

Night Light Alters Menstrual Cycles

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Abstract. Dewan asserted 20 years ago that a bedside light could shorten and regularize the menstrual cycle among women with long and irregular menstrual patterns. To replicate this, seven volunteers slept with a 100-watt bulb by the bedside from days 13-17 of their menstrual cycles, while nine controls similarly used a dim red placebo (photographic safe light). Indeed, the 100-watt bulbs shortened menstrual cycles from a mean of 45.7 days to 33.1 days and reduced variability, but the placebo had no effect. These results suggest that light may have promise for treatment of infertility, for contraception, and for other endocrine interventions.

Key Words. Light, menstruation, phototherapy.

Dewan reported over 20 years ago that a bedside night light could shorten and regularize menstrual cycles among women experiencing long and irregular cycles (Dewan, 1967, 1969). Perhaps because his studies were not presented in archival form, or because his rationale related to moonlight seemed so implausible, the work was largely ignored.

In the last decade, dramatic biological responses to light have received increasing attention. It has been shown that human pineal melatonin secretion, which occurs mainly late at night, can be promptly suppressed by very bright light of approximately 2500 lux, which is much brighter than most customary indoor illumination (Lewy et al., 1980). The first reports suggested that light of 500 lux was not bright enough to suppress melatonin in humans, though it suppresses melatonin in many laboratory species. More recent data have suggested that 500 lux (or even 300 lux) may suppress melatonin in certain healthy subjects (Lewy et al., 1981; Bojkowski et al., 1987; Brainard et al., 1988; McIntyre et al., 1989). Patients with affective disorders may be even more sensitive to light (Lewy et al., 1981).

Light has dramatic effects on reproductive endocrinology in a variety of mammalian species (Tamarkin et al., 1985). Light suppression of melatonin can alter luteinizing hormone, follicle stimulating hormone, prolactin, corticotropin releasing factor, and thyroid stimulating hormone, as well as hypothalamic sensitivity to gonadal steroid feedback (Carter and Goldman, 1983; Tamarkin et al., 1985; Reiter, 1987).

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Women with hypothalamic amenorrhea have amplified melatonin (Berga et al., 1988). Bright light treatments are capable of reversing seasonal affective disorder, a syndrome of winter fatigue that may be accompanied by premenstrual symptoms (Lewy et al., 1987; Rosenthal and Wehr, 1987). Early evidence suggests bright light also has therapeutic potential for nonseasonal depression (Kripke et al., 1989) and late luteal phase dysphoric disorder (Parry et al., 1989). These findings made Dewan's reports seem less implausible.

To reconsider Dewan's idea that light affects the menstrual cycle, we repeated his study with innovations designed to provide experimental controls.

Methods

By advertisement, we recruited healthy volunteers of normal weight, ages 18-30, who had long or irregular menstrual cycles that were reported retrospectively to last 33-48 days. Women with known endocrine disorders, weight < 10% below normal, or appearance of masculinization were excluded. Each volunteer agreed to record her dates of menstruation for three consecutive cycles.

One undisturbed baseline menstrual cycle was prospectively observed. The women were then randomly assigned (with stratification by age and mean cycle length) to the active treatment (a 100-watt white incandescent bedside lamp producing 235 lux photopic illumination at 1 m) or to the control placebo treatment (a 25-watt shaded red photographic safe light producing 1.7 lux at 1 m). Dropouts were replaced. Subjects were told that "special lights" could regularize the menstrual cycle, but no different expectation for 235 lux versus 1.7 lux was stated. Each subject used the randomly assigned light for the entire night following days 13-17 of the second menstrual cycle. The lights were placed at 1 m from the head at the bedside. No effort was made to control head position or to keep the eyes open. In addition, the group assigned the white light were asked to read in bed for ½ hour before sleeping to ensure some waking 235 lux exposure. The dates of the following menstrual periods were then recorded, so the durations of the treatment cycle and the followup could be calculated.

Results

Seven subjects completed 235 lux treatment (eight dropped out, one *before* treatment began, some because of difficulty sleeping). The mean baseline cycle length for those dropouts was 43.3 days. Nine completed control placebo treatments (two dropped out). No significant differences were observed between groups at baseline, but several subjects (some in each group) had very long cycles (> 48 days) when prospectively observed.

As shown in Table 1, during the treatment cycle only, the group treated with the 235 lux light had significantly shorter menstrual cycles than the controls (Wilcoxon Rank Sum Test, one-tailed, $p < 0.05$). The Bartlett test for homogeneity of group variances showed cycle lengths were significantly less variable in the cycles with 235 lux treatment ($p = 0.006$, two-tailed), but not during baseline or followup. Further, the 235 lux treatment significantly reduced menstrual cycle durations during the treatment cycle compared to the baseline cycle (Wilcoxon Signed Ranks Test, one-tailed, $p = 0.009$).

The control 1.7 lux treatment produced no significant changes contrasted with baseline or followup. The apparent improvement in mean cycle length from baseline to followup in the control group was due to one subject with a 141-day baseline cycle. Indeed, only four of nine control subjects shortened their cycles from baseline to followup, which is by no means comparable to the shortened cycle in seven of seven subjects with 235 lux treatment (Fisher exact test: $p < 0.03$).

Most of the volunteers treated with 235 lux reported some difficulty sleeping. No other symptoms or adverse effects were described.

Table 1. Mean cycle lengths in days

	Baseline cycle	Treatment cycle	Followup cycle
235 lux light ($n = 7$)	45.7 \pm SD 16.0	33.1 \pm SD 5.3	46.3 \pm SD 27.7
1.7 lux light ($n = 9$)	53.9 \pm SD 35.5	46.0 \pm SD 18.3	40.7 \pm SD 15.6

Discussion

These data support Dewan's report that a 100-watt night light can shorten and reduce variability in menstrual cycles among women selected for long and irregular cycles. Dim red light was ineffective, though it was brighter than moonlight. We have found in other studies that dim red light is an impressive placebo which subjects often believe is the active treatment (Kripke et al., 1989). Thus, we doubt suggestion was a factor. It seems likely that 235 lux light produces a biological effect which alters menstrual irregularities in certain women. The biological mechanism is presently unknown.

Recent data suggest that melatonin is suppressed by 300 lux in some individuals (Bojkowski et al., 1987). Thus, it is conceivable that the 235 lux we used worked through melatonin suppression. To be sure, illumination exposure must have been much less than 235 lux when subjects turned away from the lamp, closed their eyes, or even put pillows over their heads, as they may well often have done. Further studies with nocturnal blood sampling should be done to determine if night lights do indeed alter melatonin secretion.

Further studies with additional control conditions will be needed to explore several alternative mechanisms by which the experimental effects could have been mediated. For example, the 235 lux light could have worked indirectly by producing sleep disturbances which then altered menstrual cyclicity. The night light's main effect may have occurred before sleep onset, during the half-hour of reading where there may have been effects related to behavioral modification. *Before* sleep onset, the light might have served as a circadian synchronizer or phase-delaying stimulus (Drennan et al., 1989). We were unable to balance this aspect of our design, because the dim red light was too dim for reading.

Future studies should examine the influence of subject expectations. For example, the more frequent dropouts in the 235 lux group may suggest that subjects viewed the 100-watt bulb as less promising than the red safe light. Our major goal was to confirm Dewan's reports that night lights have a real effect. Our future goal is to define the mechanisms by which such effects are mediated.

As Dewan (1967, 1969) originally stated, light effects on menstruation could have many applications. We do not yet know if night lights precipitated or suppressed follicle development and ovulation or worked through other mechanisms. Timed illumination could contribute to rhythm-based contraceptive methods if ovulation could be regularized, with or without suppression. If nocturnal illumination can precipitate ovulation, it could serve as a tool to promote fertility. As we learn more about the endocrine effects of light in humans, we may find other applications in

treatment of endocrine disorders. We may also learn that much of the observed menstrual irregularity and ovulatory variability in women can be explained by daily variations in the illumination experienced, variations which our group has found to be remarkable (Kripke and Gregg, 1990).

The results of this study raise important issues to be addressed in future work. For instance, the effects of light on melatonin, other hormones, ovulation, and sleep should be quantitated to establish light's regulatory role in menstruation. In addition, studies can be done to investigate light's effect on normal menstrual cycles, menarche, and menopause.

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References

- Berga, S.L.; Mortola, J.F.; and Yen, S.S.C. Amplification of nocturnal melatonin secretion in women with functional hypothalamic amenorrhea. *Journal of Clinical Endocrinology and Metabolism*, 66:242-244, 1988.
- Bojkowski, C.J.; Aldhous, M.E.; English, J.; Franey, C.; Poulton, A.L.; Skene, D.J.; and Arendt, J. Suppression of nocturnal plasma melatonin and 6-sulphatoxymelatonin by bright and dim light in man. *Hormone and Metabolic Research*, 19:437-440, 1987.
- Brainard, G.C.; Lewy, A.J.; Menaker, M.; Frederickson, R.H.; Miller, L.S.; Weleber, R.G.; Cassone, V.; and Hudson, D. Dose-response relationship between light irradiance and the suppression of plasma melatonin in human volunteers. *Brain Research*, 454:212-218, 1988.
- Carter, D.S., and Goldman, B.D. Progonadal role of the pineal in the Djungarian hamster: Mediation by melatonin. *Endocrinology*, 113:1268-1273, 1983.
- Dewan, E.M. On the possibility of a perfect rhythm method of birth control by periodic light stimulation. *American Journal Obstetrics and Gynecology*, 99:1016-1018, 1967.
- Dewan, E.M. Rhythms. *Science and Technology*, pp. 20-28, 1969.
- Drennan, M.; Kripke, D.F.; and Gillin, J.C. Bright light can delay human temperature rhythm independent of sleep. *American Journal of Physiology*, 257:R136-R141, 1989.
- Kripke, D.F., and Gregg, L. Circadian effects of varying environmental light. In: Miles, L.E., and Broughton, R.J., eds. *Medical Monitoring in the Home and Work Environment*. New York: Raven Press, 1990. pp. 187-195.
- Kripke, D.F.; Mullaney, D.J.; Savides, T.J.; and Gillin, J.C. Phototherapy for nonseasonal major depressive disorders. In: Rosenthal, N., and Blehar, M., eds. *Seasonal Affective Disorders and Phototherapy*. New York: The Guilford Press, 1989. pp. 342-356.
- Lewy, A.J.; Sack, R.L.; Miller, L.S.; and Hoban, T.M. Antidepressant and circadian phase-shifting effects of light. *Science*, 235:352-354, 1987.
- Lewy, A.J.; Wehr, T.A.; Goodwin, F.K.; Newsome, D.A.; and Markey, S.P. Light suppresses melatonin secretion in humans. *Science*, 210:1267-1269, 1980.
- Lewy, A.J.; Wehr, T.A.; Goodwin, F.K.; Newsome, D.A.; and Rosenthal, N.E. Manic-depressive patients may be supersensitive to light. (Letter) *Lancet*, February 14:383-384, 1981.
- McIntyre, I.M.; Norman, T.R.; Burrows, G.D.; and Armstrong, S.M. Human melatonin suppression by light is intensity dependent. *Journal of Pineal Research*, 6:149-156, 1989.
- Parry, B.L.; Berga, S.L.; Mostofi, N.; Sependa, P.A.; Kripke, D.F.; and Gillin, J.C. Morning versus evening bright light treatment of late luteal phase dysphoric disorder. *American Journal of Psychiatry*, 146:1215-1217, 1989.
- Reiter, R.J. Mini-review. The melatonin message: Duration versus coincidence hypotheses. *Life Sciences*, 40:2119-2131, 1987.
- Rosenthal, N.E., and Wehr, T.A. Seasonal affective disorders. *Psychiatric Annals*, 17:670-674, 1987.
- Tamarkin, L.; Baird, C.J.; and Almeida, O.F.X. Melatonin: A coordinating signal for mammalian reproduction? *Science*, 227:714-720, 1985.