ratings. This record, based on self-rating on several occasions a day, was kept by a 41-year-old woman diagnosed at 35 years with a psychiatric disorder and treated with lithium and exposure to full-spectrum light (*16).*

The results of this study also support and extend the findings made by *Günther et al. (2*) on two independent aspects of mood. A prominent circadian component for the positive mood was also ascertained, by means of the PANAS questionnaire, in 94 students enrolled in Introductory Psychology courses during the 2000–2001 regular session at the University of Manitoba.

Circadian rhythms in mood are modulated by infradian rhythms, including a periodicity of 11.5 years, with a 95% confidence interval extending from 10.11 to 13.41 years (*5).* In the case of a circadecadal rhythm in mood, the circadecadal spectrum of vigor differs drastically in that the longest component in this variable

Table 1

Circadian rhythm parameters of the variables investigated

Variable	Stage	P	MESOR, M ± SE	Double amplitude, 2A ± SE	Acrophase, ϕ (95% CI)	
					Degrees	Hour:minute
Positive Affect	I	<0.001	26.4 ± 0.55	5.4 ± 1.4	-319 (-282, -356)	21:16 (18:48, 23:44)
	II	0.306	25.5 ± 0.50	2.2 ± 1.4	-267	17:48
Negative Affect	I	0.096	19.5 ± 0.52	3.0 ± 1.4	-345	23:00
	II	<0.001	16.8 ± 0.46	4.8 ± 1.2	-335 (-302, -8)	22:20 (20:02, 00:32)
Total Affect	I	<0.001	45.9 ± 0.77	8.0 ± 2.0	-328 (-294, -2)	21:52 (19:36, 00:08)
	II	<0.001	42.4 ± 0.62	6.0 ± 1.6	-315 (-279, -352)	21:00 (18:36, 23:28)
Systolic BP	I	<0.001	122.0 ± 0.4	14.7 ± 1.3	-254 (-245, -264)	16:56 (16:20, 17:36)
(mm Hg)	II	<0.001	121.0 ± 0.5	21.4 ± 1.5	-248 (-241, -256)	16:32 (16:04, 17:04)
Diastolic BP	I	<0.001	76.6 ± 0.3	8.4 ± 0.9	-259 (-246, -271)	17:16 (16:24, 18:04)
(mm Hg)	II	<0.001	75.0 ± 0.4	11.1 ± 1.2	-249 (-238, -261)	16:36 (15:52, 17:24)
Heart rate	I	<0.001	61.8 ± 0.4	16.1 ± 1.1	-233 (-225, -241)	15:32 (15:00, 16:04)
(beats/min)	II	<0.001	60.0 ± 0.4	16.9 ± 1.2	-234 (-226, -242)	15:36 (15:04, 16:08)

Stage I, sleep disturbed (May 3 to June 12, 2000); Stage II, sleep undisturbed (June 13 to July 27, 2000); MESOR (midline-estimating statistic of rhythm), a rhythm-adjusted mean; double amplitude, measure of extent of predictable change within one cycle; acrophase, measure of timing of overall values recurring in each cycle, expressed in (negative) degrees, with 360° = 24 hours, 0° = local midnight.

is 8.48 years and its 95% confidence interval ranges from 7.33 to 9.64 years during the same span of over 30 years. The lack of overlap of the 95% confidence interval suggests different mechanisms underlying mood and vigor. The vigor spectrum further differs from a spectrum based on a 1-minute estimation, while the circadian rhythms of the mental variables are frequency-synchronised (*5*). As to a temporal organisation at the high frequency end of the spectrum, Pöppel has suggested a role for periodicities of very high frequencies (*17*), whereas Geissler has considered an alternative tentative time quantum model as a putative link between physiology and psychology *(18–20*). Our results warrant further investigation into both ends of the frequency spectrum of mental variables in relation to changes in mood.

Table 2

Associations between circadian characteristics of mood and those of blood pressure and heart rate*

P\r	Pos-M	Pos-A	Neg-M	Neg-A	SBP-M	SBP-A	DBP-M	DBP-A	HR-M	HR-A
Pos-M	1	0.156	0.01	0.033	-0.074	-0.151	-0.271	-0.077	0.027	-0.096
Pos-A	0.162	1	-0.026	0.026	0.168	-0.015	0.107	0.131	-0.038	-0.251
Neg-M	0.886	0.816	1	0.537	0.047	-0.272	0.195	-0.192	0.057	0.030
Neg-A	0.767	0.814	<0.001	1	0.363	0.115	0.389	0.172	0.101	-0.079
SBP-M	0.666	0.327	0.786	0.02	1	0.392	0.634	0.15	0.300	-0.047
SBP-A	0.379	0.932	0.108	0.506	0.018	1	0.124	0.615	-0.215	-0.326
DBP-M	0.110	0.535	0.255	0.019	<0.001	0.469	1	0.177	0.347	0.125
DBP-A	0.655	0.447	0.261	0.317	0.378	<0.001	0.322	1	-0.344	-0.360
HR-M	0.874	0.827	0.742	0.556	0.076	0.209	0.038	0.040	1	0.359
HR-A	0.578	0.139	0.861	0.646	0.784	0.052	0.468	0.031	0.031	1

M, MESOR (midline-estimating statistics of rhythm), A, amplitude; Pos, positive mood; Neg, negative mood; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate. Pearson product-moment correlation coefficients are listed above the diagonal (r=1, perfect correlation) , the corresponding *P*-values (H_0: r=0) are listed below the diagonal.

A c k n o w l e d g e m e n t s

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VZTAH MEZI POZITIVNÍ A NEGATIVNÍ NÁLADOU A KREVNÍM TLAKEM U KLINICKY ZDRAVÉHO ČLOVĚKA

S o u h r n

Studie zjišťuje vztahy mezi cirkadiánní variabilitou psychické nálady a krevního tlaku a srdeční frekvence v longitudinálním záznamu u klinicky zdravého muže starého 24 let. Cirkadiánní rytmus byl analyzován pomocí Pearsonovy "produkt-moment" korelace. Cirkadiánní rytmus byl nalezen ve všech analyzovaných veličinách. Cirkadiánní amplitůda negativní nálady korelovala pozitivně s MESORem systolického a diastolického krevního tlaku.

REFERENCES

1. *Halberg F, Johnson EA, Nelson W, Runge W, Sothern R.* Autorhythmometry—procedures for physiologic self-measurements and their analysis. Physiol Tchr 1972; 1: 1–11.
2. *Günther R, Knapp E, Halberg F, Haus E.* Cosinor mapping of physiologic and psychologic variables in 18 healthy men before and during balneotherapy. In: Scheving LE, Halberg F, Pauly JE eds. Chronobiology, Proc. Int. Soc. for the Study of Biological Rhythms, Little Rock, Ark. Stuttgart: Georg Thieme Publishers/Tokyo: Igaku Shoin Ltd., 1974: 228–233.
3. *Eckert E, Zimmermann RL, Sothern RB, Trapp G, Halberg F.* Differing mood spectrum in identical twins with differing clinical stages of bipolar affective disease. Chronobiologia 1979; 6: 93–94.
4. *Halberg E, Cornélissen G, Bakken E, Halberg F.* Chrononeuroimmunomodulation (chrono-NIM): lead-lag cross-correlations of mental state and tumor burden. Chronobiologia 1994; 21: 144–145.
5. *Halberg F, Cornélissen G, Otsuka K, et al.* International BIOCOS Study Group. Cross-spectrally coherent ~10.5- and 21-year biological and physical cycles, magnetic storms and myocardial infarctions. Neuroendocrinol Lett 2000; 21: 233–258.
6. *Madjirova NP, Halberg F, Dimitrov BD, Petrova N, Kitcheva L.* Carbamazepine—stability of the circadian rhythm of mood, vigor, temperature and pulse during combined antidepressive therapy in patients with affective disorders. In: Mikulecky M. (ed.), Chronobiology and its Roots in the Cosmos, Proceedings of a Symposium, High Tatras, Slovakia, September 2–6, 1997. Bratislava, Slovak Medical Society, 1997: 285–300.
7. *Simpson HW, Gjessing L, Fleck A, Kühl JFW, Halberg F.* Phase analysis of the somatic and mental variables in Gjessing's case 2484 or intermittent catatonia. In: Scheving LE, Halberg F, Pauly JE eds. Chronobiology, Proceedings of the International Society for the Study of Biological Rhythms, Little Rock, Ark. Stuttgart, Georg Thieme Publishers/Tokyo, Igaku Shoin Ltd., 1974: 535–539.
8. *Thayer RE.* The Biopsychology of Mood and Arousal. New York: Oxford University Press, 1989.
9. *Spector NH, Dolina S, Cornélissen G et al.* Neuroimmunomodulation: neuroimmune interactions with the environment. In: Fregly MJ, Blatteis CM, eds. Handbook of Physiology, Section 4: Environmental Physiology. New York, American Physiological Society/Oxford University Press, 1995: 1537–1550.
10. *Tellegen A*. Structures of mood and personality, and their relevance to assessing anxiety, with an emphasis on self-report. In: Tuma AH, Maser JD, eds. Anxiety and the anxiety disorders. Hillsdale, New Jersey, L.Erlbaum Associates 1985: 681–706.
11. *Tellegen A, Watson D, Clark LA.* Further support for a hierarchical model of affect: Reply to Green and Salovey. Psychol Sci, 1999; 10, 307–309.
12. *Tellegen A, Watson D, Clark LA.* On the dimensional and hierarchical structure of affect. Psychol Sci, 1999; 10, 297–303.
13. *Watson D, Clark LA, Tellegen A.* Development and validation of brief measures of positive and negative affect: the PANAS scales. J Personal Soc Psychol, 1988; 54(6), 1063–1070.
14. *Watson D, Wiese D, Vaidya J, Tellegen A.* The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. J Personal Soc Psychol, 1999; 76, 820–838.
15. *Halberg F, Carandente F, Cornélissen G, Katinas GS*. Glossary of chronobiology. Chronobiologia 1977; 4 (Suppl. 1), 189.
16. *Rawson MJ, Cornélissen G, Holte J et al.* Circadian and circaseptan components of blood pressure and heart rate during depression. Scripta Med 2000; 73: 117–124.
17. *Pöppel E.* Time perception. In: Autrum H ed. Handbook of Sensory Physiology VIII. Berlin: Springer, 1978: 713–729.
18. *Geissler HG.* The temporal architecture of central information processing: Evidence for a tentative time-quantum model. Psychol Res 1987; 49: 99–106.
19. *Geissler HG.* New magical numbers in mental activity: On a taxonomic system for critical time periods. In: Geissler HG, Link SW, Townsend JT, eds. Cognition, Information Processing and Psychophysics: Basic Issues. Hillsdale, New Jersey: L. Erlbaum Associates, 1992: 293–322.
20. *Geissler HG.* Zeitkodekonstanten — ein Bindeglied zwischen Psychologie und Physiologie bei der Erforschung kognitiver Prozesse? Hypothesen und Überlegungen zu Quantenstrukturen in der Alpha-Aktivität des Gehirns. Z Psychol 1991; 199: 121–143.