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Editorial: Maintaining health, safety and cognitive function under challenging environmental and working conditions

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Editorial on the Research Topic
Maintaining health, safety and cognitive function under challenging environmental and working conditions

We humans have always aspired to occupy niches, both spatial and temporal. We have illuminated the night and started working around the clock, we have conquered the skies and explored space, and we are connected on a global scale never seen before. As an (unintended) consequence, our lives and work conditions have become much more challenging in many ways, with sleep and biological rhythms tested by irregular working hours, night and rotational shift work. These temporal challenges often result in short sleep and disrupted circadian rhythms threatening health and safety, especially in operational settings where impaired health and cognitive performance can have severe consequences.

While associated risks to health and safety are well-documented, the goal of this Research Topic was to shift the focus to potential solutions and gather novel findings on how to stay healthy and maintain performance under challenging environmental and working conditions. Of particular interest were studies that explored (i) strategies to improve or maintain health and safety in temporally challenging environments and working conditions, such as shift/night work, irregular/flexible work hours, and home office; (ii) strategies to improve or maintain cognitive performance, fatigue, and duty-readiness in challenging operational environments, such as spaceflight, aviation, emergency/rescue services, hospitals, maritime and military operations; and (iii) the role of individual factors in maintaining health, safety, and cognitive function under such challenging conditions.

The current Research Topic garnered publications with diverse settings and populations, ranging from the effects of the Antarctic summer photoperiod on the human circadian clock and the implementation of a physiotherapy program in healthcare workers to the efficacy of fatigue countermeasures during (ultra-) long-haul flights. Here, we briefly summarize their findings.

Grewal et al. report that work-related musculoskeletal disorders represent the second largest cause of short-term or temporary work disability after the common cold. The incidence is especially high in the healthcare sector, where work conditions are physically challenging. The study investigated the effectiveness of an in-hospital

physiotherapy for healthcare professionals with musculoskeletal disorders. They observed that the program significantly reduced symptoms and led to an 80.3% decrease in reported absenteeism among participants.

In their perspective article, Tassino and Silva make the case for using naturalistic scenarios to tease apart environmental, social, and behavioral challenges of the human circadian clock in real-life conditions. They use two distinct settings, each with their own temporal and/or spatial challenge: time-of-day training effects in professional dancers (socio-behavioral challenge), and trips from Montevideo to Antarctica in summer (socio-environmental challenge). In both settings, the light-dark cycle, to which the circadian clock predominantly synchronizes (a process known as "entrainment") is altered, either because electrical illumination extends into the night or because the daily photoperiod is prolonged to near-constant light. In the Antarctica scenario, individual light exposure was the determining factor of circadian phase, with an overall reduced variance between individuals compared to the baseline assessments in Montevideo, Uruguay.

In the scenario with professional dancers, both groups had similar daily light exposure profiles, but there was a large between-individual variance in dim-light melatonin onset (DLMO, a marker of circadian phase). Tassino and Silva observed that the amount and timing of physical exercise, which differed due to the timing of their training-shifts (morning vs. evening), accounted for the variance in DLMO. The study demonstrated that in circumstances where light exposure is comparable, other non-photic factors may exert influence on the circadian system and can act as a phase-delaying (and possibly a phase-advancing) agent. They argue that designing interventions to improve circadian alignment with the external light-dark cycle need to consider the varying synchronizing influences encountered in real life, including individual light history, and that it is possible, if not warranted, to derive such interventions from naturalistic, ecologically valid settings.

In aviation, safety is key, and research in this area has covered the challenges of flying multiple sectors, long hours, and at night during the window of circadian low (WOCL) for maintaining alertness and managing fatigue. Three publications in this Research Topic studied how pilots and cabin crew members managed fatigue during (ultra-)long haul operations, with a focus on in-flight rest as well as controlled rest. Hilditch et al. assessed sleepiness and psychomotor vigilance performance before and during non-augmented long-haul flights. They aimed to predict the likelihood of pilots taking controlled rest and to evaluate its benefit for cognitive performance at top-of-descent (i.e., right before the final descent is initiated, which is often considered most relevant in fatigue risk management). Higher pre-flight sleepiness and flights during the night increased the likelihood for taking controlled rest. Controlled rest modestly improved vigilant attention and might thus be considered a beneficial strategy for fatigue risk management in cockpit crew. Signal et al. and Van den Berg et al. examined mitigations used by pilots and cabin crew to manage fatigue during ultra-long range (ULR) flights. ULR flights are operations that exceed the regulatory limit of 16 h. Such long duties can be very challenging, due to sleep loss, extended wakefulness, and potential jet lag symptoms. They found that sleep in the 24 h before and after the trip was longer than usual, indicating that mitigations that allow for preparation and recovery were well utilized by crew members. However, in-flight rest was relatively short and incomplete adaptation during the layover affected rest break strategies on the return flight, suggesting that increasing the amount of sleep obtained during ULR flights is a promising target for fatigue risk management strategies. Jet lag symptoms tended to linger for several days after the return and the authors highlight the importance of a protected post-trip rest period to allow crew to recover from the effects of sleep restriction and circadian disruption, avoiding cumulative fatigue before the next trip.

McCauley et al. presented a modified biomathematical model to predict fatigue, with improved accuracy of its predictions for recuperation due to recovery sleep. Biomathematical models in this area have long been used as tremendously helpful tools for predicting and managing neurobehavioral functioning, increasing safety in 24/7 operations. By including an additional feedback mechanism, assumed to predominantly involve the adenosine system, the expanded model can be used for work scheduling, including how much time off is needed in-between duties or shifts to safely return to work.

The current Research Topic sought to highlight studies that aim to find solutions to our modern world's challenges, specifically how to stay healthy and safe in environments that do not temporally align with our physiological need to sleep and rest. We believe these studies make an important contribution towards that goal and will inspire more research in this area.

Author contributions

EE: Conceptualization, Writing – original draft, Writing – review & editing. MS: Writing – original draft, Writing – review & editing. DF: Conceptualization, Writing – original draft, Writing – review & editing.

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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.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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