# BIOGRAPHICAL SKETCH

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NAME: Eastman, Charmane I.

eRA COMMONS USER NAME (credential, e.g., agency login): ceastman

POSITION TITLE: Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| State University of New York at Albany (SUNY) | B.S. | 06/1965 | Mathematics |
| University of Chicago, Chicago, Illinois | M.S. | 06/1976 | Biological Psychology |
| University of Chicago, Chicago, Illinois | Ph.D. | 08/1980 | Biological Psychology |
| University of Chicago, Chicago, Illinois | Post-doc | 06/1983 | Psychiatry |

## A. Personal Statement

My main research interest, over the past 30+ years, has been how to reset, or phase shift, human circadian rhythms with light and melatonin in order to reduce the circadian misalignment in jet lag, shift work and circadian-based sleep disorders, such as the Delayed Sleep Phase Disorder.

## B. Positions and Honors

### Positions and Employment

| | |
|---|---|
| 1965 – 1968 | Research Assistant, Psychology Department, Harvard, Cambridge, Massachusetts |
| 1968 - 1969 | Research Assistant, Psychology Department, M. I. T., Cambridge, Massachusetts |
| 1969 - 1973 | Research Assistant, Physiology Department, University of California, Berkeley |
| 1973 - 1974 | Research Assistant, Psychology Department, University of California, Berkeley |
| 1983 - 1989 | Assistant Professor, Psychology Dept, Rush University Medical Center (RUMC), Chicago |
| 1983 - 1987 | Laboratory Coordinator, Sleep Disorders Service and Research Center, RUMC |
| 1987 - 2013 | Founder and Director of the Biological Rhythms Research Laboratory, RUMC |
| 1989 - 1998 | Associate Professor, Department of Psychology, RUMC |
| 1998 - present | Professor, Department of Behavioral Sciences, RUMC |

### Honors (selected)

Excellence in Applied Circadian Rhythm Research Award from the National Sleep Foundation, presented March 2, 2012 in Washington, D.C.

Consultant for the FDA Peripheral & Central Nervous System Drugs Advisory Committee Meeting, November, 2013, Silver Spring, MD.

The Science of Jet Lag and its Management, 1 hour briefing before the Congressional Biomedical Research Caucus in Washington DC, Sept, 2010.

Shifting Human Circadian Rhythms with Light, Dark and Melatonin: Solutions for Jet Lag and Shift Work, one hour lecture at the $19^{th}$ Annual Meeting of the Associated Professional Sleep Societies (APSS), Denver, June, 2005.

Young Investigator Award, Applications of Non-24-Hour Sleep-Wake Schedules, NIH, National Institute of Neurological Disorders and Stroke (NINDS), R23 NS23421, 1986-1989.

**C. Contributions to Science**

**1. Basic Mechanisms of Human Circadian Rhythms.** I was the first to suggest that exposure to bright light outdoors could affect our sensitivity to the light stimuli from light boxes used in experiments and treatments. Together with my post-doc, Marc Hébert, we designed a study to test how light history could affect the response to light in the lab (Ref a. below). After one week of remaining in relatively dim light (by staying indoors as much as possible and wearing dark goggles when outside) subjects were much more sensitive to light than when they were after a week of getting a lot of bright light (by going outside as much as possible and using light boxes when inside). Since this pivotal study, others have pursued the topic, such as: Smith KA, Schoen MW and Czeisler CA (2004) Adaptation of human pineal melatonin suppression by recent photic history. *J Clin Endocrinol Metab* 89:3610-3614; Jasser SA, Hanifin JP, Rollag MD and Brainard GC (2006) Dim light adaptation attenuates acute melatonin suppression in humans. *J Biol Rhythms* 21:394-404; Chang AM, Scheer FA and Czeisler CA (2011) The human circadian system adapts to prior photic history. *J Physiol* 589.5:1095-1102; Chang AM, Scheer FA, Czeisler CA and Aeschbach D (2013) Direct effects of light on alertness, vigilance, and the waking electroencephalogram in humans depend on prior light history. *Sleep* 36:1239-1246. Thus, we started a new, ongoing line of research.

As described above we were also the first to explore the role of sleep length (dark length) in modulating the phase shifting responses to bright light in humans. We showed that sleep restriction reduces both phase advances to morning bright light (Ref 3, above) and phase delays to evening bright light (Ref b, below).

After the discovery of the new mammalian photoreceptors in the retina (distinct from rods and cones) called intrinsically photosensitive retinal ganglion cells (ipRCGs), that are most sensitive to blue light, there was much excitement in the field. Light box manufacturers designed light boxes that emitted more blue light (blue-enriched) or emitted only blue light. We compared the blue-enriched light boxes with the traditional fluorescent light boxes for their phase advancing ability (Ref c, below) and their phase delaying ability (Smith MR and Eastman CI (2009) Phase delaying the human circadian clock with blue-enriched polychromatic light. *Chronobiol Int* 26:709-725). There was no difference; the traditional light boxes were already emitting enough blue light for maximal results. Thus, the extra expense of new, blue-emitting lamps is not necessary. We generated the only phase response curve (PRC) to blue light. Subjects were exposed to one small LED goLITE. The phase advances extend further into the late afternoon than PRCs generated with white polychromatic light (Ref d, below).

This work has contributed significantly to understanding the basic mechanisms of human circadian physiology.

a. Hébert M, Martin SK, Lee C and Eastman CI (2002) The effects of prior light history on the suppression of melatonin by light in humans. *J Pineal Res* 33:198-203. PMID:12390501, PMCID: PMC3925650
b. Burgess HJ and Eastman CI (2006) Short nights reduce light-induced circadian phase delays in humans. *Sleep* 29:25-30. PMID:16453978, PMCID: PMC3841979
c. Smith MR, Revell VL and Eastman CI (2009) Phase advancing the human circadian clock with blue-enriched polychromatic light. *Sleep Med* 10:287-294. PMID:18805055, PMCID:PMC 2723863.
d. Revell VL, Molina TA and Eastman CI (2012) Human phase response curve to intermittent blue light using a commercially available device. *J Physiol* 590:4859-4868. PMID: 22753544, PMCID: PMC3487041.

**2. Jet Lag**. I have contributed much to the science of how to phase shift human circadian rhythms with light, dark and melatonin, and one of the applications of this work is to reduce or eliminate jet lag. I was the first to specify how to start shifting circadian rhythms towards the destination time zone before the flight using appropriately timed bright light, sunglasses, sleep schedules and melatonin (see Ref 1, above and Refs a and b, below). Previous recommendations focused on how to accelerate re-entrainment after landing in the new time zone, which unfortunately guarantees that people will have jet lag, at least for a few days. We have published schedules designed to reduce or eliminate jet lag in several reviews such as Refs c and d, below.

a. Eastman CI, Gazda CJ, Burgess HJ, Crowley SJ and Fogg LF (2005) Advancing circadian rhythms before eastward flight: A strategy to prevent or reduce jet lag. *Sleep* 28:33-44. PMID:15700719, PMCID: PMC1249488
b. Revell VL and Eastman CI (2005) How to trick Mother Nature into letting you fly around or stay up all night. *J Biol Rhythms* 20:353-365. PMID:16077154, PMCID: PMC3841977

c. Eastman CI and Burgess HJ (2009) How to travel the world without jet lag. *Sleep Med Clin* 4:241-255. PMID:20204161, PMCID: PMC2829880
d. Revell VL and Eastman CI (2012) Jet lag and its prevention. In *Therapy in Sleep Medicine*, TJ Barkoukis, JK Matheson, R Ferber and K Doghramji, eds, pp 390-401, Elsevier.

**3. Shift Work.** Most of the vast literature on shift work is about all the negative consequences of shift work. By contrast, there is very little research on how to reduce circadian misalignment in shift workers, which is the main underlying cause of the sleep deprivation, the increased risk of many diseases including cancer, and the safety risks to both workers and the public. Unlike most research which focuses on symptomatic relief, such as when to drink coffee, my research focuses on how to reduce circadian misalignment in order to prevent or attenuate the cause of these shift work problems. We have designed and tested a sleep and light schedule for permanent night workers based on the fact that the best sleep occurs when the body temperature minimum falls within the sleep opportunity. By controlling the exposure to light and dark (sleep) we can delay the temperature minimum so that it falls within daytime sleep after the night shift (it falls near the beginning of sleep) and this position also puts it within sleep on days off (it falls near the end of sleep as long as a late sleep schedule is kept on days off). This schedule is described in Refs c and d, below. Our subjects were able to sleep well on the prescribed sleep and light schedule, and their performance during the night shifts was remarkably improved; they performed almost as well as during the day shifts. The studies listed below and many others were supported by my R01 grants OH003954 and NS23421.

a. Eastman CI and Martin SK (1999) How to use light and dark to produce circadian adaptation to night shift work. *Ann Med* 31:87-98. PMID:10344580
b. Crowley SJ, Lee C, Tseng CY, Fogg LF and Eastman CI (2004) Complete or partial circadian re-entrainment improves performance, alertness, and mood during night shift work. *Sleep* 27:1077-1087. PMID:15532201
c. Smith MR, Fogg LF and Eastman CI (2009) A compromise circadian phase position for permanent night work improves mood, fatigue, and performance. *Sleep* 32:1481-1489. PMID:19928387, PMCID: PMC2768954.
d. Smith MR and Eastman CI (2012) Shift work: health, performance and safety problems, traditional countermeasures, and innovative management strategies to reduce circadian misalignment. *Nat Sci Sleep* 4:111-132. PMID: 23620685 PMCID: PMC3630978.
e. Eastman, CI. How to reduce circadian misalignment in rotating shift workers. ChronoPhysiology and Therapy. 6:41-46, 2016.

**4. Melatonin**. We have studied the phase-shifting and soporific effects of melatonin, supported by my R01s (NS35695, NR007677 and HL086934). We found that sustained release melatonin given to night shift workers before daytime sleep had a modest beneficial effect on sleep (Ref a, below), but not as much as in our night shift studies, such as those cited above, in which we shifted the circadian clock to reduce circadian misalignment. We found that regular release melatonin (0.5 mg and 3.0 mg) helped advance the circadian clock when given before a sleep schedule that was advanced to occur in the evenings before the night shifts. Both doses produced significantly larger phase advances than placebo, and there was only a slight difference between the doses (Ref b, below). We generated a PRC to 0.5 mg melatonin and one to 3.0 mg melatonin which showed that the best time to take melatonin to get a phase advance was earlier with the larger dose, but there was no difference in phase shift magnitude between the two does (Ref d, below). We found that the largest phase advances were produced by the combination of afternoon melatonin with morning bright light. The effects of melatonin and bright light were additive (Ref c, below).

a. Sharkey KM, Fogg LF and Eastman CI (2001) Effects of melatonin administration on daytime sleep after simulated night shift work. *J Sleep Res* 10:181-192. PMID:11696071. PMCID: PMC3679650.
b. Sharkey KM and Eastman CI (2002) Melatonin phase shifts human circadian rhythms in a placebo-controlled simulated night-work study. *Am J Physiol* 282:R454-R463. PMID:11792655. PMCID: PMC3696986
c. Revell VL, Burgess HJ, Gazda CJ, Smith MR, Fogg LF and Eastman CI (2006) Advancing human circadian rhythms with afternoon melatonin and morning intermittent bright light. *J Clin Endocrinol Metab* 91:54-59. PMID:16263827, PMCID: PMC3841985

d. Burgess HJ, Revell VL, Molina TA and Eastman CI (2010) Human phase response curves to three days of daily melatonin: 0.5 mg versus 3.0 mg. *J Clin Endocrinol Metab* 95:3325-3331. PMID:20410229, PMCID: PMC2928909.

e. Crowley, SJ & Eastman, CI. Melatonin in the afternoons of a gradually advancing sleep schedule enhances the circadian rhythm phase advance. Psychopharmacology, 225:825-837, 2013, PMID:23001190, PMCID:PMC3558560.

f. Crowley, SJ & Eastman, CI. Phase advancing human circadian rhythms with morning bright light, afternoon melatonin, and gradually shifted sleep: can we reduce morning bright-light duration? Sleep Med. 16:288-297, 2015. PMID:25620199, PMCID:PMC4344919

**5. Racial Differences in Human Circadian Rhythms**. We discovered that African-Americans have shorter free-running periods (tau) than European-Americans, and showed that a shorter tau facilitates phase advances whereas a longer tau facilitates phase delays. We speculate that African-Americans retain the original short tau that we had during our evolution in Africa, whereas Europeans developed longer taus as an adaptation to the change in day length with seasons in the north. We are continuing this new, unique, line of research.

a. Smith MR, Burgess HJ, Fogg LF and Eastman CI (2009) Racial differences in the human endogenous circadian period. *PLoS One* 4:e6014. PMID:19564915, PMCID: PMC2699031
b. Eastman CI, Molina TA, Dziepak ME and Smith MR (2012) Blacks (African Americans) have shorter free-running circadian periods than whites (Caucasian Americans). *Chronobiol Int* 29:1072-1077. PMID:22894720, PMCID:PMC3454515.
c. Eastman CI, Suh C, Tomaka VA and Crowley SJ (2015) Circadian rhythm phase shifts and endogenous free-running circadian period differ between African-Americans and European-Americans. *Sci Rep* 5:8381. PMID:25670162, PMCID:PMC4323653
d. Crowley SJ, Smith MR, Tomaka VA and Eastman CI (2015) African-Americans sleep less than European-Americans after a 9-hour advance of sleep. *Sleep* 38:A70.
e. Eastman, CI, Tomaka, VA, Crowley, SJ. Circadian rhythms of European and African-Americans after a large delay of sleep as in jet lag and night work. Sci. Rep. 6:36716, 2016. PMID:27819313, PMCID:PMC5098183

A list of almost all of my published work can be found here:
http://www.ncbi.nlm.nih.gov/myncbi/browse/collection/43700490/?sort=date&direction=descending

**D. Research Support**

**Ongoing Research Support**

R01 HL105395 Crowley (PI) 4/9/12 - 2/28/17
NIH/NHLBI
Adolescent Sleep Delay: Circadian Regulation and Phase Shifting with Light
The major goal of this project is to construct and compare phase response curves to bright white light in pubertal adolescents and middle-aged adults. In doing so, we propose to examine possible mechanisms underlying the pubertal circadian phase delay.
Role: Co-Investigator

R01 HL112756 Crowley (PI) 9/1/14 – 6/30/19
NIH/NHLBI
Teen School-Night Sleep Extension: An Intervention Targeting the Circadian System
The major goal of this project is to develop and test an effective, yet feasible behavioral intervention to extend school-night sleep duration of older adolescents.
Role: Co-Investigator

R01 NR007677 Eastman (PI) 8/7/12 - 5/31/17
NIH/NINR
Racial Differences in Human Circadian Rhythms
The major goal of this project is to determine whether there are racial differences in the ability of the circadian clock to phase shift to realign with shifted sleep schedules that create circadian misalignment (such as in shift work and jet travel).

**Completed Research Support**

R01 HL083971 Burgess (PI) 3/1/08 - 2/28/13
NIH/NHLBI
Sleep Length and Circadian Regulation in Humans
The major goals of this project were to test the effect of sleep deprivation and night (dark) length on circadian phase shifts to bright light.
Role: Co-Investigator

R01 HL105385 Burgess (PI) 9/1/11 – 6/30/14
NIH/NCCAM
Circadian Phase Assessments at Home: Validity and Normative Data
The major goals of this project were to establish the validity of an at home circadian phase assessment procedure in healthy controls and patients with delayed sleep phase disorder.
Role: Co-Investigator