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'nparACT' package for R: A free software tool for the non-parametric analysis of actigraphy data

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A B S T R A C T

For many studies, participants' sleep-wake patterns are monitored and recorded prior to, during and following an experimental or clinical intervention using actigraphy, i.e. the recording of data generated by movements. Often, these data are merely inspected visually without computation of descriptive parameters, in part due to the lack of user-friendly software. To address this deficit, we developed a package for R Core Team [6], that allows computing several non-parametric measures from actigraphy data. Specifically, it computes the interdaily stability (IS), intradaily variability (IV) and relative amplitude (RA) of activity and gives the start times and average activity values of M10 (i.e. the ten hours with maximal activity) and L5 (i.e. the five hours with least activity). Two functions compute these 'classical' parameters and handle either single or multiple files. Two other functions additionally allow computing an L-value (i.e. the least activity value) for a user-defined time span termed 'Lflex' value. A plotting option is included in all functions. The package can be downloaded from the Comprehensive R Archives Network (CRAN).

- The package 'nparACT' for R serves the non-parametric analysis of actigraphy data.
- Computed parameters include interdaily stability (IS), intradaily variability (IV) and relative amplitude (RA) as well as start times and average activity during the 10 h with maximal and the 5 h with minimal activity (i.e. M10 and L5).

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Method details

Actigraphy is a non-invasive method of monitoring participants' rest-activity cycles, which is most commonly used in sleep and circadian rhythm research [2,8]. In many studies, actigraphy recordings are used to ensure that participants adhere to a prescribed sleep-wake rhythm (cf. e.g. [5,9]). Moreover, actigraphy data can inform about disturbances of the sleep-wake cycle such as circadian rhythm disorders and sleep disorders (for an overview see [1]). It is measured with a wrist-watch-like device, usually worn on the non-dominant hand, for several days before, during and after an experiment. In some cases ankle movements rather than wrist movements are expected to reflect the 'true' activity of the participant (e.g. when the upper limbs are spastic) and in these instances the device can be worn on the ankle. Movements the device undergoes are continuously recorded with a previously specified sampling rate (SR; e.g. 4/60 Hz).

In most studies, however, the analysis of actigraphy data is limited to a rather crude visual inspection of the general pattern of rest and activity or sleep and wakefulness, which is also reflected in the purposes other available R packages serve. The 'PhysicalActivity' package [3] for example only allows analysing device wear and non-wear time intervals and other tools such as the 'accelerometry' package [10] even focus solely on the analysis of periods of activity thus completely ignoring rhythmic changes between rest and activity. We think that sometimes, however, a more advanced analysis of rest-activity cycles could yield further information and certain parameters may even become variables of interest. While the 'GGIR' package computes the M5 and L5 descriptives (i.e. five hours with minimal and maximal activity) for data obtained with specific devices, it does not calculate other parameters that might be valuable for a comprehensive description of the rest-activity pattern. In particular, parameters quantifying how well the period length of a rhythm matches the earth's 24 h light-dark cycle, how fragmented a rhythm is and what amplitude the rest-activity pattern has could be of special interest. We assume that the reluctance to further analyse actigraphy data regarding such parameters and thus the underestimation of their scientific value is, partly, due to the lack of adequate analysis tools. We thus developed the package 'nparACT' for R Core Team [6], that computes several non-parametric measures from actigraphy data that allow for a quantification of the parameters mentioned above (cf. [11–13]). The most recent version of the package can be downloaded from the Comprehensive R Archives Network (CRAN) and is, just as R itself, open source. As the package is updated from time to time, we deliberately do not provide a zip file of the package along with this publication.

Method description*Data requirements*

Confounding factors such as the dependence of rest-activity patterns on the day of the week can impair the interpretability of the data. Actigraphy data should therefore be acquired over the course of a whole week or multiple weeks, unless, of course, workdays are of special interest. In repeated measures designs the same days of the week should be recorded on each occasion as otherwise the interpretability of the results may suffer. We moreover recommend recordings to cover at least five workdays or a whole week to obtain reliable estimates of the parameters (cf. also [12]). As participants do usually not wear the actigraph continuously during the recording period (e.g. they take it off for showering or exercising), recordings typically contain 'invalid' data. Although the 'nparACT' package

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