Hormones: The Inside Story

Episode 2 – Can I hack my hormones to beat jetlag?

Every year in many countries in the world there is an event.

Every spring, like clockwork, it happens.

We mark the day with complaints, grumbles, missed appointments.

When it does, it's followed by a rise in heart attacks.

And a 6% increase in fatal car accidents.

A rise in heart attacks. And a rise in strokes.

The event? It's daylight savings.

Each spring, when we lose an hour of sleep to our clocks changing there is a small but noticeable rise in deaths in the following week. Can throwing our bodies out of sync just by an hour, really have such an impact?

Maybe.

This is Hormones the Inside Story, the podcast from the society for endocrinology, where we take a look at the tiny things pulling the strings inside your body.

I'm Georgia Mills and this time - can we hack our hormones to beat jet lag! Whether it's daylight savings, working night shifts, a new baby or anything else that's keeping you up at night, most of us will know the feelings that come with having your body out of step with our time zone- craving breakfast in the evening, crashing out at lunch and generally feeling pretty useless.

So over this episode we're finding out the hormones at play that keep us sleeping at night, and awake during the day - what happens when that goes wrong - and how we can use hormone science to get back on track- plus meeting the athletes who shocked scientists by being completely immune to jet lag.

But first - it's time to go to sleep...

Jamie - So sleep is something that we all experience. It's part of our daily routines. We actually spend a third of our time in sleep, which is just an incredible thing when you think about it.

This is Jamie Thackrar, a PhD student at Bristol University. She spends her time researching hormones and how they interplay with the brain.

Jamie - I've always been interested with neuroscience, I just like to understand what makes us who we are, what makes us work, what makes our brains work in the way that they do.

Which you can probably imagine, not the easiest pursuit.

Jamie - Unfortunately, the more I learn about the brain, the more I realise I don't know.

I caught up with her to chat: sleep, hormones and the body clock.

*Jamie - S*leep is a state of mind and body. It's characterised by altered consciousness and relatively inhibited sensory activity. And what we find with sleep is that it occurs in repeating periods. So the body alternates between two distinct modes: REM sleep and non REM sleep. REM sleep is what we call rapid eye movement sleep, it's just a shortening of that. And this is this mode of sleep has many other aspects, including virtual paralysis of the body. And so that's what we say when we talk about sleep, it's sort of a state of altered consciousness for the body.

And although sleep takes up so much of our lives, it's still something of a mystery as to why we need it. But there are ideas.

Jamie - Professor Maiken Nedergaard *from the University of Rochester discovered that a network of microscopic, fluid-filled channels exist in the brains of rats that clears waste chemicals from the brain. So we think that sleep is an important opportunity for the brain to be cleared of waste. And this professor described it as "you can think of it like having a house party. You can either entertain the guests or you can clean up the house, but you can't really do both at the same time."*

Which I thought was a fantastic way to think about sleep as something which is this completely altered state of consciousness where we're doing almost almost the opposite of what we're doing when we're awake, but we're still active.

So sleep is perhaps the brain clearing out from the party of thoughts and activities of the day, cataloguing the memories, and chucking out the unwanted guests. And what is crystal clear is that if you don't get enough, things can get really bad.

Jamie - We understand that sleep is really important for metabolism, immune function, disease resistance, memory consolidation. We've also shown that a lack of sleep, or getting poor quality sleep, increases the risk of disorders including high blood pressure, cardiovascular disease, depression and obesity. There's also evidence that in conditions of memory loss like Alzheimer's disease that sleep is really important for how the disease progresses.

I mean, we all know the feeling of not getting enough sleep - the whole day feels sluggish - and long term it is really dangerous. So how do our hormones regulate our sleeping behaviour? Making us tired at night, awake in the morning?

Jamie - In mammals, concentrations of hormones actually fluctuate across day and night. Numerous hormones are directly affected by sleep, feeding and other behaviours. You might think that the daily rhythm in sleep and other behaviours fully explains the existence of a day-night rhythm in hormone levels, because that's what we see, but actually, hormones are affected by an endogenous timing system as well. So that's sort of a natural timing system within us.

AKA our body clock, or circadian rhythm as it's more formally known. We have little timers inside our brain and every cell in our body which regulates hormone levels.

Jamie - And that's what we talk about when we talk about circadian rhythms and endogenous rhythms. Circadian rhythm is a rhythm that follows the day-night cycle, and we have an endogenous rhythm of around 24 hours, which tends to match that. But actually, when the day-night cycle around us changes, so if our daily behaviour falls out of sync with our endogenous system. So, for example, people who do things like shift work or people who suffer from insomnia, they're not actually in sync with their day-light cycle. And this actually affects their normal hormone variation.

Or jet lag, which happens when you travel quickly across time zones so your internal body clock gets out of sync with the day-night cycle in your destination. Whatever the reason, being awake when your body thinks it should be asleep, or vice versa, messes with these regular hormone cycles.

Debra - We have a clock system and one of the master clock is in an area of the brain. The timing and the rhythms that this clock generates really tells our body what time of day it is.

This is Debra Skene, professor of neuroendocrinology at the University of Surrey.

Debra - The clock is directly responsible for generating circadian rhythms in important hormones. And two of these clock-generated hormones, one is melatonin and the other is cortisol.

These are sort of like the yin and yang hormones, because melatonin as a hormone is produced at night and it begins to be produced before we sleep. So it almost prepares our body for sleep.

And then, on the other hand, cortisol is a hormone that begins to rise before we wake up. And so prepares our body to be in wake up mode, or our closest approximation - giving us extra glucose and energy. And it allows us to almost cope with getting up in the morning. So melatonin for sleep, cortisol for wake.

Debra - And it's these two hormones that tell the rest of our body that it's daytime and Night-Time.

So our hormones rise and fall signalling day and night. And if day comes at the wrong time - like we've flown into a new time zone, or it's daylight savings - our signals are the wrong ones.

So what effect does this have on our brains and bodies? To find out more about the impact of flipping time zones on performance, I took a closer look at one particular group of people...

Domingo - Baseball players can be beaten by jet lag.

This is Domingo Tortonese, a veterinary surgeon and researcher at the University of Bristol.

Domingo - Jet lag alters, in a negative manner, your cognitive and your physical performance. So when you are moved from a given time zone to a different time zone, your body clock needs to adjust to a new time in that zone.

And that takes a long time for humans, approximately one hour per time zone. And that causes a detrimental effect on performance, particularly if their flight was eastwards.

People flying across the world for a sporting fixture don't usually have 10 days to wait for their body clock to speed up. But there's one athlete who seems to be immune to this effect, or at least reacts very differently.

Domingo - The horse is the only species apart from humans that are transported across time zones for competitions.

Polo players have noticed when they fly to their polo ponies from Argentina to the northern hemisphere and then come to the UK to play, the horses play for a week or so, and then they stop playing, meaning they don't perform as well as they used to. And they have a big problem with that.

So horses are fine for the first week, they don't get that jet lag related dip in performance, until around a week later. Which is something of an oddity.

Domingo - Because I am very fond of horses and I've been bringing horses since I was a child. I was aware of this problem.

So loving all things horse and all things science, Domingo took matters into his own hands.

Domingo - We decided to look at it from a scientific point of view by simulating jet lag so that we bought thoroughbred horses that had proven racing records and brought them to Bristol. And we put them in light controlled rooms.

So the horses end up in a standardised environment, they all get the same type of training and food...

Domingo - And the only thing we changed was the light dark cycle, meaning the time when the lights are on and are off, mimicking a flight across seven time zones. And with that, you can assess exactly what the effects of jet lag are. So the hypothesis was that the horse was going to suffer the consequences of jet lag in a similar way that humans do. But we found the opposite. We found that horses recover extremely quickly to a phase shift, to a change in a 24 hour light-dark cycle, similar to what they would experience if they travel across time zones.

Horses adapted in no time at all, but that wasn't what really surprised Domingo.

Domingo - The process of recovery allows them to perform better athletically. So that means that the horses, for example, were able to gallop at full speed for 25 seconds longer than the day before. And although that appears to be insignificant, 25 seconds before reaching fatigue is a lot! That shows that the horse is adjusting to the new time zone extremely fast and that process of adaptation enables the animal to perform better.

So horses don't get jet lag. What's more... they actually perform BETTER after having their light dark cycle destabilised.

Domingo - It was very surprising to us, what we were finding because he was the opposite toward where we were expecting. We had never encountered anything like this.

Domingo found that this boost was down to a hormone called prolactin- which has hundreds of effects, but is known to affect performance. But why do horses react so differently to humans?

To find out they did a second experiment. Instead of CONTROLLING the day-light cycle they removed it - no regular feeding schedule, irregular exercise and no light. This means you can find out what that endogenous clock - the internal clock - is doing without being reset by light. It's been done in humans, and this was how we found out most of us have an internal clock near to around 24 hours. But never before in horses.

Domingo - In order to not let them know what time it was, every night we were training at different times. So we wanted to avoid any cue that would be giving the horse an idea of what time of day it was.

Which meant getting up at all sorts of hours in the night.

Domingo - We were jet lagged, the horses were not!

And again the findings surprised everyone.

Domingo - Horses, when subjected to constant darkness, do not have any rhythm at all. There was no rhythm already on the first day.

Horses didn't have a slow internal clock, or even a fast one. They had one that was completely dependent on light.

Domingo - They're using light to express their rhythms, which makes them light dependent, meaning horses are exquisitely sensitive to light, and they need light to express their biological rhythms. That's why when we switch them to a different time zone like jet lag, they can adjust so quickly.

Unfortunately, we don't have that horse super power, we still get jet lag, but Domingo's research raises an important therapy. Back to Debra.

Debra - Light directly affects this, the timing of this molecular clockwork.

If you expose yourself to light it gives a message to your brain that it's day - especially blue light - which is the kind of light we get in the morning. This effect is leading to concerns about the blue light given off by our screens. Some scientists are sounding the alarm that if we use them late at night this could be giving our internal clock messages that it's time to get up - maybe even giving us tiny nightly doses of jet lag, which is why it's really important to remove screens from our bedrooms.

But used effectively, light can help us beat jet lag and or give us a boost in the morning - which is why we should throw those curtains open as soon as we wake up. Which is especially important because our internal clocks aren't quite right.

Debra - So I would say 80 percent of humans have a clock speed that is longer than 24 hours.

If you want to know if your clock is slow or fast - if you're a morning person, it's probably fast, if mornings are hellish - like me, it's probably a bit on the slow side. But thanks to light, the clock is reset each morning.

Debra - I think the most important part about these clock speeds is that every day, therefore, we need to see light to be able to reset our clock each day so that we remain on track and synchronised to our 24 hour light-dark cycle.

But there are a group of people who cannot use light in this way to reset their clock.

Debra - Now, totally blind people have no conscious light perception, so they don't know whether it's day or night. And so they have no signal from the environment to their body to tell them what time of day or night it is. And so their body clocks sort of free run at their own cycle length. We all have body clocks that have a specific cycle length, but every day these clocks are reset because we see light and that light resets our clock to the 24 hour light-dark cycle that we live on, because we live on Earth. Now blind people don't have this, totally blind people. And of course, this makes them extremely tired during the day when they have to be functional and perform and work. And then, of course, when they try and go to sleep at night, their clock is telling them to be awake and alert.

Without functioning light receptors in the eye, your body clock runs at whatever your internal body clock timing is, and the longer a slow or fast clock runs. The more far out the time will be. So half your life is essentially being jet lagged.

Debra - Some totally blind people who we've studied and speak to have said that, you know, they don't mind actually being blind. They find that coping with the sleep deprivation that is brought about by this disorder that they have is more debilitating for them than their actual blindness.

So can we circumvent the light, and go straight to the hormones? Remember the yin yang hormones - melatonin and cortisol. Melatonin is the one that prepares you for sleep - and we can actually take it in tablet form.

Debra - By taking melatonin each night, the melatonin is able to synchronise a blind person's body clock. And this means that they're able to sleep well during the night and have a good, solid block of sleep and then are alert during the day. So, it's very important that we try and align their clock system with their sleep-wake cycle. A melatonin is the only drug so far that he's able to do that in totally blind people.

So melatonin can tell the brain it's time to sleep, and reset the clock, without needing light.

Debra - Well, we think it's working directly at the level of this clock - this master clock that we have in the hypothalamus. And there are melatonin receptors there at that level. And we know also that the light works at the level of this clock as well by directly innovating this area of the hypothalamus. So both light and melatonin are working at the level of this master clock in the hypothalamus.

And so melatonin is becoming a very popular drug for jet lag and insomnia.

Debra - Some people anyway, even without flying just in their homes at night when they're in bed do take it to help them go to sleep more quickly.

So we can 'hack our hormones', and tell our brains it's time for sleep - but hormones rarely do one thing - so is it safe?

Debra - These studies have been done for 30 years now and have built up. For example, in America, melatonin as a drug is available in health food stores because it's not considered a medicine, it's classified as a food supplement. *And so indeed people can buy melatonin and use it for jet lag, and in these studies and in the jet lag studies that have been done, very few side effects have been shown for melatonin. The most common side effect is the sleepiness that you may get. So we recommend taking melatonin in bed before you sleep, or if you do have to take it in an evening, then ensure that you don't drive after that. But apart from that, some reports of a little nausea or headache have been reported, but no major side effects to melatonin. And of course, if you think of all the people that might self-medicate in the US on melatonin and the rarity of side effects that have been reported, I think that almost confirms the controlled studies that have been done.*

So, by and large this treatment seems to be working, with serious side effects being rare. And Debra and other scientists are still searching for other ways to hack our body clock.

Debra - We've just begun to start investigating whether food and the timing of food can be a time cue. And we suspect that that is true. It's been shown in animals and we recently have been the first to show that this may occur in people. Likewise, exercise as a time cue. So when we have more time cues at our disposal, then just in the same way I've discussed melatonin as a drug being time cue, we could perhaps think of food, exercise and using those two time cues, in addition to melatonin, in addition to light, to reset your clock. And using them all together at the right time, depending on the findings that we get, might more quickly help us to synchronise when we, for example, move across time zones or when, for example, we do night shift work.

Georgia - Right. You mentioned food, I think I remember hearing that the queen had a trick where she just ate some barley sugar - can that help then, just eating at the right time or are there specific things you can eat for curing jet lag?

Debra - We need more studies on that. Are there specific foods and food groups, carbohydrates or fats or proteins that may do this better? Because our first early study, the meals were all the same. We didn't start manipulating the food composition. But these are the next questions that need to be addressed in human studies. There's some evidence in animal work that by changing of the type of food that you give animals, this can affect the timing of the clock. So there's a lot of potential for more studies here.

So, is the Queen onto something? Or is she just partial to travel sweeties? We'll have to wait for the results of all this research to know for sure.

But for now - we do have some tips to stay in sync. Keep sleep patterns regular - and use light to overcome jet lag faster - but don't use blue light in the bedroom. If daylight savings is coming- prepare yourself for the shock by getting to sleep earlier for a few days before. And for special cases, there is melatonin. What we already know about how hormones and light drive our internal biological clockwork mechanisms is opening up all kinds of possibilities - good and bad - for fiddling with the settings of our body clocks to keep us healthy and well-rested, whatever time it is.

Thanks to Jamie Thackrar, Domingo Tortonese and Debra Skene for their help this episode.

Next time we'll be diving deep into the hormone going undercover as a vitamin - and asking whether an over the counter supplement can really protect us from COVID-19, do join us then.

Hormones, the inside story is a podcast from the Society for Endocrinology. You can explore more about the world of hormones at yourhormones.info, follow them on twitter @soc_endo and find them online at endocrinology.org

This show was produced by yours truly, Georgia Mills. Kat Arney is the executive producer and it was made by FIRST CREATE THE MEDIA. Thanks for listening, and see you next time.