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Measures to Combat Fatigue Suffered by Long Distance Transport Drivers:

Lessons from Ultra Marathon Sport.

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Preamble

Rod Evans works for the Department of Transport in Western Australia. He is currently responsible for assisting in developing Western Australia's road safety strategy.

Rod is an experienced ultra marathon athlete. Between 1989 and 1994 he broke six world cycling records, including the Around Australia cycling record and the 100 mile, 200 mile, 12 hour, 24 hour and 1,000 kilometre world track records.

Rod also has an interest in the road transport industry. He has experience driving trucks and buses, including a number of Australian interstate trips driving B doubles and road trains.

In this paper, Rod combines his experiences in ultra marathon sport and the road transport industry to examine the techniques used to manage fatigue in ultra marathon sport and the application of these techniques in reducing the fatigue suffered by long distance transport drivers.

Introduction

Fatigue is widely recognised as a problem for many drivers in the road transport industry. Approximately three in every four Australian long distance transport drivers rate fatigue as at least a substantial problem in the Australian road transport industry and approximately one in three drivers rate fatigue as a substantial problem for them personally (Table 1).

To minimise possible road crashes arising from driver fatigue, most road safety strategies recommend educating drivers on the early signs of fatigue, such as misjudgment of velocities, crossing marked lines, slow responses or yawning so that having recognised these signs of fatigue, these drivers can stop and rest (eg Wertheim,1978; Haworth, Triggs and Grey, 1988).

The inherent problem with this strategy is that many professional transport drivers, because of financial pressures, commitments to employers, demands placed on them by freight forwarders and customers, family pressures and even accepted industry practices will continue to drive even if they know they are fatigued .

Without dramatic changes to industry practices or road legislation and enforcement it can be expected that many drivers are going to continue to be subject to fatigue and continue to drive when fatigued.

If fatigue education for transport drivers is to be effective it must go beyond merely educating drivers on the signs of fatigue and the need to rest. Education must help drivers to manage their fatigue by providing them with strategies they can use that will delay the onset of fatigue, reduce the extent of their fatigue and maximise fatigue recovery when rest periods can and are taken.

This paper examines such strategies by drawing on the experience and practices of ultra marathon athletes.

Table 1

Drivers' rating of extent to which fatigue is a problem for the industry and for themselves

Extent of problem	Major problem	Substantial problem	Minor problem	No problem
For industry (percentage of drivers)	37.5	40.0	20.1	2.3
For driver personally (percentage of drivers)	8.6	26.3	50.1	5.0

Source: Williamson, Feyer, Coumarelos, and Jenkins, 1992

Ultra marathon sport

Ultra marathon athletes face many of the same fatigue patterns and stress as long distance truck drivers. Ultra marathon sporting events, normally running or cycling, are conducted over periods of 24 hours up to several weeks. Athletes often compete, without sleep for periods of up to 50 hours and might only have one or two hours of sleep per night in events lasting over a week.

The main causes of fatigue for ultra marathon athletes are, not suprisingly, long periods of uninterrupted exercise, inadequate rest or sleep, hilly terrain, adverse weather and monotonous routes. Transport drivers identify very similar causes of fatigue. The major contributors to driver fatigue are working for long periods without rest, insufficient rest before or during the trip, poor roads or weather, dawn driving and monotonous routes (Table 2).

Because ultra marathon athletes are often subject to extreme levels of fatigue (there have been cases where participants hallucinate or even fall asleep while competing), ultra marathon athletes have developed, through necessity, a wide range of fatigue management techniques. *Many of these techniques have application in the road transport industry.*

Table 2

Contributors to Driver Fatigue

Factor	Percentage of drivers reporting factor as a contributor
Poor roads	58.2
Dawn driving	56.0
Long driving hours	48.6
Poor weather	47.5
Loading/unloading	47.2
Insufficient sleep during trips	40.1
Insufficient sleep before trips	38.9
Monotonous routes	37.2
Poor diet/ irregular eating	30.2
Heavy city traffic	25.3
Insufficient rest breaks	24.8
Dusk driving	19.0
Poor truck ventilation	18.9
Night driving	19.0
Heavy highway traffic	13.8
Family problems	13.8

Source: Williamson, Feyer, Coumarelos, and Jenkins, 1992

Drugs

The strategies transport drivers identify as the most helpful in dealing with fatigue are drugs and sleep (Table 3).

Stimulant drugs such as amphetamines have been scientifically shown in the laboratory to improve tracking, concentration and attention (Schroeder, Collins and Elam, 1974; Blum, Stern and Melville, 1964; Wenzel and Rutledge, 1962; Strasser and Muller-Limroth, 1973; all in Seppala, Linnoila and Mattila, 1979). The degree of enhancement is usually greater in fatigued subjects and in simple rather than complex tasks. The effect is usually not large unless subjects are deprived of sleep. (Hurst, 1976) (taken from Haworth et al 1988).

Since the late nineteenth century, and probably since the original Olympic Games in the third century BC, athletes have been taking 'drugs' to enhance their performance.

Long distance cyclists in the early part of this century used nitroglycerine, sugar cubes dipped in either, caffeine, brandy, cocaine, herion and strychnine (a poison) to enhance their performance.

Drugs today include anabolic steroids and growth hormone to enhance strength characteristics, diuretics to lose weight for sporting events, analgesics for pain relief, stimulants for pre-game arousal and to alleviate the sensation of fatigue and beta-blockers for hand steadiness.

The effectiveness of drug use in enhancing performance however is evident in the 'relatively' high number of athletes who use, have used, or have experimented with drugs despite the illegal use of such drugs.

Between 1979 and 1982 the Australian Sports Medicine Federation carried out a survey of drug use amongst 4000 athletes. Fifty eight percent had used drugs ranging from vitamins and pain killers through to anabolic steroids and the like. One in five of these athletes had used diuretics, anabolic steroids or stimulants within a year of the survey. One in a hundred of the athletes surveyed admitted to using a large number of drugs with drug taking most prevalent in power lifting and swimming (Inge and Brukner, 1986). In response to the survey, the National Program on Drugs in Sport was set up. (In quoting these research findings I would stress that the use of drugs by international level athletes in Australia is probably minimal, with drug use mainly taking place in lower level competitions or in sports where drug testing is not strictly enforced.)

It is well accepted by most athletes that drugs can enhance athletic performance including delaying the onset of fatigue.

The use of drugs in sport however, with only minor exceptions, illegal. The ban on the use of these drugs by athletes is strictly enforced in most countries. (I have been tested for drugs prior to, during, or after all my world record attempts, including a 5.00 am test for drugs at Geraldton during my *Around Australia* record attempt.)

Drugs are banned in sport because of a desire by sporting officials and the public to maintain a 'level playing field', for sport to remain a 'physical' rather than a 'chemical' competition, the widely held ethical view that athletes taking drugs are 'cheating' and the concern (and evidence) that athletes might damage their health from drug use.

These arguments against drug use do not as readily apply to the transport industry.

Given the effectiveness of certain drugs, in delaying fatigue and maintaining a state of alertness, as controversial as it may sound, the use of drugs by professional transport drivers, backed up with proper research, education and controls should perhaps not be overlooked as a strategy for managing driver fatigue and reducing the incidence of fatigue related road crashes.

Table 3

Strategies Used by Drivers to Deal with Fatigue

Strategy used by drivers	Percentage of drivers using strategy at least sometimes	Percentage of drivers who use strategy at least sometimes, Percentage rating it as among most helpful
Music/radio	80.7	20.0
Using ventilation	79.9	17.5
Caffeine drink	78.4	20.7
Sleep	78.2	45.9
Kicking tyres/walking around	77.4	21.7
CB Radio	70.3	22.9
Rest	70.2	21.9
Stopping for meal	63.2	14.8
Shower	54.0	15.2
Eating while driving	49.2	14.2
Smoking	47.0	20.0
Drugs	31.7	53.3
Other	10.6	-

Source: Williamson, Feyer, Coumarelos, and Jenkins, 1992

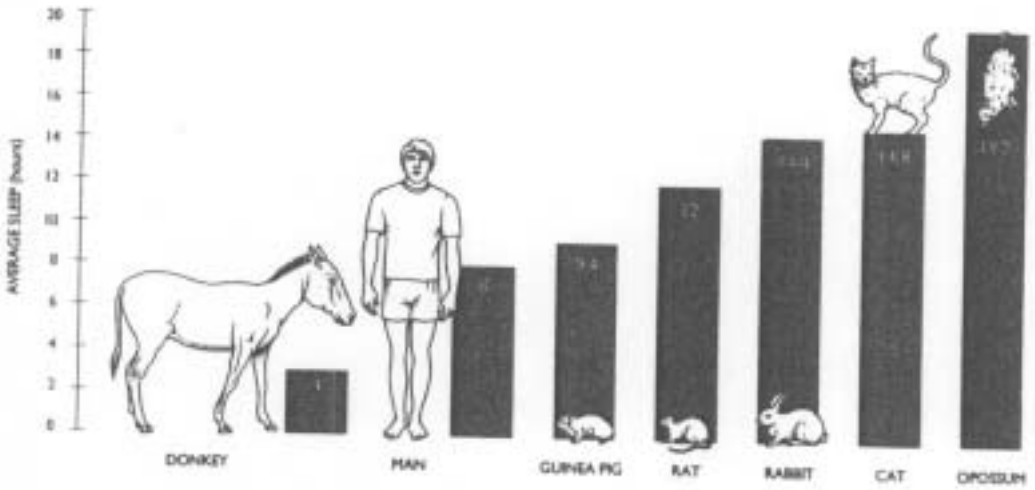
Rest and sleep

Rest and sleep are two of the most effective methods to combat fatigue.

In one of the first documented studies of sleep deprivation, which was carried out in 1896, a team of research psychologists set out to determine what would happen to sleep deprived humans under careful observation. Three men were kept awake for 90 consecutive hours (just 6 hours short of four days). All three showed decreased concentration and performance on tests and all experienced hallucinations, but after 12 hours of recovery sleep, all symptoms disappeared (Coleman, 1986). Countless tests over the last 100 years continue to support these findings on the benefit of sleep in recovering from fatigue.

Humans are normally deemed as requiring, on average, 8 hours of sleep per night. The question is, what is the minimal amount of sleep a person might realistically survive on if required to work for long periods each day?

Figure 1
Average Sleep Time of Mammals Per 24 Hours



Source: Coleman 1986

Australian Road Research Studies cited by Anon (1977) and Vondra (1977) conclude that driving for ten hours or more without a break of at least two hours is dangerous. They recommend that food or rest stops are scheduled about every 90 minutes to two hours during daylight hours and more often at night (Haworth et al, 1988).

Many transport drivers however feel that such a schedule is unrealistic and inappropriate given current work demands.

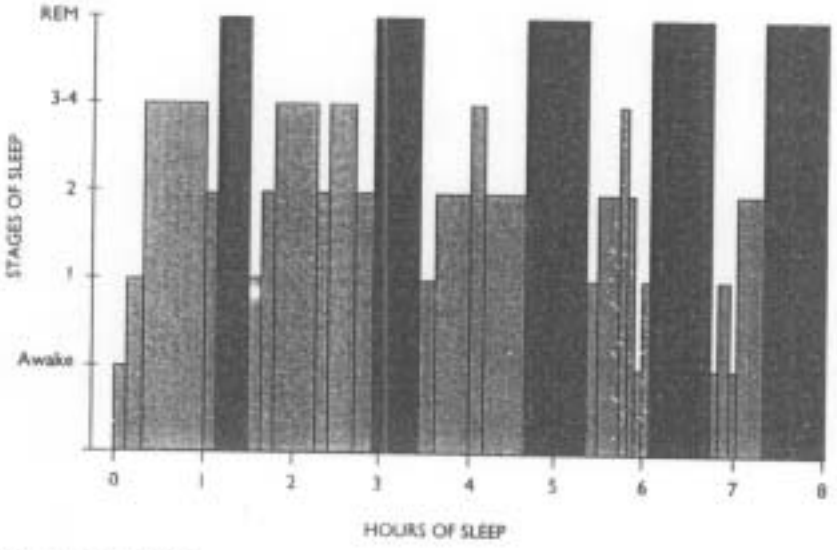
Ultra marathon athletes have found that they can perform 'efficiently' with far less rest than that normally subscribed for in most research. They do this by resting at prescribed times, sleeping for scientifically based lengths of time and by following certain 'rules' governing activities that are undertaken during rest periods. These strategies are examined below.

Experimentation by ultra marathon athletes over the last decade has found that minimum sleep periods in multiples of 90 minutes per 24 hour period are the most effective. These are then supplemented with power sleeps (10 or 15 minutes) if an athlete is extremely exhausted but cannot afford time to take a 'proper sleep'. (It should be noted that in high level ultra marathon events athletes normally only take rest periods for the purpose of sleeping.)

A scientific study of two ultra marathon athletes competing in an event of nearly 8 days found that with a total sleep of only 9 hours over the 8 day period (90 minutes on day 2 to 7) these athletes were able to maintain a wakeful state after their 90 minutes sleep without much difficulty and without stimulants. Their most difficult night was the first night when they both chose as a consequence to use caffeine (Ice, 199?).

The use of multiples of 90 minutes of sleep is based on the findings of sleep research which has found that the sleep pattern of a typical adult includes periods of rapid eye movement (REM) and periods of non-rapid eye movement (NREM). During sleep, the brain moves back and forth through various stages of REM and NREM within roughly a 90 minute cycle.

Figure 2
Sleep-Stage Cycles



Source: Coleman 1986

To maximise the psychological and physiological benefits of these sleep periods, some athletes take their 90 minute sleep just before dawn. This has two beneficial effects. Firstly, it allows the athlete to sleep at a time when their body clock (metabolism) is at its slowest and therefore they are able to sleep during a period when they are most likely to be feeling the highest level of fatigue. Secondly, because the athlete has had a full cycle of sleep and the morning sun is rising when they awake, psychologically they can often feel that they have had a full night's sleep.

Power sleeps are then sometimes used to supplement these longer sleeps. A power sleep involves a person making a conscious decision to have a very deep 10 minute sleep. My own

experience has been that these sleeps can involve wild intense psychedelic coloured dreams, but after 10 minutes you naturally awaken and within a few minutes feel significantly refreshed.

Closing the eyes even for a short period of time enables the neurological system responsible for attentive oculomotor control to relax and recover. (Wertheim, 1978).

As an interesting aside, a strategy used by Pensyres and Haldeman in their 1987 tandem cycling record attempt across America was to take it in turns to sit on the back of the tandem. By doing so the cyclist on the back could sleep whilst going down hill, although sometimes for only 5 to 10 seconds at a time. They found this very beneficial. [By rotating the cyclist on the back of the tandem this also reduced fatigue for the cyclists by creating an environment of change and by allowing a period when, although they were required to pedal hard, the mental demands required for steering, changing gears and watching the road were removed (see section on mental fatigue)].

In experiments with people deprived of sleep, physiological monitoring reveals that the subjects normally undergo multiple brief sleep episodes, lasting 2 to 3 seconds, intruding into the background wakefulness pattern (Coleman, 1986). It is therefore likely that not only tandem cyclists, but all ultra marathon athletes and transport drivers when fatigued unknowingly undergo these brief periods of sleep.

To maximise the effectiveness of rest periods when ultra marathon athletes rest, that is all they do, rest! They avoid discussing or thinking about anything to do with exercising, logistics or other matters related to their race or record attempt. The only exception might be when some athletes use the time while they are asleep to receive a massage.

Many experienced and successful ultra marathon athletes have a motto during rest periods of 'don't stand if you can sit, and don't sit if you can lie down'.

As a final observation on sleep and rest, sleep deprived ultra marathon athletes commonly report a slowing of their speed at night and a difficulty in staying awake an hour or so after their normal bed time and around their normal waking up time. Human physiological and psychological functions tend to follow a 24 hour cycle related to diurnal activity.

Ultra marathon athletes accommodate these factors by attempting to maximise the distance they cover during day light hours and by taking a short sleep just prior to their normal wake up time.

Ultra marathon athletes also commonly report feeling very tired in the middle of the afternoon or in the early hours of the morning before it gets light. This feeling of fatigue is often reduced once it changes from day to night or night to day respectively and athletes either continue competing through these periods of tiredness or stop for a brief sleep (often only 10 to 15 minutes).

Whilst transport drivers, for various reasons, which include the need for company, conversation and a change of scenery, may not wish to be as fanatical in the way they use their rest periods, drivers might still benefit from sleeping in multiples of 90 minutes, sleeping just before dawn, taking power sleeps and following a 'rule' that one hour in the bunk is worth two hours in the road house.

As a final aside, in early experiments, when extremely fatigued from long periods of cycling, I tried to continue to cycle by closing one eye and allowing it to rest or 'sleep' while the other eye stayed open and 'awake'. This experiment was not successful.

Diet

In a 1991 survey of transport drivers, 30% of the respondents regarded a poor diet and irregular eating as a factor contributing to driving fatigue. (Table 2) The Long Distance Road Transport Association also identified the need to provide transport drivers with information on the relevance of diet in managing fatigue (Williamson et al, 1992).

Over the last 15 years, diet has represented one of the single biggest breakthroughs in controlling fatigue in ultra marathon athletes.

Prior to the early 1980's, most ultra marathon athletes survived on large quantities of any food that tasted good and was easy to eat. This included hamburgers, thick shakes, chips, pasta meals, rice, cakes, etc. In the early 1980's, ultra marathon athletes started experimenting with liquid foods (eg water and corn starch) which provided a readily digestible carbohydrate source. This liquid food was ingested by the athlete every 15 minutes or so. By the late 1980's, liquid food was readily available commercially (eg Maxim, Ulta Energy, Exceed) and by the early 1990's nearly all successful ultra marathon athletes used liquid foods either solely or predominantly during ultra marathon events.

Liquid foods significantly delay the onset and extent of fatigue in an athlete for a number of reasons. Firstly, liquid foods tend to be very high in complex carbohydrates and very low in protein and fats. Carbohydrates require much less effort (energy) by the body to digest than fats. Secondly, liquid foods can be consumed in small quantities at frequent, regular intervals during an event. This helps to maintain a constant blood sugar level in the body - it is the fluctuations in blood sugar levels, or more particularly the troughs in blood sugar levels, that are a common cause of fatigue. Finally, liquid foods encourage hydration. With liquid foods it is impossible to eat without drinking, conversely with liquid foods it is impossible to drink without eating, which also helps to maintain blood sugar concentrations. (Also see section on hydration.)

Whilst transport drivers are unlikely to replace roadhouse meals with liquid foods, it is possible for transport drivers to emulate the effect of liquid foods by eating little amounts often and always eating foods high in carbohydrates and low in fats. The concept of transport drivers eating little often is supported in the transport driver fatigue research of Lisper and Eriksson (1980), who, although they were unable to find any difference between breaks of 15

minutes and 60 minutes, did note that eating during breaks seemed to have a positive effect (reported in Haworth et al, 1988).

As a further aside on the subject of diet and fatigue, anecdotal evidence from support crew members at ultra marathon events, who have been required to stay awake for periods of up to 50 hours without rest or sleep, is that they find it easier to stay awake and alert if they significantly reduce their overall food intake during the period they are required to stay awake.

Food supplements

Athletes are continually experimenting with vitamins and other natural food supplements to enhance their performance.

It is worth noting three products which are used by some people to manage fatigue and if researched, might be found to be beneficial in treating fatigue in transport drivers.

a) *Guarana*

This is a dietary supplement produced from the seed of the Amazon jungle vine *Prullinia Cupana*. Guarana is used by some athletes to generate increased energy levels and maintain stamina.

Some transport drivers already take guarana to help them stay alert while driving.

I conducted an informal experiment with 'Go gum' a guarana based chewing gum, when driving a truck to Melbourne in September 1995. I found it helped in delaying the onset of fatigue. It is, however, possible that the effect was a placebo, related to the act of chewing, or related to the sugar in the gum.

b) *Vitamin B*

In 1989 I was advised by an East-West transport driver that by taking vitamin B with caffeine the effect of the caffeine was enhanced. I have not experimented with this.

c) *L-Glutamine*

L-Glutamine is an amino acid and has recently been trialed in the rehabilitation of patients suffering from chronic fatigue syndrome. It is possible that L-Glutamine might assist transport drivers to recover from periods of fatigue.

Caffeine

Because of the accepted recreational use of caffeine, such as through the consumption of tea, coffee or chocolate, minimal levels of caffeine may be legally ingested by athletes before or during competition.

Caffeine, like amphetamine, stimulates the central nervous system and also increases the body's capacity for muscular work by releasing stored fats into the system for energy. A study in the late 1970's found that cyclists who ingested 330 milligrams of caffeine one hour before

exercising at 80% of their maximum aerobic capacity were able to pedal 19.5% longer than those test subjects who did not use caffeine (Burke, 1992). It is therefore common for ultra marathon athletes, within legal limits, to consume caffeine during an event.

An important characteristic of caffeine use is that the more frequently caffeine is ingested, the smaller its effect becomes, in other words, the more you consume the greater your immunity to the effect of caffeine.

By eliminating all caffeine from an athlete's diet eg 3 or 4 weeks prior to an event, thereby reducing the athlete's tolerance to caffeine, athletes are able to consume small legal quantities of caffeine (ie 200 mg) during an ultra marathon event with very significant beneficial effects on fatigue.

In contrast to this planned use of caffeine, many transport drivers consume large quantities of caffeine daily (through coffee and cola drinks) and therefore experience little or no 'caffeine effect'. (Research also indicates that consuming two to five cups of coffee or more per day may increase the risk of heart disease significantly. Caffeine has also been linked to high levels of cholesterol (Burke, 1992)).

Transport drivers could make better use of caffeine if they ingested caffeine, such as drinking coffee or cola drinks only at times when they are experiencing extreme levels of fatigue. Herbal teas, hot or cold water, or other non caffeine drinks could replace caffeine based drinks when the driver does not require a 'caffeine hit'.

Table 4

Caffeine in Various Products

Beverages	Mg caffeine
Brewed coffee	100-150 /cup
Instant coffee	86-99 /cup
Tea	60-75 /cup
Decaffeinated coffee	2-4 /cup
Cola drinks	40-60 /glass
Cold Preparations	
Over-the-counter	30 /tablet
Stimulants	
No-Doz	100 /tablet
Vivarine	200 /tablet
Analgesics	
Anacin, Cope, Midol	32 /tablet
Vanquish	60 /tablet
Exerdrin	66 /tablet

Source: Burke 1992

Alcohol

Historically, alcohol has been used by some long distance athletes to enhance their performance. In the early part of this century, whisky, brandy or rum and a couple of raw eggs and milk were taken by some athletes as a tonic just before retiring to bed. (Some athletes left out the eggs and milk after they retired from sport!) Even as late as the 1970's, some cyclists might take a nip of whisky or brandy near the end of the race to 'get themselves across the finish line'.

Alcohol is now recognised in sport as being a fatiguing agent and the consumption of any form of alcohol during an event by an athlete would be minimal if not non-existent.

In a similar way the use of alcohol by transport drivers should be viewed as contributing to fatigue.

In a study of the role of alcohol in crash causation, Treat, Tumbles, McDonald, Shinar, Hume, Mayer, Stansfind and Castellen (1977), in Smiley, (1986) found that the most common effect of alcohol was the increase by a factor of five in the likelihood of the driver blacking out or falling asleep.

Another adverse impact of alcohol is that it dehydrates the body which also worsens the onset of fatigue.(see section on hydration)

Tobacco Smoking

Forty seven per cent of transport drivers report using tobacco smoking as a strategy to deal with fatigue (Table 3).

I am unaware of any ultra marathon athlete who uses cigarette smoking to manage fatigue. Indeed smoking can be shown to adversely impact on athletic performance, including speeding up the onset of fatigue.

Athletes depend on the ability of their muscles to consume oxygen as a means of supplying the energy necessary to exercise. This is termed aerobic energy. Cigarette smoking has two main effects on this energy system: firstly, it increases shortness of breath (the resistance to air moving in and out of the lungs); secondly, the carbon monoxide inhaled from cigarette smoke combines more readily with the oxygen-carrying blood pigment (haemoglobin) than does oxygen. If you smoke, less oxygen is carried to the tissues for use in energy production (Inge and Brukner, 1986).

It is possible that transport drivers benefit from smoking tobacco due to a nicotine addiction and the need for a nicotine 'hit'. However it would be expected that transport drivers, like ultra marathon athletes, would experience less fatigue if they did not smoke.

Sugar

A frequent mistake made by inexperienced ultra marathon athletes when feeling tired is to consume large quantities of sugary foods such as cola or soft drinks, cakes or sweets.

The effect of ingesting these foods is to provide the body with a large rapidly ingested supply of sugar to the blood. In a body that is fatigued due to a low blood sugar level this will create an almost instant feeling of well being. Unfortunately, the body reacts to high intakes of sugar by producing an over compensating amount of insulin aimed at balancing the body's blood sugar level. The resulting effect is for the body, because of the impact of the insulin, to return to a low blood sugar state which again creates a feeling of fatigue. This fluctuation in blood sugar levels is also mentally fatiguing in itself.

To reduce the incidence of fatigue transport drivers could maintain a stable blood sugar level by avoiding sugary foods and regularly and frequently ingesting small quantities of complex carbohydrate .

Hydration

Dehydration is a very common cause of fatigue in marathon and ultra marathon athletes. Unfortunately, the mental signal that the body is becoming dehydrated occurs well after actual dehydration. There is, therefore, a maxim in sport, 'if you feel thirsty, it's too late!'. Approximately 70% of the human body is made up of water. As little as a 2% loss in body weight through dehydration will result in a loss in performance and a 5% loss will certainly cause fatigue. A 10% loss can be fatal (Keen, 1992).

It is possible that transport drivers, like athletes, unwittingly suffer from fatigue due to dehydration.

The best indicator for monitoring fluid balance (apart from body weight) is the colour and quantity of urine that is passed. Clear urine indicates normal fluid balance, while dark urine indicates that more fluids are needed. The body should produce at least four full bladders of pale urine per day (Ryan, 1992).

Familiarity and experience

Many discussions on fatigue management overlook the impact of familiarity and experience on the timing and effect of fatigue.

It is commonly recognised in ultra marathon sport that the less experience an athlete has in ultra marathon sport and with experiencing and managing fatigue, the more likely they are to suffer from fatigue during an event.

Familiarity with a route lessens fatigue significantly. By knowing a route, athletes are able to better judge when to push themselves, when to rest and what to expect. As a result, their concentration levels tend to be lower and they tend to become less fatigued.

It would be expected that similar observations would apply for transport drivers with experienced drivers on familiar routes experiencing less fatigue than inexperienced drivers on unfamiliar routes.

Experienced transport drivers, like experienced ulta marathon cyclists, are also less likely to have a crash as a result of driving errors (which may be caused by fatigue). Dart and MacKenzie (1982) concluded that most single vehicle run-off-roadway crashes they surveyed resulted from careless driving, driving while fatigued or overreaction by inexperienced drivers.

Hamelin (1987) found 'experience of work' and the associated 'know-how' introduces skill. This skill amounts to a capacity to manage fatigue and the dangers associated with it.

'Highway Hypnosis'

Continual and repetitive visual stimulus, such as passing over a broken (or continuous) white line can have a fatiguing effect similar to watching the 'swinging watch' of a hypnotist. This can lead to a rapid increase in fatigue and ultimately sleep.

As a cyclist, I have experienced this 'hypnosis' as a result of unintentionally focusing on the unchanging road surface as it passes underneath my bike. I have found this hypnotic effect to be not only fatiguing, but on occasions it has put me to sleep while I continued to ride my bike (occasionally I have also been nauseated by the effect).

To overcome 'highway hypnosis' many athletes have found it beneficial to refocus their eyes and cause movement in their eye muscles. This can be done by concentrating on a point on the horizon, then concentrating on a point close to you, rolling your eyes, moving your eyes up and down, and repeating. *Not only do these exercises reduce fatigue, but there are good scientific reasons why such eye exercises might also improve safety for long distance transport drivers.*

When visual stimulus is predictable, eye movement significantly reduces and therefore the detection of changes in the visual field, such as movement or new objects is impaired (Haworth et al, 1988). *Consciously creating eye movement might therefore significantly improve a person's ability to register the emergence or movement of vehicles, people or other obstacles on the road.*

Another strategy that ultra marathon athletes employ to overcome highway hypnosis it to have their support crew place signs beside or on the road or track which the athlete is encouraged to read. This breaks both the visual and mental monotony of the road or track.

The success of this strategy in preventing highway hypnosis in athletes suggests a number of simple solutions that road engineers might employ in preventing highway hypnosis in long distance transport drivers.

Haworth et all, provide the following useful and logical summary of these strategies in their 1988 report on Driver Fatigue Counter Measures:

'Wertheim (1978) showed that highway hypnosis was produced by the predicability of the road. He argued that putting in a curve would make the road less predictable but would lead to more drowsy drivers continuing to travel in a straight line off the road. But there are ways of reducing the predicability of the road which are not dangerous. It is possible to alert dozing drivers by the use of rumble strips, which are studs or bands of different texture on the road. Such modifications would probably be beneficial prior to curves on straight stretches of road or at other hazardous locations. Raised studs and centre lines that cause a drumming sound when the car passes over them serve a similar function to rumble strips. Another fatigue countermeasure which involves changes to road design is that of providing shoulders with very different texture to that of the road surface.'(Haworth et al 1988)

Noise

It is normally accepted that noise is an arousing stimulus and will reduce fatigue. Not surprisingly, listening to music or the radio is a strategy used by most transport drivers to reduce fatigue (Table 3).

Music and noise are also commonly used by ultra marathon athletes to help them stay awake. Sir Hubert Opperman reported that in the 1931 1,200 kilometre non-stop Paris - Brest - Paris race which he won in just under 50 hours, a car often travelled alongside the cyclists at night, ringing a large cow bell to help keep the cyclists awake.

Noise, however, has been variously identified as increasing or decreasing fatigue levels (Jones, 1983).

In tests I conducted, on the advice of a hypnotist, prior to my record attempts in 1994 I found some music to be arousing whilst other music induced varying levels of fatigue. In April 1994 I conducted an experiment where I cycled in a low light environment at night, listening to loud heavy metal music. I had to stop after only 1.5 hours of cycling because of the fatiguing effect of the music.

As a result of these experiments, during my indoor cycling record attempts in the Midvale Velodrome, certain music was preselected to be played, depending on my level of fatigue. For example, music such as 'Chariots of Fire', 'Rocky' and 'I am an Australian' was used to arouse me when my fatigue was at its most critical.

Conversely, a choir which was brought into the centre of the velodrome to entertain the crowd during my May 1994 record attempt had to be taken off because of the fatiguing effect they were having on me. I was not aware of this effect, but my lap times dropped noticeably while they were singing and improved noticeably when they stopped singing.

It is highly probable that certain music, because of thought association, could have an arousing or fatiguing effect. But it is also possible that music or sound has a fatiguing or arousing effect, depending on its rhythm, strength of beat and noise level.

Already many researchers have found that continuous broad band noise in excess of 80 dBa is detrimental to performance on a number of tasks. Of particular interest to drivers is the finding that there is a narrowing of attention in noise above 80-90 dBa, such that less peripheral information is noticed, although events in the central field of view may be reacted to more quickly (Hartley 1989).

It is therefore likely that some transport drivers are unintentionally being fatigued by the type of music they are playing in their vehicles. It is also likely that different vehicles and vehicle models have a differing effect on the fatigue level of their drivers because of differences in the types and level of cabin noise.

More research should be carried out in this area.

Mental fatigue

The management of fatigue not only involves minimising physical (physiological) stresses, and promoting physiological recovery, but also minimising mental (psychological) stress.

To reduce psychological stress during my record attempts, prior to commencing a record attempt, I had every aspect of the record attempt planned and rehearsed down to the last detail, even down to how and who lifted me off my bike at toilet stops. As a result, in nearly all cases when a stressful situation arose, it was handled automatically without any mental anguish.

In 1990, during my attempt on the world 24 hour record, the temperature fell to a low of 2°C. To prevent me from worrying about how cold it was, the support crew stayed dressed in short sleeve shirts. I didn't worry about the cold during the record attempt and it wasn't until after the record that I learnt how cold it had been.

Experience in the Race Across America has also found that the greater the involvement of an athlete in responsibilities other than cycling, and the more mental stress they are under, the more quickly they become fatigued and the greater the probability that they will not finish the race. To reduce the incidence of fatigue in athletes it is essential that activities including race organisation, mechanical support, decisions on when to eat and drink, the preparation of food, the organisation of logistics are made by people whose decisions the athlete implicitly trusts but these decisions in no way involve the athlete personally.

In the same way it can be expected that if there is a reduction in the responsibilities placed upon drivers for loading and unloading, vehicle maintenance and cleanliness, arranging and negotiating for loads and arranging schedules, although in some cases these activities may not be time consuming, there will be a reduction in the fatigue experienced by those drivers.

Hartley and El Hassani (1994) also argue that ' a reduction in the life and occupational stresses associated with the job of truck driver, such as those that arise from mortgages on their trucks and from long hours of duty, could reduce accident and conviction rates'. The effect of such stresses is evident in the number of owner drivers who sell their trucks and return to salaried driving.

Where people, companies or customers are creating stressful situations for drivers it is inevitable that they are exacerbating the incidence of fatigue in drivers.

Drivers who are better able to manage the mental stress and worries they face are less likely to become fatigued (Hartley, Arnold, Smythe and Hansen ,1994).

Athletes have developed techniques to minimise the impact on their performance from being exposed to mental stresses. These techniques are covered in the following section on mental preparation.

Mental Preparation

Together with diet, mental preparation represents one of the most significant modern day breakthroughs in the enhancement of sporting performance.

Most top athletes now use some form of mental preparation as part of their training and pre-event preparation.

Sport magazines are increasingly devoting articles to mental preparation strategies. The October 1995 issue of Bicycling carried a lead article ' Train your brain: a practical, non-pyscholabble guide to gaining a mental edge - including specific exercises to boost speed and endurance' (White, 1995).

Whole books have also been written on mental preparation techniques for sport. "The Centred Athlete' is an excellent reference (Hendricks and Carlson,1982).

In 1989, prior to my around Australia record attempt, I started exploring mental preparation techniques to help improve my performance and minimise my susceptibility to fatigue. I spent 15 to 20 minutes each day, in the months leading up to the record attempt, imagining myself cycling around Australia, the problems I would face and how I would successfully deal with them. I found this mental visualisation very valuable in handling the stress that later arose during my around Australia record attempt.

By 1994, I had become more sophisticated in my use of visualisation techniques, many of which I developed under the guidance of a hypnotist.

I used a form of meditation to visualise all aspects of my 1994 1000 km record attempt. During these sessions I experienced the emotions of my record attempt, the problems. the solutions, the highs and the lows. By May 1994 I was pre-programmed to withstand very high levels of both physical and emotional stress. It is of interest to note that during my successful May 1994 record attempts I rode similar distances and times to those I had visualised.

Whilst transport drivers may not be willing, or even need to, go as far as athletes in using mental preparation techniques to manage stress and therefore delay fatigue, it can be expected that mental preparation skills such as simple relaxation or stress management techniques would significantly help transport drivers to manage their fatigue.

Physical fitness

The most commonly used strategy for delaying fatigue in sport is training aimed at achieving the highest possible level of fitness prior to competition.

Unfortunately this strategy does not immediately translate to the transport industry. Drivers who are already compromising on sleep and rest must weigh up the fact that the act of becoming fitter is fatiguing in itself.

However even if drivers don't have time whilst at work for physical activity, it can be expected that they would still benefit significantly from watching their weight and from a few long walks in the time off between trips.

This conclusion is supported by the findings of Harma (1993) who found that experienced fatigue can be reduced by up to 20 per cent following certain 'physical conditioning'.

Conclusion

Fatigue is a major problem for many drivers in the long distance road transport industry.

Whilst adequate rest and sleep are by far the most effective strategies for combating fatigue, without changes to industry practice or law and enforcement most drivers will not be able, or will be unwilling, to stop driving even when they know they are fatigued.

Education on fatigue for professional transport drivers must go beyond assisting the driver to identify the early signs of fatigue and therefore the need to stop and rest.

It is important that these drivers be educated on how to minimise the incidence and effect of fatigue and to maximise the effectiveness of fatigue recovery strategies.

This paper has identified a number of ways ultra marathon athletes manage their fatigue. These strategies might also be used by professional long distance drivers. They include:

- only consuming caffeine products when extremely fatigued
- sleeping in blocks of 1.5 hours
- not smoking
- using 10 - 15 minutes power sleeps when extremely fatigued
- using more of any given rest period for sleep
- sleeping just before sun-up
- driving on familiar routes

- regularly refocussing their eyes and exercising their eye muscles
- ensuring cabin noise is not fatiguing (vehicle companies also need to address this issue)
- minimising mental stress (also the responsibility of those dealing with the driver)
- learning relaxation and other techniques for managing stress
- eating high carbohydrate, low fat foods
- eating small amounts regularly
- not eating or drinking large quantities of sugary foods
- not drinking alcohol
- drinking lots of water
- exercising

There is no doubt that professional drivers would benefit from further research in these areas and better education on the use of these and other techniques in reducing fatigue.

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