Chapter 23  Social issues and personal growth

The psychological study of sleep and stress has been applied to a number of social and individual problems. In this chapter we will first look at how fatigue contributes to road and work-related accidents. We will then suggest some strategies for coping with fatigue. Lastly we will re-examine our own management of stress specifically in the school context as well as stress reduction at work.

Sleepiness and fatigue

Sleep is an extremely important part of everyday life. Put simply, humans need sleep to survive. This is particularly clear from the wide range of studies that demonstrate that inadequate sleep has a profound negative impact on alertness, physical and cognitive-behavioural performance, and health (refer to chapter 21). The consequences of reduced or no sleep, and thus the need for sleep, have recently become better recognised by health care professionals and the public. It is clear that when our sleep is restricted or we are deprived of sleep altogether, our state of awareness becomes altered. We start to feel increasingly sleepy and our fatigue levels increase.

The terms sleepiness and fatigue are often used interchangeably because they are closely linked. Both fatigue and sleepiness are caused by inadequate restorative sleep. Conversely, sleep is the primary mechanism for reducing our sleepiness and decreasing our levels of fatigue. While the two are separate concepts—an individual can be fatigued without being sleepy—the consequences associated with both are similar. Individuals who do not get adequate sleep are generally less alert and may find that they doze off without warning. Generally, health and quality of life degrade, and people who do not obtain adequate sleep feel lethargy, apathy, and are more moody. They are likely to make more errors and take longer to respond, and experience greater difficulty making appropriate decisions, comprehending situations, retaining information, and communicating. This impairment is of particular concern because it reduces individual and societal productivity and safety, and increases the risk of accident and injury. Thus, for the sake of simplicity, this chapter will use the terms somewhat interchangeably.

Exactly what causes sleepiness and fatigue

Inadequate sleep

The average amount of sleep that adults obtain each night is declining in Western populations. Many individuals report that they sleep for substantially less than the recommended optimum of eight hours each night. When sleep is reduced below optimum on a regular basis, people accumulate a sleep debt, which means the difference between a person's minimum sleep requirement needed to maintain appropriate levels of alertness and performance, and the actual amount of sleep obtained. If so, they become increasingly more sleepy and fatigued.

Medical problems such as sleep apnoea and diabetes are sometimes to blame for this reduction in sleep quantity. For example, people who suffer from sleep apnoea (see Chapter 22) are often awoken during the night because their breathing is irregular and it disturbs them. In severe cases, people with sleep apnoea stop breathing altogether, and are awoken when they start to gasp for breath again. As a result, they find it difficult to get a good night's sleep.

Alternatively, in a lot of cases people do not obtain enough sleep because they are now working longer hours than they used to. In the past it was standard to work Monday to Friday, 9 am to 5 pm. Because of an increasing demand for 'around the clock' services, however, many people now work longer hours and often have to work at irregular times of the day, such as night shifts. It is estimated that in most industrialised countries, at least 25% of the workforce work some
form of shiftwork, with this percentage likely to increase. While the transportation sector remains one of the largest sectors involved in shiftwork, an increasing number of industries require employees to be available on a 24-hour basis, including power production, hospitality, security and health services and, more recently, manufacturing, communication and financial sectors.

To compensate for working longer hours, people often voluntarily reduce the amount of time normally allocated to sleep to spend time with family and friends. That is, they put sleep lower on their list of priorities. However, the amount of sleep that people obtain each day is also affected by the time at which the sleep period occurs, (that is, during the day versus at night) and the length of the sleep opportunity.

Sleep disturbances and sleep problems are one of the major complaints reported by people who work at night. This is because the human biological timing system is programmed for sleep during the night and for activity during the day. For people who work at night, achieving an adequate amount of sleep is difficult because of the time at which sleep opportunities occur.

When studies examine the sleep of individuals who work at night using subjective measures (such as sleep diaries and questionnaires) and objective measures such as activity monitors and sleep recording equipment, it is clear that they obtain significantly less sleep (2-4 hours) than individuals who work during the day.

**Research data**

Using data collected from 256 train drivers Australia-wide, this graph shows the likelihood that drivers were asleep at different times of the day (0% = not at all to 100% asleep). It is clear that it is much easier to obtain sleep at night than it is during the day. See Figure 2302.

The quality of sleep that people obtain is also dependent on the timing of the sleep opportunity. Generally speaking, the quality of day sleep is lower than sleep obtained at night. In general, people who work at night have more difficulty initiating sleep, experience more broken sleep, often wake early, and their sleep is lighter and therefore less restorative. Inadequate sleep arising from shorter and less restorative sleep periods, leads to the accumulation of a 'sleep debt' and to high levels of sleepiness and fatigue. However, sleepiness and fatigue do not arise solely from inadequate sleep.
The timing and length of work periods
Fatigue levels also vary as a function of the time of day, independent of previous sleep history. The body’s natural rhythms of alertness and performance are high across the day and fall during the night hours. Fatigue levels are highest around 3–5 am and alertness and performance levels are also lowest at this time. Thus, night work is conducive to high fatigue levels, purely because of the body’s natural rhythms. After a succession of night shifts, the combination of inadequate sleep during the day and high fatigue in the early morning hours can produce a dangerously high level of fatigue.

The amount of time spent on shift can also affect fatigue levels. The longer a person is concentrating or working at a task, the more fatigued they become. This aspect of fatigue has significant implications in light of the fact that 12-hour shifts are becoming increasingly popular in many industries. For example, approximately 50% of Australian mining organisations currently employ 12-hour shift schedules. Research suggests that where appropriate scheduling of shifts and breaks during shifts are absent, more than nine hours on task can expose workers to a higher rate of incidents and accidents. It is now known that a large proportion of ‘accidents’ occur because an individual’s state of awareness is altered such that they are no longer functioning at their best.

**Information Box**

**Wakefulness experiment**

This graph clearly shows what happens when people are required to remain awake for long periods that involve the night-time hours. In this 1999 study by researchers at the Centre for Sleep Research, people were asked to remain awake for 36 hours (from 7:00 am Day 1 until 7:00 pm Day 2). Every two hours, a researcher turned off their light for 20 minutes, but asked them to remain awake. This test—called the Maintenance of Wakefulness Test (MWT)—is a common means for assessing fatigue levels.

As you can see from this graph, people were able to stay awake for the whole 20 minutes on the first day, when they weren’t fatigued. However, because they had to stay awake into the night hours, their fatigue levels steadily increased, and they could no longer remain awake for the whole 20 minutes, no matter how hard they tried. Given that people have so much trouble staying awake at night, it is not surprising that this is when accidents are most likely to occur.

The graph shows how long people can remain awake for when they become increasingly fatigued (i.e. when they stay up for 36 hours). The circles indicate the average number of minutes for which the group of subjects remained awake. The vertical lines indicate the variability in the scores.
Fatigue on the road

The study of sleep has important implications and applications for a number of pressing social problems. In this section we will look at the issue of deaths on our roads, before turning to fatigue-related issues in the workplace.

Fatigue and crashes

Car crashes are a leading cause of death, particularly among young people. Currently, motor-vehicle accidents are the most frequent cause of accidental death, followed by falls, drowning, fire and burns. Previously, the contribution of fatigue to accidents was largely unstudied. However, in recent years, attention has started to focus on the relationship between fatigue and accidents. It is becoming increasingly clear that fatigue is a major contributor to accidents on the road, in various industrial settings, and in several transport modalities, including air, rail, marine, and road.

While the exact cost of fatigue-related accidents is not known, conservative estimates suggest that they are considerable. It has been estimated that in the USA in 1988, sleep-related accidents—work-related, motor vehicle, home-based, and public—resulted in almost two million disabling injuries and about 25,000 fatalities, at a total economic cost of about $US50 billion. Such figures clearly indicate that sleep-related accidents are a major problem and are associated with enormous economic and emotional costs. Despite this, in comparison with the more classic causes of accidents, such as alcohol and drug abuse, the role of sleepiness and fatigue is still generally underrated.

Fatigue and the road toll

Road crashes may be caused by many factors, including road conditions, traffic congestion and speed limits. Yet next to alcohol intoxication, fatigue is the major cause of car crashes. This is largely because tasks that are long, undemanding and monotonous, such as driving, are very prone to sleepiness and fatigue.

In Australia, 20–30% of serious motor vehicle accidents are caused by fatigue. The Victorian Road Authority estimates that fatigue is a contributing factor in 25% of all road crashes and closer to 33% in all single-vehicle rural crashes. The Queensland Department of Transport reported that 12% of crashes involving articulated vehicles were fatigue-related. In other countries, the statistics are similar.

The financial burden that fatigue-related road accidents impose on the community is often high. The Department of Transport and Regional Services of Australia estimated that in 1993 the annual cost of fatigue-related road crashes was approximately $A850 million, while the cost of heavy vehicle fatigue-related crashes was approximately A$100 million. In 2000, however, the Bureau of Transport Economics, using revised and updated methodology, estimated that the cost to the Australian economy of road transport accidents that were fatigue-related was closer to A$3 billion.
When do road crashes occur
Statistics clearly show that road crashes are much more likely to occur in the late night or early morning hours. It is also common for them to occur mid-afternoon. This bimodal pattern is clearly displayed in Figure 2305, which plots the distribution of over 6,000 single-vehicle accidents caused by the driver 'falling asleep at the wheel'. A major peak in accidents is evident between midnight and 7:00 am, and is particularly pronounced between 1:00 am and 4:00 am. A secondary peak is visible between 1:00 pm and 4:00 pm.

As most accidents occur within two hours of the start of the journey, they are generally not due to time on task, but due to the time of day. Thus, individuals driving at night need to be particularly careful.

Fatigue-related accidents and injuries in the workplace
Fatigue is also a major concern in many industrial settings that require 24-hour operations. In the USA, there are over five million work-related injuries each year, incurring a total cost of $US48 billion ($AUS70 billion). It is becoming increasingly clear that about 50% of these incidents occur because of human error. In today's society, humans tend to make errors because they are fatigued and, in turn, their awareness of the situation is impaired.

The extent to which sleepiness and fatigue contribute to the occurrence of workplace accidents has been estimated to be as high as 53%. In a single year in the USA, it is believed that nearly 6,000 fatalities and one million disabling injuries occur in the workplace as a result of fatigue, creating a cost of nearly $US25 billion ($AUS40 billion). Thus, it is clear that fatigue-related accidents in the workplace are a significant phenomenon that warrant a great deal of attention.

The notion that sleepiness causes many workplace accidents is strongly supported by an abundance of studies. Subjective reports, behavioural measurements, and physiological data collected from truck drivers, train drivers, airline pilots, miners, process operators and other industrial groups clearly show that these workers often suffer from attacks of sleepiness and steep while on duty. Indeed, sleepiness affects 75–90% of workers during night shifts, while day work is associated with little or no sleepiness.

Of even greater concern, studies indicate that a large proportion of shiftworkers admit to actual incidents of involuntary sleep during night shift, and between 10 and 20% report regularly falling asleep when working at night.

As one would expect, fatigue-related accidents often occur in the workplace when individuals are unable to maintain wakefulness and fall asleep at an inappropriate time or place.
Falling asleep on the job is not the only reason that accidents occur. Prior to the actual onset of sleep, there is a steady degradation in performance as fatigue increases that may reach a safety-critical level well before sleep onset occurs. That is, individuals are more likely to make errors because their performance and attention are impaired.

A prime example of this is provided by the 1997 inquiry into the Beresfield rail accident in New South Wales, Australia. This inquiry found that even though the driver had not actually fallen asleep, reduced 'driver alertness' prior to the accident was most likely the major contributing factor to the driver failing to respond to signals and therefore delaying in applying the brakes.

More accidents occur at night
Numerous studies examining workplace accident and injury data clearly show that the risks associated with night work are considerably greater than those associated with work at other times of the day (refer to Information Box below).

| Information Box |

**Driving at night**

The dangers associated with driving home from work, particularly after a night shift, are highlighted by a study that compared the driving behaviour of 70 doctors who were regularly on-call during the night with the driving behaviour of 85 faculty members who were rarely called on during the night.

A greater percentage of doctors than faculty members had fallen asleep at the wheel while driving or at a red light (49% and 13%, respectively). Moreover, 90% of the occasions when doctors fell asleep at the wheel occurred after a night-time call-out.

In summary, individuals are 1.23 times more likely to sustain an injury at work on night shift than they are on the morning shift. In addition, a recent study investigating 668 accidents/incidents in the metallurgical industry found that while the risk of injury was similar across all shifts, injuries that occurred at night were typically more serious.

**Commuting to and from work**

Driving to, from, and during work also exposes shiftworkers to heightened risk. Shiftworkers in Australia are 4–7 times more likely to be involved in an accident when driving home from a night shift than are other people on the road at the same time. As people become sleepier, they also become worse at judging when they are about to fall asleep. Thus, they may not be aware that they are about to fall asleep.

Figure 2306 The Beresfield rail accident

Figure 2307 Evening commuters
Some information that people should know about commuting, which may decrease the risk of collision, includes:

- People driving between 2 am and 5 am are at higher risk of accident.
- Shiftworkers should think carefully about driving after work and consider what other options may be available. Public transport or a lift might be possible for the shifts that cause most risk.
- The consumption of caffeine or food will generally increase alertness.
- Increasing radio volume and exposure to cold air will not reduce sleepiness.
- A nap is the best countermeasure. Shiftworkers should consider pulling over and having a 15–20 minute nap, but no longer or they may feel sleepier.

**Poor health and shiftwork**

*'Shiftwork is probably bad for the heart, almost certainly bad for the head and definitely bad for the gut'.*

(Monk and Folkard, 1992)

Poor management of work schedules and inadequate sleep may result in both short- and long-term health problems. Shiftwork is associated with an increase in several health problems, including risk of cardiovascular disease, miscarriage rates and reduced birth weights. For example, shiftwork increases the risk of myocardial infarction by 30% in both men and women independent of body mass index, smoking, job strain, or education level. Studies also suggest a link between irregular work hours and reduced immune function.

Gastrointestinal problems are particularly common in shiftworkers. For example, studies show that shiftworkers who work night shift are 2–8 times more likely to get peptic ulcers—one of the most severe digestive disorders—than day workers or shiftworkers who do not work night shifts. There are a variety of reasons why shiftwork, and in particular night work, lead to gastrointestinal problems.

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**Information Box**

**Shiftwork and gastro-intestinal problems**

*Shiftwork interferes with meal times.* Shiftworkers often skip meals—for example, they often miss out on a normal lunch when they are sleeping during the day. Then, on evening or night shift they may have a large meal early in the morning (i.e. around 2 am). Shiftworkers often have meals at times when their stomachs are not prepared for food. During the day, digestive juices such as stomach acids and enzymes are secreted, especially at normal mealtimes—that is, breakfast, lunch or dinner time. At night, the digestive activity is generally programmed to slow down. As such, food that is consumed at night is digested at a slower rate than it would be during the day, and may result in feeling bloated and/or constipated and the discomfort of heartburn and/or indigestion.

*Companies rarely offer meals from the canteen at night.* The foods available at nighttime are often highly processed and low in nutrition—for example, a chocolate bar or chips from the vending machine.

*Shiftworkers tend to consume more stimulants.* Shiftworkers, in particular, consume more tea and coffee (caffeine) and more cigarettes. High use of caffeine can cause digestive problems. It can also disturb sleep, which can result in people being more aware of any digestive pains.
The chronic sleep limitation associated with shiftwork may also be associated with increased mental health disturbances. For example, there is evidence that shiftworkers are more prone to major depressive disorders, increased drug and alcohol consumption to combat symptoms of a neurotic character, and job stress and emotional problems.

**Major catastrophes**

Many of the world’s recent industrial and aviation ‘mega-accidents’ have been linked to fatigue-related human error—for example, the Three Mile Island partial nuclear meltdown (1979), the space shuttle ‘Challenger’ accident (1986), and Operation Desert Storm (1990).

**Information Box**

**Space Shuttle Challenger disaster**

It has been officially acknowledged that human error and poor judgment related to sleep loss and fatigue contributed to the 1986 space shuttle Challenger explosion. It was determined that certain key management personnel had obtained less than 2 hours sleep the night prior to the accident and had been on duty since 1:00 am that morning. Because of the combined effects of fatigue and time pressures, communication and judgment was poor.

This is an eye witness account of a technician:

“The Challenger was at a height of 46,000 feet [about 14 km] when it exploded. The white vapor that had been seen by everyone who saw the explosion was a mixture of oxygen and hydrogen. The last time the Challenger had contact with NASA was at 73.62 seconds after launch. The main cause of the explosion consisted of two things. First the cold weather. Secondly failure of the aft joint seal in the right SRB. It was a sad day for NASA and for all of America. The day the Challenger exploded will remain in the hearts and minds of everyone who saw it forever.”

*Quote from: <http://www.geocities.com/Athens/Agora/9805/challenger.html>.*

In the same year, the launch of the shuttle ‘Columbia’ was a near catastrophe, when console operators at the Kennedy Space Center inadvertently drained 18,000 pounds of liquid oxygen from the shuttle external tank within five minutes of the scheduled launch. The loss of liquid oxygen went undetected until the mission was cancelled only 31 seconds before lift-off, because of a secondary effect on the engine inlet temperature. When we consider the work schedule of the operators during this period, it is not surprising that operator fatigue was reported ‘as one of the major factors contributing to this incident’. Operators were working their third consecutive 12-hour night shift, and had been at work for 11 hours when the incident occurred.

For a more recent illustration of the disastrous consequence of fatigue-related human error, we can look at the events that occurred during Operation Desert Storm in 1990. During their 48 hours on duty, American military personnel obtained minimal sleep. As a consequence, the fatigued fighter pilots failed to update positional information and became disoriented and confused. Their subsequent actions resulted in them firing at and killing pilots from their own unit.

Such high-profile ‘incidents’ have resulted in a greater awareness about the association of fatigue and human performance, particularly with reference to health and safety.