{mctq}: An R Package for the Munich ChronoType Questionnaire

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Overview

`mctq` is an R package that provides a complete and consistent toolkit to process the Munich ChronoType Questionnaire (MCTQ), a quantitative and validated method to assess peoples' sleep behavior presented by Till Roenneberg, Anna Wirz-Justice, and Martha Merrow in 2003.

The aim of `mctq` is to facilitate the work of sleep and chronobiology scientists with MCTQ data while also helping with research reproducibility.

Code repository:
https://github.com/gipsousp/mctq

Documentation website:
https://gipsousp.github.io/mctq

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What is MCTQ?

Circadian phenotypes: a (very) brief history of time and life

Chronotypes

Journal of Biological Rhythms

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Life between Clocks: Daily Temporal Patterns of Human Chronotypes

Till Roenneberg, Anna Wirz-Justice, Martha Merrow

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Article information

Abstract

Human behavior shows large interindividual variation in temporal organization. Extreme “larks” wake up when extreme “owls” fall asleep. These chronotypes are attributed to differences in the circadian clock, and in animals, the genetic basis of similar phenotypic differences is well established. To better understand the genetic basis of temporal organization in humans, the authors developed a questionnaire to document individual sleep times, self-reported light exposure, and self-assessed chronotype, considering work and free days separately. This report summarizes the results of 500 questionnaires completed in a pilot study. Individual sleep times show large differences between work and free days, except for extreme early types. During the workweek, late chronotypes accumulate considerable sleep debt, for which they compensate on free days by lengthening their sleep by several hours. For all chronotypes, the amount of time spent outdoors in broad daylight significantly affects the timing of sleep: Increased self-reported light exposure advances sleep. The timing of self-selected sleep is multifactorial, including genetic disposition, sleep debt accumulated on workdays, and light exposure. Thus, accurate assessment of genetic chronotypes has to incorporate all of these parameters. The dependence of human chronotype on light, that is, on the amplitude of the light:dark signal, follows the known characteristics of circadian systems in all other experimental organisms. Our results predict that the timing of sleep has changed during industrialization and that a majority

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The Munich ChronoType Questionnaire for Shift-Workers (MCTQ^{Shift})

Myriam Juda[1], Céline Vetter[1], Till Roenneberg[3]

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Article information

Abstract

Sleep is systematically modulated by chronotype in day-workers. Therefore, investigations into how shift-work affects sleep, health, and cognition may provide more reliable insights if they consider individual circadian time (chronotype). The Munich ChronoType Questionnaire (MCTQ) is a useful tool for determining chronotype. It assesses chronotype based on sleep behavior, specifically on the local time of mid-sleep on free days corrected for sleep debt accumulated over the workweek (MSF_{sc}). Because the original MCTQ addresses people working standard hours, we developed an extended version that accommodates shift-work (MCTQ^{Shift}). We first present the validation of this new version with daily sleep logs (n = 52) and actimetry (n = 27). Next, we evaluated 371 MCTQ^{Shift} entries of shift-workers (rotating through 8-h shifts starting at 0600 h, 1400 h, and 2200 h). Our results support experimental findings showing that sleep is difficult to initiate and to maintain under the constraints of shift-work. Sleep times are remarkably stable on free days (on average between midnight and 0900 h), so that chronotype of shift-workers can be assessed by means of MSF—similar to that of day-workers. Sleep times on free-days are, however, slightly influenced by the preceding shift (displacements <1 h), which are smallest after evening shifts. We therefore chose this shift-specific mid-sleep time (MSF^{E}) to assess

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The μMCTQ: An Ultra-Short Version of the Munich ChronoType Questionnaire

Neda Ghotbi[1], Luísa K. Pilz[1], Eva C. Winnebeck, more... Show all authors

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Article information

Abstract

Individuals vary in how their circadian system synchronizes with the cyclic environment (zeitgeber). Assessing these differences in "phase of entrainment"—often referred to as chronotype—is an important procedure in laboratory experiments and epidemiological studies but is also increasingly applied in circadian medicine, both in diagnosis and therapy. While biochemical measurements (e.g., dim-light melatonin onset [DLMO]) of internal time are still the gold standard, they are laborious, expensive, and mostly rely on special conditions (e.g., dim light). Chronotype estimation in the form of questionnaires is useful in approximating the timing of an individual's circadian clock. They are simple, inexpensive, and location independent (e.g., administrable on- and offline) and can therefore be easily administered to many individuals. The Munich ChronoType Questionnaire (MCTQ) is an established instrument to assess chronotype by asking subjects about their sleep-wake-behavior. Here we present a shortened version of the MCTQ, the μMCTQ, for use in situations in which instrument length is critical, such as in large cohort studies. The μMCTQ contains only the core chronotype module of the standard MCTQ (stdMCTQ), which was shortened and adapted from 17 to 6 essential questions, allowing for a quick assessment of chronotype and other related parameters such as social jetlag and sleep duration. μMCTQ results correspond well to the ones collected by the stdMCTQ and are externally validated by

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Munich ChronoType Questionnaire (MCTQ)

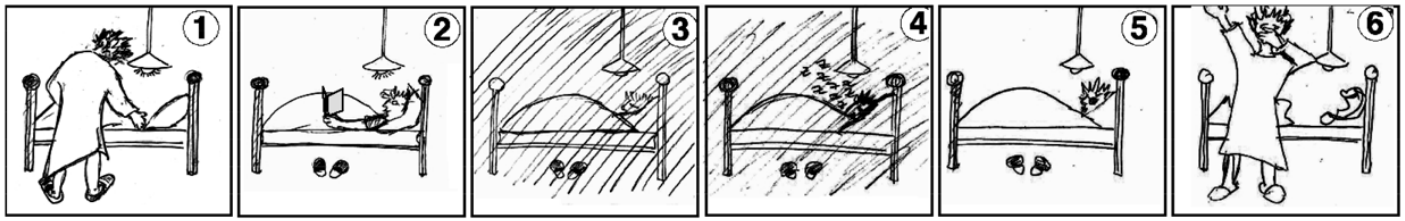
In this questionnaire, you report on your typical sleep behaviour over the past 4 weeks. We ask about work days and work-free days separately. Please respond to the questions according to your perception of a standard week that includes your usual work days and work-free days.

I have a regular work schedule (this includes being, for example, a housewife or househusband):

Yes ☐ I work on 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ days per week.

No ☐

Is your answer "*Yes, on 7 days*" or "*No*", please consider if your sleep times may nonetheless differ between regular 'workdays' and 'weekend days' and fill out the MCTQ in this respect.



Please use 24-hour time scale (e.g. 23:00 instead of 11:00 pm)!

Workdays

Image 1: **I go to bed at _____ o'clock.**

Image 2: **Note that some people stay awake for some time when in bed!**

Image 3: **I actually get ready to fall asleep at _____ o'clock.**

Please use 24-hour time scale (e.g. 23:00 instead of 11:00 pm)!

Workdays

Image 1: I go to bed at _____ o'clock.

Image 2: Note that some people stay awake for some time when in bed!

Image 3: I actually get ready to fall asleep at _____ o'clock.

Image 4: I need _____ minutes to fall asleep.

Image 5: I wake up at _____ o'clock.

Image 6: After _____ minutes I get up.

I use an alarm clock on workdays: Yes ☐ No ☐

If "Yes": I regularly wake up BEFORE the alarm rings: Yes ☐ No ☐

Free Days

Image 1: I go to bed at _____ o'clock.

Image 2: Note that some people stay awake for some time when in bed!

Image 3: I actually get ready to fall asleep at _____ o'clock.

Image 4: I need _____ minutes to fall asleep.

Image 5: I wake up at _____ o'clock.

Image 6: After _____ minutes I get up.

My wake-up time (Image 5) is due to the use of an alarm clock: Yes ☐ No ☐

There are particular reasons why I cannot freely choose my sleep times on free days:

Yes ☐ If "Yes": Child(ren)/pet(s) ☐ Hobbies ☐ Others ☐, for example:_____

No ☐

The problem(s)

Main challenges

- MCTQ requires a lot of date/time manipulation
- MCTQ deals with temporal objects detached from a timeline
- Lack of consistency of computations
- Inconsistencies lead to irreproducible results

These problems surface even more when dealing with a large dataset.

Temporal objects

Time objects demand more abstraction levels.

- Time is not metric
- Time is cyclical
- Time is relational (itself does not exist)

  Cool stuff: [Why Don't We Have Metric Time? | Answers With Joe](#).

The {mctq} package

Installation

```
# install.packages("pak")
pak::pkg_install("gipsousp/mctq")
```

```
library(mctq)
```

Conversion

`mctq` works with a set of object classes specially created to hold time values. These classes can be found in the lubridate and hms packages from tidyverse.

```
# From decimal hours to `hms`
convert(6.5, "hms", input_unit = "H")
```

```
## 06:30:00
```

```
# From radians to `Duration`
convert(1.308997, "Duration", input_unit = "rad")
```

```
## [1] "18000s (~5 hours)"
```

```
# From `character` `HM AM/PM ` to `hms`
convert("10:00 PM", "hms", orders = "IMp")
```

```
## 22:00:00
```

Workdays and work-free days variables

Combining workdays and work-free days variables

Data

The package also provides **fictional** datasets of the standard, micro, and shift MCTQ versions **for testing and learning purposes**.

	id	shift_work	wd	fd	so_w	se_w	sd_w	msw	
1	1	false	2	5	21:45:00	09:15:00	11:30:00	03:30:00	0(
2	2	false	7	0	23:15:00	06:25:00	07:10:00	02:50:00	23
3	3	false	5	2	23:00:00	05:50:00	06:50:00	02:25:00	03
4	4	false	5	2	01:45:00	06:30:00	04:45:00	04:07:30	02
5	5	false	2	5	23:45:00	05:35:00	05:50:00	02:40:00	02
6	6	false	5	2	00:00:00	06:45:00	06:45:00	03:22:30	01

Previous 1 2 3 4 5 … 9 Next

Utilities

In addition to `convert()`, `mctq` is also equipped with many other utility functions.

```
random_mctq(model = "standard") %>% head(5)
```

```
## $work
## [1] TRUE
##
## $wd
## [1] 7
##
## $bt_w
## 00:00:00
##
## $sprep_w
## 00:20:00
##
## $slat_w
## [1] "600s (~10 minutes)"
```

Documentation

`mctq` is fully documented. Learn more in gipsousp.github.io/mctq.

Compute MCTQ corrected local time of mid-sleep on work-free days

Source: `R/ms.R` (https://github.com/gipsousp/mctq/blob/master/R/ms.R)

lifecycle maturing (https://lifecycle.r-lib.org/articles/stages.html#maturing)

`msf_sc()` computes the **chronotype or corrected local time of mid-sleep on work-free days** for standard, micro, and shift versions of the Munich Chronotype Questionnaire (MCTQ).

`chronotype()` is just a wrapper for `msf_sc()`.

When using the shift version of the MCTQ, replace the value of `sd_week` to `sd_overall`, as instructed in the Arguments section.

Final remarks

Notes

- `mctq` is maturing
- `mctq` is fully documented
- `mctq` is currently under a rOpenSci peer review
- `mctq` will be submitted to CRAN soon
- We plan to invite MCTQ authors to review and author the package
- An article about `mctq` will be published soon

Thank you!