Unlocking Circadian Mysteries in Sleep Disorders

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Sleep disorders can significantly disrupt daily life, but their underlying causes are not always clear. Dr Leon Lack from Flinders University has spent decades studying these disorders and how to treat them. By shedding light on the role of circadian rhythms in delayed sleep-wake phase disorder and non-24-hour sleep-wake rhythm disorder, he hopes to unravel why some people struggle to maintain conventional sleep patterns and could lead to more effective treatments for these challenging conditions.

The Ticking of Our Internal Clocks

Most of us take for granted our ability to fall asleep at night and wake up refreshed in the morning. But for people with certain sleep disorders, this natural rhythm is disrupted, leading to difficulty sleeping at conventional times and struggling to function during the day. These conditions, known as circadian rhythm sleep disorders, occur when a person's internal body clock becomes misaligned with the external 24-hour day.

Two such conditions are delayed sleep-wake phase disorder (DSWPD) and non-24-hour sleep-wake rhythm disorder (N24SWD). People with DSWPD typically find it difficult or impossible to fall asleep at conventional bedtimes, often not feeling sleepy until the early hours of the morning. As a result, they struggle to wake up at socially acceptable times, leading to difficulties with work, education, and social life. N24SWD is an even more severe condition where a person's sleep-wake cycle is completely out of sync with the 24-hour day, progressively shifting later each day.

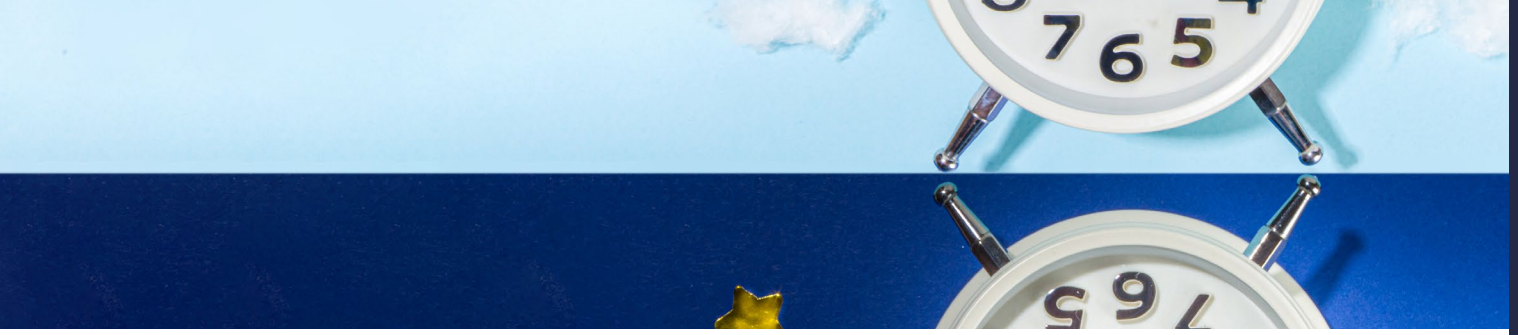
Decoding the Enigma of Circadian Rhythm Disorders

Dr Leon Lack, a professor of psychology at Flinders University in Australia, has devoted much of his career to studying these disorders and developing better ways to diagnose and treat them. His work has provided key insights into the underlying mechanisms of circadian rhythm disorders and how they differ from typical sleep patterns. One of his team's major contributions has been investigating the intrinsic period length, or 'tau', of the circadian rhythm in people with DSWPD and N24SWD. The tau represents how long a person's internal clock takes to complete one full cycle when isolated from external time cues. In most people, this internal rhythm runs slightly longer than 24 hours – about 24 hours and 15 minutes on average. Dr Lack and his colleagues wanted to determine if people with circadian disorders have significantly longer taus, which could help explain their persistent tendency to delay their sleep times.

A Tale of Two Body Clocks: Comparing Disordered and Healthy Rhythms

Dr Lack's team used an innovative research protocol called the 'ultradian routine' to measure circadian rhythms with precision. Participants spend 80 hours in a sleep lab under carefully controlled conditions, alternating between 20-minute naps and 40-minute wake periods. This allows researchers to track fluctuations in core body temperature and melatonin levels – two critical markers of the circadian rhythm – without interference from standard sleep-wake patterns or environmental cues.

Using this method, Dr Lack and his colleagues conducted a landmark study comparing circadian rhythms in people with DSWPD, N24SWD, and healthy sleepers. They found that DSWPD patients had significantly longer taus than the control group – about 24 hours and 34 minutes on average, compared to 24 hours and 22 minutes in healthy sleepers. The N24SWD group had even longer rhythms, averaging about 25 hours. These results may help explain why people with these disorders have such persistent difficulty adapting to conventional sleep-wake schedules. Their internal clocks are running on a longer cycle, so they have a constant tendency to delay their sleep timing relative to the 24-hour day.



Beyond the Body Clock: Other Factors in Sleep Delays

The study also revealed that about half of the DSWPD participants had taus within the normal range, suggesting other factors beyond rhythm length contribute to their sleep delays. These could include heightened sensitivity to evening light exposure, which can further push sleep timing later, or reduced sensitivity to morning light, which would reduce the ability to stop the circadian delay tendency and also result in later sleep timing.

Another key finding was that the timing of internal circadian markers like core body temperature and melatonin onset was significantly delayed in DSWPD patients compared to healthy sleepers. On average, their temperature minimum (the lowest point in the daily temperature cycle) occurred nearly 3 hours later, and their dim light melatonin onset was over 2 hours later.

The Weekly Rollercoaster: Sleep Debt and Weekend Catch-Up

These circadian delays can create significant challenges for patients trying to adhere to typical school or work schedules. Dr Lack's research has shown that DSWPD patients often accumulate significant sleep debt during the week as they have to wake up before getting enough sleep. They then tend to sleep very late on weekends to catch up, which can shift their rhythms even later. This becomes a vicious cycle – the weekend sleep-ins avoid morning light exposure that could help nudge their rhythm earlier, so without this morning light, the person's body clock keeps drifting later.

For people with N24SWD, the challenges are even more significant. Their sleep times progressively delay each day, making it nearly impossible to maintain a stable sleep schedule aligned with the 24-hour day. Dr Lack found that their circadian rhythms were delayed by about an hour each day on average. With a 25-hour internal clock, these patients would need to essentially phase advance by an hour every single day just to remain synchronised with the 24-hour world – an incredibly difficult thing to achieve.

From Understanding to Treatment: Light Therapy and Melatonin

Understanding these underlying rhythm differences is crucial for developing effective treatments. Traditional sleep hygiene advice or cognitive behavioural approaches are often insufficient for circadian disorders. Instead, precisely timed light exposure and melatonin administration are typically needed to shift the internal clock. Dr Lack has also found that bright morning light exposure can help advance DSWPD patients' sleep timing. However, the longer intrinsic rhythms in these patients mean they may need more intensive or prolonged light therapy to achieve lasting benefits. For this purpose, his team has developed ambulatory and convenient light therapy devices which are effective in re-timing the body clock called 'Re-timers'. In addition to light therapy, precisely timed low doses of melatonin in the early evening can help advance circadian rhythms. Dr Lack's research has shown that combining light and melatonin treatments often produces the best results for DSWPD patients.

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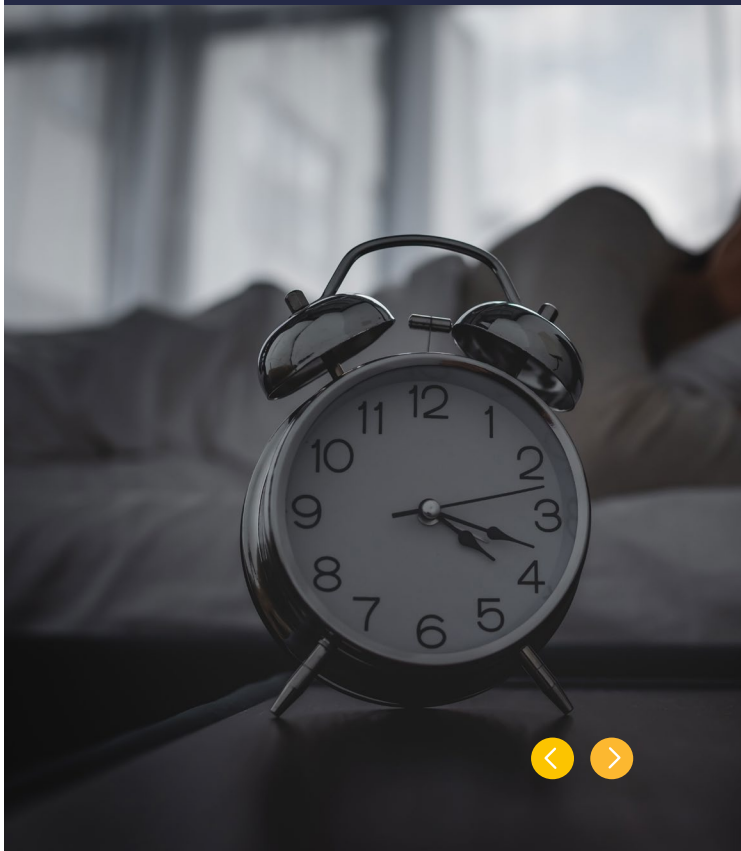

The Future of Circadian Research: Personalised Treatments and Genetic Insights

One area for further research is the potential differences in how DSWPD patients' bodies respond to light exposure. Some may be overly sensitive to evening light, making them more prone to delays. Others may not respond as strongly to morning light, making them more susceptible to delaying their body clock. Pinpointing these variations could allow for more personalised treatment plans. For countless patients affected by these disorders, this research offers the promise of finally achieving restful nights and energised days in sync with the world around them.

MEET THE RESEARCHER

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Professor Leon Lack obtained his first degree from Stanford University and PhD from the University of Adelaide. Since 1971, he has been at Flinders University, teaching and researching sleep, circadian rhythms, bright light therapy and insomnia. He has published over 200 refereed articles, books and book chapters, and presented at over 200 conferences. Since 1992, Dr Lack has directed the non-drug insomnia treatment programme at the Adelaide Institute for Sleep Health. He is actively involved in public education about sleep through lectures, workshops, media appearances, and a popular book on insomnia treatment. Dr Lack is co-inventor of Re-timer, a portable bright light therapy device for treating circadian rhythm disorders. His integrated approach to teaching, research, clinical practice, public education and commercial development aims to improve understanding of sleep and address insomnia and circadian rhythm disorders in society.

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FURTHER READING

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