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Racehorses being loaded for an international flight to the races

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Why horses don't lag behind after travelling

The effect of 'jet lag' on horses crossing time zones is markedly different to what might have been expected

We've all been there. That dreadful feeling of cotton wool around the head and an inability to think clearly on the first few days abroad. You look at your watch and sure enough it's around the time that you would have been in bed for an hour or so at home. Similarly, 'bang, wide awake' in the middle of the night, you look at the bedside clock and it's around the time that you would have been getting up at home.

These phenomena, symptoms of 'jet lag', happen because our bodies are governed by innate 'clock' genes which tell us the time of day or night without any need for an external clock. This is the reason many of us wake up just minutes before our alarms go off every day. Our innate clock genes are ticking away happily whilst we are fast asleep, but nonetheless remind us bang on time that it's soon going to be time to wake up.

Jet lag has serious implications in man because of reduction in both mental and physical performance. For these reasons, it's of serious interest to the military when moving troops across time zones. Because of the negative effects on performance, it is also very much on the radar for athletes. Human athletes and horses are about the only sports competitors who regularly travel by air to compete, often crossing several time zones. Human athletic performance is significantly affected by time zone shift, particularly in the eastward direction. Does the same thing happen in horses? To answer this, a group at the University of Bristol's School of Veterinary Sciences, led by Dr Domingo Tortonese, investigated the effect of jet lag on athletic performance in the racehorse. This study, supported by research funding from the Horserace Betting Levy Board, turned up some surprising results.

Circadian rhythms

Almost all animal species, even down to very simple single-cell organisms, show rhythms of biological activity which correspond approximately to a 24-hour cycle. These natural rhythms result in the excretion of chemicals and hormones, which can stimulate both wakefulness and sleepiness. In human beings maintained in constant darkness, these patterns of activity continue for many days, although the exact 24-hour period usually begins to drift a little, a phenomenon known as 'free-running'.

Nonetheless, for many days and nights in complete darkness humans will be active during the hours when it would have been daytime and will feel the need to sleep in the hours when it would have been night. Mice and rats are identical but opposite. They show a normal activity cycle of sleeping during the day and activity during the night, and once again when subjected to constant 24-hour darkness will continue to exhibit patterns of activity at the correct time, even though there are no light cues.

It is this circadian pattern of hormonal activity which is the basis of the awful feeling of jet lag. These feelings are produced because the body and its chemicals are telling us to sleep and slow down whilst the light cues and the time of day are telling us to 'rev up' and perform activities. This is the basis of the impairment in both mental and physical function which constitutes jet lag. So do horses have the same problem?

Horse sleep patterns

The Bristol team kept some thoroughbred horses under continuous observation and logged the amount of activity during the day and night.

What they found was that horses both slept and were active during both the day and the night. They showed periods of activity interspersed with periods of sleep throughout the entire period. Under normal lighting conditions the horses certainly showed more periods of sleep during the night than they did during the day, with a clustering of intense activity just after daybreak but had periods of activity throughout the entire period, including the depth of the night.

The research group then investigated the effect of subjecting the horses to continuous darkness to see whether this pattern of activity continued. What they found, in complete contrast to the situation in man and rodents, was that as soon as the light cues were removed, the pattern of activity and sleep became completely random. Periods of activity were followed by periods of sleep but with no evidence of patterning. Interestingly, after ten days of continuous darkness, when the lights were turned back on again the horses returned to their normal pattern. They had both sleep and activity spread through the day, but with clustering of bouts of activity during the daylight hours and clustering of bouts of sleep during the night.

This switch back was immediate, in contrast to what would occur in animals with strong inbuilt circadian rhythms. This gave a hint that the horse is different, is extremely sensitive to light, and that much of its activity patterning will be determined by light-dark stimuli rather than by endogenous rhythmicity mediated by circadian rises in hormones and neurotransmitters.

Does all this matter?

Given that the horse clearly shows differences to man and rodents in how it deals with changes in sleep patterns linked to photoperiod, what would be the effect on performance? To test this, horses were stabled in an environment in which the hours of daylight could be artificially manipulated.

The horses were accustomed to treadmill exercise as a completely normal part of daily life. They were then subjected to a standard exercise test on a high-speed treadmill, and a basic 'athletic ability' baseline was obtained for each horse. Once the horses were acclimatised to this daily pattern of activity they were subjected to an artificial 'flight' by adjusting daylight length for dawn to be seven hours ahead of its normal time. A human in this situation would be expected to perform significantly less well, but did horses follow the same pattern?

Dr Tortonese, the lead investigator, says: "The results were essentially the opposite to what we were expecting. First of all, we assessed several components of the physiology of the animal. We assessed the performance of both the aerobic (exercise using oxygen) and anaerobic (exercise running up an oxygen debt) capacities. We assessed three neuroendocrine systems that measure the response to stress, homeostasis and time measurement, and then we measured clock genes that allowed the animal actually to measure time, so we went through from the molecular aspect of timing to the behavioural aspect, which was the effect on performance.

"The first thing we noticed was that the horse clock gene machinery (the clock genes are the components of the cell nucleus, which work in feedback loops and measure time) was immediately disrupted by the simulated flight but, contrary to the situation in other species, we also found that the readjustment of that clock gene expression was already apparent on the first day after the flight. In other words, the horse adapts instantly to the change in daylight and resets the internal clock. That was something unexpected.

"The second thing we found was that the horse's athletic performance, instead of being diminished, which is what would happen to a human being after a simulated flight to the east, was actually enhanced. That was very surprising, because of course we had only data from humans and it is very clear that in humans an eastward flight will diminish the performance of the athlete. In our case, it was the opposite, and this was true for both for the aerobic and anaerobic capacities. This was very surprising.

"With time, this effect faded away, and two weeks later, having been maintained in the daylight hours of the 'new' time zone, the horses' performance was identical to that before the simulated flight."

So paradoxically, jet travel in an eastward direction in the horse appears to significantly enhance athletic performance, if undertaken within the same hemisphere, at least in the first few days following arrival, although the effects of the 'flight' were gone two weeks later. Interestingly, prior to this work trainers tended to fall into one of two groups in their recommendations for flying horses to race in other time zones, for instance, in the USA.

One camp believed that the best way to do this was to "run the horse straight off the plane". The other camp held an equally strong opinion that the horse should be shipped in at least two weeks prior to its intended race to give it time to acclimatise. These research findings show that both camps were probably correct. The early improvement in athletic performance seen immediately after the flight may well compensate for any of the disadvantages of a period of travel itself: the horse should run well, possibly even showing improved form. Similarly, if the horse is given two weeks to acclimatise to the new location, then its performance should be just as good as at home, and any detriment from feed and drink disturbances in the flight will have had time to be corrected.

How is performance increased?

The researchers looked at the levels of several hormones and chemicals both before and immediately after the change in time zone. There were several interesting findings. First, changing the time zone did not appear to stress the horse in any way. The horse adapted very quickly and took the cue of 'lights on' as meaning the beginning of the day; even on the first day there was no 'jet lag'. The level of cortisol, the 'stress' hormone, was identical throughout the day and night both before and after the time-shift. Similarly, the production of the hormone melatonin, which is inhibited by light, and is actually used as a medication in man to mitigate the effects of jet lag, was very rapidly re-regulated in the new time zone.

One hormone, prolactin, which has profound physiological effects on many body systems, was seen to be significantly affected by the change in time zone, with a large 'surge' on the first day after arrival. It may be this rise in prolactin which is responsible for the apparent increase in athletic performance. As its name suggests, prolactin is involved in the production of milk in the mare but, as with many hormones, over the millennia it has evolved to have many different functions in the body and is well known to have marked effects on the heart and blood vessels, the liver, kidneys, adrenal glands and brain.

European-based horses have always figured large on the international racing scene, with regular success at the Breeders' Cup, Japan Cup and the Hong Kong international races. Dr Tortonese's study gives us reassurance that as far as jet lag goes, air travel to the competition need not have any deleterious effect on performance – and in some circumstances might even help.

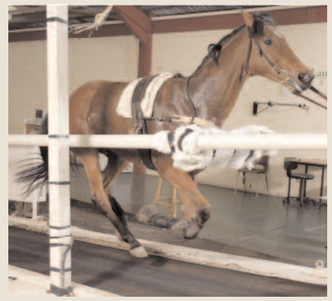
'Jet lag' as a performance enhancer

The Britol University study detailed showed that shifts in photoperiod can produce significant improvement in athletic performance. Some of the experimental horses were able to gallop on the treadmill for a full 25 seconds longer than normal before fatigue began to show, following their simulated travel.

But of course horses do not actually need to travel in order for this phenomenon to occur, as long as the day-night conditions make it appear to them that they have entered a new time zone. So would it ever be a practical possibility to manipulate photoperiod deliberately to affect athletic performance and the time to fatigue?

Dr. Tortonese comments: "Of course you do not need to put the horse on a plane to alter the light-dark cycle. That can be done in the box, and that could be a means by which you can allow the horse to have an advantage – it could be a part of the system of training. It could help the horse to prevent an injury, because you have to remember that both the aerobic and the anaerobic capacities were improved.

"That means that the horse is better off for a short sprint race and also for a long staying race. We know that many injuries occur towards the end of races, when the horse is fatigued, and this system could in theory be used to delay the onset of that fatigue. This is something that we should keep in mind."



DOMINGO TORTONESE

One of the jet lag project horses cantering on the treadmill. By exercising in this way, performance indicators could be measured easily during and after exercise