The impact of the circadian phase of chronic insomniacs and controls upon their sleep characteristics

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Introduction
It has been shown that chronic insomniacs, selected on the basis of the type of their sleep complaint (i.e. delayed sleep-onset vs early morning awakening) differ with respect to the phase of their circadian body temperature rhythm (Lack & Wright, 1993; Morris et al., 1990). If these results reflect a causal relationship, it should be possible to predict the nature of the sleep complaint of chronic insomniacs from the assessment of their circadian phase. The present study investigated this relationship by measuring the circadian phase of insomniacs and controls and relate this to their sleep characteristics.

Methods
215 Poor sleepers (PS; age 42 ± 12 y; 133 females) and 145 good sleepers (GS; age 39 ± 12 y; 77 females) were recorded. PS were referred to a sleep disorders clinic and were diagnosed as primary insomniacs. GS were healthy subjects without sleep complaints. Circadian phase was estimated by ambulatory daytime measurements of oral temperature during a two-week period, following a procedure of which the validity has been corroborated by a constant-routine study (Kerkhof & Van Dongen, 1996). Per subject, an average of 72 temperature measurements, about evenly distributed over the waking period, were obtained. These values were subjected to Lomb-Scargle periodogram analysis (Van Dongen et al., 1999) and only those subjects were included for whom a significant 24-h periodicity was found (170 PS, 113 GS). For these subjects the temperature values were fitted with 3rd-degree polynomials, for which the times of maximum (peak times) were identified. In addition, subjective measure-
mements of various sleep variables were collected by means of two-week sleep diaries.

Results and Discussion
The frequency distribution of the PS temperature peak times showed a larger range (18.07) than the GS distribution (11.83; Levene's test for equality of variances: F=12.99, p<.001). Using the 25- and 75-percentiles of the frequency distribution of the peak times of the GS as boundaries, all subjects were classified into early-, middle- and late-phase subgroups. The mean peak times for the three PS subgroups were, respectively: 13.6, 17.5 and 21.2 h; for the GS subgroups these values were: 14.7, 17.3 and 19.9 h.

Figure 1

ANOVA with the factors Groups (2 levels) and Phase (3 levels) gave the following results. Significant Group effects (at least p < .005) were obtained for mean sleep latency (PS: 59 min; GS: 18 min), mean wake after sleep onset (PS: 31 min; GS: 8 min), mean rising time (PS: 8:34 h; GS: 8:06 h), mean and standard deviation of total time spent asleep (PS: 373±76 min; GS: 437±65 min), mean number of days on which napping occurred (PS: 19%; GS: 11%), sleep quality rating (PS: 2.4; GS: 3.0) and mood after rising (PS: 3.0; GS: 3.6). Evidently, insomniacs reported relatively less night sleep and more napping and thus more fragmented sleep. In addition (and maybe in association with this), they scored a larger percentage of hypnotic use (PS: 33%; GS: 2%).

Significant overall Phase effects (at least p < .05) were obtained for: mean times of bed-in (early phase: 23:27 h; late phase: 0:43 h), mean sleep latency (early: 34 min; late: 54 min), mean and standard deviation of awakening time (early:
6:58 h ± 59 min; late: 9:09 h ± 75 min), mean and standard deviation of total time spend asleep (early: 395 ± 67 min; late: 414 ± 81 min) and mean number of days on which napping occurred (early: 22%; late: 11%).

Significant Group x Phase interactions were observed for the following variables: morningness/eveningness score (F2,232 = 4.77, p=.009), bedtime (F2,277 = 3.45, p=.033), final wake time (F2,276 = 6.76, p=.001), and rising time (F2,277 = 6.57, p=.002), indicating that the larger range of temperature phase values for the insomniacs covaries with a larger range of sleep timing variables. Also, there was a trend of a larger nap propensity for the early-phase insomniacs in particular (F2,274 = 2.44, p=.089). Significant interactions were also obtained for the variables ‘feeling refreshed upon rising’ (F2,276 = 3.87, p=.022), and ‘mood after rising’ (F2,274 = 3.50, p=.032), showing a particularly poor subjective sleep quality for the late-phase insomniacs.

In order to estimate the circadian phase of their sleep times, the individual temperature phase values were subtracted from the corresponding times of sleep onset and times of final awakening, respectively. For both poor and good sleepers the phase factor had a significant impact upon the relative times of sleep onset and awakening: the relative sleep times of early phasers appeared significantly later than those of the late phasers (sleep onset: F2,268 = 139.29, p<.001; awakening: F2,276 = 351.79, p<.001). Thus, as shown in Figure 2, the morning-type individuals started their sleep at a relatively late circadian phase, whereas the evening-type individuals started their sleep at a relatively early phase. This might reflect the restricted range of bedtimes allowed by society,
forcing morning-types to postpone their bedtimes and evening-types to advance theirs. As also shown in Figure 2, the relative sleep onsets of the poor sleepers were consistently later than those of the good sleepers ($F_{1,268} = 5.07, p=.025$). This did not apply to the relative awakening times.

**Conclusion**

In conclusion, among chronic insomniacs more extreme phase positions were observed for the temperature rhythm as well as for the timing of sleep. Circadian phase appeared to influence sleep characteristics of poor and good sleepers in a similar way. The absence of significant interactions for such core variables as sleep latency and wake after sleep onset indicates that circadian phase does not have more impact upon the sleep of insomniacs than upon the sleep of good sleepers. Subjectively, however, late-phase insomniacs show more dissatisfaction with their sleep than early-phase insomniacs.

**References**


