Aamu-iltavirkkuuden merkitys terveydelle

Timo Partonen, tutkimusprofessori, Terveyden ja hyvinvoinnin laitos (THL)

Chronotype = morningness-eveningness

19. One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be ?

Definitely a "morning"type

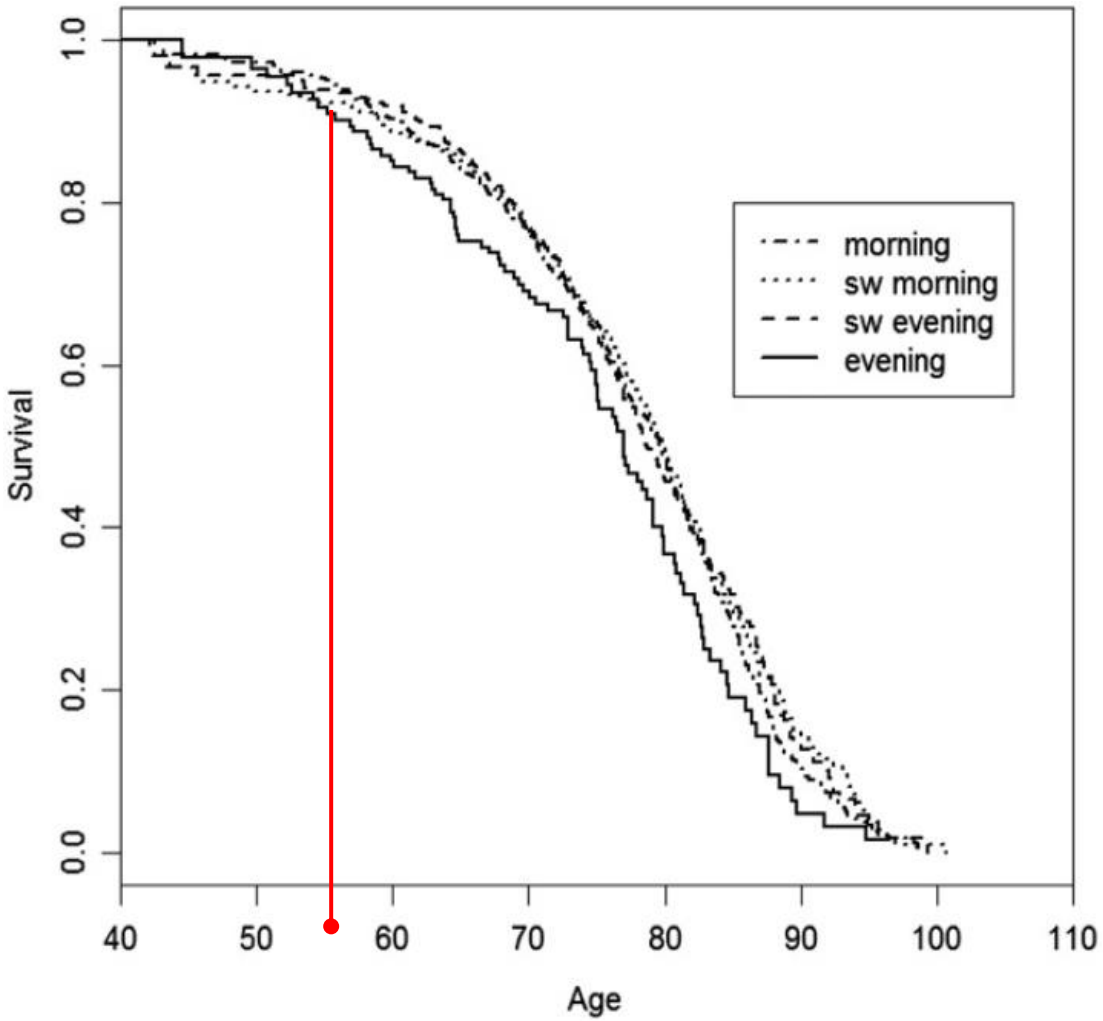
Rather more a "morning" than an "evening" type

Rather more an "evening" than a "morning" type

Definitely an "evening" type

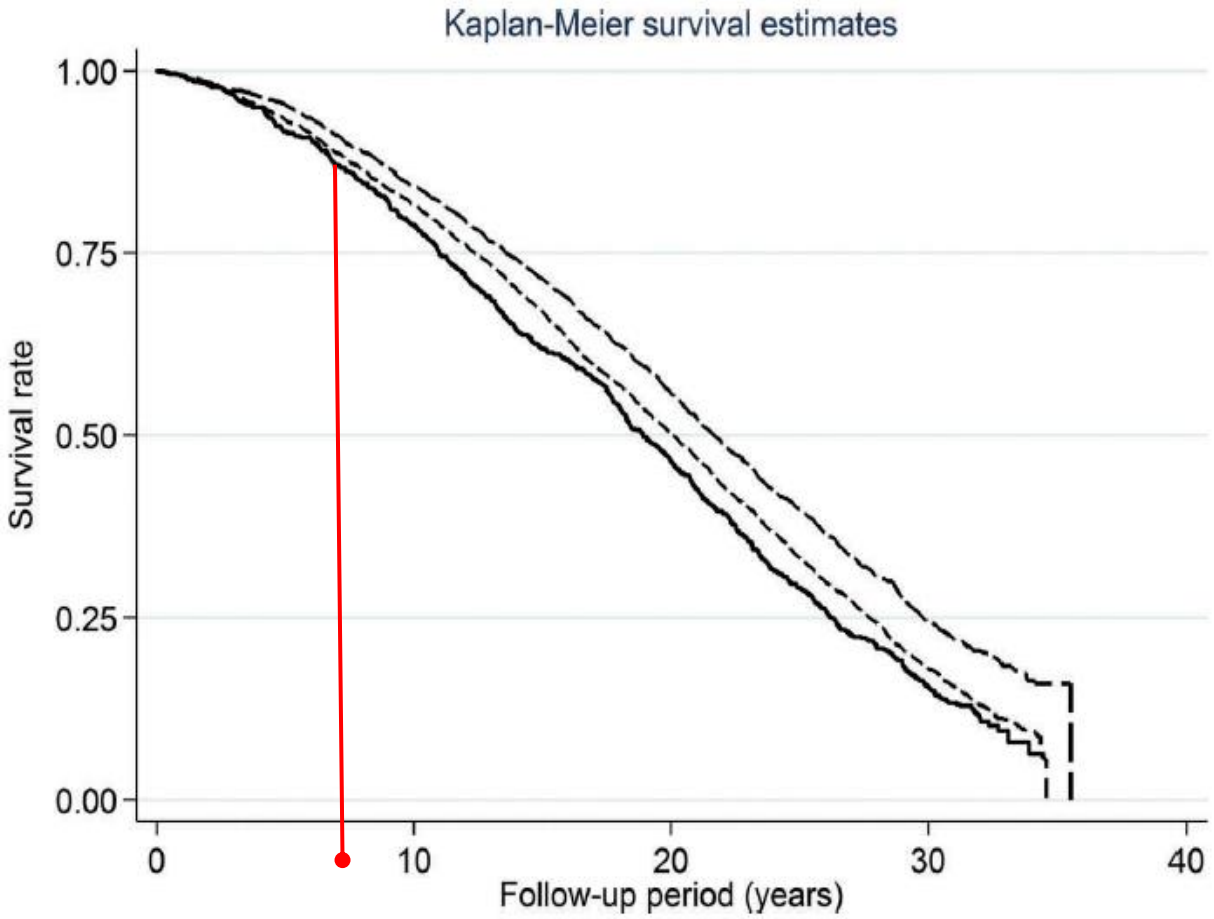
Int J Chronobiol 1976;4:97-110.

Chronotype and mortality



The UMLCHA cohort (Chronobiol Int 2019;36:1285-300) and UK Biobank cohort (Chronobiol Int 2018;35:1045-53) showed the increased mortality for the "night owls" among those aged 40–90 years and 63–73 years, respectively, and **agreed with our finding of those aged 56 years or older as above (Chronobiol Int 2014;31:182-8)**.

Chronotype and mortality



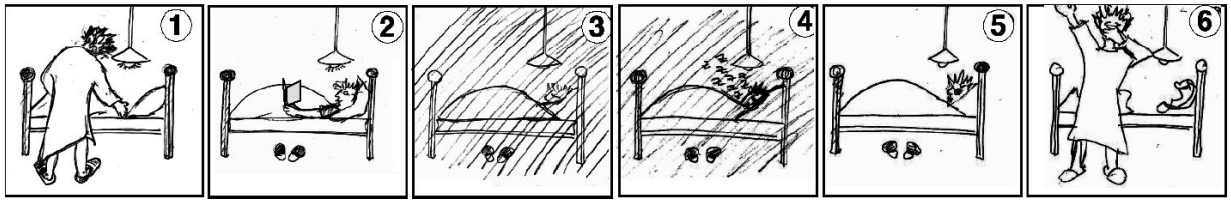
The UMLCHA (University of Manchester Longitudinal Study of Cognition in Normal Healthy Old Age) cohort (Chronobiol Int 2019;36:1285-300) and UK Biobank cohort (Chronobiol Int 2018;35:1045-53) showed the increased mortality for the "night owls" among those aged 40–90 years and 63–73 years, respectively, and agreed with our finding of those aged 56 years or older as above (Chronobiol Int 2014;31:182-8).

Two different ways of assessing the **chronotype** by self-reports:

1. Morningness/eveningness questionnaire (MEQ) of 1976 determines the preference for timing the daily activities and produces **a score**, whereas

2. Munich ChronoType Questionnaire (MCTQ) of 2003 aims to determine the phase of entrainment by middle-point of sleep and produces **a clock time**.

Chronobiol Int 2001;18:809-22. J Sleep Res 2007;16:156-62. Chronobiol Int 2014;31:222-31.
J Biol Rhythms 2015;30:487-91.



On work days (including the night before a work day)

... I go to bed at _____ o'clock **(see image 1)**

... at _____ o'clock, I decide to fall asleep **(see image 3)**

... I need _____ minutes to fall asleep **(see image 4)**

... I wake up at _____ o'clock **(see image 5)**

without alarm clock ☐ with alarm clock ☐

... after _____ minutes I get up **(see image 6)**

On average, how long per day,
do you spend outside exposed to daylight (without a roof above head)? _____h _____min

On free days (including the night before a free day)

... I go to bed at _____ o'clock **(see image 1)**

... at _____ o'clock, I decide to fall asleep **(see image 3)**

... I need _____ minutes to fall asleep **(see image 4)**

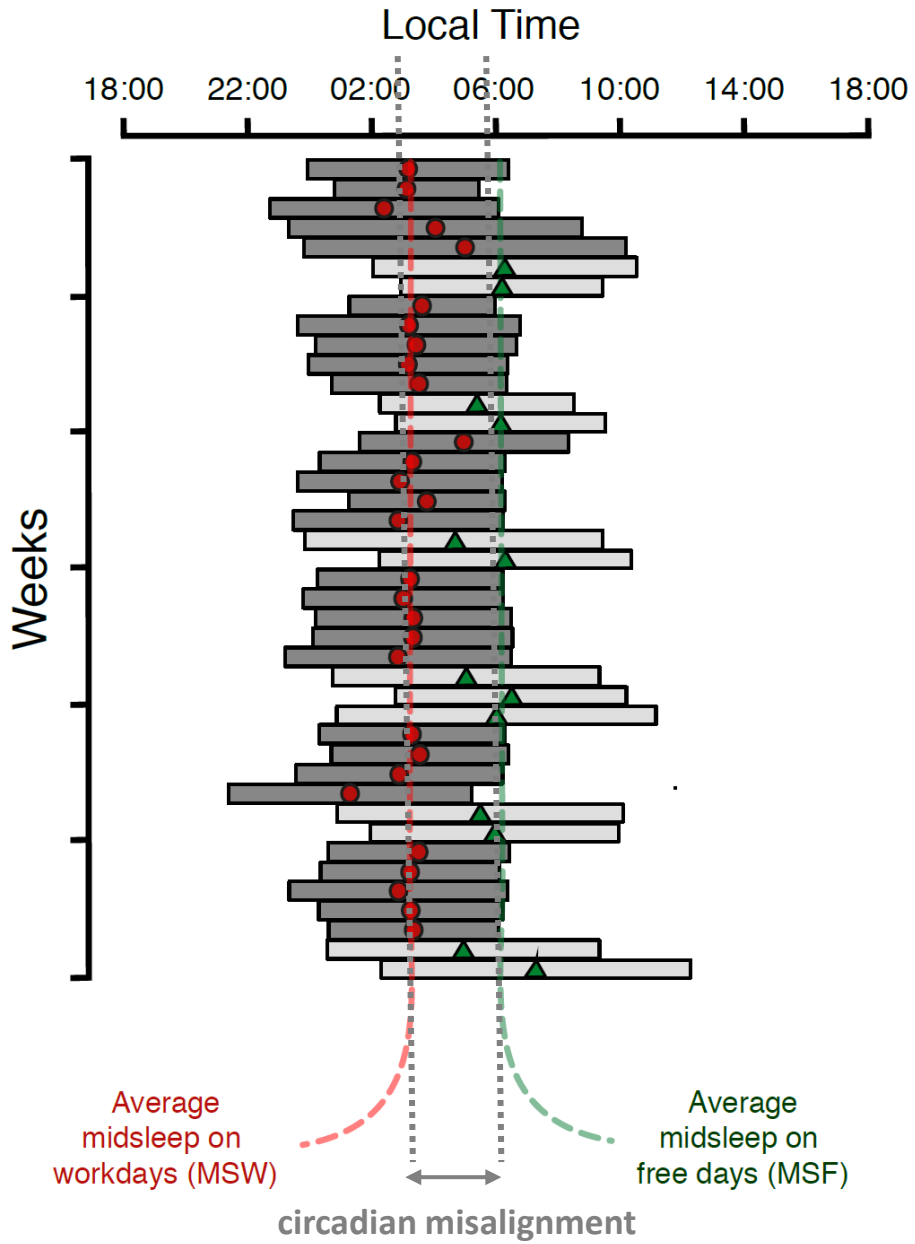
... I wake up at _____ o'clock **(see image 5)**

without alarm clock ☐ with alarm clock ☐

... after _____ minutes I get up **(see image 6)**

On average, how long per day,
do you spend outside exposed to daylight (without a roof above head)? _____h _____min

J Biol Rhythms 2003;18:80-90.



Biology (Basel) 2019;8:E54.

TAULUKKO 1.

Kronotyypin määritys

Kronotyypin määritys kyselylomakkeen (58) ja uni-valvepäiväkirjan (59) perusteella.

Kronotyyppi	Kyselylomake	Uni-valvepäiväkirja	
	Summa (pistemäärä)	Nukahtamisen kellonaika	Heräämisen kellonaika
Ehdottomasti aamuihminen	70–86	21.00–21.30	4.00–5.00
Enemmän aamu- kuin iltaihminen	59–69	21.30–22.45	5.00–6.30
Ei enempää aamu- kuin iltaihminen	42–58	22.45–0.45	6.30–8.30
Enemmän ilta- kuin aamuihminen	31–41	0.45–2.00	8.30–10.00
Ehdottomasti iltaihminen	16–30	2.00–3.00	10.00–11.30

Suom Lääkäril 2019;74:2221-5.

Two different ways of assessing the **chronotype** by measurements:

1. accelerometers record **the diurnal cycle** of rest-activity movements, whereas

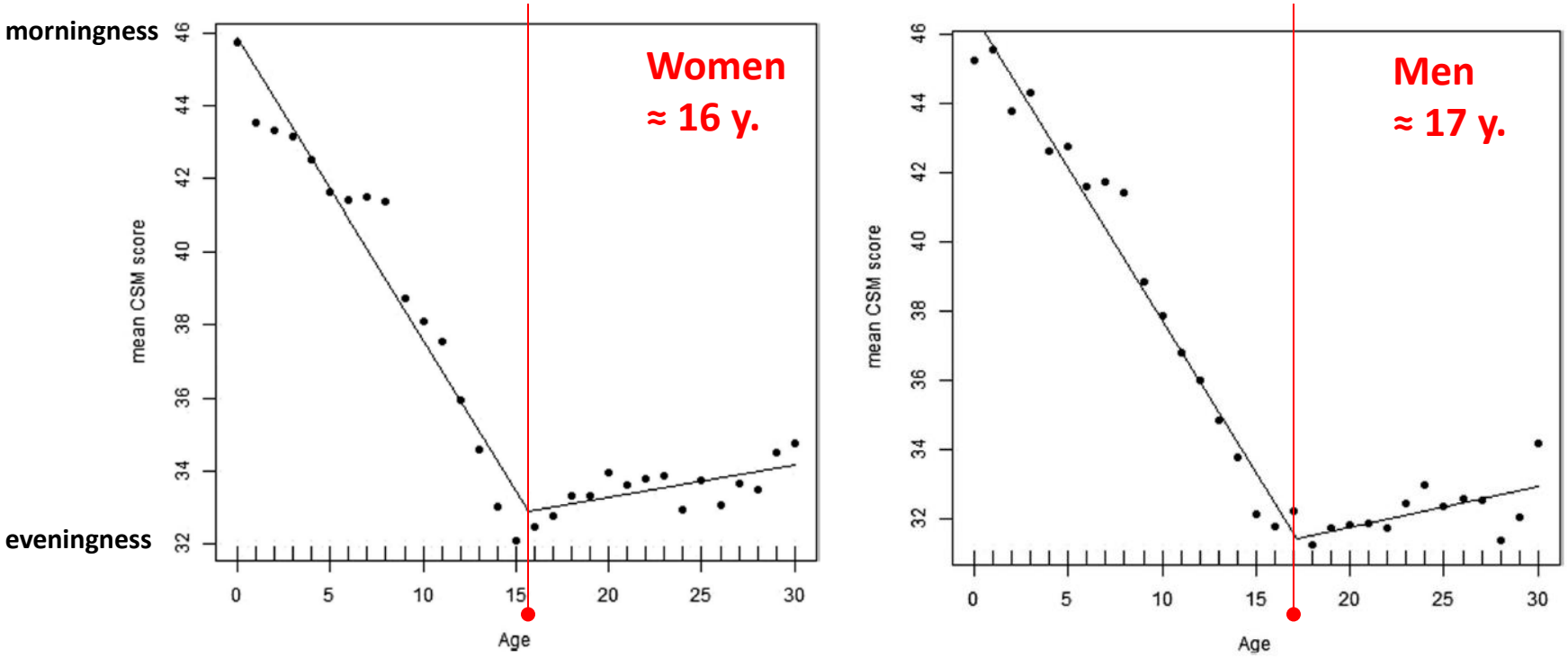
2. rectal/ingestible/dermal sensors record **the circadian rhythm** of core body temperature or distal skin temperature.

Physiol Behav 2008;95:570-80. Chronobiol Int 2011;28:719-26.

Master circadian clock tends to delay every day

The delay intensifies during puberty.

Aged <1 year: 70% morning larks and 1% night owls
Aged 16 years: 5% morning larks and 19% night owls



Sci Rep 2017;7:45874 (n=26,214).

Chronotype stability

A population-based longitudinal study of 2007 → 2014 (n=2915).

Chronotype:

- ✓ **no change in chronotype** **70.3%**
- ✓ **towards more eveningness** **16.2%**
- ✓ **towards more morningness** **13.5%**

From one extreme to another:

- ✓ **“night owl” → “morning lark”** **0.5%**
- ✓ **“morning lark” → “night owl”** **0.5%**

FINRISK 2007 and DILGOM 2014.

Chronotype stability

A longitudinal study of 1985 → 2008 (n=567).

TABLE 3. Cross-tabulation of numbers (percentages in parentheses) by diurnal type of 567 participants of Male Former Top Athletes study from 1985 to 2008.

		2008				
		Morning	Somewhat morning	Somewhat evening	Evening	Total
1985	Morning	128 (64.7)[a]	60 (30.3)	9 (4.6)	1 (0.5)	198 (100)
	Somewhat morning	48 (27.3)	100 (56.8)	23 (13.1)	5 (2.8)	176 (100)
	Somewhat evening	11 (7.5)	57 (39.0)	65 (44.5)	13 (8.9)	145 (100)
	Evening	4 (8.5)	12 (25.5)	15 (31.9)	16 (34.0)	47 (100)
		191	229	112	35	567

[a]Estimated transmission probability.

Chronotype:

- ✓ **no change in chronotype** **54.5%** **(70.3%)**
- ✓ **towards more eveningness** **19.6%** **(16.2%)**
- ✓ **towards more morningness** **25.9%** **(13.5%)**

From one extreme to another:

- ✓ **"night owl" → "morning lark"** **0.7%** **(0.5%)**
- ✓ **"morning lark" → "night owl"** **0.2%** **(0.5%)**

Chronobiol Int 2014;31:182-8.

Master circadian clock

The timing of night sleep contributes to ...

Characteristic	EE n = 719	EL n = 453	LE n = 378	LL n = 650
Bedtime	9:20PM[ab] ± 29 min	9:28 PM[cd] ± 25 min	10:40 PM[ac] ± 28 min	10:46PM[bd] ± 38 min
Wake up time	7:03 AM[ab] ± 30 min	8:09 AM[ac] ± 26 min	7:09 AM[cd] ± 30 min	8:22 AM[bd] ± 34 min
Sleep (min/d)	9h43[a] ± 44 min	10h41[a] ± 45 min	8h39[a] ± 45 min	9h36[a] ± 54 min

EE, Early-bed/Early-rise; EL, Early-bed/Late-rise; LE, Late-bed/Early-rise; LL, Late-bed/Late-rise

Sleep 2011;34:1299-307. Int J Obes (Lond) 2013;37:546-51 (n=2200, Australia, aged 9–16 years).

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Bedtime	9:20PM[ab] ± 29 min	9:28 PM[cd] ± 25 min	10:40 PM[ac] ± 28 min	10:46PM[bd] ± 38 min
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Sleep (min/d)	9h43[a] ± 44 min	10h41[a] ± 45 min	8h39[a] ± 45 min	9h36[a] ± 54 min

EE, Early-bed/Early-rise; EL, Early-bed/Late-rise; LE, Late-bed/Early-rise; LL, Late-bed/Late-rise

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Sleep 2011;34:1299-307. Int J Obes (Lond) 2013;37:546-51 (n=2200, Australia, aged 9–16 years).

Master circadian clock

The timing of night sleep contributes to health status.

If sleep of equal duration but late bedtime + late wake-up call, the increased risk of weight gain, obesity, sedentary physical activity, long screen time, unhealthy diet.

Sleep 2011;34:1299-307. Int J Obes (Lond) 2013;37:546-51 (n=2200, Australia, aged 9–16 years).

Late bedtime and health status

At population level, the individuals with greater eveningness have the heightened odds for the following:

- Tiredness or dizziness
- Trouble falling asleep or with nightly awakenings, and poor sleep quality
- Headaches, neck or shoulder pains, stomachaches, and lower back pains
- Irritation or tantrums, anxiety or nervousness, and depressive symptoms
- Troubles with school performance [except: not with teamwork performance or getting along with school friends]

Sleep Med 2013;14:1105-11.

Chronotype and sleep

At population level, the individuals with greater eveningness have more frequently the following:

- Not enough sleep, nearly always
- Insomnia, often
- Nightmares, often
- Use of sleeping pills, current as well as past 12 months

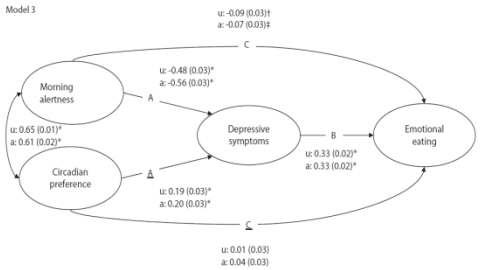
Among pregnant women (n=1646), the individuals with greater eveningness have more frequently the following:

- Insomnia (as assessed with BNSQ), and troubles in falling asleep
- Poor sleep quality
- Among their offspring, late bedtime (at 3 and 8 months of age) and prolonged sleep onset latency (at 18 and 24 months of age)

Chronobiol Int 2012;29:311-7. Chronobiol Int 2017;34:650-8. Sleep Med 2019;54:223-30.

Chronotype and eating

At population level, the individuals with greater eveningness have more frequently the following:



- Emotional eating
- Greater weight gain and increase in body-mass index from 2007 to 2014 (n=1097, only among women)
- Unhealthy dietary intake (as assessed with BSDS)
- Less whole grain (rye), protein and vegetables or roots (potatoes) as well as fish and fruits
- More wine and chocolate as well as soft drinks and sweets
- More sucrose, fat (saturated fatty acid) and energy after 8 PM
- More sucrose by 10 AM
- On the weekend this pattern is more pronounced as well as eating occasions are more frequent but meals more irregular

Chronobiol Int 2012;29:920-7. Chronobiol Int 2014;31:554-63. Chronobiol Int 2016;33:972-81. Obesity (Silver Spring) 2017;25:608-15. Chronobiol Int 2019;36:27-41.

Chronotype and physical activity

At population level, the individuals with greater eveningness have more frequently the following:

- None, very low or low physical activity
- Sedentary behaviors (as assessed with a sitting index)

Chronobiol Int 2015;32:1090-100.

Chronotype and health status

At population level, the individuals with greater eveningness have the heightened odds for the following:

- Bronchial asthma
  - A diagnosis or treatment for bronchial asthma, OR=1.9 (1.3–2.7)
  - Wheezy breathing with dyspnea, OR=1.6 (1.2–2.2)
  - Wheezy breathing without respiratory infection, OR=1.9 (1.5–2.3)
  - Awoken in shortness of breath, OR=1.8 (1.3–2.5)
  - Medication for asthma, OR=1.5 (1.2–1.9)
- Chronic obstructive pulmonary disease, OR=3.6 (1.3–10.1)
  - Current smoking, OR=1.4 (1.1–1.6)
  - Ever smoking, OR=1.2 (1.0–1.4)
  - Nicotine dependence (as assessed with FTND), OR=1.6 (1.0–2.5)
  - 1st cigarette in the morning within first 5 min, OR=2.3 (1.3–3.9)
  - Plasma cotinine (in µg/L), +0.7 (0.2–1.1) [only among men]

J Addict Res Ther 2012;25(Suppl 2):002. Chronobiol Int 2014;31:95-101. Chronobiol Int 2017;34:462-70.

Chronotype and health status

At population level, the individuals with greater eveningness have the heightened odds for the following:

- Hypertension, OR=1.3 (1.0–1.8)
  - Weight (in kg), +1.5 (0.7–2.9)
  - Waist circumference (in cm), +1.4 (0.2–2.7)
  - Resting heart rate (as beats during 30 s), +0.7 (0.2–1.3)
- Type 2 diabetes, OR=2.6 (1.5–4.4)
- Spinal disease
  - A diagnosis or treatment for spinal disease, OR=1.6 (1.2–2.0)
  - Backache, OR=1.5 (1.3–1.8)
  - Hospital treatments for dorsopathies within 3 years, OR=1.8 (1.0–2.9)

Chronobiol Int 2013;30:470-7. PLoS ONE 2014;9:e114635. Biol Rhythm Res 2017;48:263-74.

Chronotype and mood

At population level, the individuals with greater eveningness have the heightened odds for the following:

- Depression
  - Depressed mood, OR=2.2 (1.8–2.7)
  - Anhedonia, OR=2.2 (1.8–2.7)
  - Depressive symptoms, OR=2.2 (1.8–2.6)
  - A diagnosis or treatment for depressive disorder, OR=2.9 (2.2–3.9)
  - Antidepressant medication, OR=2.1 (1.7–2.8)

J Affect Disord 2015;188:143-8.

Chronotype and mood

SAD-like symptoms by chronotype in Finnish adults (n=4351).

	SAD	sub-SAD	Healthy	
“Night owl”	**9.7%**	**17.4%**	**72.9%**	100%
Intermediate	3.2%	9.5%	87.4%	100%
“Morning lark”	1.6%	5.8%	92.6%	100%

FINRISK 2012.

Chronotype and mood

SAD-like symptoms by chronotype in Finnish adults (n=4351).

	SAD	sub-SAD	Healthy
“Night owl”	**42.2%**	**29.1%**	**12.8%**
Intermediate	39.0%	44.9%	43.5%
“Morning lark”	18.8%	26.1%	43.7%
	100%	100%	100%

FINRISK 2012.

To conclude

Health hazards cumulate on “night owls”.

Insomnia, nightmares, depression, winter blues, hypertension, type 2 diabetes, bronchial asthma, spinal diseases, back pain, etc.
Sleep debt, unhealthy diet, emotional eating, smoking, high alcohol use, low physical activity, long screen time, etc.

FINRISK 2007 and FINRISK 2012.

Chronotype =

Genetic factors
Clock gene mutations

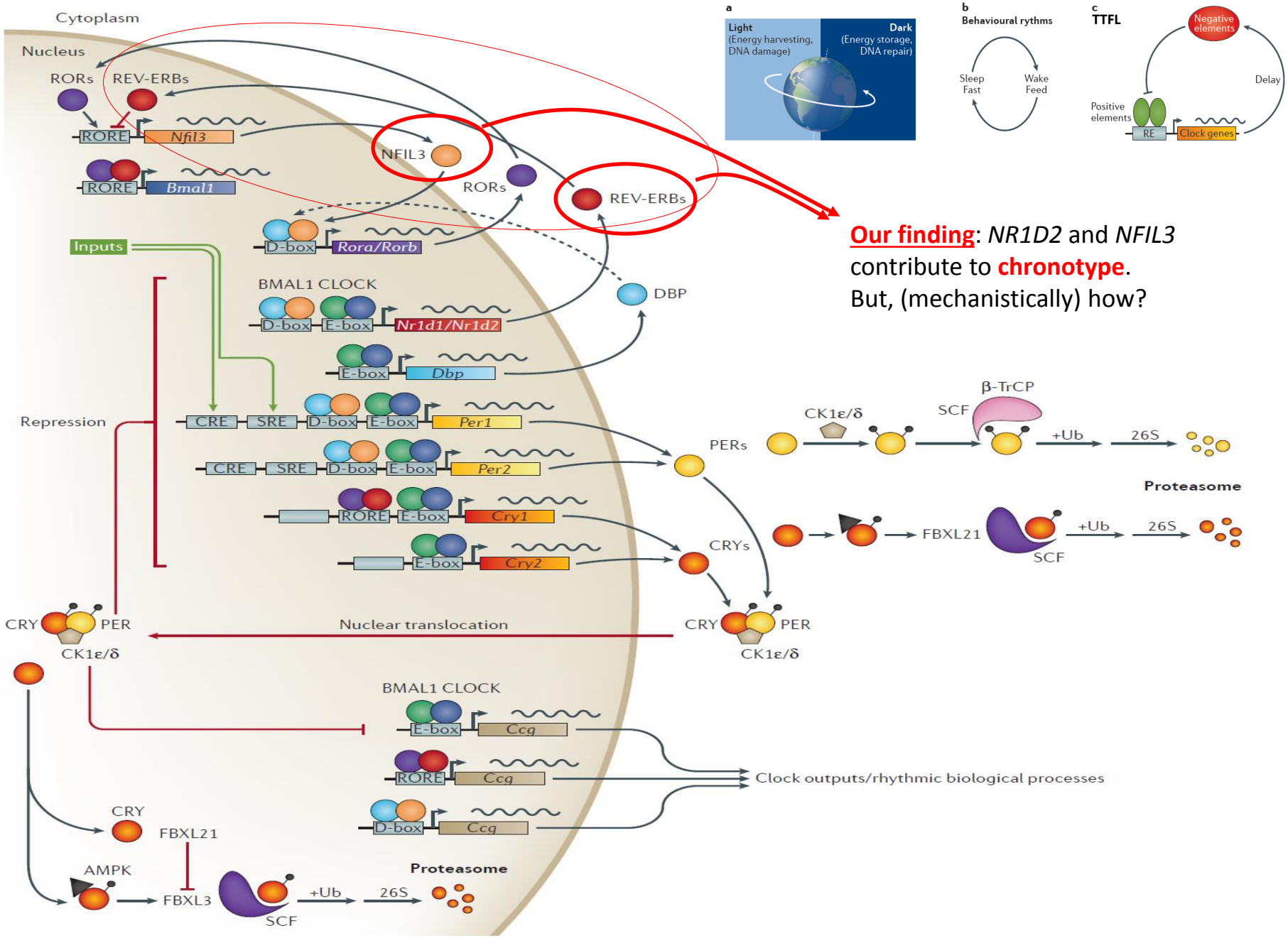
Environmental factors
Shiftwork, repeated jetlag,
sleep restriction, DST, etc.

Morningness-eveningness (chronotype) is a behavioral trait and refers to the preferred timing of behaviors, e.g., bedtimes and wake-up calls.

Morningness-eveningness = ½ genetic factors + ½ environmental factors.

- ✓ The estimate for overall genetic effect (broad sense heritability) was 50% [46–53%], with the remainder accounted for by environmental factors not shared by twins.
- ✓ Of the total variance in diurnal preference, additive genetic influences accounted for 52% [46–57%], and non-shared environmental influences accounted for 48% [43–54%].

Int J Chronobiol 1976;4:97-110. J Sleep Res 2007;16:156-62. Chronobiol Int 2014;31:222-31.

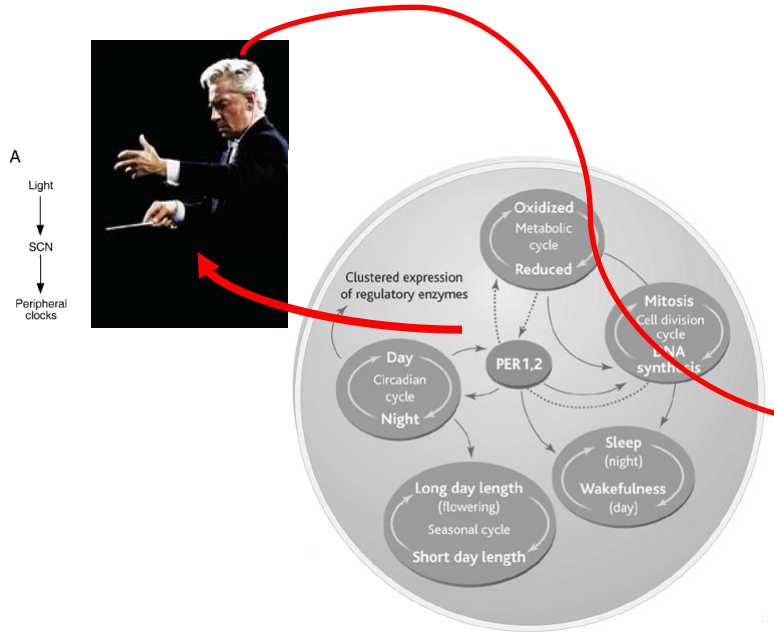


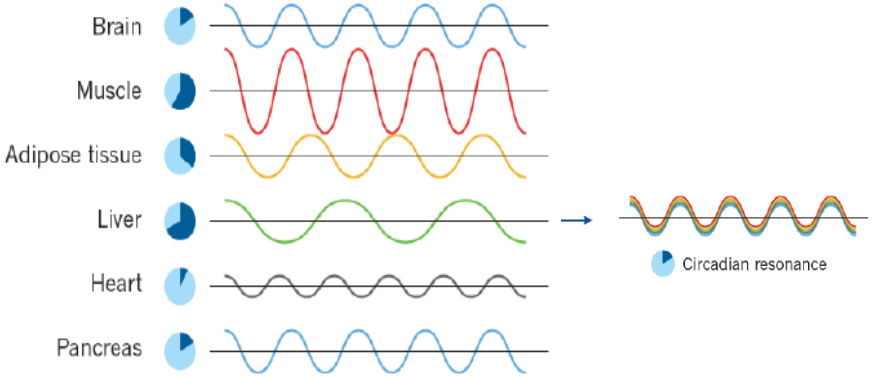
Our finding: *NR1D2* and *NFIL3* contribute to **chronotype**.
But, (mechanistically) how?

Nat Rev Genet 2017;18:164-79.

Circadian clock generates and maintains rhythm

Master clock is a pacemaker and transmits time signals.

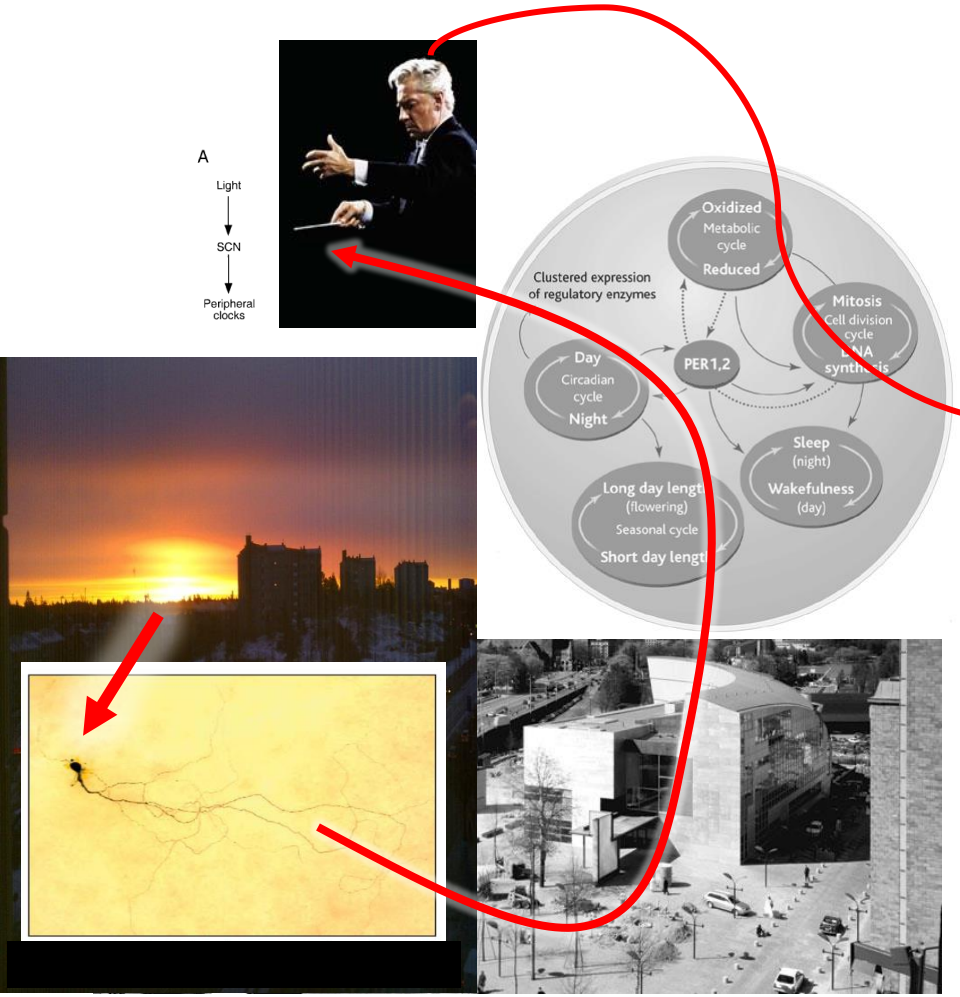


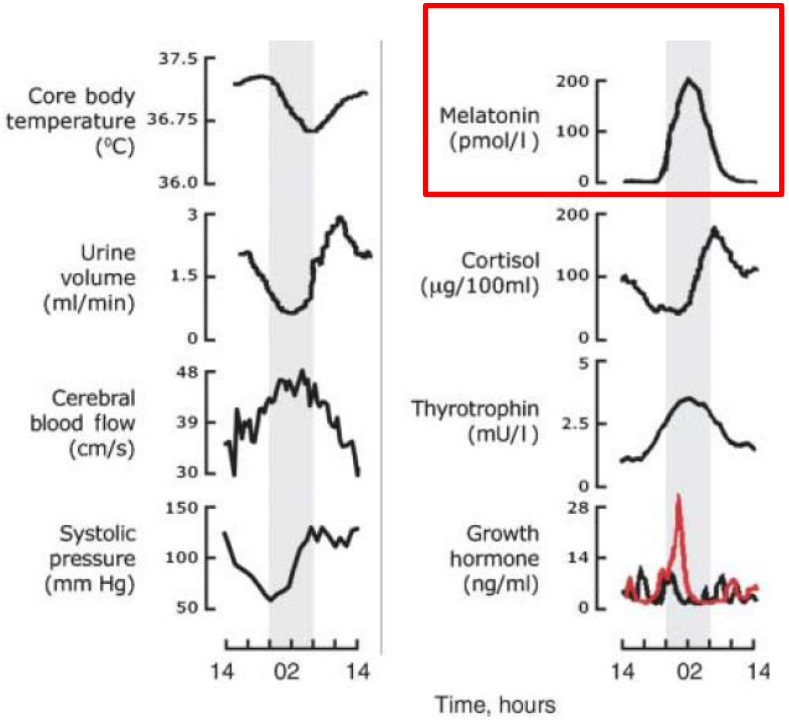


J Endocrinol 2007;195:187-98. Nature 2012;491:348-56. Ann Neurol 2015;78:317-22.

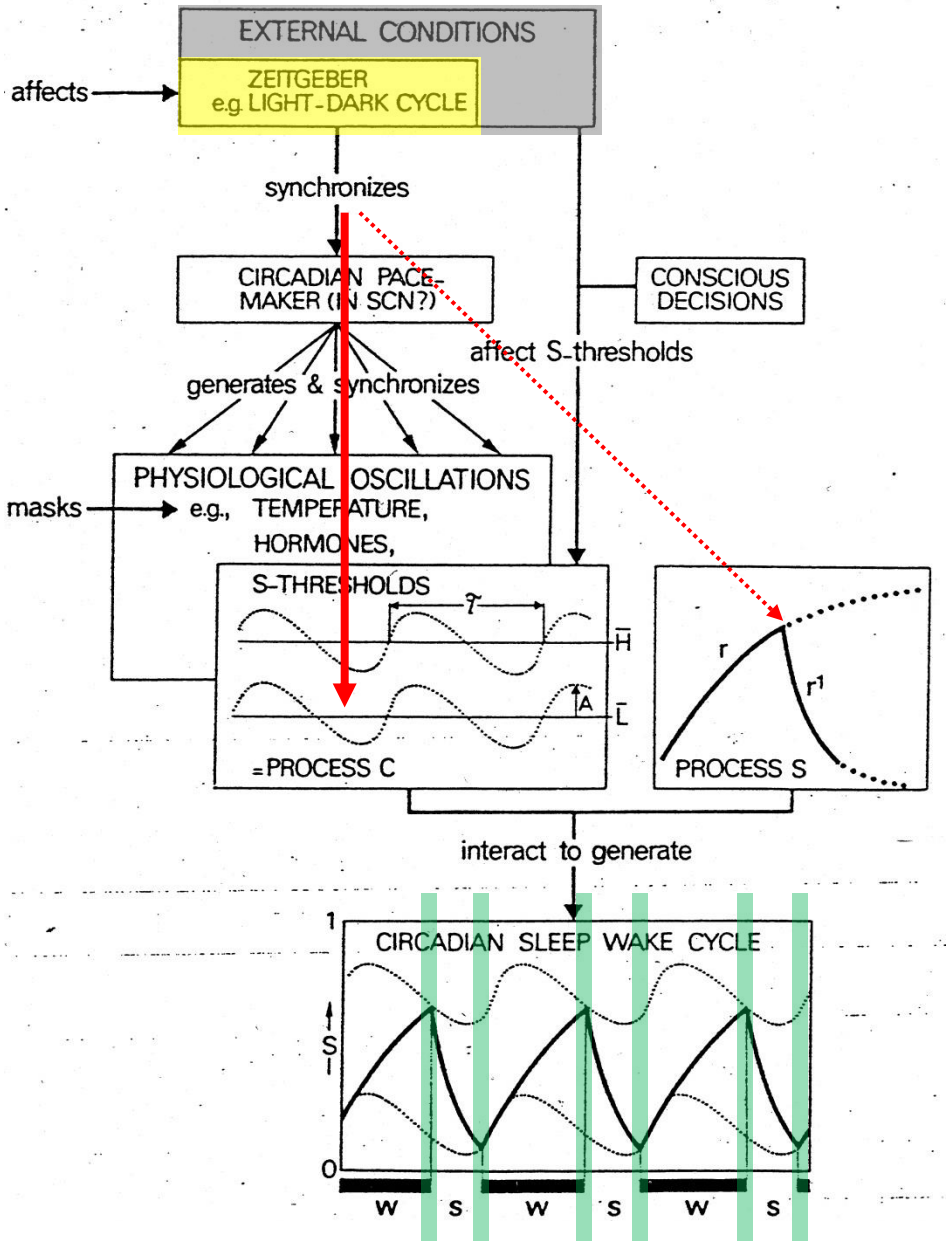
Light and darkness are time-givers

Human master clock synchronizes with light exposure.

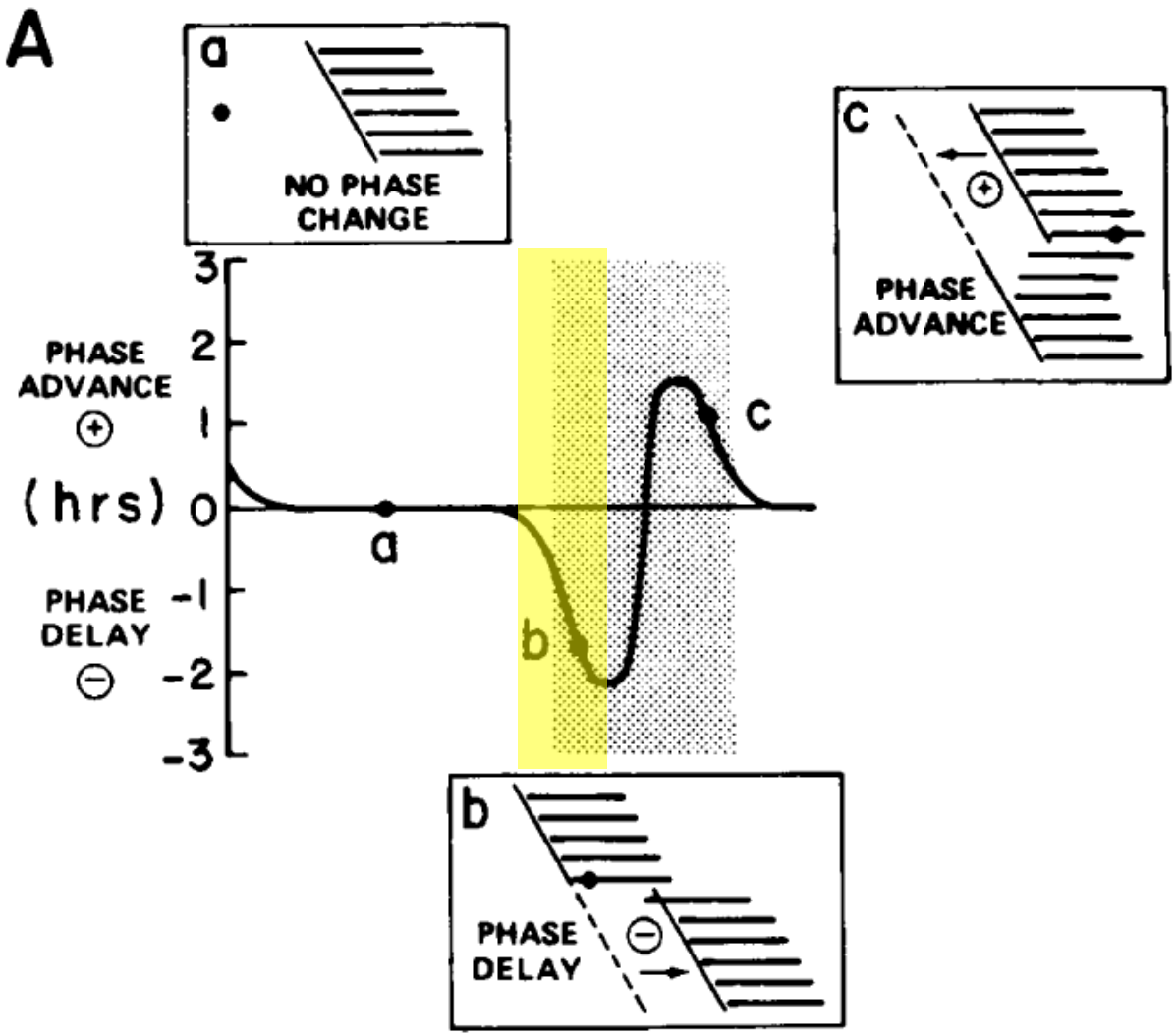




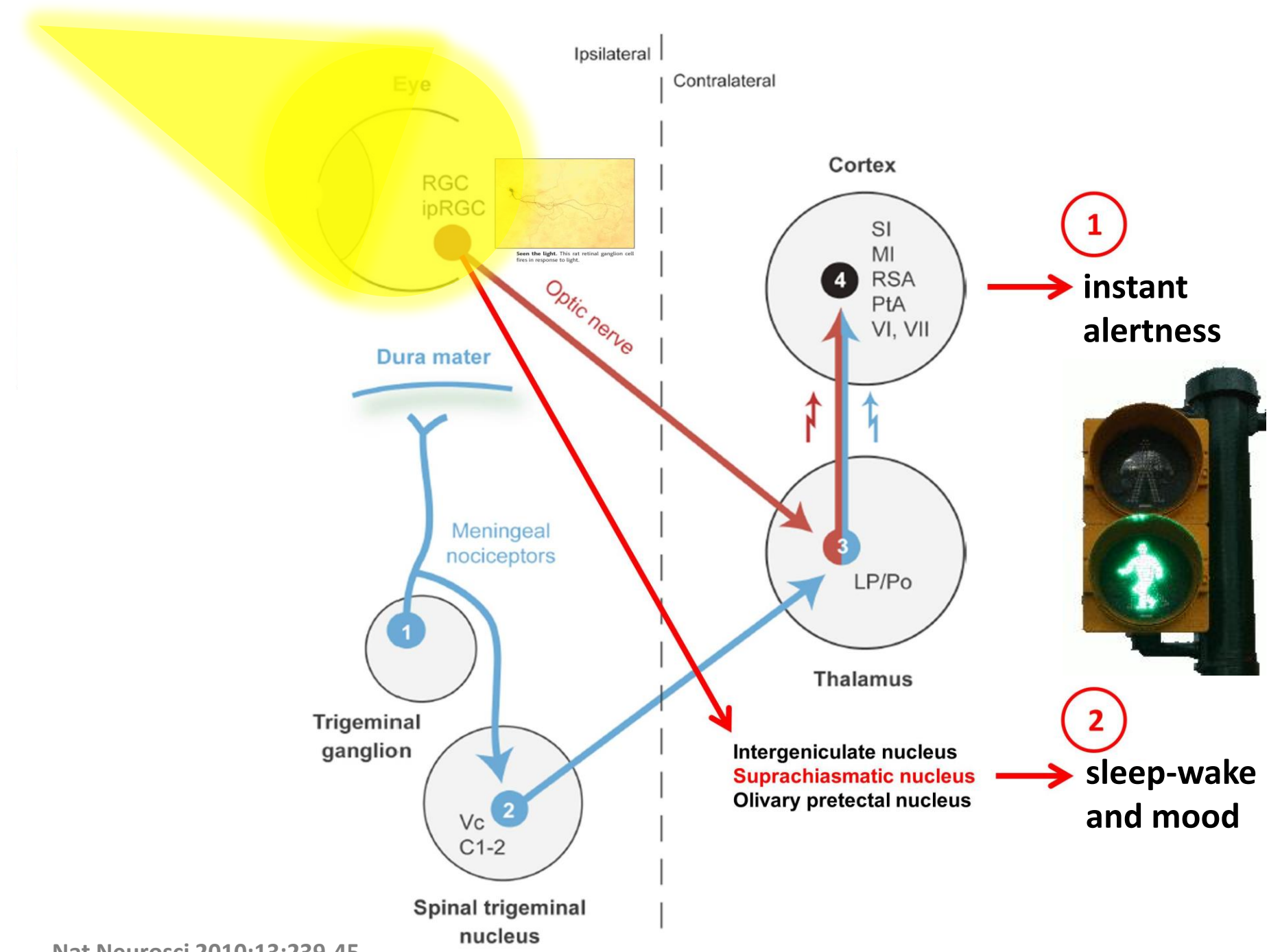
J Neurosci 2002;22:RC191. Science 2002;295:1065-70. J Endocrinol 2007;195:187-98. Curr Biol 2007;17:R44-5.



Hum Neurobiol 1982;1:195-204.



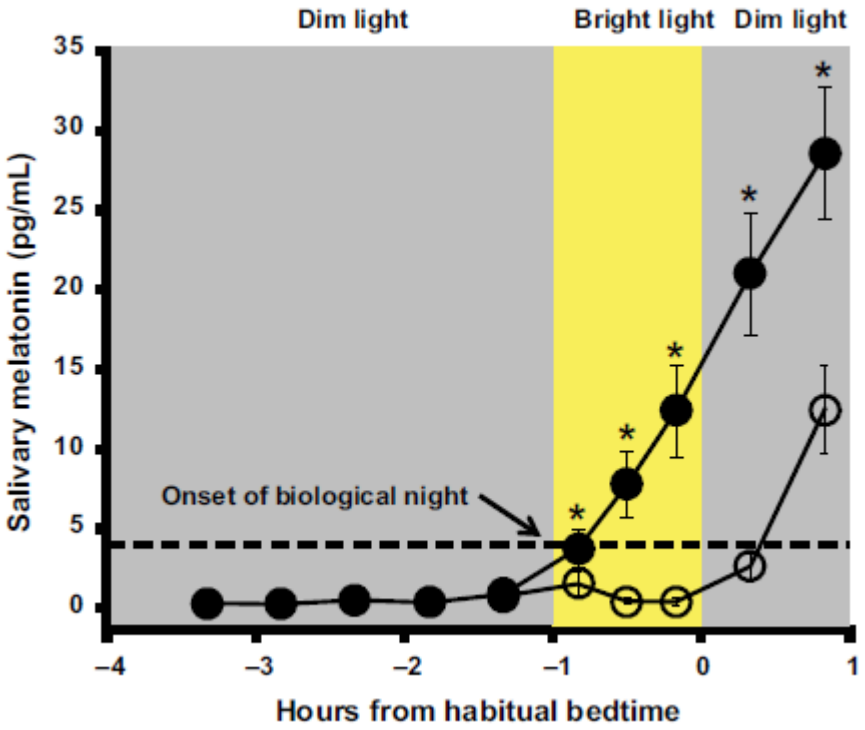
NEJM 1983;309:469-76.



Nat Neurosci 2010;13:239-45.

Melatonin opens the gate of night sleep ...

... but only if it is dark enough!



Physiol Rep 2018;6:e13617.

Smart phone in the bedroom ...

... vs. no smart phone in the bedroom.

Research question: Does portable screen-based media device (e.g., cell phones and tablet devices) access or use in the bedroom affect sleep?

- Bedtime media device access with usage:
  - inadequate sleep quantity (OR = 2.17; 95%CI = 1.42–3.32)
  - poor sleep quality (OR = 1.46; 95%CI = 1.14–1.88)
  - excessive daytime sleepiness (OR = 2.72; 95%CI = 1.32–5.61).

- Bedtime media device access without usage:
  - inadequate sleep quantity (OR = 1.79; 95%CI = 1.39–2.31)
  - poor sleep quality (OR = 1.53; 95%CI = 1.11–2.10)
  - excessive daytime sleepiness (OR = 2.27; 95%CI = 1.54–3.35).

JAMA Pediatr 2016;170:1202-8 (n=125,198 aged 6–20 years, meta-analysis of 20 studies).


CELL PHONE USE
PROHIBITED
7:30AM - 9:00AM
2:00PM - 4:15PM

Eveningness → health hazard? Yes.

Health hazard → eveningness? No.

Eveningness predicts worse academic performance, more substance use, greater social jetlag. Substance use predicts greater social jetlag, but not eveningness.

Chronobiol Int 2015;32:1233-45 (n=942, southern Ontario, aged 17–25 years, follow-up 3 years). J Youth Adolesc 2012;41:1184-96. Sleep 2018;41:zsx202. Chronobiol Int 2018;35:1248-61. Addict Biol 2018;23:750-60.

Eveningness → health hazard? Yes.

Health hazard → eveningness? No.

Eveningness predicts more frequent depressive symptoms and depressive disorder.

Depress Anxiety 2017;34:967-76 (n=255, northern Colorado, aged 11–18 years, follow-up 1 year).

“Night owls” and the depressed are alike

A pre-depression condition or a predisposition to depression?

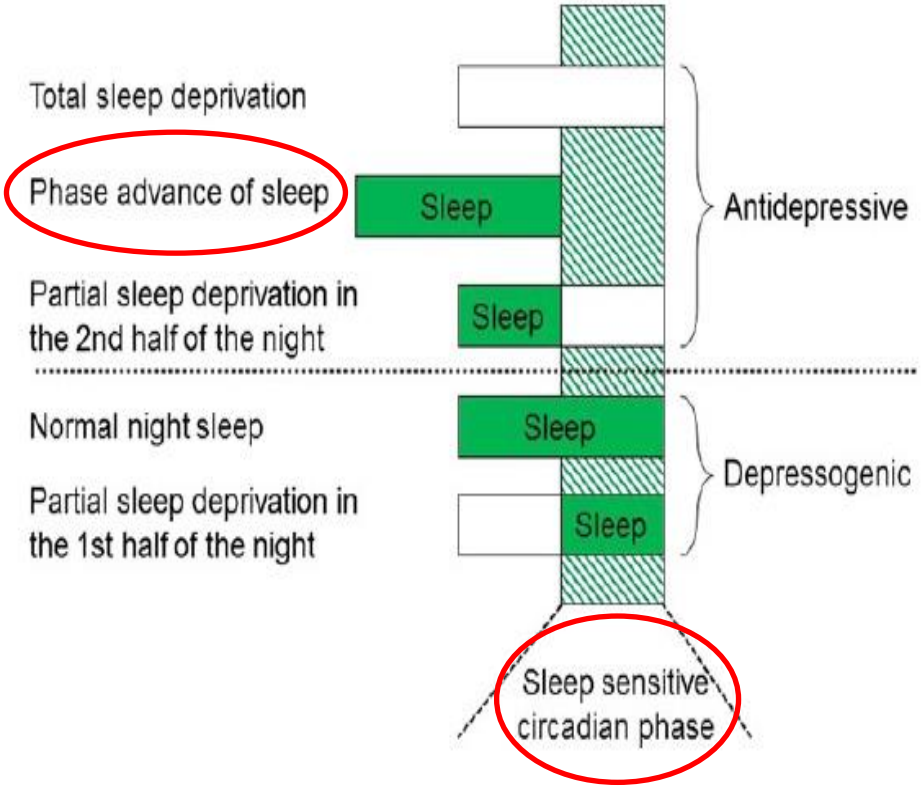


Figure 5. Timing of sleep and mood – the internal coincidence model of sleep deprivation (Wehr and Wirz-Justice, 1981).

- **Total sleep deprivation**
  - → **leads to decreased feelings of depression in the “owls”.**
  - → **leads to increased feelings of depression in the “larks”.**
- **Partial sleep deprivation in the 2nd half of the night**
  - → **leads to decreased feelings of depression in the “owls”.**
  - → **no change in feelings of depression in the “larks”.**

Biol Psychiatry 1999;46:445-53. J Sleep Res 2007;16:241-4. J Sleep Res 2016;25:131-43.

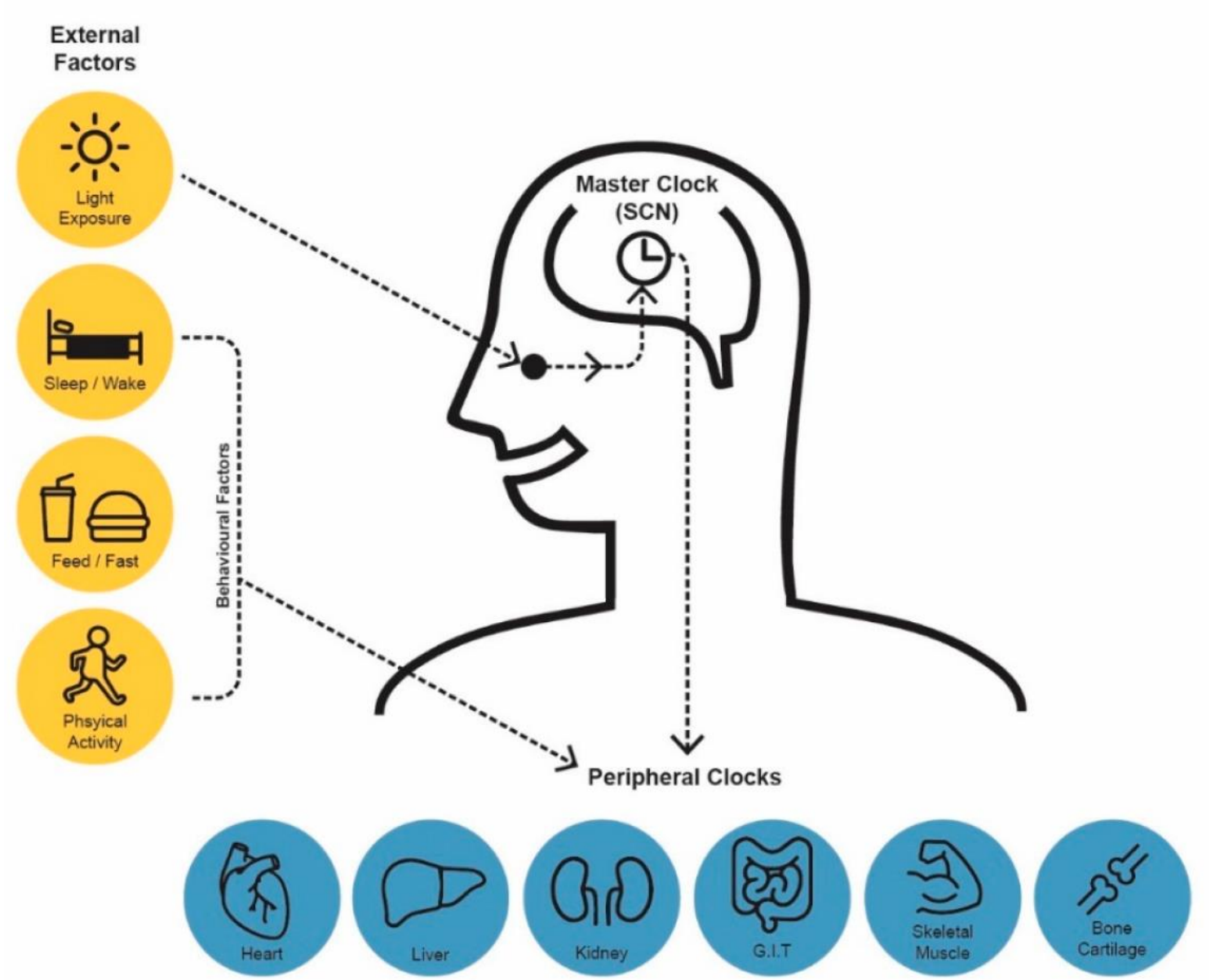
Eveningness → health hazard? Not necessarily.

A phase-advance strategy has a positive impact.

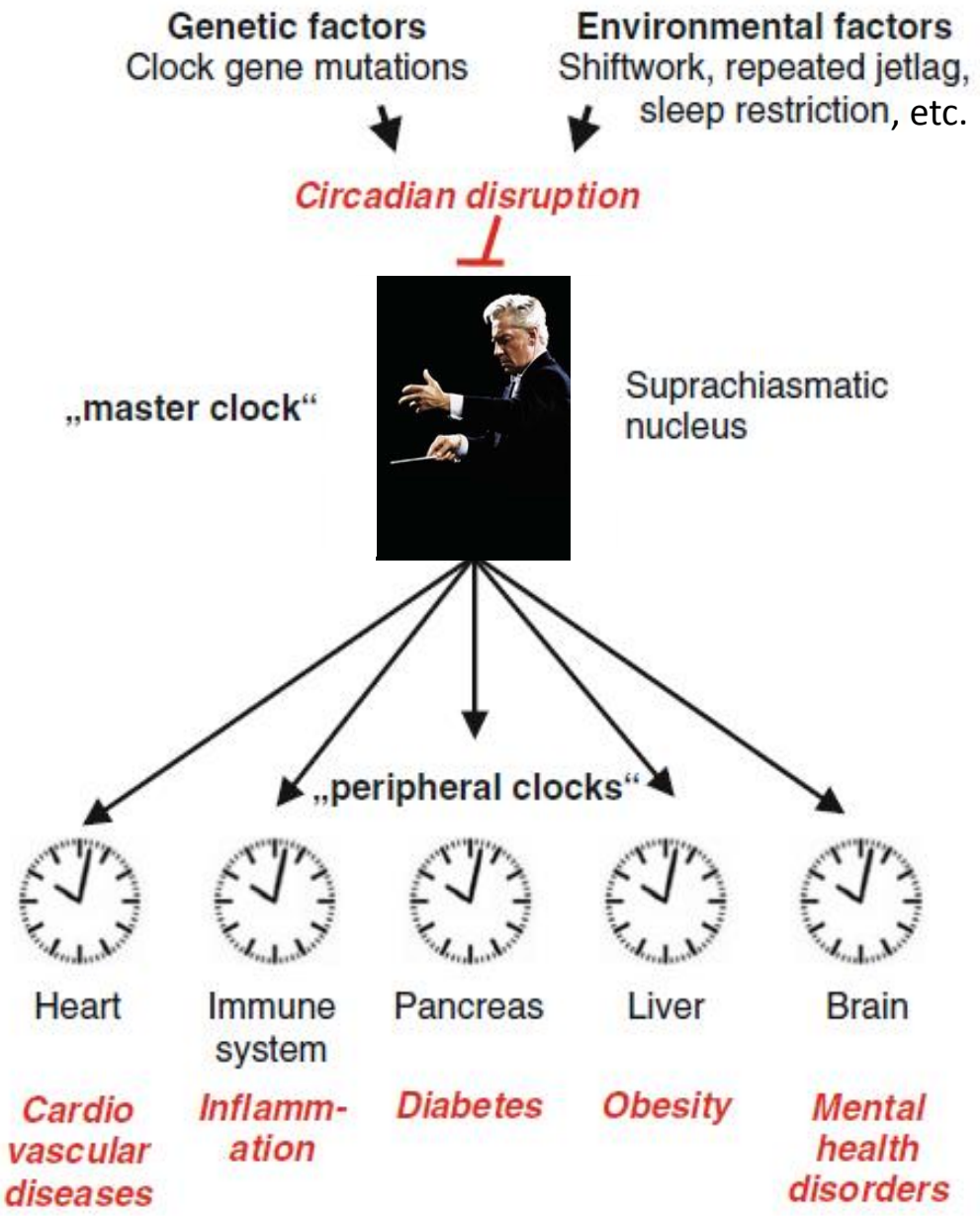
Table 1
Details of intervention schedule given to participants in the experimental group. The control group were given a single instruction (shown in **bold**). Method of monitoring adherence (in addition to a feedback questionnaire administered post-intervention) is given for each intervention target.

Intervention target	Instructions given	How adherence was monitored
Wake up time	Participants were asked to try and wake up 2–3 h before habitual wake up time. Participants were asked to maximise outdoor light exposure during the mornings.	Continuous monitoring pre- and post-intervention through actigraphy and sleep diaries.
Sleep/wake timings	Participants were asked to try and keep sleep/wake times fixed (within 15/30 min) between workdays and free days.	Continuous monitoring pre- and post-intervention through actigraphy and sleep diaries.
Sleep onset	Participants were asked to try and go to sleep 2–3 h before habitual bedtime. Participants were asked to limit light exposure during the evenings.	Continuous monitoring pre- and post-intervention through actigraphy and sleep diaries.
Diet/nutrition	Participants were asked to keep a regular schedule for daily meals. Participants were asked to have breakfast as soon after wake up as possible. **Participants were asked to eat lunch at the same time every day.** Participants were asked not to have dinner after 19:00 h.	An online questionnaire was completed at all testing sessions to record time since last meal.
Caffeine intake	Participants were asked not to drink any caffeine after 15:00 h.	An online questionnaire was completed at all testing sessions to record time since caffeine intake.
Power naps	Participants were asked not to nap after 16:00 h.	Napping was recorded through self-reported daily sleep diaries.
Exercise	If exercise was part of an individual's usual routine they were asked to schedule this during the morning.	An online questionnaire was completed at all testing sessions to record time since exercise.

Sleep Med 2019;60:236-47.



Nutrients 2019;11:E2383.



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Further reading

Meira E Cruz M, Marques S, David A, Laureano C, D'Elia C, Teixeira C, Feliciano A. Position paper of the Portuguese Association of Chronobiology and Sleep Medicine regarding daylight saving time and its impact on circadian timing system. Acta Med Port 2019 Apr 30;32(4):258-259.

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