

# Package ‘mctq’

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**Title** Tools to Process the Munich ChronoType Questionnaire (MCTQ)

**Version** 0.1.0

**Description** A complete and consistent toolkit to process the Munich ChronoType Questionnaire (MCTQ) for its three versions (standard, micro, and shift). MCTQ is a quantitative and validated tool to assess chronotypes using peoples' sleep behavior, originally presented by Till Roenneberg, Anna Wirz-Justice, and Martha Merrow (2003, <[doi:10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679)>).

**biocViews** Infrastructure, Preprocessing, Visualization

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**URL** <https://docs.ropensci.org/mctq/>, <https://github.com/ropensci/mctq/>

**BugReports** <https://github.com/ropensci/mctq/issues/>

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assign_date	<i>Assign dates to two sequential hours</i>
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## Description

### [Maturing]

assign\_date() assign dates to two sequential hours. It can facilitate time arithmetic by locating time values without a date reference on a timeline.

## Usage

```
assign_date(start, end, ambiguity = 0)
```

## Arguments

start, end	A hms or POSIXt object indicating the start or end hour.
ambiguity	(optional) a numeric or NA value to instruct assign_date() on how to deal with ambiguities (see Details) (default: 0).

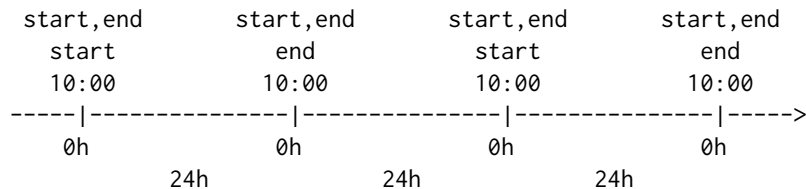
## Details

### Class requirements:

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the [lubridate](#) and [hms](#) packages. Please refer to those package documents to learn more about them.

### ambiguity argument:

In cases when start is equal to end, there are two possibilities of intervals between the two hours (ambiguity). That's because start and end can be at the same point in time or they can distance themselves by one day, considering a two-day timeline.



You must instruct assign\_date() on how to deal with this problem if it occurs. There are three options to choose.

- ambiguity = 0: to consider the interval between start and end as 0 hours, i.e., start and end are located at the same point in time (default).
- ambiguity = 24: to consider the interval between start and end as 24 hours, i.e., start and end distance themselves by one day.
- ambiguity = NA: to disregard these cases, assigning NA as value.

**Base date and timezone:**

assign\_date() uses the **Unix epoch** (1970-01-01) date as the start date for creating intervals. The output will always have "UTC" set as timezone. Learn more about time zones in [base::timezone](#).

**POSIXt objects:**

[POSIXt](#) objects passed as argument to start or end will be stripped of their dates. Only the time will be considered.

Both POSIXct and POSIXlt are objects that inherits the class POSIXt. Learn more about it in [base::DateTimeClasses](#).

**NA values:**

assign\_date() will return an Interval NA-NA if start or end are NA.

**Value**

A start–end Interval object.

**See Also**

Other utility functions: [cycle\\_time\(\)](#), [pretty\\_mctq\(\)](#), [qplot\\_walk\(\)](#), [random\\_mctq\(\)](#), [raw\\_data\(\)](#), [round\\_time\(\)](#), [shorter\\_interval\(\)](#), [sum\\_time\(\)](#)

**Examples**

```
## Scalar example

start <- hms::parse_hms("23:11:00")
end <- hms::parse_hms("05:30:00")
assign_date(start, end)
#> [1] 1970-01-01 23:11:00 UTC--1970-01-02 05:30:00 UTC # Expected

start <- hms::parse_hms("10:15:00")
end <- hms::parse_hms("13:25:00")
assign_date(start, end)
#> [1] 1970-01-01 10:15:00 UTC--1970-01-01 13:25:00 UTC # Expected

start <- hms::parse_hms("05:42:00")
end <- hms::as_hms(NA)
assign_date(start, end)
#> [1] NA--NA # Expected

## Vector example

start <- c(hms::parse_hm("09:45"), hms::parse_hm("20:30"))
end <- c(hms::parse_hm("21:15"), hms::parse_hm("04:30"))
assign_date(start, end)
#> [1] 1970-01-01 09:45:00 UTC--1970-01-01 21:15:00 UTC # Expected
#> [2] 1970-01-01 20:30:00 UTC--1970-01-02 04:30:00 UTC # Expected

## To assign a 24 hours interval to ambiguities
```

```

start <- lubridate::as_datetime("1985-01-15 12:00:00")
end <- lubridate::as_datetime("2020-09-10 12:00:00")
assign_date(start, end, ambiguity = 24)
#> [1] 1970-01-01 12:00:00 UTC--1970-01-02 12:00:00 UTC # Expected

```

---

cycle\_time

*Cycle time objects*

---

## Description

### [Maturing]

cycle\_time() cycles time span objects in a predetermined cycle length, converting linear time objects to a circular time frame.

## Usage

```
cycle_time(time, cycle, reverse = TRUE)
```

## Arguments

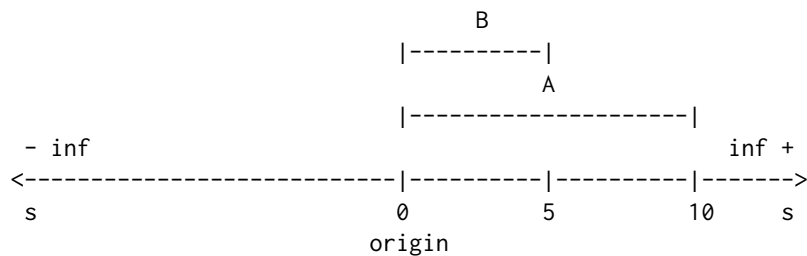
time	An object belonging to one of the following classes: numeric, Duration, difftime, or hms.
cycle	A numeric or Duration object of length 1, equal or greater than 0, indicating the cycle length in seconds (see Details to learn more).
reverse	(optional) A logical value indicating if the function must use a reverse cycle for negative values in time (see Details to learn more) (default: TRUE).

## Details

### Linear versus circular time:

Time can have different "shapes".

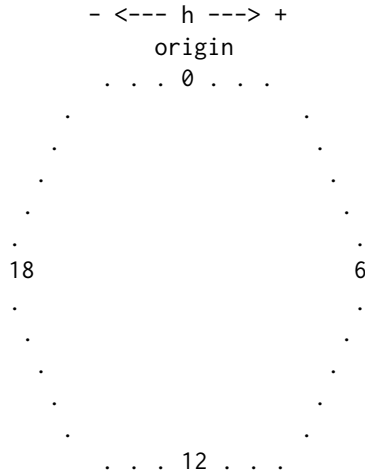
If the objective is to measure the duration (time span) of an event, time is usually measured considering a linear frame, with a fixed point of **origin**. In this context, the time value distance itself to infinity in relation to the origin.



$$A + B = 10 + 5 = 15s$$

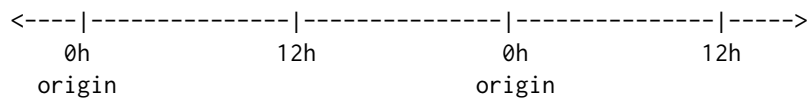
But that's not the only possible "shape" of time, as it can also be measured in other contexts.

In a "time of day" context, time will be linked to the rotation of the earth, "resetting" when a new rotation cycle starts. That brings a different kind of shape to time: a circular shape. With this shape the time value encounters the origin at the end of each cycle.



$$18 + 6 = 0h$$

If we transpose this circular time frame to a linear one, it would look like this:



Note that now the origin is not fix, but cyclical.

`cycle_time()` operates by converting linear time objects using a circular approach relative to the cycle length (e.g, `cycle = 86400` (1 day)).

### Fractional time:

`cycle_time()` uses the `%%` operator to cycle values. Hence, it can be subject to catastrophic loss of accuracy if `time` is fractional and much larger than `cycle`. A warning is given if this is detected.

`%%` is a builtin R function that operates like this:

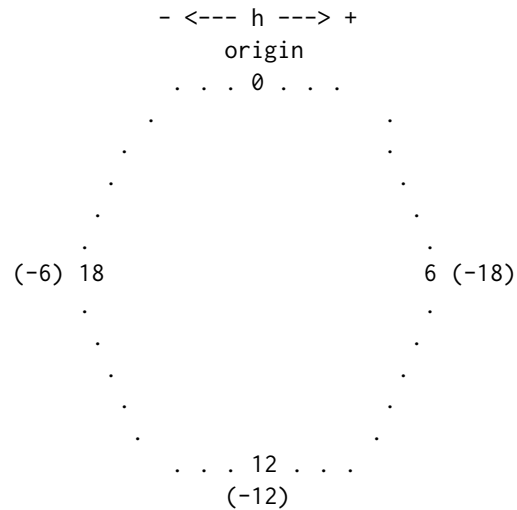
```
function(a, b) {
  a - floor(a / b) * b
}
```

### Negative time cycling:

If `time` have a negative value and `reverse = FALSE`, `cycle_time()` will perform the cycle considering the absolute value of `time` and return the result with a negative signal.

However, If `time` have a negative value and `reverse = TRUE` (default), `cycle_time()` will perform the cycle in reverse, relative to its origin.

Example: If you have a `-30h` time span in a reversed cycle of `24h`, the result will be `18h`. By removing the full cycles of `-30h` you will get `-6h` (`-30 + 24`), and `-6h` relative to the origin will be `18h`.

**Period objects:**

**Period** objects are a special type of object developed by the [lubridate](#) team that represents "human units", ignoring possible timeline irregularities. That is to say that 1 day as **Period** can have different time spans, when looking to a timeline after a irregularity event.

Since the time span of a **Period** object can fluctuate, `cycle_time()` don't accept this kind of object. You can transform it to a **Duration** object and still use the function, but beware that this can produce errors.

Learn more about **Period** objects in the [Dates and times](#) chapter of Wickham & Grolemund (n.d.).

**Value**

The same type of object of time cycled with the `cycle` parameter.

**References**

Wickham, H., & Grolemund, G. (n.d.). *R for data science*. Sebastopol, CA: O'Reilly Media.  
<https://r4ds.had.co.nz>

**See Also**

Other utility functions: [assign\\_date\(\)](#), [pretty\\_mctq\(\)](#), [qplot\\_walk\(\)](#), [random\\_mctq\(\)](#), [raw\\_data\(\)](#), [round\\_time\(\)](#), [shorter\\_interval\(\)](#), [sum\\_time\(\)](#)

**Examples**

```
## Scalar example

time <- lubridate::dhours(25)
cycle <- lubridate::ddays(1)
cycle_time(time, cycle)
#> [1] "3600s (~1 hours)" # Expected

time <- lubridate::dhours(-25)
```

```

cycle <- lubridate::ddays(1)
reverse <- FALSE
cycle_time(time, cycle, reverse)
#> [1] "-3600s (~-1 hours)" # Expected

time <- lubridate::dhours(-25)
cycle <- lubridate::ddays(1)
reverse <- TRUE
cycle_time(time, cycle, reverse)
#> [1] "82800s (~23 hours)" # Expected

## Vector example

time <- c(lubridate::dmonths(24), lubridate::dmonths(13))
cycle <- lubridate::dyears(1)
cycle_time(time, cycle)
#> [1] "0s"                "2629800s (~4.35 weeks)" # Expected

time <- c(lubridate::dmonths(24), lubridate::dmonths(-13))
cycle <- lubridate::dyears(1)
reverse <- FALSE
cycle_time(time, cycle, reverse)
#> [1] "0s"                "-2629800s (~-4.35 weeks)" # Expected

time <- c(lubridate::dmonths(24), lubridate::dmonths(-13))
cycle <- lubridate::dyears(1)
reverse <- TRUE
cycle_time(time, cycle, reverse)
#> [1] "0s"                "28927800s (~47.83 weeks)" # Expected

```

---

 fd

---

*Compute MCTQ work-free days*


---

## Description

### [Maturing]

fd() computes the **number of work-free days per week** for standard and micro versions of the Munich Chronotype Questionnaire (MCTQ).

## Usage

```
fd(wd)
```

## Arguments

wd An [integerish](#) numeric object or an integer object corresponding to the **number of workdays per week** from a standard or micro version of the MCTQ questionnaire.



## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Merrow (2003), Roenneberg, Allebrandt, Merrow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

## Value

An integer object corresponding to the difference between the number of days in a week (7) and the number of workdays (wd).

## Guidelines

Roenneberg, Allebrandt, Merrow, & Vetter (2012) and The Worldwide Experimental Platform (n.d.) guidelines for `fd()` (*FD*) computation are as follows.

$$7 - WD$$

Where:

- *WD* = number of workdays ("I have a regular work schedule and work \_\_\_ days per week").

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other MCTQ functions: [gu\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [msl\(\)](#), [napd\(\)](#), [sd24\(\)](#), [sd\\_overall\(\)](#), [sd\\_week\(\)](#), [sdu\(\)](#), [sjl\\_weighted\(\)](#), [sjl\(\)](#), [so\(\)](#), [tbt\(\)](#)

**Examples**

```
## Scalar example

fd(5)
#> [1] 2 # Expected
fd(4)
#> [1] 3 # Expected
fd(as.numeric(NA))
#> [1] NA # Expected

## Vector example

fd(0:7)
#> [1] 7 6 5 4 3 2 1 0 # Expected
fd(c(1, NA))
#> [1] 6 NA # Expected
```

---

gu

---

*Compute MCTQ local time of getting out of bed*


---

**Description****[Maturing]**

gu() computes the **local time of getting out of bed** for standard and shift versions of the Munich Chronotype Questionnaire (MCTQ).

**Usage**

```
gu(se, si)
```

**Arguments**

se	A hms object corresponding to the <b>local time of sleep end</b> from a standard or shift version of the MCTQ questionnaire.
si	A Duration object corresponding to the <b>sleep inertia</b> or <b>time to get up</b> from a standard or shift version of the MCTQ questionnaire.

**Details**

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mewes (2003), Roenneberg, Allebrandt, Mewes, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ MCTQ functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

MCTQ<sup>Shift</sup> functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

**Class requirements:**

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documentations to learn more about them.

**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A `hms` object corresponding to the vectorized sum of `se` and `si` in a circular time frame of 24 hours.

**Guidelines**

Roenneberg, Allebrandt, Merrow, & Vetter (2012), Juda, Vetter, & Roenneberg (2013), and The Worldwide Experimental Platform (n.d.) guidelines for `gu()` (*GU*) computation are as follows.

**Notes:**

- The computation below must be applied to each section of the questionnaire.
- $MCTQ^{Shift}$  uses *TGU* (time to get up) instead of *SI* (sleep inertia). For the purpose of this computation, both represent the same thing.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**For standard and micro versions of the MCTQ:**

$$SE_{W/F} + SI_{W/F}$$

Where:

- $SE_{W/F}$  = local time of sleep end on work **or** work-free days.
- $SI_{W/F}$  = sleep inertia on work **or** work-free days ("after \_\_\_ min, I get up").

\*  $W$  = workdays;  $F$  = work-free days.

**For the shift version of the MCTQ:**

$$SE_{W/F}^{M/E/N} + TGU_{W/F}^{M/E/N}$$

Where:

- $SE_{W/F}^{M/E/N}$  = local time of sleep end between two days in a particular shift **or** between two free days after a particular shift.
- $TGU_{W/F}^{M/E/N}$  = time to get up after sleep end between two days in a particular shift **or** between two free days after a particular shift ("after \_\_\_ min, I get up").

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other MCTQ functions: [fd\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [msl\(\)](#), [napd\(\)](#), [sd24\(\)](#), [sd\\_overall\(\)](#), [sd\\_week\(\)](#), [sdu\(\)](#), [sjl\\_weighted\(\)](#), [sjl\(\)](#), [so\(\)](#), [tbt\(\)](#)

## Examples

```
## Scalar example

gu(hms::parse_hm("08:00"), lubridate::dminutes(10))
#> 08:10:00 # Expected
gu(hms::parse_hm("11:45"), lubridate::dminutes(90))
#> 13:15:00 # Expected
gu(hms::as_hms(NA), lubridate::dminutes(90))
#> NA # Expected

## Vector example

se <- c(hms::parse_hm("12:30"), hms::parse_hm("23:45"))
si <- c(lubridate::dminutes(10), lubridate::dminutes(70))
gu(se, si)
#> 12:40:00 # Expected
#> 00:55:00 # Expected
```

---

le\_week

---

*Compute MCTQ average weekly light exposure*


---

## Description

### [Maturing]

`le_week()` computes the **average weekly light exposure** for the standard version of the Munich Chronotype Questionnaire (MCTQ).

**Usage**

```
le_week(le_w, le_f, wd)
```

**Arguments**

le_w	A Duration object corresponding to the <b>light exposure on workdays</b> from a standard version of the MCTQ questionnaire.
le_f	A Duration object corresponding to the <b>light exposure on work-free days</b> from a standard version of the MCTQ questionnaire.
wd	An <a href="#">integerish</a> numeric object or an integer object corresponding to the <b>number of workdays per week</b> from a standard version of the MCTQ questionnaire.

**Details**

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mellow (2003), Roenneberg, Allebrandt, Mellow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

**Class requirements:**

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the [lubridate](#) and [hms](#) packages. Please refer to those package documents to learn more about them.

**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with [round\\_time\(\)](#).

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A Duration object corresponding to the vectorized weighted mean of `le_w` and `le_f` with `wd` and `fd(wd)` as weights.

**Guidelines**

Roenneberg, Allebrandt, Mellow, & Vetter (2012) and The Worldwide Experimental Platform (n.d.) guidelines for `le_week()` ( $LE_{week}$ ) computation are as follows.

**Notes:**

- The average weekly light exposure is the weighted average of the light exposure on work and work-free days in a week.

- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

### Computation:

$$\frac{LE_W \times WD + LE_F \times FD}{7}$$

Where:

- $LE_W$  = light exposure on workdays.
- $LE_F$  = light exposure on work-free days.
- $WD$  = number of workdays per week ("I have a regular work schedule and work \_\_\_ days per week").
- $FD$  = number of work-free days per week.

\*  $W$  = workdays;  $F$  = work-free days.

### Missing sections in standard and micro MCTQ versions

Although the standard and micro versions of the MCTQ asks for respondents to complete the workdays and work-free days sections, even when they do not have a regular work schedule ( $wd = 0$ ) or have a 7 day/week work schedule ( $wd = 7$ ), some of them may still end skipping one of this parts of the questionnaire. In those cases, `sd_week()`, `sloss_week()`, `le_week()`, `msf_sc()`, `sjl_rel()`, and `sjl()` will produce NA (Not Available) as output. That's because those computations combine workdays and work-free days variables.

For those special standard and micro MCTQ cases, where one section is missing, a NA value is the correct output for the functions mentioned above when  $wd$  (number of workdays per week) are  $wd > 0$  &  $wd < 7$ , but it may not be when  $wd == 0$  or  $wd == 7$ . There are different approaches to deal with this issue. See `vignette("missing-sections", package = "mctq")` to learn more.

### References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shiftworkers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Mellow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Mellow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

**See Also**

Other MCTQ functions: `fd()`, `gu()`, `msf_sc()`, `mstl()`, `napd()`, `sd24()`, `sd_overall()`, `sd_week()`, `sdu()`, `sjl_weighted()`, `sjl()`, `so()`, `tbt()`

**Examples**

```
## Scalar example

le_w <- lubridate::dhours(1.5)
le_f <- lubridate::dhours(3.7)
wd <- 5
le_week(le_w, le_f, wd)
#> [1] "7662.85714285714s (~2.13 hours)" # Expected

le_w <- lubridate::dhours(3)
le_f <- lubridate::dhours(1.5)
wd <- 6
le_week(le_w, le_f, wd)
#> [1] "10028.5714285714s (~2.79 hours)" # Expected

le_w <- lubridate::dhours(5.6)
le_f <- lubridate::as.duration(NA)
wd <- 3
le_week(le_w, le_f, wd)
#> [1] NA # Expected

## Vector example

le_w <- c(lubridate::dhours(3), lubridate::dhours(2.45))
le_f <- c(lubridate::dhours(3), lubridate::dhours(3.75))
wd <- c(4, 5)
le_week(le_w, le_f, wd)
#> [1] "10800s (~3 hours)" # Expected
#> [2] "10157.1428571429s (~2.82 hours)" # Expected

## Checking second output from vector example

if (requireNamespace("stats", quietly = TRUE)) {
  i <- 2
  x <- c(le_w[i], le_f[i])
  w <- c(wd[i], fd(wd[i]))
  lubridate::as.duration(stats::weighted.mean(x, w))
}
#> [1] "10157.1428571429s (~2.82 hours)" # Expected

## Converting the output to `hms`

le_w <- lubridate::dhours(1.25)
le_f <- lubridate::dhours(6.23)
wd <- 3
x <- le_week(le_w, le_f, wd)
x
```

```

#> [1] "14744.5714285714s (~4.1 hours)" # Expected
hms::hms(as.numeric(x))
#> 04:05:44.571429 # Expected

## Rounding the output at the seconds level

le_w <- lubridate::dhours(3.4094)
le_f <- lubridate::dhours(6.2345)
wd <- 2
x <- le_week(le_w, le_f, wd)
x
#> [1] "19538.3828571429s (~5.43 hours)" # Expected
round_time(x)
#> [1] "19538s (~5.43 hours)" # Expected

```

---

micro\_mctq

*A fictional  $\mu$ MCTQ dataset*


---

## Description

### [Maturing]

A fictional dataset, **for testing and learning purposes**, composed of basic/measurable and computed variables of the Munich Chronotype Questionnaire (MCTQ) micro version.

This data was created following the guidelines in Ghotbi *et.al* (2020), in addition to the guidelines in Roenneberg, Wirz-Justice, & Merrow (2003), Roenneberg, Allebrandt, Merrow, & Vetter (2012), and The Worldwide Experimental Platform (n.d.). See the References and Details sections to learn more.

## Usage

```
micro_mctq
```

## Format

A tibble with 17 columns and 50<sup>+</sup> rows:

**id** A unique integer value to identify each respondent in the dataset.

Type: Control.

R class: integer.

**shift\_work** A logical value indicating if the respondent has been a shift- or night-worker in the past three months.

Statement (EN): "I have been a shift- or night-worker in the past three months: Yes ( \_\_\_ )  
No ( \_\_\_ )".



Type: Basic.

R class: logical.

**wd** Number of **workdays** per week.

Statement (EN): "Normally, I work \_\_\_ days/week".

Type: Basic.

R class: integer.

**fd** Number of **work-free days** per week.

Type: Computed.

R class: integer.

**so\_w** Local time of sleep onset on **workdays**.

Statement (EN): "On WORKDAYS ... I normally fall asleep at \_\_\_ : \_\_\_ AM/PM (this is NOT when you get into bed, but rather when you fall asleep)".

Type: Basic.

R class: hms.

**se\_w** Local time of sleep end on **workdays**.

Statement (EN): "On WORKDAYS ... I normally wake up at \_\_\_ : \_\_\_ AM/PM (this is NOT when you get out of bed, but rather when you wake up)".

Type: Basic.

R class: hms.

**sd\_w** Sleep duration on **workdays**.

Type: Computed.

R class: Duration.

**msw** Local time of mid-sleep on **workdays**.

Type: Computed.

R class: hms.

**so\_f** Local time of sleep onset on **work-free days** when the respondent **doesn't** use an alarm clock to wake up.

Statement (EN): "On WORK-FREE DAYS when I DON'T use an alarm clock ... I normally fall asleep at \_\_\_ : \_\_\_ AM/PM (this is NOT when you get into bed, but rather when you fall asleep)".

Type: Basic.

R class: hms.

**se\_f** Local time of sleep end on **work-free days** when the respondent **doesn't** use an alarm clock to wake up.

Statement (EN): "On WORK-FREE DAYS when I DON'T use an alarm clock ... I normally wake up at \_\_\_ : \_\_\_ AM/PM (this is NOT when you get out of bed, but rather when you wake up)".

Type: Basic.

R class: hms.

**sd\_f** Sleep duration on **work-free days** when the respondent **doesn't** use an alarm clock to wake up.

Type: Computed.

R class: Duration.

**msf** Local time of mid-sleep on **work-free days** when the respondent **doesn't** use an alarm clock to wake up.

Type: Computed.

R class: hms.

**sd\_week** Average weekly sleep duration.

Type: Computed.

R class: Duration.

**sloss\_week** Weekly sleep loss.

Type: Computed.

R class: Duration.

**msf\_sc** Chronotype or corrected local time of mid-sleep on **work-free days**.

Type: Computed.

R class: hms.

**sjl\_rel** Relative social jetlag.

Type: Computed.

R class: Duration.

**sjl** Absolute social jetlag.

Type: Computed.

R class: Duration.

## Details

micro\_mctq is a tidied, validated, and transformed version of `raw_data("micro_mctq.csv")`.

### Guidelines:

To learn more about the Munich Chronotype Questionnaire (MCTQ), see Roenneberg, Wirz-Justice, & Mellow (2003), Roenneberg, Allebrandt, Mellow, & Vetter (2012), Roenneberg et al. (2015), and Roenneberg, Pilz, Zerbini, & Winnebeck (2019).

To know about different MCTQ versions, see Juda, Vetter, & Roenneberg (2013) and Ghotbi et al. (2020).

If you're curious about the variable computations and want to have access to the full questionnaire, see The Worldwide Experimental Platform (n.d.).

### Data building and data wrangling:

This dataset was created by randomized sampling (see `random_mctq()`) and by manual insertions of special cases. Its purpose is to demonstrate common cases and data issues that researchers may find in their MCTQ data, in addition to be a suggested data structure for MCTQ data.

You can see the `micro_mctq` build and data wrangling processes [here](#).

### Variable naming:

The naming of the variables took into account the naming scheme used in MCTQ publications, in addition to the guidelines of the [tidyverse style guide](#).

### Variable classes:

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

### Duration objects:

If you prefer to view Duration objects as hms objects, run `pretty_mctq(micro_mctq)`.

## Source

Created by Daniel Vartanian (package author).

## References

Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).

Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).

Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).

Roenneberg, T., Keller, L. K., Fischer, D., Matora, J. L., Vetter, C., & Winnebeck, E. C. (2015). Human activity and rest in situ. In A. Sehgal (Ed.), *Methods in Enzymology* (Vol. 552, pp. 257-283). London, UK: Academic Press. doi: [10.1016/bs.mie.2014.11.028](https://doi.org/10.1016/bs.mie.2014.11.028).

Roenneberg, T., Pilz, L. K., Zerbini, G., & Winnebeck, E. C. (2019). Chronotype and social jetlag: a (self-) critical review. *Biology*, 8(3), 54. doi: [10.3390/biology8030054](https://doi.org/10.3390/biology8030054).

Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).

The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other datasets: [shift\\_mctq](#), [std\\_mctq](#)

---

msf\_sc

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

---

## Description

### [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.

## Usage

```
msf_sc(msf, sd_w, sd_f, sd_week, alarm_f)
```

```
chronotype(msf, sd_w, sd_f, sd_week, alarm_f)
```

## Arguments

- |      |   |
|------|---|
| msf  | A hms object corresponding to the <b>local time of mid-sleep on work-free days</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <a href="#">msl()</a> to compute it. |
| sd_w | A Duration object corresponding to the <b>sleep duration on work days</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.          |

sd_f	A Duration object corresponding to the <b>sleep duration on work-free days</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <code>sdu()</code> to compute it.
sd_week	A Duration object corresponding to the <b>average weekly sleep duration</b> from a standard or micro version of the MCTQ questionnaire (you can use <code>sd_week()</code> to compute it) <b>or</b> the <b>overall sleep duration of a particular shift</b> from a shift version of the MCTQ questionnaire (you can use <code>sd_overall()</code> to compute it).
alarm_f	A logical object corresponding to the <b>alarm clock use on work-free days</b> from a standard, micro, or shift version of the MCTQ questionnaire. Note that, if <code>alarm_f == TRUE</code> , <code>msf_sc</code> cannot be computed, <code>msf_sc()</code> will return NA for those cases. For the $\mu$ MCTQ, this value must be set as FALSE all times, since the questionnaire considers only the work-free days when the respondent does not use an alarm.

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mellow (2003), Roenneberg, Allebrandt, Mellow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

### Class requirements:

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documents to learn more about them.

### Rounding and fractional time:

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", "01:15:44.505"). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

## Value

A `hms` object corresponding to the MCTQ chronotype or corrected local time of mid-sleep on work-free days.

## Guidelines

Roenneberg, Allebrandt, Mellow, & Vetter (2012), Ghotbi et al. (2020), Juda, Vetter, & Roenneberg (2013), and The Worldwide Experimental Platform (n.d.) guidelines for `msf_sc()` ( $MSF_{sc}$ ) computation are as follows.

### Notes:

- For all cases,  $MSF_{sc}$  cannot be computed if the participant wakes up with an alarm clock on work-free days ( $Alarm_F$ ).
- For  $MCTQ^{Shift}$ , the computation below must be applied to each shift section of the questionnaire.
- $MSF_{sc}$  is a proxy for the participant chronotype in standard and micro versions of the MCTQ.
- The basis for estimating chronotype in shift-workers is the mid-sleep on work-free days after evening shifts ( $MSF^E$ ). In case work schedules do not comprise evening shifts, Juda, Vetter, & Roenneberg (2013) propose to derive it from the  $MSF_{sc}$  of other shifts (e.g., by using a linear model). Unfortunately, the `mctq` package can't help you with that, as it requires a closer look at your data.
- $MSF_{sc}$  depends on developmental and environmental conditions (e.g., age, light exposure). For epidemiological and genetic studies,  $MSF_{sc}$  must be normalized for age and sex to make populations of different age and sex compositions comparable (Roenneberg, Allebrandt, Merrow, & Vetter, 2012).
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**For standard and micro versions of the MCTQ:**

$$\text{If } SD_F \leq SD_W, MSF$$

$$\text{If } SD_F > SD_W, MSF - \frac{SD_F - SD_{week}}{2}$$

Where:

- $MSF$  = local time of mid-sleep on work-free days.
- $SD_W$  = sleep duration on workdays.
- $SD_F$  = sleep duration on work-free days.
- $SD_{week}$  = average weekly sleep duration.

\*  $W$  = workdays;  $F$  = work-free days.

**For the shift version of the MCTQ:**

$$\text{If } SD_F^{M/E/N} \leq SD_W^{M/E/N}, MSF^{M/E/N}$$

$$\text{If } SD_F^{M/E/N} > SD_W^{M/E/N}, MSF^{M/E/N} - \frac{SD_F^{M/E/N} - \emptyset SD^{M/E/N}}{2}$$

Where:

- $MSF^{M/E/N}$  = local time of mid-sleep between two free days after a particular shift.
- $SD_W^{M/E/N}$  = sleep duration between two days in a particular shift.
- $SD_F^{M/E/N}$  = sleep duration between two free days after a particular shift.
- $\emptyset SD^{M/E/N}$  = overall sleep duration of a particular shift.

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

### Missing sections in standard and micro MCTQ versions

Although the standard and micro versions of the MCTQ asks for respondents to complete the work-days and work-free days sections, even when they do not have a regular work schedule ( $wd = 0$ ) or have a 7 day/week work schedule ( $wd = 7$ ), some of them may still end skipping one of this parts of the questionnaire. In those cases, `sd_week()`, `sloss_week()`, `le_week()`, `msf_sc()`, `sjl_re1()`, and `sjl()` will produce NA (Not Available) as output. That's because those computations combine workdays and work-free days variables.

For those special standard and micro MCTQ cases, where one section is missing, a NA value is the correct output for the functions mentioned above when  $wd$  (number of workdays per week) are  $wd > 0$  &  $wd < 7$ , but it may not be when  $wd == 0$  or  $wd == 7$ . There are different approaches to deal with this issue. See `vignette("missing-sections", package = "mctq")` to learn more.

### References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Mellow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Mellow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

### See Also

Other MCTQ functions: `fd()`, `gu()`, `le_week()`, `msl()`, `napd()`, `sd24()`, `sd_overall()`, `sd_week()`, `sdu()`, `sjl_weighted()`, `sjl()`, `so()`, `tbt()`

### Examples

```
## Scalar example

msf <- hms::parse_hms("04:00:00")
sd_w <- lubridate::dhours(6)
sd_f <- lubridate::dhours(7)
sd_week <- lubridate::dhours(6.29)
alarm_f <- FALSE
msf_sc(msf, sd_w, sd_f, sd_week, alarm_f)
#> 03:38:42 # Expected

msf <- hms::parse_hm("01:00:00")
sd_w <- lubridate::dhours(5.5)
sd_f <- lubridate::dhours(9)
```

```

sd_week <- lubridate::dhours(6.75)
alarm_f <- FALSE
msf_sc(msf, sd_w, sd_f, sd_week, alarm_f)
#> 23:52:30 # Expected

msf <- hms::parse_hms("05:40:00")
sd_w <- lubridate::dhours(7.5)
sd_f <- lubridate::dhours(10)
sd_week <- lubridate::dhours(8.5)
alarm_f <- TRUE
msf_sc(msf, sd_w, sd_f, sd_week, alarm_f)
#> NA # Expected (`msf_sc` cannot be computed if `alarm_f == TRUE`)

## Vector example

msf <- c(hms::parse_hms("03:45:00"), hms::parse_hm("04:45:00"))
sd_w <- c(lubridate::dhours(9), lubridate::dhours(6.45))
sd_f <- c(lubridate::dhours(5), lubridate::dhours(10))
sd_week <- c(lubridate::dhours(8.5), lubridate::dhours(9.2))
alarm_f <- c(FALSE, FALSE)
msf_sc(msf, sd_w, sd_f, sd_week, alarm_f)
#> 03:45:00 # Expected
#> 04:21:00 # Expected

## A wrapper for msf_sc()

msf <- hms::parse_hms("07:00:00")
sd_w <- lubridate::dhours(6)
sd_f <- lubridate::dhours(12)
sd_week <- lubridate::dhours(9.45)
alarm_f <- FALSE
chronotype(msf, sd_w, sd_f, sd_week, alarm_f)
#> 05:43:30 # Expected

## Rounding the output at the seconds level

msf <- hms::parse_hms("05:40:00")
sd_w <- lubridate::dhours(5.43678)
sd_f <- lubridate::dhours(9.345111)
sd_week <- lubridate::dhours(7.5453)
alarm_f <- FALSE
x <- msf_sc(msf, sd_w, sd_f, sd_week, alarm_f)
x
#> 04:46:00.3402 # Expected
round_time(x)
#> 04:46:00 # Expected

```



## Description

### [Maturing]

`msl()` computes the **local time of mid-sleep** for standard, micro, and shift versions of the Munich Chronotype Questionnaire (MCTQ).

Please note that, although we tried to preserve the original authors' naming pattern for the MCTQ functions, the name `ms` provokes a dangerous name collision with the `lubridate::ms()` function (a function for parsing minutes and seconds components). That's why we named it `msl`. `msl()` and `sdu()` are the only exceptions, all the other `mctq` functions maintain a strong naming resemblance with the original authors' naming pattern.

## Usage

```
msl(so, sd)
```

## Arguments

- |                 |  |
|-----------------|--|
| <code>so</code> | A <code>hms</code> object corresponding to the <b>local time of sleep onset</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <code>so()</code> to compute it for the standard or shift version. |
| <code>sd</code> | A <code>Duration</code> object corresponding to the <b>sleep duration</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <code>sdu()</code> to compute it for any MCTQ version.                   |

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mellow (2003), Roenneberg, Allebrandt, Mellow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

### Class requirements:

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documents to learn more about them.

### Rounding and fractional time:

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A hms object corresponding to the vectorized sum of `so` and `(sd / 2)` in a circular time frame of 24 hours.

**Guidelines**

Roenneberg, Allebrandt, Merrow, & Vetter (2012), Ghotbi et al. (2020), Juda, Vetter, & Roenneberg (2013), and The Worldwide Experimental Platform (n.d.) guidelines for `msl()` (*MSW* or *MSF*) computation are as follows.

**Notes:**

- The computation below must be applied to each section of the questionnaire.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**For standard and micro versions of the MCTQ:**

$$SO_{W/F} + \frac{SD_{W/F}}{2}$$

Where:

- $SO_{W/F}$  = local time of sleep onset on work **or** work-free days.
- $SD_{W/F}$  = sleep duration on work **or** work-free days.

\*  $W$  = workdays;  $F$  = work-free days.

**For the shift version of the MCTQ:**

$$SO_{W/F}^{M/E/N} + \frac{SD_{W/F}^{M/E/N}}{2}$$

Where:

- $SO_{W/F}^{M/E/N}$  = local time of sleep onset between two days in a particular shift **or** between two free days after a particular shift.
- $SD_{W/F}^{M/E/N}$  = sleep duration between two days in a particular shift **or** between two free days after a particular shift.

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

**References**

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).

Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).

Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).

The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

### See Also

Other MCTQ functions: [fd\(\)](#), [gu\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [napd\(\)](#), [sd24\(\)](#), [sd\\_overall\(\)](#), [sd\\_week\(\)](#), [sdu\(\)](#), [sjl\\_weighted\(\)](#), [sjl\(\)](#), [so\(\)](#), [tbt\(\)](#)

### Examples

```
## Scalar example

so <- hms::parse_hm("23:30")
sd <- lubridate::dhours(8)
msl(so, sd)
#> 03:30:00 # Expected

so <- hms::parse_hm("01:00")
sd <- lubridate::dhours(10)
msl(so, sd)
#> 06:00:00 # Expected

so <- hms::as_hms(NA)
sd <- lubridate::dhours(7.5)
msl(so, sd)
#> NA # Expected

## Vector example

so <- c(hms::parse_hm("00:10"), hms::parse_hm("01:15"))
sd <- c(lubridate::dhours(9.25), lubridate::dhours(5.45))
msl(so, sd)
#> [1] 04:47:30 # Expected
#> [1] 03:58:30 # Expected
```

---

napd

*Compute MCTQ nap duration (only for MCTQ<sup>ˆ</sup> Shift)*

---

### Description

#### [Maturing]

`napd()` computes the **nap duration** for the shift version of the Munich Chronotype Questionnaire (MCTQ).

**Usage**

```
napd(napo, nape)
```

**Arguments**

napo	A hms object corresponding to the <b>local time of nap onset</b> from the shift version of the MCTQ questionnaire.
nape	A hms object corresponding to the <b>local time of nap end</b> from the shift version of the MCTQ questionnaire.

**Details**

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Meroow (2003), Roenneberg, Allebrandt, Meroow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

**Class requirements:**

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documentations to learn more about them.

**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A `Duration` object corresponding to the vectorized difference between `nape` and `napo` in a circular time frame of 24 hours.

**Guidelines**

Juda, Vetter & Roenneberg (2013) and The Worldwide Experimental Platform (n.d.) guidelines for `napd()` (*NapD*) computation are as follows.

**Notes:**

- The computation below must be applied to each shift section of the questionnaire.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**Computation:**

$$NapE_{W/F}^{M/E/N} - NapO_{W/F}^{M/E/N}$$

Where:

- $NapO_{W/F}^{M/E/N}$  = local time of nap onset between two days in a particular shift **or** between two free days after a particular shift ("I take a nap from \_\_\_ o'clock [...]").
- $NapE_{W/F}^{M/E/N}$  = local time of nap end between two days in a particular shift **or** between two free days after a particular shift ("[...] to \_\_\_ o'clock").

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

**References**

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Mellow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Mellow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

**See Also**

Other MCTQ functions: `fd()`, `gu()`, `le_week()`, `msf_sc()`, `msl()`, `sd24()`, `sd_overall()`, `sd_week()`, `sdu()`, `sjl_weighted()`, `sjl()`, `so()`, `tbt()`

**Examples**

```
## Scalar example

napo <- hms::parse_hm("12:30")
nape <- hms::parse_hm("14:20")
napd(napo, nape)
#> [1] "6600s (~1.83 hours)" # Expected

napo <- hms::parse_hm("23:45")
nape <- hms::parse_hm("00:30")
napd(napo, nape)
#> [1] "2700s (~45 minutes)" # Expected

napo <- hms::parse_hm("10:20")
```

```

nape <- hms::as_hms(NA)
napd(napo, nape)
#> [1] NA # Expected

## Vector example

napo <- c(hms::parse_hm("01:25"), hms::parse_hm("23:50"))
nape <- c(hms::parse_hm("03:10"), hms::parse_hm("01:10"))
napd(napo, nape)
#> [1] "6300s (~1.75 hours)" "4800s (~1.33 hours)" # Expected

```

---

pretty\_mctq

*Make an MCTQ dataset more presentable*


---

## Description

### [Maturing]

pretty\_mctq() helps you to transform your Munich Chronotype Questionnaire (MCTQ) data in many ways. See the Arguments and Details section to learn more.

## Usage

```
pretty_mctq(data, round = TRUE, hms = TRUE)
```

## Arguments

data	A data.frame object.
round	(optional) a logical value indicating if Duration and hms objects must be rounded at the level of seconds (default: TRUE).
hms	(optional) a logical value indicating if Duration and difftime objects must be converted to hms (default: TRUE).

## Details

### Rounding:

Please note that by rounding MCTQ values you discard data. That is to say that if you need to redo a computation, or do new ones, your values can be off by a couple of seconds (see [round-off error](#)).

Round your values only if and when you want to present them more clearly, like in graphical representations. You can also round values to facilitate data exporting to text formats (like .csv), but note that this will come with a precision cost.

Note also that pretty\_mctq() uses [round\\_time\(\)](#) for rounding. round\_time() is based on [round\(\)](#), which uses the IEC 60559 standard. For more information see [?round\\_time](#).

## Value

A transformed data.frame object, as indicated in the arguments.

**See Also**

Other utility functions: [assign\\_date\(\)](#), [cycle\\_time\(\)](#), [qplot\\_walk\(\)](#), [random\\_mctq\(\)](#), [raw\\_data\(\)](#), [round\\_time\(\)](#), [shorter\\_interval\(\)](#), [sum\\_time\(\)](#)

**Examples**

```
data <- data.frame(
  a = 1,
  b = lubridate::duration(1.12345),
  c = hms::hms(1.12345))

## Rounding time objects from `data`

pretty_mctq(data, round = TRUE, hms = FALSE)

## Converting non-`hms` time objects from `data` to `hms`

pretty_mctq(data, round = FALSE, hms = TRUE)
```

---

qplot\_walk

*Walk through distribution plots*


---

**Description****[Maturing]**

`qplot_walk()` helps you to visually assess the distribution of your data. It uses `ggplot2::qplot()` to walk through each selected variable from a data frame.

**Usage**

```
qplot_walk(
  data,
  ...,
  cols = NULL,
  pattern = NULL,
  ignore = "character",
  remove_id = TRUE,
  midday_change = TRUE
)
```

**Arguments**

<code>data</code>	An atomic or <code>data.frame</code> object.
<code>...</code>	(optional) additional arguments to be passed to <code>ggplot2::qplot()</code> .
<code>cols</code>	(optional) (only for data frames) a character object indicating column names in data for plotting. If <code>NULL</code> , <code>qplot_walk()</code> will use all columns in data. This setting only works if <code>pattern = NULL</code> (default: <code>NULL</code> ).

pattern	(optional) (only for data frames) a string with a regular expression to select column names in data for plotting. This setting only works if cols = NULL (default: NULL).
ignore	(optional) (only for data frames) a character object indicating which object classes the function must ignore. This setting can be used with cols and pattern. Assign NULL to disable this behavior (default: "character").
remove_id	(optional) (only for data frames) a logical value indicating if the function must ignore column names in data that match with the regular expression "^id\$ [\.\_\-]id\$" (default: TRUE).
midday_change	(optional) a logical value indicating if the function must apply a midday change for hms variables with values greater than 22:00:00 (see Details section to learn more) (default: TRUE).

## Details

### Requirements:

This function requires the `grDevices` and `ggplot2` package and can only run in interactive mode. The `grDevices` package comes with a standard R installation and is typically loaded by default. Most people also run R interactively.

If you don't have any of the two packages mentioned above, you can install them with `install.packages("grDevices")` and `install.packages("ggplot2")`.

### Plot recover:

`qplot_walk()` erases all plots after it runs. For that reason, the function first emits a dialog message warning the user of this behavior before it runs. If you want to recover a single distribution plot, assign the variable vector to the data argument.

### Additional arguments to `ggplot2::qplot()`:

`qplot_walk()` uses `ggplot2::qplot()` to generate plots. If you are familiar with `ggplot2::qplot()`, you can pass additional arguments to the function using the ellipsis argument (`...`).

Note that `x`, `y`, and `data` arguments are reserved for `qplot_walk()`.

### Duration, Period, and `difftime` objects:

To help with the visualization, `qplot_walk()` automatically converts `Duration`, `Period`, and `difftime` objects to `hms`.

### Midday change:

Time variables with values greater than 22:00:00 will automatically be converted to `POSIXct` and be attached to a two-day timeline using the midday hour as a cutting point, i.e., all values with 12 hours or more will be placed on day 1, and all the rest will be placed on day 2.

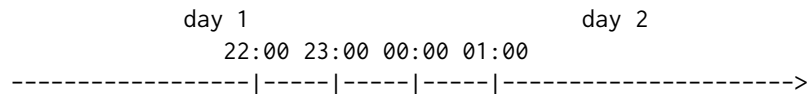
This is made to better represent time vectors that cross the midnight hour. You can disable this behavior by using `midday_change = FALSE`.

Example: Say you have a vector of time values that cross the midnight hour (e.g., an `hms` vector with 22:00, 23:00, 00:00, 01:00 values). If you use `midday_change = FALSE`, your data will be represented linearly.

```
00:00 01:00                                22:00 23:00
|-----|----->                        |-----|----->
```



By using `midday_change = TRUE` (default), `qplot_walk()` will fit your data to a circular time frame of 24 hours.



#### id variables:

`qplot_walk()` will ignore any variable with the follow name pattern `"^id$|[\.\_ -]id$"`, i.e. any variable named `id` or that ends with `.id`, `_id`, or `-id`.

You can disable this behavior using `remove_id = FALSE`.

#### Value

An invisible NULL. `qplot_walk()` was made to only display plots.

#### See Also

Other utility functions: [assign\\_date\(\)](#), [cycle\\_time\(\)](#), [pretty\\_mctq\(\)](#), [random\\_mctq\(\)](#), [raw\\_data\(\)](#), [round\\_time\(\)](#), [shorter\\_interval\(\)](#), [sum\\_time\(\)](#)

#### Examples

```
if (interactive()) {

  ## Ploting a single column from `data`

  qplot_walk(mctq::std_mctq$bt_w)

  ## Ploting all columns from `data`

  qplot_walk(mctq::std_mctq, ignore = NULL, remove_id = FALSE)

  ## Ploting selected columns from `data`

  qplot_walk(mctq::std_mctq, cols = c("bt_w", "msf_sc"))

  ## Ploting selected columns from `data` using a name pattern

  qplot_walk(mctq::std_mctq, pattern = "_w$")

  ## Examples using other datasets

  if (requireNamespace("datasets", quietly = TRUE)) {
    qplot_walk(datasets::iris)
    qplot_walk(datasets::mtcars)
  }
}
```

---

`random_mctq`*Build a random MCTQ case*

---

## Description

### [Maturing]

`random_mctq` builds a fictional Munich Chronotype Questionnaire (MCTQ) case composed of MCTQ basic/measurable variables.

This function is **for testing and learning purposes only**. Please don't misuse it.

## Usage

```
random_mctq(model = "standard")
```

## Arguments

`model` A string indicating the data model to return. Valid values are: "standard", "shift", and "micro" (default: "standard").

## Details

The case structure (variable names and classes) are the same as the datasets provided by the `mctq` package. See [std\\_mctq](#), [micro\\_mctq](#) and [shift\\_mctq](#) to learn more.

### Requirements:

This function requires the [stats](#) package. This won't be an issue for most people since the package comes with a standard R installation.

If you don't have the [stats](#) package, you can install it with `install.packages("stats")`.

### Cases:

Random standard and micro MCTQ cases were created with the general population in mind. The data was set to resemble the distribution parameters shown in Roenneberg, Wirz-Justice, & Merrow (2003).

MCTQ<sup>Shift</sup> random cases were created based on the shift configuration from "Study Site 1" shown in Vetter, Juda, & Roenneberg (2012). The data was set to resemble the distribution parameters shown in Juda, Vetter, & Roenneberg (2013).

You can see more about the distribution parameters used [here](#).

## Value

A named list with elements representing each MCTQ basic/measurable variable of the model indicated in the `model` argument.

## References

- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shiftworkers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg, T., Wirz-Justice, A., & Mellow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- Vetter, C., Juda, M., & Roenneberg, T. (2012). The influence of internal time, time awake, and sleep duration on cognitive performance in shiftworkers. *Chronobiology International*, 29(8), 1127-1138. doi: [10.3109/07420528.2012.707999](https://doi.org/10.3109/07420528.2012.707999).

## See Also

Other utility functions: [assign\\_date\(\)](#), [cycle\\_time\(\)](#), [pretty\\_mctq\(\)](#), [qplot\\_walk\(\)](#), [raw\\_data\(\)](#), [round\\_time\(\)](#), [shorter\\_interval\(\)](#), [sum\\_time\(\)](#)

## Examples

```
## Not run:
random_mctq("standard")
random_mctq("micro")
random_mctq("shift")

## End(Not run)
```

---

raw_data	<i>Get paths to mctq raw datasets</i>
----------	---------------------------------------

---

## Description

### [Maturing]

mctq comes bundled with raw fictional datasets for testing and learning purposes. `raw_data()` makes it easy to access their paths.

## Usage

```
raw_data(file = NULL)
```

## Arguments

`file` (optional) a character object indicating the raw data file name(s). If NULL, all raw data file names will be printed (default: NULL).

## Value

- If `file = NULL`, a character object with all file names available.
- If `file != NULL`, a string with the file name path.

**See Also**

Other utility functions: [assign\\_date\(\)](#), [cycle\\_time\(\)](#), [pretty\\_mctq\(\)](#), [qplot\\_walk\(\)](#), [random\\_mctq\(\)](#), [round\\_time\(\)](#), [shorter\\_interval\(\)](#), [sum\\_time\(\)](#)

**Examples**

```
## Not run:
## To list all raw data file names available

raw_data()

## To get the file path from a specific raw data

raw_data(raw_data()[1])

raw_data("std_mctq.csv")
## End(Not run)
```

---

round_time	<i>Round time values</i>
------------	--------------------------

---

**Description****[Maturing]**

`round_time()` takes a `Duration`, `difftime`, `hms`, `POSIXct`, or `POSIXlt` object and round it at the level of seconds.

**Usage**

```
round_time(x)

## S3 method for class 'Duration'
round_time(x)

## S3 method for class 'difftime'
round_time(x)

## S3 method for class 'hms'
round_time(x)

## S3 method for class 'POSIXct'
round_time(x)

## S3 method for class 'POSIXlt'
round_time(x)
```

**Arguments**

x                    An object belonging to one of the following classes: Duration, Period, difftime, hms, POSIXct, or POSIXlt.

**Details****Round standard:**

round\_time() uses `base::round()` for rounding. That is to say that round\_time() uses the same IEC 60559 standard ("go to the even digit") for rounding off a 5. Therefore, round(0.5) is equal to 0 and round(-1.5) is equal to -2. See ?round to learn more.

**Period objects:**

Period objects are a special type of object developed by the `lubridate` team that represents "human units", ignoring possible timeline irregularities. That is to say that 1 day as Period can have different time spans, when looking to a timeline after a irregularity event.

Since the time span of a Period object can fluctuate, round\_time() don't accept this kind of object. You can transform it to a Duration object and still use the function, but beware that this can produce errors.

Learn more about Period objects in the [Dates and times](#) chapter of Wickham & Grolemund (n.d.).

**Value**

An object of the same class of x rounded at the level of seconds.

**References**

Wickham, H., & Grolemund, G. (n.d.). *R for data science*. Sebastopol, CA: O'Reilly Media. <https://r4ds.had.co.nz>

**See Also**

Other date-time rounding functions: `hms::round_hms()` `hms::trunc_hms()` `lubridate::round_date()`.

Other utility functions: `assign_date()`, `cycle_time()`, `pretty_mctq()`, `qplot_walk()`, `random_mctq()`, `raw_data()`, `shorter_interval()`, `sum_time()`

**Examples**

```
## Scalar example

lubridate::dmilliseconds(123456789)
#> [1] "123456.789s (~1.43 days)" # Expected
round_time(lubridate::dmilliseconds(123456789))
#> [1] "123457s (~1.43 days)" # Expected

as.difftime(12345.6789, units = "secs")
#> Time difference of 12345.68 secs # Expected
round_time(as.difftime(12345.6789, units = "secs"))
#> Time difference of 12346 secs # Expected
```

```

hms::as_hms(12345.6789)
#> 03:25:45.6789 # Expected
round_time(hms::as_hms(12345.6789))
#> 03:25:46 # Expected

lubridate::as_datetime(12345.6789, tz = "EST")
#> [1] "1969-12-31 22:25:45 EST" # Expected
as.numeric(lubridate::as_datetime(12345.6789, tz = "EST"))
#> [1] 12345.68 # Expected
round_time(lubridate::as_datetime(12345.6789, tz = "EST"))
#> [1] "1969-12-31 22:25:46 EST" # Expected
as.numeric(round_time(lubridate::as_datetime(12345.6789, tz = "EST")))
#> [1] 12346 # Expected

## Vector example

x <- c(lubridate::dhours(5.6987), lubridate::dhours(2.6875154))
x
#> [1] "20515.32s (~5.7 hours)" "9675.05544s (~2.69 hours)" # Expected
round_time(x)
#> [1] "20515s (~5.7 hours)" "9675s (~2.69 hours)" # Expected

```

---

sd24

---

*Compute MCTQ 24 hours sleep duration (only for MCTQ<sup>Shift</sup>)*


---

## Description

### [Maturing]

sd24() computes the **24 hours sleep duration** for the shift version of the Munich Chronotype Questionnaire (MCTQ).

## Usage

```
sd24(sd, napd, nap)
```

## Arguments

sd	A Duration object corresponding to the <b>sleep duration</b> from the shift version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.
napd	A Duration object corresponding to the <b>nap duration</b> from the shift version of the MCTQ questionnaire. You can use <a href="#">napd()</a> to compute it.
nap	A logical value corresponding to the <b>"I usually take a nap"</b> from the shift version of the MCTQ questionnaire.

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Meroow (2003), Roenneberg, Allebrandt, Meroow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

### Class requirements:

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documentations to learn more about them.

### Rounding and fractional time:

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

## Value

- If `nap == TRUE`, a `Duration` object corresponding to the vectorized sum of `sd` and `napd` in a circular time frame of 24 hours.
- If `nap == FALSE`, a `Duration` object equal to `sd`.

## Guidelines

Juda, Vetter & Roenneberg (2013) and The Worldwide Experimental Platform (n.d.) guidelines for `sd24()` ( $SD_{24}$ ) computation are as follows.

### Notes:

- The computation below must be applied to each shift section of the questionnaire.
- If the respondent don't usually take a nap in a particular shift **or** between two free days after a particular shift, `sd24()` will return only  $SD_{W/F}^{M/E/N}$ .
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

### Computation:

$$SD_{W/F}^{M/E/N} + NapD_{W/F}^{M/E/N}$$

Where:

- $SD_{W/F}^{M/E/N}$  = sleep duration between two days in a particular shift **or** between two free days after a particular shift.
- $NapD_{W/F}^{M/E/N}$  = nap duration between two days in a particular shift **or** between two free days after a particular shift.

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other MCTQ functions: [fd\(\)](#), [gu\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [msl\(\)](#), [napd\(\)](#), [sd\\_overall\(\)](#), [sd\\_week\(\)](#), [sdu\(\)](#), [sjl\\_weighted\(\)](#), [sjl\(\)](#), [so\(\)](#), [tbt\(\)](#)

## Examples

```
## Scalar example

sd <- lubridate::dhours(6)
napd <- lubridate::dhours(0.5)
nap <- TRUE
sd24(sd, napd, nap)
#> [1] "23400s (~6.5 hours)" # Expected

sd <- lubridate::dhours(9)
napd <- lubridate::dhours(1.5)
nap <- TRUE
sd24(sd, napd, nap)
#> [1] "37800s (~10.5 hours)" # Expected

sd <- lubridate::dhours(6.5)
napd <- lubridate::as.duration(NA)
nap <- FALSE
sd24(sd, napd, nap)
#> [1] "23400s (~6.5 hours)" # Expected
```



```

sd <- lubridate::as.duration(NA)
napd <- lubridate::dhours(2.3)
nap <- TRUE
sd24(sd, napd, nap)
#> [1] NA # Expected

## Vector example

sd <- c(lubridate::dhours(7.5), lubridate::dhours(8))
napd <- c(lubridate::dhours(0.75), lubridate::dhours(1))
nap <- c(TRUE, TRUE)
sd24(sd, napd, nap)
#> [1] "29700s (~8.25 hours)" "32400s (~9 hours)" # Expected

```

---

sdu

---

*Compute MCTQ sleep duration*


---

## Description

### [Maturing]

sdu() computes the **sleep duration** for standard, micro, and shift versions of the Munich Chronotype Questionnaire (MCTQ).

Please note that, although we tried to preserve the original authors' naming pattern for the MCTQ functions, the name `sd` provokes a dangerous name collision with the widely used `stats::sd()` function (standard deviation). That's why we named it `sdu`. `sdu()` and `msl()` are the only exceptions, all the other `mctq` functions maintain a strong naming resemblance with the original authors' naming pattern.

## Usage

```
sdu(so, se)
```

## Arguments

<code>so</code>	A <code>hms</code> object corresponding to the <b>local time of sleep onset</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <code>so()</code> to compute it for the standard or shift version.
<code>se</code>	A <code>hms</code> object corresponding to the <b>local time of sleep end</b> from a standard, micro, or shift version of the MCTQ questionnaire.

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mellow (2003), Roenneberg, Allebrandt, Mellow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

**$\mu$ MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

**Class requirements:**

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documentations to learn more about them.

**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", "01:15:44.505"). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A `Duration` object corresponding to the vectorized difference between `se` and `so` in a circular time frame of 24 hours.

**Guidelines**

Roenneberg, Allebrandt, Merrow, & Vetter (2012), Ghotbi et al. (2020), Juda, Vetter, & Roenneberg (2013), and The Worldwide Experimental Platform (n.d.) guidelines for `sdu()` (*SD*) computation are as follows.

**Notes:**

- The computation below must be applied to each section of the questionnaire.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**For standard and micro versions of the MCTQ:**

$$SE_{W/F} - SO_{W/F}$$

Where:

- $SE_{W/F}$  = local time of sleep end on work **or** work-free days.
- $SO_{W/F}$  = local time of sleep onset on work **or** work-free days.

\*  $W$  = workdays;  $F$  = work-free days.

**For the shift version of the MCTQ:**

$$SE_{W/F}^{M/E/N} - SO_{W/F}^{M/E/N}$$

Where:

- $SE_{W/F}^{M/E/N}$  = local time of sleep end between two days in a particular shift **or** between two free days after a particular shift.
- $SO_{W/F}^{M/E/N}$  = local time of sleep onset between two days in a particular shift **or** between two free days after a particular shift.

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other MCTQ functions: [fd\(\)](#), [gu\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [msl\(\)](#), [napd\(\)](#), [sd24\(\)](#), [sd\\_overall\(\)](#), [sd\\_week\(\)](#), [sjl\\_weighted\(\)](#), [sjl\(\)](#), [so\(\)](#), [tbt\(\)](#)

## Examples

```
## Scalar example

so <- hms::parse_hm("23:00")
se <- hms::parse_hm("08:00")
sdu(so, se)
#> [1] "32400s (~9 hours)" # Expected

so <- hms::parse_hm("02:00")
se <- hms::parse_hm("12:30")
sdu(so, se)
#> [1] "37800s (~10.5 hours)" # Expected

so <- hms::parse_hm("03:15")
se <- hms::as_hms(NA)
sdu(so, se)
#> [1] NA # Expected

## Vector example

so <- c(hms::parse_hm("04:12"), hms::parse_hm("21:20"))
```

```
se <- c(hms::parse_hm("14:30"), hms::parse_hm("03:45"))
sdu(so, se)
#> [1] "37080s (~10.3 hours)" "23100s (~6.42 hours)" # Expected
```

---

sd\_overall

---

*Compute MCTQ overall sleep duration (only for MCTQ<sup>Shift</sup>)*


---

## Description

### [Maturing]

sd\_overall() computes the **overall sleep duration in a particular shift** for the shift version of the Munich Chronotype Questionnaire (MCTQ).

See [sd\\_week\(\)](#) to compute the average weekly sleep duration for the standard and micro versions of the MCTQ.

## Usage

```
sd_overall(sd_w, sd_f, n_w, n_f)
```

## Arguments

- |      |   |
|------|---|
| sd_w | A Duration object corresponding to the <b>sleep duration between two days in a particular shift</b> from a shift version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.            |
| sd_f | A Duration object corresponding to the <b>sleep duration between two free days after a particular shift</b> from a shift version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.    |
| n_w  | An <a href="#">integerish</a> numeric object or an integer object corresponding to the <b>number of days worked in a particular shift within a shift cycle</b> from a shift version of the MCTQ questionnaire.  |
| n_f  | An <a href="#">integerish</a> numeric object or an integer object corresponding to the <b>number of free days after a particular shift within a shift cycle</b> from a shift version of the MCTQ questionnaire. |

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mewes (2003), Roenneberg, Allebrandt, Mewes, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ MCTQ functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

MCTQ<sup>Shift</sup> functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

**Class requirements:**

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the [lubridate](#) and [hms](#) packages. Please refer to those package documents to learn more about them.

**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A `Duration` object corresponding to the vectorized weighted mean of `sd_w` and `sd_f` with `n_w` and `n_f` as weights.

**Guidelines**

Juda, Vetter, & Roenneberg (2013) and The Worldwide Experimental Platform (n.d.) guidelines for `sd_overall()` ( $\emptyset SD^{M/E/N}$ ) computation are as follows.

**Notes:**

- The computation below must be applied to each shift section of the questionnaire. If you're using the three-shift design proposed by the authors, you need to compute three overall sleep duration (e.g.,  $\emptyset SD^M$ ;  $\emptyset SD^E$ ;  $\emptyset SD^N$ ).
- The overall sleep duration is the weighted average of the shift-specific mean sleep durations.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**Computation:**

$$\frac{SD_W^{M/E/N} \times n_W^{M/E/N} + SD_F^{M/E/N} \times n_F^{M/E/N}}{n_W^{M/E/N} + n_F^{M/E/N}}$$

Where:

- $SD_W^{M/E/N}$  = sleep duration between two days in a particular shift.
- $SD_F^{M/E/N}$  = sleep duration between two free days after a particular shift.
- $n_W^{M/E/N}$  = number of days worked in a particular shift within a shift cycle.
- $n_F^{M/E/N}$  = number of free days after a particular shift within a shift cycle.

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Mellow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Mellow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other MCTQ functions: [fd\(\)](#), [gu\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [msl\(\)](#), [napd\(\)](#), [sd24\(\)](#), [sd\\_week\(\)](#), [sdu\(\)](#), [sjl\\_weighted\(\)](#), [sjl\(\)](#), [so\(\)](#), [tbt\(\)](#)

## Examples

```
## Scalar example

sd_w <- lubridate::dhours(5)
sd_f <- lubridate::dhours(9)
n_w <- 2
n_f <- 2
sd_overall(sd_w, sd_f, n_w, n_f)
#> [1] "25200s (~7 hours)" # Expected

sd_w <- lubridate::dhours(3.45)
sd_f <- lubridate::dhours(10)
n_w <- 3
n_f <- 1
sd_overall(sd_w, sd_f, n_w, n_f)
#> [1] "18315s (~5.09 hours)" # Expected

sd_w <- lubridate::as.duration(NA)
sd_f <- lubridate::dhours(12)
n_w <- 4
n_f <- 4
sd_overall(sd_w, sd_f, n_w, n_f)
#> [1] NA # Expected

## Vector example

sd_w <- c(lubridate::dhours(4), lubridate::dhours(7))
sd_f <- c(lubridate::dhours(12), lubridate::dhours(9))
```

```

n_w <- c(3, 4)
n_f <- c(2, 4)
sd_overall(sd_w, sd_f, n_w, n_f)
#> [1] "25920s (~7.2 hours)" "28800s (~8 hours)" # Expected

## Checking second output from vector example

if (requireNamespace("stats", quietly = TRUE)) {
  i <- 2
  x <- c(sd_w[i], sd_f[i])
  w <- c(n_w[i], n_f[i])
  lubridate::as.duration(stats::weighted.mean(x, w))
}
#> [1] "28800s (~8 hours)" # Expected

## Converting the output to `hms`

sd_w <- lubridate::dhours(4.75)
sd_f <- lubridate::dhours(10)
n_w <- 5
n_f <- 2
x <- sd_overall(sd_w, sd_f, n_w, n_f)
x
#> [1] "22500s (~6.25 hours)" # Expected
hms::as_hms(as.numeric(x))
#> 06:15:00 # Expected

## Rounding the output at the seconds level

sd_w <- lubridate::dhours(5.9874)
sd_f <- lubridate::dhours(9.3)
n_w <- 3
n_f <- 2
x <- sd_overall(sd_w, sd_f, n_w, n_f)
x
#> [1] "26324.784s (~7.31 hours)" # Expected
round_time(x)
#> [1] "26325s (~7.31 hours)" # Expected

```

---

sd\_week

---

*Compute MCTQ average weekly sleep duration*


---

## Description

### [Maturing]

sd\_week() computes the **average weekly sleep duration** for the standard and micro versions of the Munich Chronotype Questionnaire (MCTQ).

See [sd\\_overall\(\)](#) to compute the overall sleep duration of a particular shift for the shift version of the MCTQ.

**Usage**

```
sd_week(sd_w, sd_f, wd)
```

**Arguments**

sd_w	A Duration object corresponding to the <b>sleep duration on workdays</b> from a standard or micro version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.
sd_f	A Duration object corresponding to the <b>sleep duration on work-free days</b> from a standard or micro version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.
wd	An <a href="#">integerish</a> numeric object or an integer object corresponding to the <b>number of workdays per week</b> from a standard or micro version of the MCTQ questionnaire.

**Details**

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Merrow (2003), Roenneberg, Allebrandt, Merrow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ MCTQ functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

MCTQ<sup>Shift</sup> functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

**Class requirements:**

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the [lubridate](#) and [hms](#) packages. Please refer to those package documents to learn more about them.

**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with [round\\_time\(\)](#).

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A Duration object corresponding to the vectorized weighted mean of `sd_w` and `sd_f` with `wd` and `fd(wd)` as weights.

**Guidelines**

Roenneberg, Allebrandt, Merrow, & Vetter (2012), Ghotbi et al. (2020), and The Worldwide Experimental Platform (n.d.) guidelines for `sd_week()` ( $SD_{week}$ ) computation are as follows.

**Notes:**



- The average weekly sleep duration is the weighted average of the sleep durations on work and work-free days in a week.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**Computation:**

$$\frac{SD_W \times WD + SD_F \times FD}{7}$$

Where:

- $SD_W$  = sleep duration on workdays.
- $SD_F$  = sleep duration on work-free days.
- $WD$  = number of workdays per week ("I have a regular work schedule and work \_\_\_ days per week").
- $FD$  = number of work-free days per week.

\*  $W$  = workdays;  $F$  = work-free days.

**Missing sections in standard and micro MCTQ versions**

Although the standard and micro versions of the MCTQ asks for respondents to complete the work-days and work-free days sections, even when they do not have a regular work schedule ( $wd = 0$ ) or have a 7 day/week work schedule ( $wd = 7$ ), some of them may still end skipping one of this parts of the questionnaire. In those cases, `sd_week()`, `sloss_week()`, `le_week()`, `msf_sc()`, `sjl_re1()`, and `sjl()` will produce NA (Not Available) as output. That's because those computations combine workdays and work-free days variables.

For those special standard and micro MCTQ cases, where one section is missing, a NA value is the correct output for the functions mentioned above when  $wd$  (number of workdays per week) are  $wd > 0$  &  $wd < 7$ , but it may not be when  $wd == 0$  or  $wd == 7$ . There are different approaches to deal with this issue. See `vignette("missing-sections", package = "mctq")` to learn more.

**References**

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Meroow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Meroow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

**See Also**

Other MCTQ functions: `fd()`, `gu()`, `le_week()`, `msf_sc()`, `msl()`, `napd()`, `sd24()`, `sd_overall()`, `sdu()`, `sjl_weighted()`, `sjl()`, `so()`, `tbt()`

**Examples**

```
## Scalar example

sd_w <- lubridate::dhours(4)
sd_f <- lubridate::dhours(8)
wd <- 5
sd_week(sd_w, sd_f, wd)
#> [1] "18514.2857142857s (~5.14 hours)" # Expected

sd_w <- lubridate::dhours(7)
sd_f <- lubridate::dhours(7)
wd <- 4
sd_week(sd_w, sd_f, wd)
#> [1] "25200s (~7 hours)" # Expected

sd_w <- lubridate::as.duration(NA)
sd_f <- lubridate::dhours(10)
wd <- 6
sd_week(sd_w, sd_f, wd)
#> [1] NA # Expected

## Vector example

sd_w <- c(lubridate::dhours(4.5), lubridate::dhours(5.45))
sd_f <- c(lubridate::dhours(8), lubridate::dhours(7.3))
wd <- c(3, 7)
sd_week(sd_w, sd_f, wd)
#> [1] "23400s (~6.5 hours)" "19620s (~5.45 hours)" # Expected

## Checking second output from vector example

if (requireNamespace("stats", quietly = TRUE)) {
  i <- 2
  x <- c(sd_w[i], sd_f[i])
  w <- c(wd[i], fd(wd[i]))
  lubridate::as.duration(stats::weighted.mean(x, w))
}
#> [1] "19620s (~5.45 hours)" # Expected

## Converting the output to `hms`

sd_w <- lubridate::dhours(5.45)
sd_f <- lubridate::dhours(9.5)
wd <- 5
x <- sd_week(sd_w, sd_f, wd)
x
#> [1] "23785.7142857143s (~6.61 hours)" # Expected
```

```
hms::as_hms(as.numeric(x))
#> 06:36:25.714286 # Expected

## Rounding the output at the seconds level

sd_w <- lubridate::dhours(4.5)
sd_f <- lubridate::dhours(7.8)
wd <- 3
x <- sd_week(sd_w, sd_f, wd)
x
#> [1] "22988.5714285714s (~6.39 hours)" # Expected
round_time(x)
#> [1] "22989s (~6.39 hours)" # Expected
```

---

shift\_mctq

*A fictional MCTQ<sup>^</sup> Shift dataset*

---

## Description

### [Maturing]

A fictional dataset, for **testing and learning purposes**, composed of basic/measurable and computed variables of the Munich Chronotype Questionnaire (MCTQ) shift version.

This data was created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines found in Roenneberg, Wirz-Justice, & Merrow (2003), Roenneberg, Allebrandt, Merrow, & Vetter (2012), and The Worldwide Experimental Platform (n.d.). See the References and Details sections to learn more.

## Usage

```
shift_mctq
```

## Format

A tibble with 128 columns and 50<sup>4</sup> rows:

**id** A unique integer value to identify each respondent in the dataset.

Type: Control.

R class: integer.

**n\_w\_m** Number of days **worked in morning shifts** within a shift cycle.

Type: Basic.

R class: integer.

**bt\_w\_m** Local time of going to bed on workdays **between two morning shifts**.

Statement (EN): "I go to bed at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**sprep\_w\_m** Local time of preparing to sleep on workdays **between two morning shifts**.

Statement (EN): "I actually get ready to fall asleep at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**slat\_w\_m** Sleep latency or time to fall asleep after preparing to sleep on workdays **between two morning shifts**.

Statement (EN): "I need \_\_\_ minutes to fall asleep".

Type: Basic.

R class: Duration.

**so\_w\_m** Local time of sleep onset on workdays **between two morning shifts**.

Type: Computed.

R class: hms.

**se\_w\_m** Local time of sleep end on workdays **between two morning shifts**.

Statement (EN): "I wake up at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**tgu\_w\_m** Time to get up on workdays **between two morning shifts**.

Statement (EN): "I get up after \_\_\_ minutes".

Type: Basic.

R class: Duration.

**gu\_w\_m** Local time of getting out of bed on workdays **between two morning shifts**.

Type: Computed.

R class: hms.

**alarm\_w\_m** A logical value indicating if the respondent uses an alarm clock to wake up on workdays **between two morning shifts**.

Statement (EN): "I wake up at \_\_\_ o'clock: ( \_\_\_ ) with alarm ( \_\_\_ ) without alarm".

Type: Basic.

R class: logical.

**reasons\_w\_m** A logical value indicating if the respondent has any particular reasons for why they **cannot** freely choose their sleep times on workdays **between two morning shifts**.

Statement (EN): "There are particular reasons why I **cannot** freely choose my sleep times on morning shifts: Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**reasons\_why\_w\_m** Particular reasons for why the respondent cannot freely choose their sleep times on workdays **between two morning shifts**.

Statement (EN): "If "Yes": Child(ren)/pet(s) ( \_\_\_ ) Hobbies ( \_\_\_ ) Others, for example: \_\_\_".

Type: Basic.

R class: character.

**sd\_w\_m** Sleep duration on workdays **between two morning shifts**.

Type: Computed.

R class: Duration.

**tbt\_w\_m** Total time in bed on workdays **between two morning shifts**.

Type: Computed.

R class: Duration.

**msw\_m** Local time of mid-sleep on workdays **between two morning shifts**.

Type: Computed.

R class: hms.

**nap\_w\_m** A logical value indicating if the respondent usually takes a nap on workdays **between two morning shifts**.

Statement (EN): "I usually take a nap: Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**napo\_w\_m** Local time of nap onset on workdays **between two morning shifts**.

Statement (EN): "If "Yes": I take a nap from \_\_\_ o'clock to \_\_\_ o'clock".

Type: Basic.

R class: hms.

**nape\_w\_m** Local time of nap end on workdays **between two morning shifts**.

Statement (EN): "If "Yes": I take a nap from \_\_\_ o'clock to \_\_\_ o'clock".

Type: Basic.

R class: hms.

**napd\_w\_m** Nap duration on workdays **between two morning shifts**.

Type: Computed.

R class: Duration.

**sd24\_w\_m** 24 hours sleep duration (sleep duration + nap duration) on workdays **between two morning shifts**.

Type: Computed.

R class: Duration.

**n\_fm** Number of free days **after working in morning shifts** within a shift cycle.

Type: Basic.

R class: integer.

**bt\_fm** Local time of going to bed on work-free days **between two free days after morning shifts**.

Statement (EN): "I go to bed at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**sprep\_fm** Local time of preparing to sleep on work-free days **between two free days after morning shifts**.

Statement (EN): "I actually get ready to fall asleep at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**slat\_f\_m** Sleep latency or time to fall asleep after preparing to sleep on work-free days **between two free days after morning shifts.**

Statement (EN): "I need \_\_\_ minutes to fall asleep".

Type: Basic.

R class: Duration.

**so\_f\_m** Local time of sleep onset on work-free days **between two free days after morning shifts.**

Type: Computed.

R class: hms.

**se\_f\_m** Local time of sleep end on work-free days **between two free days after morning shifts.**

Statement (EN): "I wake up at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**tgu\_f\_m** Time to get up on work-free days **between two free days after morning shifts.**

Statement (EN): "I get up after \_\_\_ minutes".

Type: Basic.

R class: Duration.

**gu\_f\_m** Local time of getting out of bed on work-free days **between two free days after morning shifts.**

Type: Computed.

R class: hms.

**alarm\_f\_m** A logical value indicating if the respondent uses an alarm clock to wake up on work-free days **between two free days after morning shifts.**

Statement (EN): "I wake up at \_\_\_ o'clock: ( \_\_\_ ) with alarm ( \_\_\_ ) without alarm".

Type: Basic.

R class: logical.

**reasons\_f\_m** A logical value indicating if the respondent has any particular reasons for why they **cannot** freely choose their sleep times on work-free days **between two free days after morning shifts.**

Statement (EN): "There are particular reasons why I **cannot** freely choose my sleep times on morning shifts: Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**reasons\_why\_fm** Particular reasons for why the respondent cannot freely choose their sleep times on work-free days **between two free days after morning shifts**.

Statement (EN): "If "Yes": Child(ren)/pet(s) ( \_\_\_ ) Hobbies ( \_\_\_ ) Others, for example: \_\_\_".

Type: Basic.

R class: character.

**sd\_fm** Sleep duration on work-free days **between two free days after morning shifts**.

Type: Computed.

R class: Duration.

**tbt\_fm** Total time in bed on work-free days **between two free days after morning shifts**.

Type: Computed.

R class: Duration.

**msf\_fm** Local time of mid-sleep on work-free days **between two free days after morning shifts**.

Type: Computed.

R class: hms.

**nap\_fm** A logical value indicating if the respondent usually takes a nap on work-free days **between two free days after morning shifts**.

Statement (EN): "I usually take a nap: Yes ( \_\_\_ ) No ( \_\_\_)".

Type: Basic.

R class: logical.

**napo\_fm** Local time of nap onset on work-free days **between two free days after morning shifts**.

Statement (EN): "If "Yes": I take a nap from \_\_\_ o'clock to \_\_\_ o'clock".

Type: Basic.

R class: hms.

**napenf\_fm** Local time of nap end on work-free days **between two free days after morning shifts**.

Statement (EN): "If "Yes": I take a nap from \_\_\_ o'clock to \_\_\_ o'clock".



Type: Basic.

R class: hms.

**napd\_f\_m** Nap duration on work-free days **between two free days after morning shifts.**

Type: Computed.

R class: Duration.

**sd24\_f\_m** 24 hours sleep duration (sleep duration + nap duration) on work-free days **between two free days after morning shifts.**

Type: Computed.

R class: Duration.

**sd\_overall\_m** Overall sleep duration considering workdays **between two morning shifts** and work-free days **between two free days after morning shifts.**

Type: Computed.

R class: Duration.

**msf\_sc\_m** Corrected local time of mid-sleep on work-free days **between two free days after morning shifts.**

Type: Computed.

R class: hms.

**sjl\_rel\_m** Relative social jetlag considering workdays **between two morning shifts** and work-free days **between two free days after morning shifts.**

Type: Computed.

R class: Duration.

**sjl\_m** Absolute social jetlag considering workdays **between two morning shifts** and work-free days **between two free days after morning shifts.**

Type: Computed.

R class: Duration.

... For brevity, the subsequent variables, except for **sjl\_weighted** (described below), are not shown here. That's because they have the same configurations of the variables shown above, differing only by shift (**evening shift** (`_e`) and **night shift** (`_n`)).

**sjl\_weighted** Absolute social jetlag across all shifts.

Type: Computed.

R class: Duration.

## Details

shift\_mctq is a tidied, validated, and transformed version of `raw_data("shift_mctq.csv")`.

### Guidelines:

To learn more about the Munich Chronotype Questionnaire (MCTQ), see Roenneberg, Wirz-Justice, & Meroow (2003), Roenneberg, Allebrandt, Meroow, & Vetter (2012), Roenneberg et al. (2015), and Roenneberg, Pilz, Zerbini, & Winnebeck (2019).

To know about different MCTQ versions, see Juda, Vetter, & Roenneberg (2013) and Ghotbi et al. (2020).

If you're curious about the variable computations and want to have access to the full questionnaire, see The Worldwide Experimental Platform (n.d.).

### Data building and data wrangling:

This dataset was created by randomized sampling (see `random_mctq()`) and by manual insertions of special cases. Its purpose is to demonstrate common cases and data issues that researchers may find in their MCTQ data, in addition to be a suggested data structure for MCTQ data.

You can see the shift\_mctq build and data wrangling processes [here](#).

### Variable naming:

The naming of the variables took into account the naming scheme used in MCTQ publications, in addition to the guidelines of the [tidyverse style guide](#).

### Variable classes:

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the [hms](#) and [lubridate](#) package.

### Duration objects:

If you prefer to view Duration objects as hms objects, run `pretty_mctq(shift_mctq)`.

## Source

Created by Daniel Vartanian (package author).

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
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- Roenneberg T., Allebrandt K. V., Meroow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Keller, L. K., Fischer, D., Matera, J. L., Vetter, C., & Winnebeck, E. C. (2015). Human activity and rest in situ. In A. Sehgal (Ed.), *Methods in Enzymology* (Vol. 552, pp. 257-283). London, UK: Academic Press. doi: [10.1016/bs.mie.2014.11.028](https://doi.org/10.1016/bs.mie.2014.11.028).

Roenneberg, T., Pilz, L. K., Zerbini, G., & Winnebeck, E. C. (2019). Chronotype and social jetlag: a (self-) critical review. *Biology*, 8(3), 54. doi: [10.3390/biology8030054](https://doi.org/10.3390/biology8030054).

Roenneberg, T., Wirz-Justice, A., & Mellow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).

The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other datasets: [micro\\_mctq](#), [std\\_mctq](#)

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shorter\_interval      *Find the shorter interval between two hours*

---

## Description

### [Maturing]

`shorter_interval()` finds and returns the shorter interval between two hms or POSIXt object hours.

`longer_interval()` do the inverse of `shorter_interval()`, i.e., finds the longer interval between two hours. It's just a wrapper for `shorter_interval(x, y, inverse = TRUE)`.

## Usage

```
shorter_interval(x, y, inverse = FALSE)
```

```
longer_interval(x, y)
```

## Arguments

<code>x, y</code>	A hms or POSIXt object.
<code>inverse</code>	(optional) a logical value indicating if the function must return an inverse output, i.e., the longer interval between <code>x</code> and <code>y</code> .

## Details

### The two intervals problem:

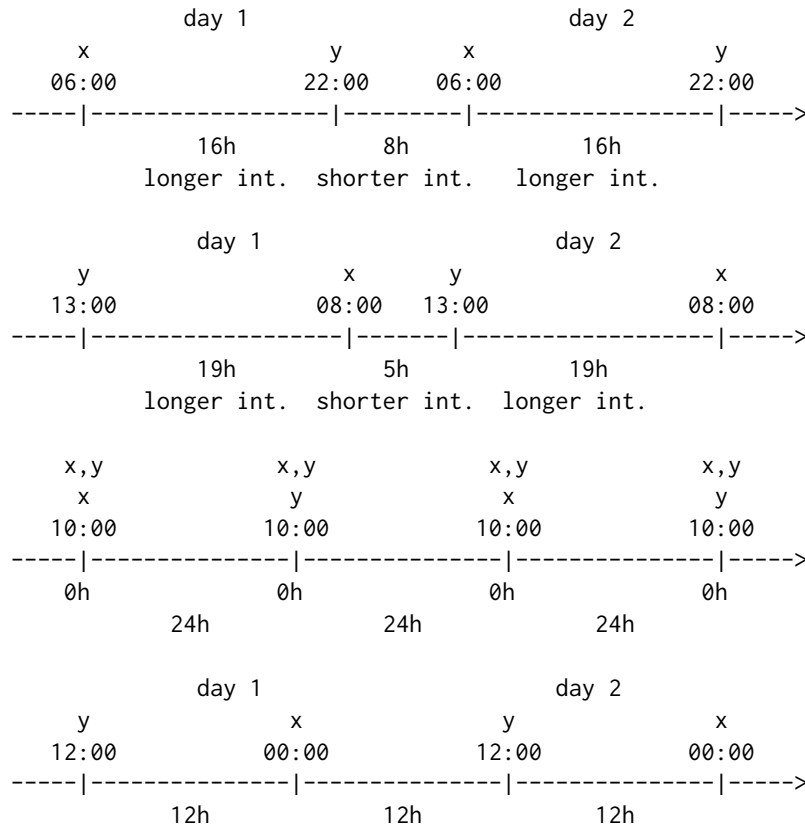
Given two hours, `x` and `y`, in a two-day timeline, without date references, there will be always two possible intervals between them, as illustrated below.

To figure out what interval is the shorter or the longer, `shorter_interval()` verify two scenarios: 1. When `x` comes before `y`; and 2. when `x` comes after `y`. This only works if `x` value is smaller than `y`, therefore, the function will make sure to swap `x` and `y` values if the latter assumption is not true.

Because `shorter_interval()` objective is to find the shorter interval, if `x` and `y` are equal, the shorter interval will have a length of 0 hours, resulting in an interval from `x` to `x`. But, if `inverse`

= TRUE or longer\_interval() is used instead, the latter condition will return a interval with 24 hours of length (from x to x + 1 day).

In cases when x and y distance themselves by 12 hours, there will be no shorter or longer interval (they will have equal length). In those cases, shorter\_interval() and longer\_interval() will return the same value (an interval of 12 hours).



#### Class requirements:

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the [hms](#) and [lubridate](#) package.

#### Base date and timezone:

shorter\_interval() uses the **Unix epoch** (1970-01-01) date as the start date for creating intervals.

The output will always have "UTC" set as timezone. Learn more about time zones in [base::timezone](#).

#### POSIXt objects:

POSIXt objects passed as argument to x or y will be stripped of their dates. Only the time will be considered.

Both POSIXct and POSIXlt are objects that inherits the class POSIXt. Learn more about it in [base::DateTimeClasses](#).

#### NA values:

shorter\_interval() will return an Interval NA-NA if x or y are NA.

**Value**

- If `inverse = FALSE` (default), an `Interval` object with the shorter interval between `x` and `y`.
- If `inverse = TRUE`, an `Interval` object with the longer interval between `x` and `y`.

**See Also**

Other utility functions: [assign\\_date\(\)](#), [cycle\\_time\(\)](#), [pretty\\_mctq\(\)](#), [qplot\\_walk\(\)](#), [random\\_mctq\(\)](#), [raw\\_data\(\)](#), [round\\_time\(\)](#), [sum\\_time\(\)](#)

**Examples**

```
## Scalar example

x <- hms::parse_hm("23:00")
y <- hms::parse_hm("01:00")
shorter_interval(x, y)
#> [1] 1970-01-01 23:00:00 UTC--1970-01-02 01:00:00 UTC # Expected

x <- lubridate::as_datetime("1985-01-15 12:00:00")
y <- lubridate::as_datetime("2020-09-10 12:00:00")
shorter_interval(x, y)
#> [1] 1970-01-01 12:00:00 UTC--1970-01-01 12:00:00 UTC # Expected

## Vector example

x <- c(hms::parse_hm("15:30"), hms::parse_hm("21:30"))
y <- c(hms::parse_hm("19:30"), hms::parse_hm("04:00"))
shorter_interval(x, y)
#> [1] 1970-01-01 15:30:00 UTC--1970-01-01 19:30:00 UTC # Expected
#> [2] 1970-01-01 21:30:00 UTC--1970-01-02 04:00:00 UTC # Expected

## Finding the longer interval between two hours

x <- lubridate::parse_date_time("01:10:00", "HMS")
y <- lubridate::parse_date_time("11:45:00", "HMS")
shorter_interval(x, y, inverse = TRUE)
#> [1] 1970-01-01 11:45:00 UTC--1970-01-02 01:10:00 UTC # Expected

x <- lubridate::as_datetime("1915-02-14 05:00:00")
y <- lubridate::as_datetime("1970-07-01 05:00:00")
longer_interval(x, y)
#> [1] 1970-01-01 05:00:00 UTC--1970-01-02 05:00:00 UTC # Expected
```

## Description

### [Maturing]

sjl() computes the **relative or absolute social jetlag** for standard, micro, and shift versions of the Munich Chronotype Questionnaire (MCTQ).

sjl\_rel() it's just a wrapper for sjl() with abs = FALSE.

## Usage

```
sjl(msw, msf, abs = TRUE, method = "shorter")
```

```
sjl_rel(msw, msf, method = "shorter")
```

## Arguments

msw	A hms object corresponding to the <b>local time of mid-sleep on workdays</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <a href="#">ms()</a> to compute it.
msf	A hms object corresponding to the <b>local time of mid-sleep on work-free days</b> from a standard, micro, or shift version of the MCTQ questionnaire. You can use <a href="#">msl()</a> to compute it.
abs	(optional) a logical object indicating if the function must return an absolute social jetlag (default: TRUE).
method	(optional) a string indicating which method the function must use to compute the social jetlag. See the Methods section to learn more (default: "shorter").

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mellow (2003), Roenneberg, Allebrandt, Mellow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ MCTQ functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

### Class requirements:

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the [lubridate](#) and [hms](#) packages. Please refer to those package documentations to learn more about them.

### Rounding and fractional time:

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with [round\\_time\(\)](#).

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

- If `abs = TRUE`, a `Duration` object corresponding to the absolute social jetlag.
- If `abs = FALSE`, a `Duration` object corresponding to the relative social jetlag.

The output may also vary depending on the method used.

**Guidelines**

Roenneberg, Allebrandt, Merrow, & Vetter (2012), Juda, Vetter, & Roenneberg (2013), and The Worldwide Experimental Platform (n.d.) guidelines for `sjl()` ( $SJL_{rel}$  and  $SJL$ ) computation are as follows.

**Notes:**

- For  $MCTQ^{Shift}$ , the computation below must be applied to each shift section of the questionnaire.
- Due to time arithmetic issues, `sjl()` does a slightly different computation by default than those proposed by the authors mentioned above. See `vignette("sjl-computation", package = "mctq")` for more details.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**For standard and micro versions of the MCTQ:**

Relative social jetlag ( $SJL_{rel}$ ):

$$MSF - MSW$$

Absolute social jetlag ( $SJL$ ):

$$|MSF - MSW|$$

Where:

- $MSW$  = local time of mid-sleep on workdays.
- $MSF$  = local time of mid-sleep on work-free days.

\*  $W$  = workdays;  $F$  = work-free days.

**For the shift version of the MCTQ:**

Relative social jetlag ( $SJL_{rel}$ ):

$$MSF^{M/E/N} - MSW^{M/E/N}$$

Absolute social jetlag ( $SJL$ ):

$$|MSF^{M/E/N} - MSW^{M/E/N}|$$

Where:

- $MSW^{M/E/N}$  = local time of mid-sleep between two days in a particular shift.
- $MSF^{M/E/N}$  = local time of mid-sleep between two free days after a particular shift.

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

### Methods for computing the social jetlag

There are different approaches to compute the social jetlag ( $SJL$ ). By default, `sjl()` uses an approach that we call "the shorter interval approach" ("shorter").

The topics below provide a simple explanation of each method supported by `sjl()`. To get a detail understating of this methods, see `vignette("sjl-computation", package = "mctq")`.

Please note that none of the approaches below are related to Jankowski's (2017) social jetlag sleep-corrected proposal. Since Jankowski's alternative is still disputed (Roenneberg, Pilz, Zerbini, & Winnebeck, 2019), the `mctq` package currently doesn't provide a function for it. Future versions of the package may include it.

- "difference"

By using `method = "difference"`, `sjl()` will do the exact computation proposed by the MCTQ authors, i.e.,  $SJL$  will be computed as the linear difference between  $MSF$  and  $MSW$  (see the Guidelines section).

**We do not recommend using this method**, as it has many limitations.

- "shorter"

This is the default method for `sjl()`. It's based on the shorter interval between  $MSW$  and  $MSF$ , solving most of the issues relating to  $SJL$  computation.

- "longer"

The "longer" method uses the same logic of the "shorter" method, but, instead of using the shorter interval between  $MSW$  and  $MSF$ , it uses the longer interval between the two, considering a two-day window.

This method may help with special contexts, like when dealing with shift-workers that have a greater than 12 hours distance between their mid-sleep hours.

### Missing sections in standard and micro MCTQ versions

Although the standard and micro versions of the MCTQ asks for respondents to complete the work-days and work-free days sections, even when they do not have a regular work schedule ( $wd = 0$ ) or have a 7 day/week work schedule ( $wd = 7$ ), some of them may still end skipping one of this parts of the questionnaire. In those cases, `sd_week()`, `sloss_week()`, `le_week()`, `msf_sc()`, `sjl_rel()`, and `sjl()` will produce NA (Not Available) as output. That's because those computations combine workdays and work-free days variables.

For those special standard and micro MCTQ cases, where one section is missing, a NA value is the correct output for the functions mentioned above when  $wd$  (number of workdays per week) are  $wd > 0$  &  $wd < 7$ , but it may not be when  $wd == 0$  or  $wd == 7$ . There are different approaches to deal with this issue. See `vignette("missing-sections", package = "mctq")` to learn more.



## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
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- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Pilz, L. K., Zerbini, G., & Winnebeck, E. C. (2019). Chronotype and social jetlag: a (self-) critical review. *Biology*, 8(3), 54. doi: [10.3390/biology8030054](https://doi.org/10.3390/biology8030054).
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- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other MCTQ functions: `fd()`, `gu()`, `le_week()`, `msf_sc()`, `mssl()`, `napd()`, `sd24()`, `sd_overall()`, `sd_week()`, `sdu()`, `sjl_weighted()`, `so()`, `tbt()`

## Examples

```
## Scalar example

msw <- hms::parse_hm("03:30")
msf <- hms::parse_hm("05:00")
sjl(msw, msf)
#> [1] "5400s (~1.5 hours)" # Expected
sjl(msw, msf, abs = FALSE)
#> [1] "5400s (~1.5 hours)" # Expected
sjl_rel(msw, msf) # Wrapper function
#> [1] "5400s (~1.5 hours)" # Expected

msw <- hms::parse_hm("04:30")
msf <- hms::parse_hm("23:30")
sjl(msw, msf)
#> [1] "18000s (~5 hours)" # Expected
sjl(msw, msf, abs = FALSE)
#> [1] "18000s (~-5 hours)" # Expected
sjl_rel(msw, msf) # Wrapper function
#> [1] "18000s (~-5 hours)" # Expected

msw <- hms::as_hms(NA)
msf <- hms::parse_hm("05:15")
```

```

sjl(msw, msf)
#> [1] NA # Expected

## Vector example

msw <- c(hms::parse_hm("02:05"), hms::parse_hm("04:05"))
msf <- c(hms::parse_hm("23:05"), hms::parse_hm("04:05"))
sjl(msw, msf)
#> [1] "10800s (~3 hours)" "0s" # Expected
sjl(msw, msf, abs = FALSE)
#> [1] "-10800s (~-3 hours)" "0s" # Expected
sjl_rel(msw, msf) # Wrapper function
#> [1] "-10800s (~-3 hours)" "0s" # Expected

## Using different methods

msw <- hms::parse_hm("19:15")
msf <- hms::parse_hm("02:30")
sjl(msw, msf, abs = FALSE, method = "difference")
#> [1] "-60300s (~-16.75 hours)" # Expected
sjl(msw, msf, abs = FALSE, method = "shorter") # default method
#> [1] "26100s (~7.25 hours)" # Expected
sjl(msw, msf, abs = FALSE, method = "longer")
#> [1] "-60300s (~-16.75 hours)" # Expected

msw <- hms::parse_hm("02:45")
msf <- hms::parse_hm("04:15")
sjl(msw, msf, abs = FALSE, method = "difference")
#> [1] "5400s (~1.5 hours)" # Expected
sjl(msw, msf, abs = FALSE, method = "shorter") # default method
#> [1] "5400s (~1.5 hours)" # Expected
sjl(msw, msf, abs = FALSE, method = "longer")
#> [1] "-81000s (~-22.5 hours)" # Expected

## Converting the output to `hms`

msw <- hms::parse_hm("01:15")
msf <- hms::parse_hm("03:25")
x <- sjl(msw, msf)
x
#> [1] "7800s (~2.17 hours)" # Expected
hms::as_hms(as.numeric(x))
#> 02:10:00 # Expected

## Rounding the output at the seconds level

msw <- hms::parse_hms("04:19:33.1234")
msf <- hms::parse_hms("02:55:05")
x <- sjl(msw, msf)
x
#> [1] "5068.12339997292s (~1.41 hours)" # Expected
round_time(x)
#> [1] "5068s (~1.41 hours)" # Expected

```

---

sjl_weighted	<i>Compute MCTQ absolute social jetlag across all shifts</i>
--------------	--

---

## Description

### [Maturing]

sjl\_weighted() computes the **absolute social jetlag across all shifts** for the shift version of the Munich Chronotype Questionnaire (MCTQ).

## Usage

```
sjl_weighted(sjl, n_w)
```

## Arguments

sjl	A list object with Duration elements corresponding to the <b>absolute social jetlag in each shift</b> from a shift version of the MCTQ questionnaire (you can use <a href="#">sjl()</a> to compute it). sjl elements and values must be paired with n elements and values.
n_w	A list object with <a href="#">integerish</a> integer or double elements corresponding to the <b>number of days worked in each shift within a shift cycle</b> from a shift version of the MCTQ questionnaire. n elements and values must be paired with sjl elements and values.

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Meroow (2003), Roenneberg, Allebrandt, Meroow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ MCTQ functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

MCTQ<sup>Shift</sup> functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

### Class requirements:

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the [lubridate](#) and [hms](#) packages. Please refer to those package documents to learn more about them.

### Rounding and fractional time:

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with [round\\_time\(\)](#).

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A Duration object corresponding to the vectorized weighted mean of sjl with n\_w as weights.

**Operation**

The shift version of the MCTQ was developed for shift-workers rotating through morning-, evening-, and night-shifts, but it also allows adaptations to other shift schedules (Juda, Vetter, & Roenneberg, 2013). For this reason, sjl\_weighted() must operate with any shift combination.

Considering the requirement above, sjl\_weighted() was developed to only accept list objects as arguments. For this approach to work, both sjl and n\_w arguments must be lists with paired elements and values, i.e., the first element of sjl (e.g., sjl\_m) must be paired with the first element of n\_w (e.g., n\_w\_m). The function will do the work of combining them and output a weighted mean.

**Guidelines**

Juda, Vetter, & Roenneberg (2013) and The Worldwide Experimental Platform (n.d.) guidelines for sjl\_weighted() ( $\emptyset SJJL_{weighted}$ ) computation are as follows.

**Notes:**

- The absolute social jetlag across all shifts ( $\emptyset SJJL_{weighted}$ ) is the weighted average of all absolute social jetlags.
- The authors describe an equation for a three-shift schedule, but this may not be your case. That's why this function works a little bit differently (see the Operation section), allowing you to compute a weighted average with any shift combination.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**Computation:**

$$\frac{|SJJL^M| \times n_W^M + |SJJL^E| \times n_W^E + |SJJL^N| \times n_W^N}{n_W^M + n_W^E + n_W^N}$$

Where:

- $SJJL^{M/E/N}$  = absolute social jetlag in each shift.
- $n_W^{M/E/N}$  = number of days worked in each shift within a shift cycle.

\*  $W$  = workdays;  $F$  = work-free days;  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

**References**

Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).

Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).

Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).

Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).

The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

### See Also

Other MCTQ functions: [fd\(\)](#), [gu\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [msl\(\)](#), [napd\(\)](#), [sd24\(\)](#), [sd\\_overall\(\)](#), [sd\\_week\(\)](#), [sdu\(\)](#), [sjl\(\)](#), [so\(\)](#), [tbt\(\)](#)

### Examples

```
## Scalar example

sjl <- list(sjl_m = lubridate::dhours(1.25),
           sjl_e = lubridate::dhours(0.5),
           sjl_n = lubridate::dhours(3))
n_w <- list(n_w_m = 3, n_w_e = 1, n_w_n = 4)
sjl_weighted(sjl, n_w)
#> [1] "7312.5s (~2.03 hours)" # Expected

sjl <- list(sjl_m = lubridate::dhours(1.25),
           sjl_e = lubridate::as.duration(NA),
           sjl_n = lubridate::dhours(3))
n_w <- list(n_w_m = 3, n_w_e = 1, n_w_n = 4)
sjl_weighted(sjl, n_w)
#> [1] NA # Expected

## Vector example

sjl <- list(sjl_m = c(lubridate::dhours(2), lubridate::dhours(2.45)),
           sjl_e = c(lubridate::dhours(3.21), lubridate::as.duration(NA)),
           sjl_n = c(lubridate::dhours(1.2), lubridate::dhours(5.32)))
n_w <- list(n_w_m = c(1, 3), n_w_e = c(4, 1), n_w_n = c(3, 3))
sjl_weighted(sjl, n_w)
#> [1] "8298s (~2.31 hours)" NA # Expected

## Checking the first output from vector example

if (requireNamespace("stats", quietly = TRUE)) {
  i <- 1
  x <- c(sjl[["sjl_m"]][i], sjl[["sjl_e"]][i], sjl[["sjl_n"]][i])
  w <- c(n_w[["n_w_m"]][i], n_w[["n_w_e"]][i], n_w[["n_w_n"]][i])
  lubridate::as.duration(stats::weighted.mean(x, w))
}
#> [1] "8298s (~2.31 hours)" # Expected

## Converting the output to hms
```

```

sjl <- list(sjl_m = lubridate::dhours(0.25),
           sjl_e = lubridate::dhours(1.2),
           sjl_n = lubridate::dhours(4.32))
n_w <- list(n_w_m = 4, n_w_e = 2, n_w_n = 1)
x <- sjl_weighted(sjl, n_w)
x
#> [1] "3970.28571428571s (~1.1 hours)" # Expected
hms::as_hms(as.numeric(x))
#> 01:06:10.285714 # Expected

## Rounding the output at the seconds level

round_time(x)
#> [1] "3970s (~1.1 hours)" # Expected
round_time(hms::as_hms(as.numeric(x)))
#> 01:06:10 # Expected

```

---

sloss\_week

*Compute MCTQ weekly sleep loss*


---

## Description

### [Maturing]

sloss\_week() computes the **weekly sleep loss** for the standard and micro versions of the Munich Chronotype Questionnaire (MCTQ).

## Usage

```
sloss_week(sd_w, sd_f, wd)
```

## Arguments

sd_w	A Duration object corresponding to the <b>sleep duration on workdays</b> from a standard or micro version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.
sd_f	A Duration object corresponding to the <b>sleep duration on work-free days</b> from a standard or micro version of the MCTQ questionnaire. You can use <a href="#">sdu()</a> to compute it.
wd	An <a href="#">integerish</a> numeric object or an integer object corresponding to the <b>number of workdays per week</b> from a standard or micro version of the MCTQ questionnaire.

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Meroow (2003), Roenneberg, Allebrandt, Meroow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

### Class requirements:

The `mctq` package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documents to learn more about them.

### Rounding and fractional time:

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

## Value

A `Duration` object corresponding to the weekly sleep loss.

## Guidelines

Roenneberg, Allebrandt, Meroow, & Vetter (2012) and The Worldwide Experimental Platform (n.d.) guidelines for `sloss_week()` ( $SLoss_{week}$ ) computation are as follows.

### Notes:

- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

### Computation:

$$\text{If } SD_{week} > SD_W, (SD_{week} - SD_W) \times WD$$

$$\text{If } SD_{week} \leq SD_W, (SD_{week} - SD_F) \times FD$$

Where:

- $SD_W$  = sleep duration on workdays.
- $SD_F$  = sleep duration on work-free days.
- $SD_{week}$  = average weekly sleep duration.

- $WD$  = number of workdays per week ("I have a regular work schedule and work \_\_\_ days per week").
- $FD$  = number of work-free days per week.

\*  $W$  = workdays;  $F$  = work-free days.

### Missing sections in standard and micro MCTQ versions

Although the standard and micro versions of the MCTQ asks for respondents to complete the workdays and work-free days sections, even when they do not have a regular work schedule ( $wd = 0$ ) or have a 7 day/week work schedule ( $wd = 7$ ), some of them may still end skipping one of this parts of the questionnaire. In those cases, `sd_week()`, `sloss_week()`, `le_week()`, `msf_sc()`, `sjl_rel()`, and `sjl()` will produce NA (Not Available) as output. That's because those computations combine workdays and work-free days variables.

For those special standard and micro MCTQ cases, where one section is missing, a NA value is the correct output for the functions mentioned above when  $wd$  (number of workdays per week) are  $wd > 0$  &  $wd < 7$ , but it may not be when  $wd == 0$  or  $wd == 7$ . There are different approaches to deal with this issue. See `vignette("missing-sections", package = "mctq")` to learn more.

### References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shiftworkers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

### Examples

```
## Scalar example

sd_w <- lubridate::dhours(6.5)
sd_f <- lubridate::dhours(7)
wd <- 4
sloss_week(sd_w, sd_f, wd)
#> [1] "3085.71428571429s (~51.43 minutes)" # Expected

sd_w <- lubridate::dhours(7)
sd_f <- lubridate::dhours(8)
wd <- 5
sloss_week(sd_w, sd_f, wd)
```



```

#> [1] "5142.85714285714s (~1.43 hours)" # Expected

sd_w <- lubridate::dhours(NA)
sd_f <- lubridate::dhours(9.45)
wd <- 7
sloss_week(sd_w, sd_f, wd)
#> [1] NA # Expected

## Vector example

sd_w <- c(lubridate::dhours(7), lubridate::dhours(8))
sd_f <- c(lubridate::dhours(6.5), lubridate::dhours(8))
wd <- c(2, 0)
sloss_week(sd_w, sd_f, wd)
#> [1] "2571.42857142857s (~42.86 minutes)" "0s" # Expected

## Converting the output to `hms`

sd_w <- lubridate::dhours(4)
sd_f <- lubridate::dhours(5)
wd <- 3
x <- sloss_week(sd_w, sd_f, wd)
x
#> [1] "6171.42857142858s (~1.71 hours)" # Expected
hms::as_hms(as.numeric(x))
#> 01:42:51.428571 # Expected

## Rounding the output at the seconds level

sd_w <- lubridate::dhours(5.8743)
sd_f <- lubridate::dhours(7.4324)
wd <- 6
x <- sloss_week(sd_w, sd_f, wd)
x
#> [1] "4807.85142857144s (~1.34 hours)" # Expected
round_time(x)
#> [1] "4808s (~1.34 hours)" # Expected

```

---

so

---

*Compute MCTQ local time of sleep onset*


---

## Description

### [Maturing]

so() computes the **local time of sleep onset** for standard and shift versions of the Munich Chronotype Questionnaire (MCTQ).

Note that this value is collected directly from the questionnaire if you're using the  $\mu$ MCTQ.

**Usage**

```
so(sprep, slat)
```

**Arguments**

sprep	A hms object corresponding to the <b>local time of preparing to sleep</b> from a standard or shift version of the MCTQ questionnaire.
slat	A Duration object corresponding to the <b>sleep latency or time to fall asleep after preparing to sleep</b> from a standard or shift version of the MCTQ questionnaire.

**Details**

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mellow (2003), Roenneberg, Allebrandt, Mellow, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

**Class requirements:**

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the [lubridate](#) and [hms](#) packages. Please refer to those package documentations to learn more about them.

**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with [round\\_time\(\)](#).

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A hms object corresponding to the vectorized sum of sprep and slat in a circular time frame of 24 hours.

**Guidelines**

Roenneberg, Allebrandt, Mellow, & Vetter (2012), Juda, Vetter, & Roenneberg (2013), and The Worldwide Experimental Platform (n.d.) guidelines for `so()` (*SO*) computation are as follows.

**Notes:**

- The computation below must be applied to each section of the questionnaire.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**For standard and micro versions of the MCTQ:**

$$SPrep_{W/F} + SLat_{W/F}$$

Where:

- $SPrep_{W/F}$  = local time of preparing to sleep on work **or** work-free days ("I actually get ready to fall asleep at \_\_\_ o'clock").
- $SLat_{W/F}$  = sleep latency or time to fall asleep after preparing to sleep on work **or** work-free days ("I need \_\_\_ min to fall asleep").

\*  $W$  = workdays;  $F$  = work-free days.

**For the shift version of the MCTQ:**

$$SPrep_{W/F}^{M/E/N} + SLat_{W/F}^{M/E/N}$$

Where:

- $SPrep_{W/F}^{M/E/N}$  = local time of preparing to sleep between two days in a particular shift **or** between two free days after a particular shift ("I actually get ready to fall asleep at \_\_\_ o'clock").
- $SLat_{W/F}^{M/E/N}$  = sleep latency or time to fall asleep after preparing to sleep between two days in a particular shift **or** between two free days after a particular shift ("I need \_\_\_ min to fall asleep").

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

**References**

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Mellow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Mellow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

**See Also**

Other MCTQ functions: `fd()`, `gu()`, `le_week()`, `msf_sc()`, `msl()`, `napd()`, `sd24()`, `sd_overall()`, `sd_week()`, `sdu()`, `sjl_weighted()`, `sjl()`, `tbt()`

## Examples

```
## Scalar example

sprep <- hms::parse_hm("22:00")
slat <- lubridate::dminutes(15)
so(sprep, slat)
#> 22:15:00 # Expected

sprep <- hms::parse_hm("23:30")
slat <- lubridate::dminutes(45)
so(sprep, slat)
#> 00:15:00 # Expected

sprep <- hms::parse_hm("20:45")
slat <- lubridate::as.duration(NA)
so(sprep, slat)
#> NA # Expected

## Vector example

sprep <- c(hms::parse_hm("21:30"), hms::parse_hm("22:15"))
slat <- c(lubridate::dminutes(45), lubridate::dminutes(5))
so(sprep, slat)
#> 22:15:00 # Expected
#> 22:20:00 # Expected
```

---

std\_mctq

*A fictional standard MCTQ dataset*

---

## Description

### [Maturing]

A fictional dataset, **for testing and learning purposes**, composed of basic/measurable and computed variables of the Munich Chronotype Questionnaire (MCTQ) standard version.

This data was created following the guidelines in Roenneberg, Wirz-Justice, & Merrow (2003), Roenneberg, Allebrandt, Merrow, & Vetter (2012), and The Worldwide Experimental Platform (n.d.). See the References and Details sections to learn more.

## Usage

```
std_mctq
```

## Format

A tibble with 37 columns and 50<sup>4</sup> rows:

**id** A unique integer value to identify each respondent in the dataset.

Type: Control.

R class: integer.

**work** A logical value indicating if the respondent has a regular work schedule.

Statement (EN): "I have a regular work schedule (this includes being, for example, a housewife or househusband): Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**wd** Number of **workdays** per week.

Statement (EN): "I have a regular work schedule and work \_\_\_ days per week".

Type: Basic.

R class: integer.

**fd** Number of **work-free days** per week.

Type: Computed.

R class: integer.

**bt\_w** Local time of going to bed on **workdays**.

Statement (EN): "I go to bed at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**sprep\_w** Local time of preparing to sleep on **workdays**.

Statement (EN): "I actually get ready to fall asleep at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**slat\_w** Sleep latency or time to fall asleep after preparing to sleep on **workdays**.

Statement (EN): "I need \_\_\_ minutes to fall asleep".

Type: Basic.

R class: Duration.

**so\_w** Local time of sleep onset on **workdays**.

Type: Computed.

R class: hms.

**se\_w** Local time of sleep end on **workdays**.

Statement (EN): "I wake up at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**si\_w** "Sleep inertia" on **workdays**.

Despite the name, this variable represents the time the respondent takes to get up after sleep end.

Statement (EN): "After \_\_\_ minutes, I get up".

Type: Basic.

R class: Duration.

**gu\_w** Local time of getting out of bed on **workdays**.

Type: Computed.

R class: hms.

**alarm\_w** A logical value indicating if the respondent uses an alarm clock to wake up on **workdays**.

Statement (EN): "I use an alarm clock on workdays: Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**wake\_before\_w** A logical value indicating if the respondent regularly wakes up **before** the alarm rings on **workdays**.

Statement (EN): "If "Yes": I regularly wake up BEFORE the alarm rings: Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**sd\_w** Sleep duration on **workdays**.

Type: Computed.

R class: Duration.

**tbt\_w** Total time in bed on **workdays**.

Type: Computed.

R class: Duration.

**le\_w** Light exposure on **workdays**.

Statement (EN): "On average, I spend the following amount of time outdoors in daylight (without a roof above my head)".

Type: Extra.

R class: Duration.

**msw** Local time of mid-sleep on **workdays**.

Type: Computed.

R class: hms.

**bt\_f** Local time of going to bed on **work-free days**.

Statement (EN): "I go to bed at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**sprep\_f** Local time of preparing to sleep on **work-free days**.

Statement (EN): "I actually get ready to fall asleep at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**slat\_f** Sleep latency or time to fall asleep after preparing to sleep on **work-free days**.

Statement (EN): "I need \_\_\_ minutes to fall asleep".

Type: Basic.

R class: Duration.

**so\_f** Local time of sleep onset on **work-free days**.

Type: Computed.

R class: hms.

**se\_f** Local time of sleep end on **work-free days**.

Statement (EN): "I wake up at \_\_\_ o'clock".

Type: Basic.

R class: hms.

**si\_f** "Sleep inertia" on **work-free days**.

Despite the name, this variable represents the time the respondent takes to get up after sleep end.

Statement (EN): "After \_\_\_ minutes, I get up".

Type: Basic.

R class: Duration.

**gu\_f** Local time of getting out of bed on **work-free days**.

Type: Computed.

R class: hms.

**alarm\_f** A logical value indicating if the respondent uses an alarm clock to wake up on **work-free days**.

Statement (EN): "My wake-up time is due to the use of an alarm clock: Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**reasons\_f** A logical value indicating if the respondent has any particular reasons for why they **cannot** freely choose their sleep times on **work-free days**.

Statement (EN): "There are particular reasons why I **cannot** freely choose my sleep times on free days: Yes ( \_\_\_ ) No ( \_\_\_ )".

Type: Basic.

R class: logical.

**reasons\_why\_f** Particular reasons for why the respondent cannot freely choose their sleep times on **work-free days**.

Statement (EN): "If "Yes": Child(ren)/pet(s) ( \_\_\_ ) Hobbies ( \_\_\_ ) Others ( \_\_\_ ), for example: \_\_\_".

Type: Basic.



R class: character.

**sd\_f** Sleep duration on **work-free days**.

Type: Computed.

R class: Duration.

**tbt\_f** Total time in bed on **work-free days**.

Type: Computed.

R class: Duration.

**le\_f** Light exposure on **work-free days**.

Statement (EN): "On average, I spend the following amount of time outdoors in daylight (without a roof above my head)".

Type: Extra.

R class: Duration.

**msf** Local time of mid-sleep on **work-free days**.

Type: Computed.

R class: hms.

**sd\_week** Average weekly sleep duration.

Type: Computed.

R class: Duration.

**sloss\_week** Weekly sleep loss.

Type: Computed.

R class: Duration.

**le\_week** Average weekly light exposure.

Type: Computed.

R class: Duration.

**msf\_sc** Chronotype or corrected local time of mid-sleep on **work-free days**.

Type: Computed.

R class: hms.

**sjl\_rel** Relative social jetlag.

Type: Computed.

R class: Duration.

**sjl** Absolute social jetlag.

Type: Computed.

R class: Duration.

## Details

std\_mctq is a tidied, validated, and transformed version of `raw_data("std_mctq.csv")`.

### Guidelines:

To learn more about the Munich Chronotype Questionnaire (MCTQ), see Roenneberg, Wirz-Justice, & Mewes (2003), Roenneberg, Allebrandt, Mewes, & Vetter (2012), Roenneberg et al. (2015), and Roenneberg, Pils, Zerbini, & Winnebeck (2019).

To know about different MCTQ versions, see Juda, Vetter, & Roenneberg (2013) and Ghotbi et al. (2020).

If you're curious about the variable computations and want to have access to the full questionnaire, see The Worldwide Experimental Platform (n.d.).

### Data building and data wrangling:

This dataset was created by randomized sampling (see `random_mctq()`) and by manual insertions of special cases. Its purpose is to demonstrate common cases and data issues that researchers may find in their MCTQ data, in addition to be a suggested data structure for MCTQ data.

You can see the std\_mctq build and data wrangling processes [here](#).

### Variable naming:

The naming of the variables took into account the naming scheme used in MCTQ publications, in addition to the guidelines of the [tidyverse style guide](#).

### Variable classes:

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the [hms](#) and [lubridate](#) package.

### Duration objects:

If you prefer to view Duration objects as hms objects, run `pretty_mctq(std_mctq)`.

## Source

Created by Daniel Vartanian (package author).

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
- Juda, M., Vetter, C., & Roenneberg, T. (2013). The Munich ChronoType Questionnaire for shift-workers (MCTQ<sup>Shift</sup>). *Journal of Biological Rhythms*, 28(2), 130-140. doi: [10.1177/0748730412475041](https://doi.org/10.1177/0748730412475041).
- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Keller, L. K., Fischer, D., Matera, J. L., Vetter, C., & Winnebeck, E. C. (2015). Human activity and rest in situ. In A. Sehgal (Ed.), *Methods in Enzymology* (Vol. 552, pp. 257-283). London, UK: Academic Press. doi: [10.1016/bs.mie.2014.11.028](https://doi.org/10.1016/bs.mie.2014.11.028).
- Roenneberg, T., Pilz, L. K., Zerbini, G., & Winnebeck, E. C. (2019). Chronotype and social jetlag: a (self-) critical review. *Biology*, 8(3), 54. doi: [10.3390/biology8030054](https://doi.org/10.3390/biology8030054).
- Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other datasets: [micro\\_mctq](#), [shift\\_mctq](#)

---

sum\_time

*Sum time objects*

---

## Description

### [Maturing]

sum\_time() returns the sum of the time from different kinds of date/time objects.

vct\_sum\_time() returns the vectorized sum of the time from different kinds of date/time objects.

Both functions can be set to work with a circular time frame (see Details to learn more).

## Usage

```
sum_time(..., cycle = NULL, reverse = TRUE, na_rm = FALSE)
```

```
vct_sum_time(..., cycle = NULL, reverse = TRUE, na_rm = FALSE)
```

### Arguments

...	Objects belonging to one of the following classes: <code>Duration</code> , <code>difftime</code> , <code>hms</code> , <code>POSIXct</code> , <code>POSIXlt</code> , or <code>Interval</code> .
<code>cycle</code>	(optional) A numeric or <code>Duration</code> object of length 1, equal or greater than 0, indicating the cycle length in seconds. If <code>NULL</code> the function will perform a linear sum (see Details to learn more) (default: <code>NULL</code> ).
<code>reverse</code>	(optional) A logical value indicating if the function must use a reverse cycle for negative sums (see Details to learn more) (default: <code>TRUE</code> ).
<code>na_rm</code>	(optional) a logical value indicating if the function must remove NA values while performing the sum (default: <code>FALSE</code> ).

### Details

`sum_time()` versus `vct_sum_time()`:

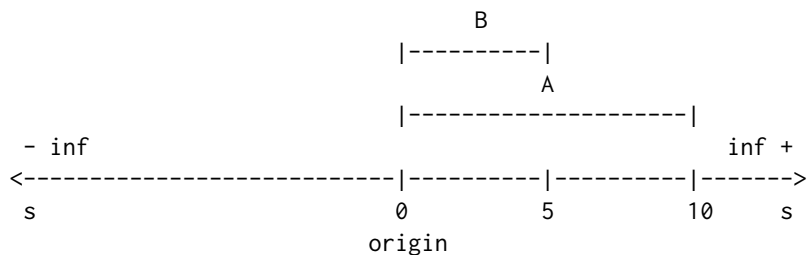
`sum_time()` behaves similar to `base::sum()`, in the sense that it aggregates the time lengths of values in ... into a single data point. For example, `sum_time(c(x,y),z)` will have the same output as `sum_time(x,y,z)`.

`vct_sum_time()` performs a different type of sum (a vectorized one). Instead of aggregating the time lengths, the function perform a paired sum between elements. For example, `sum_time(c(x,y),c(w,z))` will return a vector like `c(sum_time(x,w),sum_time(y,z))`. Because of that, `vct_sum_time()` requires that all objects in ... have the same length.

#### Linear versus circular time:

Time can have different "shapes".

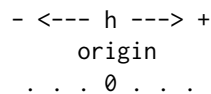
If the objective is to measure the duration (time span) of an event, time is usually measured considering a linear frame, with a fixed point of **origin**. In this context, the time value distance itself to infinity in relation to the origin.

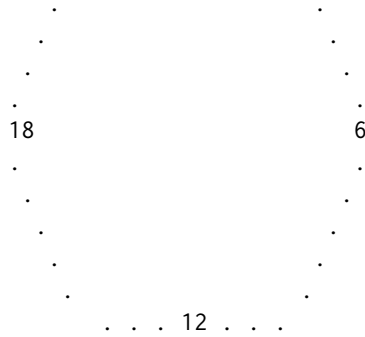


$$A + B = 10 + 5 = 15s$$

But that's not the only possible "shape" of time, as it can also be measured in other contexts.

In a "time of day" context, time will be linked to the rotation of the earth, "resetting" when a new rotation cycle starts. That brings a different kind of shape to time: a circular shape. With this shape the time value encounters the origin at the end of each cycle.





18 + 6 = 0h

If we transpose this circular time frame to a linear one, it would look like this:



Note that now the origin is not fix, but cyclical.

sum\_time() and vct\_sum\_time() can both operate in either a linear or a circular fashion. If cycle = NULL (default), the function will use a linear approach. Else, the function will use a circular approach relative to the cycle length (e.g, cycle = 86400 (1 day)).

**Fractional time:**

sum\_time() uses the %% operator to cycle values. Hence, it can be subject to catastrophic loss of accuracy if values in ... are fractional and much larger than cycle. A warning is given if this is detected.

%% is a builtin R function that operates like this:

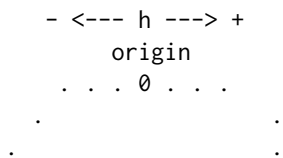
```
function(a, b) {
  a - floor(a / b) * b
}
```

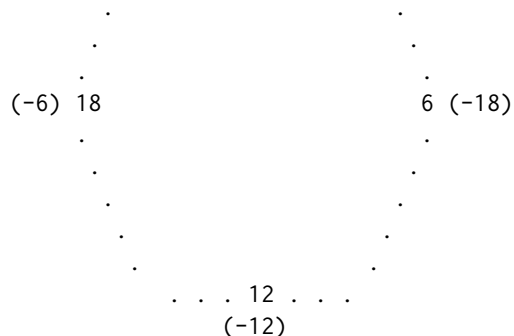
**Negative time cycling:**

If the sum of the time is negative, with a cycle assigned and reverse = FALSE, sum\_time() and vtc\_sum\_time() will perform the cycle considering the absolute value of the sum and return the result with a negative signal.

However, If the sum of the time have a negative value, with a cycle assigned and reverse = TRUE (default), sum\_time() and vtc\_sum\_time() will perform the cycle in reverse, relative to its origin.

Example: If the sum of the time have a -30h time span in a reversed cycle of 24h, the result will be 18h. By removing the full cycles of -30h you will get -6h (-30 + 24), and -6h relative to the origin will be 18h.



**Period objects:**

**Period** objects are a special type of object developed by the [lubridate](#) team that represents "human units", ignoring possible timeline irregularities. That is to say that 1 day as **Period** can have different time spans, when looking to a timeline after a irregularity event.

Since the time span of a **Period** object can fluctuate, `sum_time()` and `vct_sum_time()` don't accept this kind of object. You can transform it to a **Duration** object and still use the functions, but beware that this can produce errors.

Learn more about **Period** objects in the [Dates and times](#) chapter of Wickham & Grolemund (n.d.).

**POSIXt objects:**

**POSIXt** objects in `...` will be stripped of their dates. Only the time will be considered.

Both **POSIXct** and **POSIXlt** are objects that inherits the class **POSIXt**. Learn more about it in [base::DateTimeClasses](#).

**Interval objects:**

By using **Interval** objects in `...`, `sum_time()` and `vct_sum_time()` will consider only their time spans. That is, the amount of seconds of the intervals.

Learn more about **Interval** objects in the [Dates and times](#) chapter of Wickham & Grolemund (n.d.).

**Timeline irregularities:**

This function does not take into account timeline irregularities (e.g., leap years, DST, leap seconds). This may not be an issue for most people, but it must be considered when doing time arithmetic.

**Value**

- If `cycle = NULL`, a **Duration** object with a linear sum of the time from objects in `...`
- If `cycle != NULL`, a **Duration** object with a circular sum of the time from objects in `...`

**References**

Wickham, H., & Grolemund, G. (n.d.). *R for data science*. Sebastopol, CA: O'Reilly Media. <https://r4ds.had.co.nz>

**See Also**

Other utility functions: [assign\\_date\(\)](#), [cycle\\_time\(\)](#), [pretty\\_mctq\(\)](#), [qplot\\_walk\(\)](#), [random\\_mctq\(\)](#), [raw\\_data\(\)](#), [round\\_time\(\)](#), [shorter\\_interval\(\)](#)

**Examples**

```
## Non-vectorized sum in an linear time frame

x <- c(as.POSIXct("2020-01-01 15:00:00"), as.POSIXct("1999-05-04 17:30:00"))
y <- lubridate::as.interval(lubridate::dhours(7), as.Date("1970-05-08"))
sum_time(x, y)
#> [1] "142200s (~1.65 days)" # 39:30:00 # Expected

## Non-vectorized sum in a circular time frame of 24 hours

x <- c(lubridate::dhours(25), lubridate::dhours(5), lubridate::dminutes(50))
sum_time(x, cycle = lubridate::ddays())
#> [1] "24600s (~6.83 hours)" # 06:50:00 # Expected

x <- c(hms::parse_hm("00:15"), hms::parse_hm("02:30"), hms::as_hms(NA))
sum_time(x, cycle = lubridate::ddays())
#> NA # Expected
sum_time(x, cycle = lubridate::ddays(), na_rm = TRUE)
#> [1] "9900s (~2.75 hours)" # 02:45:00 # Expected

x <- c(lubridate::dhours(-12), lubridate::dhours(-13))
sum_time(x, cycle = lubridate::ddays(), reverse = FALSE)
#> [1] "-3600s (~-1 hours)" # -01:00:00 # Expected

x <- c(lubridate::dhours(-12), lubridate::dhours(-13))
sum_time(x, cycle = lubridate::ddays(), reverse = TRUE)
#> [1] "82800s (~23 hours)" # 23:00:00 # Expected

## Vectorized sum in an linear time frame

x <- c(lubridate::dhours(6), NA)
y <- c(hms::parse_hm("23:00"), hms::parse_hm("10:00"))
vct_sum_time(x, y)
#> [1] "104400s (~1.21 days)" NA # 29:00:00 NA # Expected
vct_sum_time(x, y, na_rm = TRUE)
#> [1] "104400s (~1.21 days)" "36000s (~10 hours)" # Expected

## Vectorized sum in a circular time frame of 24 hours

x <- c(lubridate::dhours(6), NA)
y <- c(hms::parse_hm("23:00"), hms::parse_hm("10:00"))
vct_sum_time(x, y, cycle = lubridate::ddays())
#> [1] "18000s (~5 hours)" NA # Expected
vct_sum_time(x, y, cycle = lubridate::ddays(), na_rm = TRUE)
#> [1] "18000s (~5 hours)" "36000s (~10 hours)" # Expected

x <- c(lubridate::dhours(-49), lubridate::dhours(-24))
```

```

y <- c(hms::parse_hm("24:00"), - hms::parse_hm("06:00"))
vct_sum_time(x, y, cycle = lubridate::ddays(), reverse = FALSE)
#> [1] "-3600s (~-1 hours)" "-21600s (~-6 hours)" # Expected

x <- c(lubridate::dhours(-49), lubridate::dhours(-24))
y <- c(hms::parse_hm("24:00"), - hms::parse_hm("06:00"))
vct_sum_time(x, y, cycle = lubridate::ddays(), reverse = TRUE)
#> [1] "82800s (~23 hours)" "64800s (~18 hours)" # Expected

```

---

tbt

---

*Compute MCTQ total time in bed*


---

## Description

### [Maturing]

tbt() computes the **total time in bed** for standard and shift versions of the Munich Chronotype Questionnaire (MCTQ).

## Usage

```
tbt(bt, gu)
```

## Arguments

**bt** A hms object corresponding to the **local time of going to bed** from a standard or shift version of the MCTQ questionnaire.

**gu** A hms object corresponding to the **local time of getting out of bed** from a standard or shift version of the MCTQ questionnaire. You can use `gu()` to compute it.

## Details

**Standard MCTQ** functions were created following the guidelines in Roenneberg, Wirz-Justice, & Mewes (2003), Roenneberg, Allebrandt, Mewes, & Vetter (2012), and from The Worldwide Experimental Platform (theWeP, n.d.).

$\mu$ **MCTQ** functions were created following the guidelines in Ghotbi et al. (2020), in addition to the guidelines used for the standard MCTQ.

**MCTQ<sup>Shift</sup>** functions were created following the guidelines in Juda, Vetter, & Roenneberg (2013), in addition to the guidelines used for the standard MCTQ.

See the References section to learn more.

### Class requirements:

The mctq package works with a set of object classes specially created to hold time values. These classes can be found in the `lubridate` and `hms` packages. Please refer to those package documents to learn more about them.



**Rounding and fractional time:**

Some operations may produce an output with fractional time (e.g., "19538.3828571429s (~5.43 hours)", 01:15:44.505). If you want, you can round it with `round_time()`.

Our recommendation is to avoid rounding, but, if you do, make sure that you only round your values after all computations are done. That way you avoid **round-off errors**.

**Value**

A `Duration` object corresponding to the vectorized difference between `gu` and `bt` in a circular time frame of 24 hours.

**Guidelines**

Roenneberg, Allebrandt, Merrow, & Vetter (2012), Juda, Vetter, & Roenneberg (2013), and The Worldwide Experimental Platform (n.d.) guidelines for `tbt()` (*TBT*) computation are as follows.

**Notes:**

- The computation below must be applied to each section of the questionnaire.
- If you are visualizing this documentation in plain text (ASCII), you may have some trouble understanding the equations. If you want a better viewer, you can see this documentation on the package [website](#).

**For standard and micro versions of the MCTQ:**

$$GU_{W/F} - BT_{W/F}$$

Where:

- $BT_{W/F}$  = local time of going to bed on work **or** work-free days ("I go to bed at \_\_\_ o'clock").
- $GU_{W/F}$  = local time of getting out of bed on work **or** work-free days.

\*  $W$  = workdays;  $F$  = work-free days.

**For the shift version of the MCTQ:**

$$GU_{W/F}^{M/E/N} - BT_{W/F}^{M/E/N}$$

Where:

- $BT_{W/F}^{M/E/N}$  = local time of going to bed between two days in a particular shift **or** between two free days after a particular shift ("I go to bed at \_\_\_ o'clock").
- $GU_{W/F}^{M/E/N}$  = local time of getting out of bed between two days in a particular shift **or** between two free days after a particular shift.

\*  $W$  = workdays;  $F$  = work-free days,  $M$  = morning shift;  $E$  = evening shift;  $N$  = night shift.

## References

- Ghotbi, N., Pilz, L. K., Winnebeck, E. C., Vetter, C., Zerbini, G., Lenssen, D., Frighetto, G., Salamanca, M., Costa, R., Montagnese, S., & Roenneberg, T. (2020). The  $\mu$ MCTQ: an ultra-short version of the Munich ChronoType Questionnaire. *Journal of Biological Rhythms*, 35(1), 98-110. doi: [10.1177/0748730419886986](https://doi.org/10.1177/0748730419886986).
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- Roenneberg T., Allebrandt K. V., Merrow M., & Vetter C. (2012). Social jetlag and obesity. *Current Biology*, 22(10), 939-43. doi: [10.1016/j.cub.2012.03.038](https://doi.org/10.1016/j.cub.2012.03.038).
- Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: daily temporal patterns of human chronotypes. *Journal of Biological Rhythms*, 18(1), 80-90. doi: [10.1177/0748730402239679](https://doi.org/10.1177/0748730402239679).
- The Worldwide Experimental Platform (n.d.). MCTQ. <https://www.thewep.org/documentations/mctq/>

## See Also

Other MCTQ functions: [fd\(\)](#), [gu\(\)](#), [le\\_week\(\)](#), [msf\\_sc\(\)](#), [msl\(\)](#), [napd\(\)](#), [sd24\(\)](#), [sd\\_overall\(\)](#), [sd\\_week\(\)](#), [sdu\(\)](#), [sjl\\_weighted\(\)](#), [sjl\(\)](#), [so\(\)](#)

## Examples

```
## Scalar example

bt <- hms::parse_hm("22:10")
gu <- hms::parse_hm("06:15")
tbt(bt, gu)
#> [1] "29100s (~8.08 hours)" # Expected

bt <- hms::parse_hm("01:20")
gu <- hms::parse_hm("14:00")
tbt(bt, gu)
#> [1] "45600s (~12.67 hours)" # Expected

bt <- hms::as_hms(NA)
gu <- hms::parse_hm("07:20")
tbt(bt, gu)
#> [1] NA # Expected

## Vector example

bt <- c(hms::parse_hm("23:50"), hms::parse_hm("02:30"))
gu <- c(hms::parse_hm("09:30"), hms::parse_hm("11:25"))
tbt(bt, gu)
#> [1] "34800s (~9.67 hours)" "32100s (~8.92 hours)" # Expected
```

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