Commentary: Daylight Saving Time and Artificial Time Zones -A Battle Between Biological and Social Times

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24 **The manuscript was rejected after a first major revision. One reviewer argued that we did not**
25 **sufficiently follow his requests, following which would have meant to adopt his/her opinion,**
26 **which was obviously not ours. Moreover, s/he stated that the quotation was not wrong by**
27 **his/her own judgment.**

28 **We appealed to the specialty chief editor of Frontiers in Physiology making him aware again of**
29 **the wrong quotation and arguing that the presentation of differing opinions is what Comments**
30 **are there for. However, he eventually decided that the manuscript was not suitable for**
31 **publication.**

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33 **Frontiers has asked us to remove the reviewer comments and we have followed this request in**
34 **the updated version of this preprint.**

Abstract

In this commentary, we first respond to apparent misconceptions that became evident in a recent review by Roenneberg, Winnebeck, and Klerman (2019) in this journal. Beyond this, we elaborate on our understanding of the advisory role of scientists for society. We argue that, as experts, they should inform the public and political actors about relevant topics by providing a well-balanced analysis and overview of *existing* as well as *missing* scientific evidence. However, particularly in cases where evidence is not solid, they must not fan fear. Furthermore, regarding the debate about perennial standard vs. daylight saving time more particularly, we argue that it is not wise to ignore the public opinion and simply “explain it away”. We therefore recommend strategies that could support a discourse aiming at getting the public on board. Finally, we suggest to bring the prevailing timing of social schedules, for example school start times, relative to the solar day into question, which may no longer be adequate in modern societies.

1 Introduction

In autumn 2018, an announcement of the European Commission President that the bi-annual clock change in Europe would be abolished triggered a debate about whether Europe should return to perennial standard time (ST) or daylight saving time (DST). In this context, scientists voiced their opinions on what would be “best”. In September 2018, the first author of the article we are commenting on (Roenneberg et al., 2019) claimed in a press release published by the German Press Agency (dpa; Simon, 2018a) that perennial DST would render us “fatter, more stupid, and grumpier” (translation of the authors, German original: “dicker, dümmer und grantiger”) and that this would cause “enormous problems” (translation of the authors, German original: “riesige Probleme”). This resulted in many articles in the lay press covering this media-effective perspective (e.g. Simon, 2018b). We felt that this conclusion resulted from a one-sided and selective interpretation of studies that almost exclusively present *indirect* evidence, that is, they did *not* compare ST and DST, wherefore the results warrant interpretation. In other words, as of today, we have not seen convincing *direct* evidence that would support such a fatal vision of the future if perennial DST was adopted. We would like to emphasise that we welcome diverging interpretations and opinions as they are a natural driving force for scientific advance. However, we believe that good scientific practice needs to take into account all available evidence acknowledging also, and in particular, evidence that is still missing in a balanced manner. In line with this, we think that our task as scientists is to provide the public with a balanced view on topics that cannot easily be accessed by lay people. This view must also include an adequate communication of the uncertainties scientific findings naturally bear.

However, in our opinion our task as scientists is *not* to fan fear, particularly when evidence is not solid or ambiguous. In a press release, we therefore aimed to contribute to a more balanced discourse and urged to refrain from any exaggerated recommendations regarding either perennial DST *or* ST until the scientific community would arrive at an informed opinion (Mayer, 2018). Unfortunately, this press release seems to have led to several misconceptions as reflected in a recent publication by Roenneberg et al. (2019). We would therefore like to take the opportunity to briefly clarify the most important ones.

2 Misconceptions

1. Unlike claimed by Roenneberg and colleagues, we did *not* state that there was “no hard scientific evidence against perennial DST and that the risks would be negligible” (Roenneberg et al., 2019). While there is indeed hardly any *direct* evidence against perennial DST and it is uncertain to what extent findings from indirect studies can be extrapolated to perennial DST, we stated that, “[...] in light of current scientific evidence, we feel it is non-serious to give explicit advice in favour of or against ST or DST in central Europe” (translation of the authors). It is noteworthy that this also in line with the consensus conclusions from a panel discussion at the meeting of the European Sleep Research Society (Dijk, Vandewalle, Winnebeck, Wright Jr, & Blume, 2018), which several internationally renowned researchers participated in. The conclusion of this discussion was that “indirect evidence suggests that the risk of negative effects on public health and safety of perennial Daylight Saving Time (DST) will be higher than that under perennial Standard Time (ST). At this time, however, there is no direct evidence to reliably determine the magnitude of the health and safety effects [...]” (cf. Dijk et al., 2018).
2. In their publication Roenneberg and colleagues claim that “the (negative, authors’ note [A/N]) spring and the (positive, A/N) autumn effect do not balance each other out on the *individual* level”. While this may theoretically be true, the statement is misleading in two ways. First, it suggests that myocardial infarction in an individual can be prevented by abolishing clock change. In the same vein, one could also argue the change from DST to ST saves lives in autumn on the individual level. Such a claim, however, would require that myocardial infarction or its prevention can beyond doubt be attributed to this event. As this will hardly be possible, the statement is neither verifiable nor falsifiable. Second, any conclusion about the

level of the individual is not allowed from group-level analyses (Molenaar & Campbell, 2009; Fisher, Medaglia, & Jeronimus, 2018). An intuitive example from Hamaker (2012) illustrating this problem is the relationship between typing speed and typos. On the group level, the correlation between speed and typos is negative as more experienced typists are faster and make less mistakes. At the individual level though, the correlation is positive: the faster a given individual types, the more mistakes she or he will make compared to the performance at decreased speed. Even odds ratios do not provide an intuitive understanding of the risk of an individual, and often magnify an existing effect (Holcomb Jr, Chaiworapongsa, Luke, & Burgdorf, 2001). To inform about the risk of an individual, they need to be converted to relative risks taking into account the baseline risk of the outcome (Grant, 2014).

3. Referring to a publication by Janszky and Ljung (2008) on the incidence ratio of myocardial infarction, Roenneberg and colleagues conclude that “the risk for myocardial infarction was elevated throughout DST”, because “if physiology had fully adapted to DST and if the decreased cardiac risk was not only from the extra hour of sleep the night DST ends, this decrease should not occur.” However, such a conclusion would warrant an additional comparison of the effects on the Monday following clock change with prolonged sleep on any other Monday during ST months. As this has not been done, conclusions regarding the *specific* effects of the transition out of DST are merely speculative.
4. While Roenneberg and colleagues agree that the increase in “social jetlag” (SJL) found in the only empirical study directly investigating the effects of DST and ST (Borisenkov et al., 2017) corresponds to a statistically small effect, they claim that it was “biologically large”. Statistical effect sizes are well-defined, whereas biological significance is not. Therefore, such a claim requires a more detailed explanation including support from studies that do not only explore correlations between SJL and risks for disorders, but allow for an interpretation on a ratio scale, i.e. they need to explain how much difference in SJL corresponds to a small, medium, or large effect. An alternative approach could be to report the “disability/ disease-adjusted life years” (DALY; World Health Organization, 2019) measuring the overall disease burden due to ill-health, disability, or early death, where one DALY corresponds to one year of “healthy” life lost. Theoretically, this metric can be calculated from available data under

the assumption that DST can be identified as the reason for death or disability. Then, the number of years lost due to perennial DST could be compared to the years lost under perennial ST or the status quo (i.e., bi-annual switch between DST and ST). Importantly, for an adequate appraisal the numbers eventually would have to be compared to DALYs due to other factors such as occupational stress, lack of physical activity, smoking, or sleep disorders.

5. While Roenneberg and colleagues agree that evening artificial light is associated with negative effects, they state that “the combination of nighttime light exposure and DST is far worse than nighttime night (should be “light”, A/N) exposure alone.” While an interaction at this level cannot be excluded, to the best of our knowledge there is no study supporting such a priority claim. However, modelling data suggest that the effect of a later solar noon under DST is modulated by artificial light consumption (cf. Figure S3 Skeldon, Phillips, & Dijk, 2017). Further support comes from a recent publication by Shochat et al. (2019). The authors conclude that “individual timing of sleep and activity in a modern environment with electrical lighting largely conforms to clock time and actual light exposure (which is the combination of natural and electrical light exposure) rather than sun time indexed by the timing of SN (solar noon, A/N)”.

3 Role of the Public Opinion

Beyond a necessary scientific discussion, the debate should - in our opinion - not just ignore or “explain away” the public preference. While scientists *are* the experts and the risk for negative effects *does* seem to be higher with perennial DST, pressing for a policy simply because “we know better”, especially when the public has been asked for its opinion beforehand, has usually not proven wise. In an EU survey in which <1% of the population of the EU (70% German) participated, 84% of the respondents voted to abolish clock change. If it was abolished, 56% would keep perennial DST whereas 36% would favour perennial ST with only 8% indicating no preference (for survey results see European Commission, 2018). In addition to this small and biased sample it seems important to note that those, who were not interested in the topic, wanted to keep the status quo, or simply did not care about the outcome did not participate (Harding Center for Risk Communication, 2018). Thus, this survey and its results are highly unrepresentative. While it is highly debatable whether the results

do reflect a “public opinion”, most respondents in favour of perennial ST (43%) mentioned general health considerations the main argument (43%), the main argument (42%) for perennial DST were evening leisure time activities. In short: irrespective of scientific considerations, some people feel that DST, whether perennial or during the summer months, increases quality of life. And they might be right in prioritising social and leisure time activities. This is because social relationships and activities have been shown to be a protective factor against many health-related problems including cognitive decline in dementia (Bennett, Schneider, Tang, Arnold, & Wilson, 2006; Crooks, Lubben, Petitti, Little, & Chiu, 2008). Besides this, although two studies taking the geographical position of a region into account, suggested health risks such as for example cancer incidence and mortality could increase in more western parts of a time zone (with DST equalling a shift to a more western position) (Borisenkov, 2011; Gu et al., 2017), a study in Europe did not provide support for this notion (Ferlay et al., 2013). Thus, at the moment this debate seems unsettled. Irrespective of this though, social relationships, which people feel benefit from DST, have also been associated with increased cancer survival rates (for a meta-analysis see Reynolds & Kaplan, 1990; Pinquart & Duberstein, 2010).

4 Public Preference Cannot be “Explained Away”

Moreover, the simple claim that (i) the preference for DST in the EU survey only resulted from a preference for the word “summer” (note that there is no neutral alternative for the German term “Sommerzeit”, i.e. “summer time”) and (ii) that, if the EU survey had been conducted during winter, a majority would have preferred ST (Roenneberg et al., 2019; Simon, 2018a), does not seem to hold true. A survey in Austria that, off its main focus, included questions on the attitude towards clock change between September 2018 and May 2019, i.e. during a sampling interval excluding the summer months, found an even higher preference for perennial DST compared to the EU survey. From the 58% that would abolish clock change, 58% would prefer perennial DST and 40% would vote for perennial ST (Blume et al., preprint 2019). Note that a possible reason for this result could include Austria’s geographical location in central Europe. However, it also highlights the fact that survey data of such kind cannot simply be “explained away” and ignored.

5 Conclusion

In conclusion, although the magnitude of the potential effects of perennial DST cannot be reliably determined from the available data, the current state of research suggests that the *risk of negative effects* associated with perennial DST is higher than with perennial ST (cf. Dijk et al., 2018).

Especially in cases where the *magnitude* of potential detrimental health effects are yet to be determined from solid empirical data, scientists need to be particularly careful about *what* and *how* they communicate their recommendations to the public. In this context, it also seems important to prevent the impression that they put themselves before people and ignore their concerns and preferences. This seems particularly relevant in times when scientists' authority and credibility is challenged publicly even by leading political actors. Therefore, we encourage a discourse, which aims at getting the public on board, which could include for example think tanks. Eventually, in societies where artificial light is so readily accessible, we should welcome and encourage a broader discussion about the adequacy of the prevailing timing of social schedules relative to natural light-dark cycles, especially as the EU survey indicated evening leisure time activities are an important reason to favour perennial DST.

6 Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

7 Author Contributions

CB wrote the first draft of the manuscript; CB and MS contributed to manuscript revision, read and approved the submitted version.

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