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editorial focus

Enhanced mental performance at higher body temperature?

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MOST OF US HAVE HAD THE REMARKABLE experience of performing several mental tasks very well during slight fever or while body temperature rises unexpectedly during jet lag. This may not simply be a misperception related to the fever process or desynchrony, as pointed out by Wright and colleagues (13) in this issue of the *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*.

Most neurobehavioral measures depend essentially on two processes: a circadian process depending on the time of day and a homeostatic process relating sleep duration and intensity to the amount of prior wakefulness (2, 7). Body temperature levels also demonstrate a circadian pattern (4, 6, 11), with high levels during the day and low levels during the night. Sleep exerts an influence on body temperature levels because under conditions of total sleep deprivation, the circadian rhythm of body temperature is preserved, but its amplitude is reduced to 0.5°C, compared with an amplitude of ~1°C when sleep occurs at a normal time (12).

The relationship between the circadian rhythms of body temperature and performance in simple repetitive tasks was already shown by Kleitman in 1963 (9) and by Colquhoun in 1971 (3). Performance for this type of task parallels the circadian rhythm of body temperature. More recent studies have shown a similar relationship when data were collected during extended wakefulness. Minimum performance coincides with low levels of body temperature (1, 5, 8, 10). In these studies, the pressure of the homeostatic process, because of sleep deprivation, continues to increase. Therefore, to distinguish the effects of the homeostatic process from those of the circadian process, some groups have used the forced desynchrony protocol. Under conditions in which the volunteers, for instance, live on 28-h days (with 9 h and 20 min allocated for sleep), the internal clock is not able to synchronize to the environment, allowing for the examination of variables at different circadian phases without sleep depriving the subjects. The parallelism between the circadian rhythms of body temperature and performance on various tasks persists and alertness deteriorates with time spent awake (5, 8). Similar findings have been found when subjects lived on a 20-h day (14).

In this issue, Wright et al. (13) report a study in which the subjects performed various tasks during the forced desynchrony protocol, allowing a few observations of the relationship between body temperature and performance at the same circadian phases and after the same amount of hours spent awake. They then split the performance results between the corresponding lowest or highest body temperature for each subject at various circadian phases and at various hours being awake. Globally, better performance is associated with higher body temperature levels, independently of circadian phase and time spent awake. The authors conclude that body temperature is a modulator of the neurobehavioral function.

Kleitman and Jackson hypothesized in 1950 that changes in alertness could be derived from variations in body temperature avoiding "time consuming performance tests which, in themselves, interfere with, or disrupt, the scheduled activities of the persons studied" (see Ref. 2). The complex analysis by Wright et al. verifies this assumption.

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