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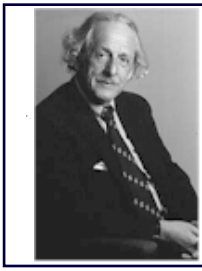

Current Comments

What Do We Know About Jet Lag?

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The world of science and scholarship is international. Consequently, ISI®'s customer base extends from Katmandu to Brooklyn, from Mandalay to the Bronx, and from Guyana to Philadelphia. (I've never been to Mandalay, Katmandu, or Guyana but chances are strong I'll get to them some day. The work of promoting ISI's services is never completed.)

Like many other scientists, I travel abroad frequently. Unlike many of my scientific colleagues, however, I have not yet enjoyed the luxury of *living* abroad. In the past 25 years I have lectured throughout the world, but I've never been in one place for more than four or five days.

Mind you—I'm not complaining, but it's not at all unusual for me to circle the globe in two or three weeks. On my last trip I flew from Philadelphia to San Francisco. I then spent 11 hours flying to Tokyo. After a week of lecture seminars, traveling from Hokkaido in the north of Japan to Fukuoka in the south, I flew to Copenhagen, via Anchorage, Alaska. I spent a week in Scandinavia (Lund, Stockholm, and Oslo) and then flew home via Paris and New York. On this trip like so many others, I experienced, albeit mildly, the phenomenon of "jet lag."

In the "old" days when I flew the prop planes to Europe the trip was much longer than it is today. After a stop in Gander, Newfoundland, I would sleep a few hours before the plane landed at Prestwick in Scotland. In Glasgow I would be aware of a strange feeling in my body. But I would ignore it until I could catch up with my sleep in London.

Today I can leave New York at 10 a.m., read or write for four or five hours, watch a movie and arrive in London or Paris in the late evening, stay up "late," and be in great shape the next morning. The average tourist, however, is unwilling to sacrifice any time, so he or she takes the night flight, sleeps on the plane and ends up half asleep and suffering from jet lag for several days.

When you travel across several time zones in a short period, you usually encounter the problem of "jet lag." Typically, symptoms include nervousness, nausea, constipation, fatigue during the day, and wakefulness at night.[1] Being awake at the wrong time can be a serious problem.

On my first trip to Japan 15 years ago, I was forewarned by Ralph Lapp. After arriving in Tokyo, I was wide awake and unable to sleep at 3 a.m. Following Ralph's advice I took a cab down to the Tokyo fish market and had a wonderful time watching the ritual fish weighing and listening to the various auctions. By the time I got back to my hotel, I was ready for a nap. But our friends in Japan had planned a very tight schedule. So I suffered a classic case of jet lag.

In more scientific terms, jet lag is described as a disruption of the body's daily biological, or "circadian,"

rhythm.[2] The term circadian, which comes from the Latin *circa* (meaning "about") and *dies* (meaning "day"), was first used in 1959 by F. Halberg of the University of Minnesota to describe the daily 24-hour rhythm experienced by all human beings.[3] Almost all life, in fact, both plant and animal, is controlled by rhythms. Temperature, excretion, pulse rate, breathing rate, and all body functions follow a daily rhythm, with periodic variations. For some plants and animals, the rhythms are determined solely by external factors, such as the rising and setting of the sun or the pattern of the tides. Humans, however, have a so-called internal "biological clock," which regulates the rhythms, telling us, for example, when to be alert and when to be sleepy.[4]

Hubertus Strughold, formerly chief scientist, and now honorary consultant, to the Aerospace Medical Division at Brooks Air Force Base, Texas, explains that the body rhythms are "integrated into a functional system, with the hypothalamus as the coordinating center and the hormones as the intermediary chemical agents...." The system is also influenced by mental activities, and repeats itself "with clocklike regularity within the temporal frame of 24 hours."[5] Arne Sollberger of the Southern Illinois University Medical School notes that the body's clock runs at its own frequency, and most people could easily operate on a longer or shorter rhythm—say, 23 or 29 hours. Normally, however, the rhythm is "*synchronized* by the environment, adopting a 24-hour period."[2] So, for example, the "lowest" part of the cycle occurs during the nighttime, or when we sleep. Respiration slows from the daytime (or active) normal of about 16 breaths per minute to 12, and the heart rate drops from 70 beats per minute to 60. Blood pressure and other body functions slow down as well,[5] thus enabling the body to enjoy a period of rest. Although this low point occurs at night for most people, many entertainers, shift workers, and other night workers have adjusted so that their low point occurs during the day.

When a person has jet lag, however, the biological clock becomes desynchronized with external factors. This happens when you cross several time zones rapidly. In other words, your new location is on one time, but your body is on another—your old time. So when you land in London at 9 a.m. local time, after a flight from New York, you may think you are prepared to begin a new day. Your body, however, will still be on New York time—where it's 3 a.m.—and it thinks it should be in bed sleeping. The body acts accordingly, by slowing down, and as a result, you feel extremely tired and sluggish. This phenomenon is called "circadian-rhythm desynchronization," or "dysrhythmia."

The phenomenon of jet lag is fairly new, having begun with the development of jet transportation after World War II. Until that time, people traveled by methods slow enough to enable them to adjust to time zone changes without noticeable difficulty. Jet travel changed that drastically. It's now common to travel over seven or eight time zones in almost as many hours. On the Concorde you leave Paris in time for an early lunch and arrive in New York in time for breakfast.

Jet lag was first recognized by Wiley Post, a record-setting global flier of the 1930s. In his book, *Around the World in Eight Days*,[6] Post discussed his experimentation with a pre-flight conditioning program intended to break his eating and sleeping habits, and thereby reduce jet lag.

After Post's book, however, jet lag was not actively studied until the 1950s. Since then, jet lag or, more accurately,

circadian rhythms and dysrhythmia, have been studied extensively. An annual bibliography on behavior and performance studies compiled by the National Technical Information Service lists, among other things, jet lag-related studies. The 1979 edition contained 188 abstracts of which 24 were new additions.[7] Jet lag studies have attempted to discover the exact effects shifting time zones has on the human body and its functions. For example, how long does it take for the body to adjust to the new time? Is the direction of the flight important? And, what effect does a time shift have on mental and physical performance?

To answer these questions, researchers study various body functions, such as pulse rate, temperature, and sleep, to determine their circadian rhythms. Then they send their subjects on either real or simulated jet flights for various periods of time. In some studies, the stay in the new time zone is several weeks, in others only a few hours. They continue to record the same functions during and after the time change. In this way, they can observe how the rhythms are affected by the change, and how long it takes them to shift to the new time.

For example, G.T. Hauty and T. Adams of the Civil Aeromedical Research Institute (now Civil Aeromedical Institute or CAMI) studied the rhythms of temperature, heart rate, and palmar evaporative water loss (a quantitative measurement of skin surface water loss measured by readings on the palm of the hand). Using four healthy male subjects, they periodically recorded data for a week prior to a jet flight from Oklahoma City to Rome, during the 12-day stay in Rome, and for a week following the return to Oklahoma City. They discovered that after the flight to Rome each of the three rhythms, which originally were closely synchronized, was affected differently.

Temperature and heart rate needed about six days to adjust to the new time, whereas palmar evaporative water loss never re-established a consistent phase while the subjects were in Rome. Approximately five days were needed after the return to Oklahoma City for the rhythms to re-adjust to the original time.[8]

From this research and similar studies, scientists conclude that the body's functions operate on somewhat different schedules, and that a time change alters those cycles drastically. Further, it takes different amounts of time for the different cycles to adjust to the new time cycle. Sleep and appetite, for example, normally need only a few days to adjust, while temperature can take up to two weeks.

The time needed for adjustment is dependent upon several factors, such as the time of departure, time of arrival, stress, age, number of time zones crossed, etc.[9] As a result, generalizations about the adaptation times are difficult to make. However, from four to eight days seems to be the average adaptation time, although some people may need two or more weeks to adjust.

Mental and physical skills are considerably impaired by jet lag.[10-13] One study of 16 female airline personnel, conducted at the British Airways Medical Service, found that performance on a series of workload tests was definitely impaired by time zone changes. The subjects, who were kept in an isolated chamber where time zone change was simulated, performed adding, reaction, memory, proofreading, and visual searching tests. The authors concluded that the poor performance was a result of loss of sleep caused by the time zone shift, and the effects of working at an adverse time of the circadian cycle.[11]

While these results are of interest to all travelers, they have particularly serious implications for flight crews. Many airlines and aviation organizations, among them the US Air Force, NASA, CAMI, the British Airways Medical Service, the British Royal Aircraft Establishment, and the German Institut für Flugmedizin are conducting or sponsoring research to determine the best ways to minimize the effects of jet lag for flight personnel. According to Siegel, Geratherwohl, and Mohler of the Federal Aviation Administration (FAA), "Almost all countries that have aircraft making long transcontinental and intercontinental flights are investigating time zone effects."[9]

Carlton Melton is chief of the Aviation Physiology Lab at CAMI. Although the lab is currently performing no on-going research in jet lag, Melton says they consider it a serious problem, particularly in terms of air crew work/rest schedules.[14] He adds that the lab has been involved in several jet lag studies in the past.

Many people claim that jet lag is not as severe after a west-east flight, while others claim east-west flights are easier to handle. In their 1969 review of the literature on jet lag, Siegel, Geratherwohl, and Mohler reported that both points of view are supported. They cite several studies in which "phase shifts were found to occur more slowly after west-east than after east-west dislocation." In contrast, the results of another study "point in the opposite direction." They conclude: "It is still an open question whether eastward or westward flights from the point of origin pose a higher stress on the air traveler."[9] Although more evidence that westward flights are easier to adjust to has accumulated since the FAA study,[9] no conclusion can yet be drawn.

In my own experience I have found east-west traveling easier. If you leave Philadelphia at 9 a.m. and arrive in California at 11 a.m., you can spend the day usefully and avoid jet lag if you don't stay up too late. When you leave California at 9 a.m. and arrive in Philadelphia at about 5 p.m., you feel as if you lost the whole day, and you'll have to stay up quite late before you're really tired.

Interestingly, some studies have found a sizable decrease in the time needed to re-adjust to the home environment after an extended period abroad.[15,16] For example, in a study by Hauty and Adams of a trip from Oklahoma City to Manila and back, with an eight day layover in Manila, the subjects required only one day to re-adjust to the Oklahoma City rhythms on their return. Hauty and Adams suggest that perhaps, despite the time spent in the new time zone, not all body functions shifted, and these exerted a synchronizing effect on the shifted functions upon return to the original location.[16]

People seem to suffer from jet lag in considerably different degrees. Many pilots and flight crews report that they suffer very little. Other people are often stricken for days, and some for weeks. One possible explanation is that some people are more settled in their daily rhythms than others, and are thus more upset by sudden change. People like flight personnel, whose schedules are always changing, probably never have time to establish a really firm daily rhythm. Studies suggest that Eskimos and others who are not exposed to a regular light-dark alternation never establish circadian rhythms.[17]

Other people are so set in their ways that even the hour change caused by the shift to and from daylight saving time causes them discomfort.[5] Studies have also shown that younger people generally suffer less from jet lag than older people. Babies under three months seem to be unaffected—probably because their

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rhythms are not yet established—while people over 60 are often incapacitated for weeks.[18] Some people are able to take naps at any hour of the day or night. Such persons may be able to offset the effects of jet lag better than others. Studies indicate that short naps can significantly improve performance[19,20] and that naps are beneficial in reducing performance impairment due to sleep loss.[21]

One area that to date has been relatively untouched in jet lag studies concerns the long-term effects of time shift adjustment. Since a large number of people, and not merely scientists and businessmen, are doing a lot of long-distance jet traveling, this area should merit some serious consideration in the future. It's not unreasonable to suspect that such drastic disruptions of body functions may have some permanent effects.

There can be no doubt that jet lag can be a significant physical disability. Some scientists have even classified it as a disease.[22] The implications for travelers are significant. If you ignore the effects of jet lag, you can easily make the first few days of your stay in a new place extremely miserable. And if you are traveling for professional reasons, as many of us do, the lowered mental performance resulting from jet lag may vitiate the purpose of your trip.

With these thoughts in mind, investigators have recently begun tackling the one question about jet lag that most travelers want answered: What can be done to lessen or eliminate it? For example, could we develop a jet lag pill? Researchers have tested such drugs as lithium compounds (antidepressants), flurazepan (hypnotic), and imipramine (antidepressant) in animal and human studies.[22,23] So far, however, none have been found especially worthwhile. One Russian study reported that the use of hypnotics during westward flight accelerated the adaptation process.[24] Mild sedatives, to help induce sleep, are sometimes considered beneficial.[15]

Another approach, not unlike that recommended by Wiley Post, has been to work out schemes whereby the body is synchronized to the new time before leaving the old. Charles F. Ehret and colleagues at Argonne National Laboratory in Illinois, created a regimen called the "Clockwatcher and World Traveler's Diet."[25] This scheme alternates feast and famine days with excesses and absences of caffeine drinks, high protein meals, and periods of heavy and light activity. According to the plan, three days before a west-east flight, you alternately feast a day (eat all you want), fast a day (eat as little as possible), and feast a day. The day of the flight you fast again, but load up on caffeine drinks just before flying time. Once on the plane, you begin functioning according to the new time—eating and sleeping when appropriate, regardless of what the other passengers are doing. The scheme is reversed on an east-west flight. One reporter who tried this plan on a trip to China reported that he lacked all his usual jet lag symptoms. On the return trip, when he did not follow the scheme, he suffered his worst case of jet lag ever.[1]

Another suggestion is to try to schedule your flight a few days early so that you have some time to take it easy at your destination before you have to do any demanding work. The International Civil Aviation Organization (ICAO), Montreal, has worked out a formula that you can use to determine how much of a rest period you need to recover. A version of the formula appears in Figure 1. The ICAO claims that adherence to this formula generally gives good results.[9]

For example, suppose you are flying from Montreal to London. The flight leaves Montreal at 8 p.m. local time. It

arrives in London six hours later at 7 a.m. local time. Since you have crossed five time zones, the rest period is computed as follows: 6/2 + 1 + 3 + 3 = 10/10, or one day.

Figure 1: ICAO rest formula for jet travelers.

A + B + C + D = The amount of time needed for recovery, in tenths of days

$$A = \frac{\text{Travel time, in hours}}{2}$$

B = The number of time zones crossed, in excess of four

C = Departure coefficient:

If your time of departure (local time) is:	use this number in the formula:
0800 - 1159 hours	0
1200 - 1759 hours	1
1800 - 2159 hours	3
2200 - 0059 hours	4
0100 - 0759 hours	3

D = Arrival coefficient:

If your arrival time (local time) is:	use this number in the formula:
0800 - 1159 hours	4
1200 - 1759 hours	2
1800 - 2159 hours	0
2200 - 0059 hours	1
0100 - 0759 hours	3

Although exercise is considered beneficial, we have been unable to find documented evidence that it reduces the effects of jet lag. It does, however, help "stave off muscle fatigue and blood clots,"[26] problems common to jet travel which accentuate the discomforts of jet lag. With this in mind, Lufthansa offers a program of isometric exercises on one of its in-flight music channels,[26] and SAS publishes a book of exercises which can be performed while sitting.[27]

To alleviate jet lag, some travelers try to stay on their home time during short trips. Certain businessmen, for example, insist that meetings and important work be held on their "old" time. A man traveling from California to New York, for example, may want meetings held upon his arrival in New York, even though it is 8 p.m. New York time. For him, it's only 5 p.m., and he may be more alert than he will be at 8 a.m. the next morning—when his body will think it is 5 a.m. Some airlines use this method as well, keeping their flight crews on their home time during stopovers on long flights.[26] Unfortunately for most of us, the places we visit, and the things we must do, either cannot or will not accommodate this sort of schedule. We have to make our own adjustments.

Other suggestions include wearing two watches—one on the new time and one on the old—and trying to eat and sleep as close to your home time as possible, sleeping immediately upon arrival, no matter what the local time, and breaking up very long trips with several stopovers on the way.[18]

There is no one best solution. Like so many other activities moderation is the best advice, but that is not always a luxury we can afford. I suspect that extra exercise is the wisest recommendation. A minimum is hard to avoid if you are sightseeing but business meetings can be deadly without a little exercise. Whenever possible, I try to do exercises while flying. I go to the rear of the plane and jump up and down a few hundred times. It seems to do me a lot of good, but I wonder if it would be wise for a whole planeload of passengers to try it at the same time.

Alcohol at a high altitude packs considerably more punch than the same amount on the ground, and smoking in the air only adds to the normal drying effects found in pressurized cabins, thus increasing your overall discomfort.[15] Most of all, I think you need to be aware of what your body's going through, and try to plan accordingly. Overeating is a danger on foreign trips and may be another reason to increase exercise. I will never understand why you are served a gourmet meal at 12

noon on the Concorde when you could enjoy it so much more in the evening *after* your arrival.

As more and more people travel, jet lag is becoming an increasingly common medical problem. It is doubtful that we will figure out a way to eliminate jet lag in the near future. But as we learn more about it, we will at least find better ways to cope with it.

* * * *

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