

Modification of Vaginal Opening Time in Rats by Light-Dark Cycle¹

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Summary | Rats reared in 10.5:10.5 hour light:dark cycle had a significantly ($p < 0.01$) earlier vaginal opening than rats reared in 4:20 hour light:dark cycle.

Key Words | Puberty — Circadian rhythm — Vagina — *Rattus* species

The estrous cycle of rats and hamsters is regulated by the daily light-dark cycle. The suprachiasmatic nucleus of the hypothalamus appears to generate a rhythm with a frequency of approximately one cycle in 24 hours. This rhythm is exactly synchronized with the external light-dark cycle by impulses received from the eyes via a retino-hypothalamic projection. Lesions which destroy the suprachiasmatic nucleus at 2 days of age produce constant vaginal estrus in the rat and alter the time of vaginal opening in blinded neonatal rats (1,2).

The purpose of the experiment described here was to determine whether a 10.5-hour light: 10.5-hour dark cycle (that is, a 21-hour light:dark cycle) causes vaginal opening to occur at a different time than a 4-hour light:20-hour dark cycle (that is, a 24-hour light:dark cycle).

Materials and Methods

Sprague Dawley outbred albino rats² Sch: Sprague-Dawley® (SD) from a colony at this institution were used in this study. Each nursing rat and her litter were housed in individual clear plastic cages. The animals were exposed to illumination from a single light source, a 7.5 Watt incandescent bulb 40 cm above the cage. The bulb was connected to a repeat cycle timer.³ The animals were exposed to either a 10.5-hour light: 10.5-hour dark cycle or a 4-hour light: 20-hour dark cycle from birth and were inspected daily for vaginal opening during the light phase of the cycle. Six litters of rats were studied, and they were assigned at random to either group. All female pups in the litter were studied.

Results

Fifteen animals reared in a 4-hour light:20-hour dark cycle had vaginal opening at 38.4 ± 2.8 (mean \pm standard deviation) days. Ten animals reared in a 10.5-hour light: 10.5-hour dark cycle had vaginal opening at

32.4 ± 4.7 days (Figure 1). The difference between the mean vaginal opening times of the animals on the 21- and 24-hour cycles was significant ($p < 0.01$).

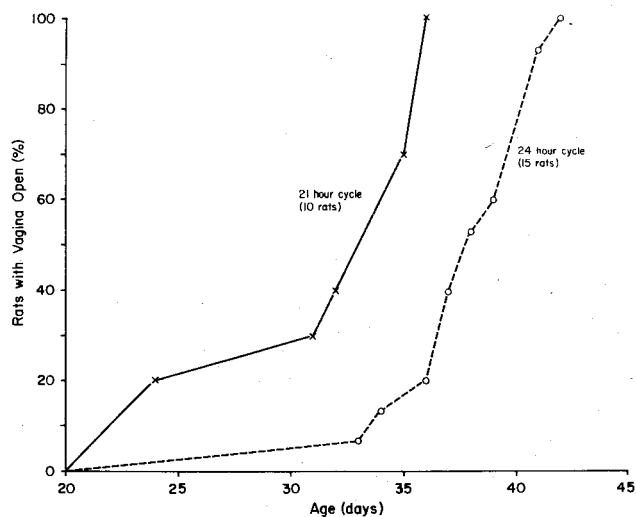


Figure 1
Percentage of rats exposed to 10.5 hours light:10.5 hours dark per day (21 hour cycle) or 4 hours light: 20 hours dark per day (24 hour cycle) with vagina opened.

Discussion

The above difference is most likely not caused by the variation in ratio of light to dark. For example, an 8-hour-light: 16-hour dark cycle has been shown to cause vaginal opening at 39.9 ± 0.4 days (3). A 12-hour light:12-hour dark cycle caused vaginal opening at 40.4 ± 0.3 days (1). The smaller variations in these opening times, compared to those in the present study, are probably the result of using inbred rather than outbred rats.

The difference in vaginal opening times demonstrated in the present study probably was due to the acceleration in circadian rhythms of the rats on the 10.5-hour

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²ARS Sprague Dawley, Madison, WI.

³Flexopulse Timer model HG110A6, Eagle Signal Company, Davenport, IA.

light: 10.5-hour dark cycle. These results suggest that the early menarche in blind girls and the early vaginal opening of rats reared in constant darkness are also due to an acceleration of normal circadian rhythms (3,4).

In a blind animal, the rhythm of the supra-chiasmatic nucleus is free running, that is, somewhat greater or lesser in frequency than one cycle in 24 hours (5). This rhythm is synchronized with and probably drives other physiologic rhythms, including plasma corticosterone levels and pineal N-acetyltransferase levels in the rat. In blinded animals, these rhythms are also free running, though synchronized with each other (6).

Blind adult humans are known to have a free running circadian rhythm of about one cycle in 25 hours, but the length of the free running rhythm in children is unknown (7). One may, therefore, postulate that the free running rhythm in a young child is more rapid than one cycle in 24 hours, perhaps one cycle in 23 hours, and slows with age. Such a slowing has been demonstrated in hamsters (though age might not have been the only factor involved) (8). An accelerated circadian rhythm would explain the early menarche in blind girls and the early vaginal opening of rats reared in constant darkness (9).

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