JETS, JET LAG, AND SLEEP: 
EFFECTS ON THE TRAVELLING ATHLETE

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Congratulations on your reaching the level of the elite, "jet-setter" athlete! You have worked long and hard to reach this goal. Now, you will have the opportunity to compete with the world's best in your sport! You will be honing your skills to their finest edge. We want to help you do just that.

Comparatively new research is showing that this fine edge can be quickly lost after travelling across as little as one time zone in a climatically dry airplane; the cabin altitude of which may be as high as 8,000 feet. Furthermore, your waking and sleeping cycle may be disrupted causing shortened, poor sleep. Many of your European and Asian competitors are well aware of this phenomenon. We want you to be aware of it also.

You probably know a great deal about the science of your sport, health, diet, nutrition, etc. We would like to introduce you to a relatively new science, chronobiology; and talk to you about something which you do every day, sleeping. As you will see, chronobiology and sleep are surprisingly intertwined and probably have a greater affect on your ability to perform than you may presently believe.

Central to both chronobiology and sleep is rhythm; for the flow of nature is rhythmic - the seasons, tides, day and night, birth and death, beat of the heart, respiration, sleep and wake, sleep itself. We speak of "getting into the rhythm of things", you develop a "rhythm" in your sport. Life has existed on earth for over 4 billion years. It is reasonable to believe that we as part of the life force developed with these rhythms and in the process developed rhythms of our own in concert with them.

Day and night are the most obvious rhythms. To measure the activities about the day, devices to measure time were invented. Thus the word "chrono" is derived from the Greek word meaning "time or duration". Hence, the concept of chronobiology is the study of how time or duration affects organisms biologically. More specifically we are concerned with activities within the 24 hour or daily period. The term "circadian" was coined. It's derivation eminates from Latin, "circa" - about, and "dies" - day. Although researchers have uncovered other rhythms in humans that have periods greater and lesser than 24
hours, we will not concern our discussion about them because, as far
as is known at this time, they appear not to affect athletic
performance.

EFFECTS OF CIRCADIAN RHYTHM

Research has shown that there are over 300 functions that perform
rhythmically during the day, having high output or activity during one
part of the 24 hours and then decreasing to a low at another part of
the 24 hours. The function may have its own rhythm, be in concert with
another, or oppose another rhythm. They do, however, work together
harmoniously. Thus, your circadian rhythms are synchronized and you
feel well. When you travel across time zones your various rhythms may
become desynchronized. This is called "jet lag" and you may not feel
very well at all! Among those bodily functions that are affected are
elimination, endocrine secretions, blood volume and pressure, heart
rate, body temperature, weight, respiratory rate, oxygen volume,
oxogen and carbon dioxide exchange in the lungs, length and quality of
sleep, and, thus, physical vigor.

It appears that when humans are removed from cues as the day/night
rhythm, they no longer retain their 24-hour rhythm. Rather, most drift
into approximately a 25-hour rhythm, some will assume 23 to 23.5 hours.
A rare individual may have 28 or a 48 hours. To return to 24 hours,
each person must be exposed to a time giver called a "zeitgeber" such
as the sun, regulation of meals, work, activity and social activity.

JET LAG

"Jet lag" is, essentially, rapidly shifting over several time
zones (East-West, West-East only) causing a disruption of the various
systems that had been coordinated within the departure time zone. When
these systems become "desynchronized" from each other (i.e.) sleep/wake
times, eat/fasting, elimination, endocrine, etc. the body reacts with
feelings of fatigue, sleepiness and their mental consequences during
wake time and insomnia during sleep time.

Similar desynchronization occurs when one attempts to stay awake
during a normal sleep period and then tries to sleep during the normal
wake period such as occurs with individuals who work nights, and then
attempt to sleep during the day. The symptoms of lassitude,
irritability, sleepiness, complacency, fatigue, desire to nap and
difficulties with mental faculties appear during the time the person
is at work during the night while insomnia occurs when the time to
sleep arrives, during the day. Adaptation requires several weeks...
and only when the schedule of night-work, day-sleep is punctiliously
maintained. If the individual attempts to "spend the weekend with the
family" by staying up during the daylight hours, the body quickly
retrains itself to the normal day-wake, night-sleep regimen. Monday
night back at work brings the same kind of discomfort as the very
first night that the individual began his night shift duties.
Nevertheless, even those who scrupulously maintain their work/sleep
schedules on days off have some difficulty.

Needless to say, the most severe kind of desynchronization occurs
when time zone AND sleep/wake cycles are severely shifted. Added decrements in this case seem to be severe mood changes and unrelenting-or waxing and waning- cognitive difficulties along with those previously cited. This can occur when you leave the United States to compete in games either in Europe or in Asia or when you fly to the East Coast from the West Coast.

LARKS, OWLS, AND PERFORMANCE

There is one other kind of rhythm that we all are affected by, the "morning-people" and the "afternoon people". The morning types are called "larks" because they are up early and happily working like Trojans early in the day. After about 2:00 p.m. they begin to slow down. The afternoon folks, called "owls", rise late and don't really get started until about 2:00 or 3:00 p.m. Measurement of temperature of both groups show that the larks temperature reaches its high (about 99 degrees f) around 11:00 a.m. and drops to a low (about 97 degrees f) around 2:00 a.m.; the owls' high is around 4:00 p.m. and the low around 4:00 a.m. Both groups suffer a "post lunch dip" where the temperature drops for a period of time right after lunch time whether they have eaten or not. We suggest that you pay careful attention to whether you are a lark or an owl, or when you are subject to the "post lunch dip". Measure your performance at the various times of day in relation to your temperature peaks. It is possible that you may do better at one time of day than at another.

SLEEP LOSS

The effects of sleep loss have been studied by scientists worldwide, from Finland to the Peoples Republic of China. Most have agreed that when human beings reduce sleep from approximately 7 hours per night; suddenly shift from night sleeping to day sleeping; or change time zones quickly, decrements in performance appear. Some decrements may not be constant, but appear, then disappear, as when an automobile begins to run out of fuel, spurting, bucking, stalling, then running smoothly for a while. Other decrements creep in slowly and insidiously and are not recognized or admitted to, and others are blatant as just feeling "downright tired."

SYMPTOMS

The symptoms of sleep deprivation have been variously described as persistent sleepiness or drowsiness, feelings of exhaustion, fatigue, irritability, difficulty in concentration, reduced vigilance, lethargy, distractibility, reduced motivation, complacency, depression, restlessness, incoordination, malaise...a vague feeling of bodily discomfort, loss of appetite, gastrointestinal disturbance, double vision, impairment of interpersonal relations and impairment in the ability to get work done. Additionally, the individual may suffer "micro-sleep", a condition where he may appear awake with eyes open but, for a period of 15 to 20 seconds, neither perceives nor reacts to stimuli from the outside world. It should be noted that research done at Stanford University indicates that college students are extremely sleep deprived. The researchers suggest a minimum sleep period of at least 9 hours to attain peak mental performance. There is
no information on physical performance, however, in regard to sleep loss itself.

WHY DO PEOPLE SLEEP?

Little is known presently about why we need sleep. Sleep is an active process, not merely absence of wakefulness, encountered by all mammals. Because it is basically neural in nature, it requires an intact brain and central nervous system. Sleep can be divided into two phases, each characterized by a different brain state. The neural activity in these states are recorded and called the Electroencephalogram (EEG). Other body functions that help delineate these states are eye movements recorded as an electrooculogram (EOG) and activity produced by muscles recorded as the electromyogram (EMG).

SLEEP DESCRIBED

The two basic sleep phases are (a) Non Rapid Eye Movement (NonREM), slow-wave sleep or orthodox sleep and (b) Rapid Eye Movement (REM), desynchronized or paradoxical sleep. We will use NonREM and REM. Normal sleep begins with NonREM and has four distinct stages, 1, light to 4, heavy as characterized by EEG, EOG and EMG recordings. As sleep deepens with its onset at stage 1 awakening becomes increasingly more difficult. The sleeper eventually drifts to stage 4, the deepest of sleep. Brain waves are slow and synchronous, cardiovascular, respiratory, and autonomic nervous system levels are somewhat reduced but steady, and subjects awakened from this stage seldom report dreaming. Yet, children will suffer night terrors here and the snorer will be at his best. From this point after roughly 20 minutes the sleeper will drift slowly up to stage one. He will have spent about 70 to 90 minutes in NonREM. All through this time his eyes were languid beneath the eyelids, almost as if one had no relationship to the other.

Suddenly eye movements become coordinated announcing the beginning of REM sleep. The EEG shows an active brain but muscles are placid from the neck down. Active dreaming begins and the phase lasts for merely about 10 minutes. REM ends and NonREM begins again. The two phases consume 90 to 110 minutes. The ride on the "mental roller-coaster" from NonREM to REM will be repeated approximately 4 to 6 times through the night of an average sleep period of 7.5 hours. The first half of the night will contain several periods of 4th stage NonREM sleep. The second half will contain longer periods of REM phase with the sleeper drifting only to stage 2 or 3 during NonREM.

No one knows yet the functional significance of sleep. Some research suggests that it may represent rest for certain specific elements of the brain and neural system when certain chemical and other substances are being replaced. Alternatively, sleep may provide a period for long-term chemical and structural changes that the brain requires to make learning and memory possible. Indeed, a decrement in memory and learning seems to occur when sleep is shortened and REM sleep is decreased.
TO SLEEP! BUT WHEN?

When is the best time to sleep? According to very recent research, sleep normally begins when the body temperature is dropping to its daily low. Awakening typically occurs during the rising temperature phase, approximately 7-8 hours after the temperature drop. This varies from person to person. Thus, the aforementioned lark will get sleepy earlier than the owl. Conversely, the lark will also wake up earlier.

In terms of getting the best sleep, research has shown that when sleep is shifted away from the time of temperature drop, both the ability to sleep and the quality of sleep deteriorates. Russian researchers have demonstrated that when sleep is gradually postponed to later and later in the night, negative effects appear in performance, physical functions, the sleep patterns themselves. Data from work done in Sweden indicates that there is also a period of time when the ability to sleep diminishes. It appears that if one tries to sleep between approximately 8:00 a.m. to 1:00 p.m. even after staying up all night, sleep length will only be approximately 4 to 5 hours. Even the slightest noise tends to awaken the sleeper. The longer one stays awake after 11:00 p.m., the greater sleep length decreases because the mechanisms controlling wake-up will now be in control.

An odd phenomenon occurs when one goes to sleep when the temperature is rising or has reached its daily peak. Research confirms that the individual will sleep for as long as 12 hours. The length of the REM periods differ from sleep begun at the lowering of temperature. Although the significance of this phenomenon is not understood, it is possible to infer that if the subject were awakened earlier so as to shorten the sleep period of 12 hours, he or she may suffer the effects of sleep deprivation.

THE UNSUSPECTED TRIBULATIONS OF THE JET SET ATHLETE

As stated earlier the worst possible combination of circadian desynchronosis and sleep deprivation is travelling across several time zones in jet transports.

The Jet Transport

Let's look at the jet transport itself. All jets travelling over 200 miles will fly at altitudes of 31,000 feet and higher. At these altitudes, there is very little moisture in the air. In addition, the air is heated to nearly 300 degrees before it is cooled for cabin pressurization and breathing. The only moisture in the cabin air is from human exhalation and perspiration. The humidity is normally around 11%. This means that moisture is literally being drawn from your body.

To preclude dehydration then, it is recommended that you drink a lot of fluids. No coffee, tea, or alcohol because each of these are diuretics causing you to eliminate even more precious fluids and may decrease your ability to adapt to the new time zone.
The cabin altitude of a jet which has a flight time of greater than 45 minutes is normally over 5,000 feet. Although the body adjusts to this, there is a possibility that you might have a small oxygen deficiency. Of course, you'll recoup on the ground. If, however, you use tobacco or marijuana, you are ingesting rather large amounts of carbon monoxide (CO) which puts your body at even a higher altitude. You will not recoup the oxygen deficiency lost from the CO. In this regard, you'll feel much better, the farther away from the smoking section that you can get. If you wear contact lenses, be sure to carry sufficient wetting agent to moisten the lenses frequently.

Jet Lag and Sleep Loss

As noted earlier, crossing only one time zone, can affect performance. Studies done in England and, recently, at San Jose State University show that there are more accidents that occur the week after the change from standard time to daylight savings time, the loss of one hour. If you travel from the West Coast to the East you loose 3 hours; to Europe, 8 or 9 hours -- any good atlas will show the various time differences.

Let's take an example of a West Coast athlete, Sam Swift, who has a meet in New York. His team is low on funds so he is going to save as much as he can on any kind of expense.

The first expense is travel, so our hero will take the midnight special that stops at several places on the way over. To save on lodging, he decides to leave the night before the meet. "I can sleep on the plane," he thinks. "Besides, the meet doesn't start until 7:00 p.m. (New York time); I'll have the whole day to rest," he tells himself. He has a home meet 4 days later, so he decides to spend only 1 night in The Big Apple and catch the first flight out the following morning leaving at 8:00 a.m. (New York time). He is slightly allergic to tobacco smoke and is definitely a lark, up at 5:30 a.m. for his morning work out. The day of the flight is a school day and he packs that evening.

The airplane leaves at midnight on the dot. Since this is an economy flight, it is one class, open seating, smokers in the back, non smokers in front. Our hero finds himself near the back of the plane, one seat in front of the smoking section. (He took Super Economy Class where they charge for a glass of water). After take-off EVERYBODY in the smoking section lights up. Sam tries to sleep, at first the cigarette smoke causes him to sneeze and cough. Finally, the smokers also try to sleep. For the 7 hours of flight he finds he can only nap. Then there are the interruptions of the two landings where he cannot even nap! Finally! They land in New York at 10:00 A.M, Eastern Standard Time (EST).

Sam is exhausted! He has had little or no rest on the airplane. First, his allergy to the tobacco smoke prevented his sleeping. Additionally, the dryness of the air made the irritation of his nasal passages worse. He did nap but he still feels tired and sleepy because the body must be horizontal to acquire quality sleep. The chairs in
the airliner only tilted back partially. Besides, since he was so concerned about napping, he drank no fluids, so it's possible that part of his exhaustion is dehydration. Even if he could have slept properly, the various take-offs and landings would have severely interrupted sleep.

After a hour bus ride and an hour search for a hotel, Sam drops into bed at 1:00 p.m., EST. He leaves a wake-up call for 5:00 p.m. Dropping off almost immediately to sleep, it seems almost minutes before the phone rings, awaking him. He feels even worse. Nothing makes him feel better, not the shower, the light dinner, the cool air from the walk to the arena.

Now he must perform. It is 8:00 p.m. in New York, but 5:00 p.m. on the West Coast. If he were there, he'd be relaxing. His body wants to do just that. He cannot push himself into "high gear." He finishes last.

Sam's troubles are not over. Although, he is in bed at midnight, New York time, close to his 9:30 p.m. West Coast bed time, he must arise at 5:00 a.m., EST in order to catch that 8:00 a.m. airplane. This is 2:00 a.m. West Coast time! In addition, the bright lights from the city are creeping in around the window shade, shinning directly into his eyes. His brain is receiving a wake up signal (light) through his closed eye lids. He does not sleep very well. The return trip is worse than his inbound to New York. Although the plane is only partially full of people and he's away from the smokers (Sam's a quick learner!), he cannot even nap! The light is just too bright. His brain is receiving that same wake up signal. His body is ready to get up because it is his normal wake up time, after 5:00 a.m. California time.

Sam is a basket case! He's depressed; he came in last at the meet; he's exhausted. He decides to tough it out and go to bed at his normal time, 9:30. At 4:30 the following morning he is wide awake. When he arrived in New York, his body began shifting some of the rhythms to New York time, some stayed on California time, and some are in between. It will take about two weeks for all these rhythms to return to California time. Meanwhile, Sam has to compete in several meets, inclusive of one within three days of his return to the West Coast.

In three weeks Sam has to compete in Japan, 8 hours ahead!

The Nitty-Gritty

Let's look a little more closely at the various problems that Sam encountered. They were either physical or behavioral in nature and were most probably affected by changes in his circadian rhythm. This means that had he paid close attention to them, Sam would have seen the differences between his normal performance at home and his poor performance in New York.

His best performance at home would probably occur at the time of his highest temperature... and his worst at the time of his lowest temperature. Although the difference is small (2 to 2.5 degrees f.) it represents as large shift in metabolism or the rate that the body
consumes energy. Now, this is not at one specific moment, but
occurs within a time frame or "window" period, several hours before
and after the temperature peak. (By the way, sensitivity to drugs as
alcohol, caffeine or medications also occurs -- thus affecting
performance!) When Sam shifted the three hours to New York, part of
his bodily rhythms were still on West Coast time and some may have
shifted to New York time. The end result often is fatigue, insomnia and
sleep disturbances, gastrointestinal complaints, headache, irritability, and REDUCED PERFORMANCE EFFICIENCY.

More spécifically, scientific research has shown that there is an
increase in coronary muscle tone between 1 p.m. and 3 p.m. There are
circadian changes in the dynamics of the blood stream. The variations
influence delivery of oxygen, glucose, and hormones to the various
organ systems as the brain. The efficiency of the brain is critically
dependent upon the blood flow for the delivery of oxygen and glucose
and, thus, is affect by the circadian changes. The liver storage of
glycogen, the fuel for rapid energy, peaks in the late morning and
begins to descend in late afternoon reaching its trough in the middle
of the night, at about 4:00 a.m. Neuromuscular functions as reaction
time, grip strength, Achilles tendon reflex, elbow flexion strength,
nerve conduction velocity, and resting forearm blood flow have
exhibited definite circadian changes. Maximal voluntary contractions of
the skeletal muscles and efficiency of the contractions are affected.

Within the endocrine system, steroids secreted by the various
glands have specific circadian rhythms. These chemicals influence
muscle tone and strength, helping the body adapt to the stress of hard
exercise. A very important hormone that has such effect is cortisol
which reaches its maximum in the system soon after waking and drops to
a minimum in the evening. The male hormone testosterone peaks at
approximately 7:00 a.m., remains at a high plateau during the day then
reaches its minimum between 10:00 p.m. and 2:00 a.m. (This only occurs
in males.) Melatonin, an hormone highly correlated with fatigue
(performance and sleepiness), is dependent on the light/dark cycle and
eating habits.

The digestive system is affected by circadian rhythm and food
intake. Digestion itself follows a circadian pattern; the acid
content of the gastric juices rises during sleep but volume decreases.
The flow of pancreatic secretion reaches its maximum in the early
afternoon and its minimum at night. A defecation rhythm of a peak 2
hours after awakening and another early in the evening has been
reported. The time required for this rhythm to adjust after a 5 hour
flight (east to west) was approximately 7 days. Thus an athlete
experiencing jet lag can expect that the bowel movements will not be
coordinated with either the old clock or the new clock for 7 days.

In general, then, the performance of the athlete is affected by
circadian rhythm. The changes are greater, as we have seen, in
physiological function than in performance tasks. Performance is
affected, and becomes more critical, however, as the complexity of the
task increases. Some examples of these performance tasks are hand-eye
coordination, reaction time, and cognitive ability.
A BETTER WAY OF DOING THINGS!

We would like to suggest some ways of overcoming Sam's problems:

1. If you are to compete in a city which is in a different time zone, attempt to readjust your body time to it within a week of departure.

2. If the city is east of your time zone, even by one hour, the adjustment should be attempted; if west, a 2 or 3 hour difference does not constitute too much of a problem.

3. Select a departure time so that you can arrive during normal awake hours of the target city.

4. During the flight DO NOT use any alcohol or drinks which contain caffeine such as coffee, tea, Coca Cola, Mountain Dew, chocolate.

5. DO drink plenty of fluids as juices and water.

6. Stay away from the smoking section.

7. On arrival, attempt to adopt the target city's time zone by eating, working, and playing on their time.

8. Ensure that your sleeping quarters are dark and quiet.

9. When you are trying to go to sleep, if you know a relaxation technique use it, if not try this:

   a. about an hour and a half before going to bed drink a glass of milk and eat something sweet like a cookie with it. The milk contains a natural sleeping substance called tryptophan. The sugar in the cookie helps the tryptophan enter the brain.

   b. take a warm bath, this will help relax the muscles

   c. make sure the room is completely dark.

   d. use your relaxation technique. If you don't know one, try this:

   Think of a word, name, sound, etc., that pleases you. Repeat this in your mind. If a thought enters, acknowledge it, then continue repeating the word. Breathe no more than 15 times a minute, that's one breath every 4 seconds. The breath that you take should be 4 seconds in length.

10. When you return home, try to get back on your time as quickly as possible.

11. Remember that readjustment for all your rhythms may take a few weeks. A rough gage for most of them is 1 day for 1 hour of time zone change. If you have a short time at the target city as Sam did you should count the time changes over and back. In Sam's case, it was 6 hours of time change, 6 days to adjust to home time.
12. In general, know whether you are a lark or an owl, find out if you have a severe post lunch dip, then try to have your events scheduled within your peak time and away from the post lunch dip time.

In summary, the best solution to the problem of circadian rhythms may be to begin to readjust your activities to the new city's time by about a week prior to departure. The next solution could be to stay on your own time. This may be possible on short trips where the time differential is not too great. On trips of great length to foreign countries, arrival early enough at the host country in order for you to become adjusted to the time water, food, etc. seems the best answer. Remember, however, that you must begin adjusting immediately on arrival by living on the new time.

At this time, there are no certain answers. Being aware that people are affected by "jet lag", however, is a step in the right direction.

A note concerning sleep. As we mentioned earlier, college students seem to be sleep deprived continuously. If you are not in school, you may be following the same patterns. Ignoring the effects of sleep deprivation. The effects of sleep deprivation are subtle, but they ARE THERE. If you want to be at the very peak of your capacity, we strongly suggest learning how many hours of sleep you need. This is done by going to bed when you feel tired at night, then sleeping until you wake up. If, during the following day you don't feel sleepy or drowsy, that sleep time is your body's requirement. Do this, by the way, after you have been home for at least three weeks. The average for college students is 9 hours, yours may be more or less. Nevertheless, it is what is built into your body. It is not important how long the period is. It is imperative, however, that you get the sleep you need.

A final note. You will probably see books advertising the elimination of jet lag. They may be of help. Check the author's credentials carefully, then make your judgement. If the book guarantees removal of jet lag by the method, be careful. If it recommends the use of any kind of pill, put the book back, you're wasting your money and could affect your health. To this date there are NO known pills that can correct jet lag. BY NO MEANS USE BENZODIAZEPINES OR BARBITURATES! They will affect the natural rhythm of your sleep and some have a half life of 54 hours. This means that not only are you suffering the debilitations of jet lag, you, now, may have a sleep deprivation problem, a la Sam Swift, AND the drug is still in your system making you sleepy.

WE HOPE THAT THIS INFORMATION WILL HELP GIVE YOU THAT EXTRA EDGE TO WIN! GOOD LUCK! GOD SPEED!