Opinion

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Oscillations in Biological Systems: Psychopathological Associations

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ABSTRACT

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Introduction

The sum of unconnected causes tends toward a gaussian distribution as a limit and that the sum of random causes is manifested as cyclical series. In contrast to the classical thermodynamic systems in which stability is maintained through energy conservation, and energy loss leads to instability and disorganization, biological systems are dissipative nonlinear, far-from-equilibrium structures in which stability is the result of energy dissipation. The fundamental source of energy in living systems is ATP which, in one of its major modes, is generated by glucose glycolysis through the biochemical oscillations of phosphofructokinase according to the nonlinear kinetics of nonequilibrium thermodynamic systems. At the molecular level this energy is transmitted by the vibrational deformation of antisymmetric solitons [1-10].

Given that living systems are inserted in a geophysical state determined by the parameters of the rotation of the earth and the consequent alternation of light and dark occurring in different cycles through yearly seasonal variations, the critical importance of circadian oscillations, the key role played by the light-dependent enzyme N-acetyltransferase in controlling circadian cycles through serotonin-melatonin transformations, and the importance of maintaining a complex pattern of reciprocal balances between the multiplicity of interlocking circadian, ultradian, and circannual oscillations immediately follows [11-20]. At all levels of biological organization, stability as a result of reciprocal oscillations of key components is apparent; in hormonal systems such as LHRH-LH-testosterone where the oscillatory solution corresponds to stability or in the pituitary thyrotropin-thyroxin-intermediary enzyme interaction in which stability hinges on the steady-state solution. It is apparent in the regulation of the REM phase of sleep determined by the reciprocal interactions of the pontine reticular giant cells' excitation and the inhibitory functions of raphe neurons and locus ceruleus, a system that conforms to predator-prey relationship defined by the Lotka-Voltera equation, and which at the chemical level is subtended by a corresponding reciprocity in cholinergic-monoaminergic balances.

At several levels biological oscillations influence, in regular periodicities, lateralized hemispheric functions. This is seen in the oscillatory biochemical kinetics of 5 hydroxytryptophan altering hemispheric serotonin concentration toward larger or smaller asymmetric gradients through lithium or cocaine interactions; it is seen in the periodic 90 to 100 minute maxim/minima of verbal/spatial cognitive efficiency taking place with 180° phase opposition; it is seen in the corresponding changes in cognitive activity of sleep: superior verbal after slow sleep awakening and superior spatial after REM-sleep awakening [21-30]. The oscillation-laterality interaction also appears curiously in the unusual relations existing between lateral nasal airflow, ipsilateral sympathetic-contralateral parasympathetic, and contralateral EEG power associations [31-50]. In psychopathology the recurring periodic or aperiodic syndromes where mood, motility, sleep, and sexual functions are all simultaneously perturbed in a dichotomy of abnormal excitation or inhibition, are the manifestations of alterations in the complex balances of oscillatory phenomena and consequent hemispheric functional organization of biological systems whose far-from-equilibrium stability has been dislocated.

References

1. ADEY WR (1981) Ionic nonequilibrium phenomena in tissue interactions with electromagnetic fields. In: Illinger KH (Eds.), Biological Effects of

Nonionizing Radiation. American Chemical Society, Washington DC, USA, pp. 271-297.

2. Adey WR (1981) Tissue interactions with nonionizing electromagnetic fields. Physiol Rev 61(2): 435-514.
3. Aschoff J (1965) Circadian rhythms in man. Science 148(3676): 1427-1432.
4. Binkley S (1979) A timekeeping enzyme in the pineal gland. Sci Am 240(4): 66-71.
5. Cronin J (1973) The Danziger-Elmergreen theory of periodic catatonic schizophrenia. Bull Math Biol 35(5-6): 689-707.
6. Cronin J (1977) Mathematical aspects of period catatonic schizophrenia. Bull Math Biol 39(2): 187-199.
7. Danziger L, Elmergreen GL (1956) The thyroid-pituitary homeostatic mechanism. Bull Math Biophys 18(1): 1-13.
8. Davydov AS (1979) Solitons in molecular systems. Physica Scripta 20(3-4): 387-394.
9. Del Giudice E, Doglia S, Milani M (1981) Solitons in biological systems at low temperature. Physica Scripta 23(3): 307-310.
10. Dirlich G, Kammerloher A, Schultz H, Lund R, Doerr P, et al. (1981) Temporal coordination of rest-activity cycle, body temperature, urinary free cortisol, and mood in a patient with 48-hour unipolar-depressive cycles in clinical and time-cue-free environments. Biol Psychiatry 16(2): 163-179.
11. Flor Henry P (1979) On certain aspects of the localization of the cerebral systems regulating and determining emotion. Biol Psychiatry 14(4): 677-698.
12. Goldbeter A (1980) Models for oscillations and excitability in biochemical systems, in Segal LA (ed): Mathematical Models in Molecular and Cellular Biology. Cambridge University Press, Cambridge, UK, pp. 248-291.
13. Goldbeter A, Segel LA (1980) Control of developmental transitions in the cyclic AMP signalling system of Dictyostelium discoideum. Differentiation 17(3): 127-135.
14. Gordon HW, Frooman B, Lavie P (1982) Shift in cognitive asymmetries between wakings from REM and NREM sleep. Neuropsychologia 20(1): 99-103.
15. Hobson JA, Mccarley RW (1977) The brain as a dream state generator: An activation-synthesis hypothesis of the dream process. Am J Psychiatry 134(12): 1335-1348.
16. Jauhar P, Weller MPI (1982) Psychiatric morbidity and time zone changes: A study of patients from Heathrow Airport. Br J Psychiatry 140: 231-235.
17. Klein R, Armitage R (1979) Rhythms in human performance: 1½ hour oscillations in cognitive style. Science 204(4399): 1326-1328.
18. Knapp S, Mandell AJ (1980) Lithium and clomipramine differentially alter bilateral asymmetry in mesostriatal hydroxylase with respect to tetrahydrobiopterin cofactor. Neuropharmacology 19(1): 1-7.
19. Kripke DF, Sonnenschein D (1978) A biologic rhythm in waking fantasy. The Stream of Consciousness USA, Plenum Publishing, pp. 321-332.
20. Kripke DF, Wyborney VG (1980) Lithium slows rat circadian activity rhythms. Life Sci 26(16): 1319-1321.
21. Kripke DF, Mullaney DJ, Atkinson M, Wolf S (1978) Circadian rhythm disorders in manic-depressives. Biol Psychiatry 13(3): 335-351.
22. Kripke DF (1979) Circadian rhythm phases in affective illnesses. Chronobiologia 6(4): 365-375.
23. Kripke DF, Judd LL, Hubbard B, Janowsky DS, Huey LY (1979) The effect of lithium carbonate on the circadian rhythm of sleep in normal human subjects. Biol Psychiatry 14(3): 545-548.
24. Lieber AL, Sherin CR (1972) Homicides and the lunar cycle: toward a theory of lunar influence on human emotional disturbance. Am J Psychiatry 129(1): 69-74.
25. Lewy AJ, Wehr TA, Goodwin FK, David A Newsome, Norman E Rosenthal (1981) Manic depressive patients may be supersensitive to light. Lancet, pp. 383-384.
26. Lund R (1974) Personality factors and desynchronization of circadian rhythms. Psychosom Med 36(3): 224-228.
27. Mandell AJ, Knapp S (1979) Asymmetry and mood, emergent properties of serotonin regulation. Arch Gen Psychiatry 36(8): 909-916.
28. Mandell AJ, Knapp S, Geyer MA (1979) Lithium decreases and cocaine increases the bilateral asymmetry of serotonin in the mesostriatal and mesolimbic systems associated with changes in the kinetic properties of tryptophan hydroxylase. Catecholamines: Basic and Clinical Frontiers. USA Pergamon Press.
29. Mccarley RW (1982) REM sleep and depression: Common neurobiological control mechanisms. Am J Psychiatry 139(5): 565-570.
30. Mccarley RW, Hobson JA (1975) Neuronal excitability modulation over the sleep cycle: A structural and mathematical model. Science 189(4196): 58-60.
31. Pflug B, Johnsson A, Ekse AT (1981) Manic-depressive states and daily temperature. Acta Psychiatr Scand 63(3): 277-289.
32. Philipp M, Marneros A (1978) Chronobiology and its implications for pharmacotherapy of endogenous depression. Pharmakopsychiatr 11(5): 235-240.
33. Prigogine I, Lefeber R (1975) Stability and thermodynamic properties of dissipative structures in biological systems. In: Miller IR (Eds.), Stability and Origin of Biological Information. Wiley & Sons, USA, p. 26-57.
34. Prigogine I, Stengers I (1979) La Nouvelle Alliance. Paris, Gallimard, pp. 138-144.
35. Reinberg A (1970) Lighting and the human menstrual cycle, in Benoit J, Assenmacher I (eds): La Photoregulation de la Reproduction Chez les Oiseaux et les Mammiferes. Colloque CNRS, No 172, Paris.
36. Reinberg A, Lagoguey M (1978) Circadian and circannual rhythms in sexual activity and plasma hormones (FSH, LH, testosterone) of five human males. Arch Sex Behav 7(1): 13-30.
37. Sitaram N, Nurnberger JI, Gershon ES, Gillin JC (1982) Cholinergic regulation of mood and REM sleep: Potential model and marker of vulnerability to affective disorder. Am J Psychiatry 139(5): 571-576.
38. Slutzky E (1937) The summation of random causes as the source of cyclic processes. Econometrica 5(2): 105-146.
39. Smith WR (1980) Hypothalamic regulation of pituitary secretion of luteinizing hormone-II feedback control of gonadotropin secretion. Bull Math Biol 42(1): 57-78.
40. Stent GS, Kirstan WB, Freisen WO, Ort CA, Poon M, et al. (1978) Neuronal generation of the leech swimming movement. Science 200(4348): 1348-1357.
41. Taub JM, Berger RJ (1974) Acute shifts in the sleep-wakefulness cycle: Effects on performance and mood. Psychosom Med 36(2): 164-173.
42. Vogel GW, Vogel F, Mcabee RS, Thurmond AJ (1980) Improvement of depression by REM sleep deprivation. Arch Gen Psychiatry 37(3): 247-253.
43. Wehr TA, Goodwin RK (1979) Rapid cycling in manic-depressives induced by tricyclic antidepressants. Arch Gen Psychiatry 36(5): 555-559.
44. Wehr TA, Wirz Justice A (1982) Circadian rhythm mechanisms in affective illness and in antidepressant drug action. Pharmakopsychiatria 15(1): 31-39.
45. Wehr TA, Wirz Justice A, Goodwin FK, Duncan W, Gillin JC (1979) Phase advance of the circadian sleep-wake cycle as an antidepressant. Science 206(4419): 710-713.
46. Wehr TA, Muscettola G, Goodwin FK (1980) Urinary 3-methoxy-4-hydroxyphenylglycol circadian rhythm. Arch Gen Psychiatry 37(3): 257-263.

47. Wehr TA, Goodwin FK, Wirz Justice A, Breitmaier J, Craig C (1982) 48-hour sleep-wake cycle in manic-depressive illness. Arch Gen Psychiatry 39(5): 559-565.

48. Werntz DA, Bickford R, Bloom Fe (1980) Cerebral hemispheric activity and autonomic nervous function. Proceedings of the Society for Neuroscience, Cincinnati, pp. 196.

49. Winfree AT (1980) The Geometry of Biological Time. In: Krickeberg K, Levin SA (Eds.), USA, Springer-Verlag.

50. Zacharias L, Wurtman RJ (1964) Blindness: Its relation to age of menarche. Science 144(3622): 1154-1155.

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