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STUDENT REPORT

SHIFT WORK: IS THERE A BETTER WAY?

MAJOR MICHAEL F. FUKEY 85-0870

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Rotating shift work causes fatigue and other physical problems in many Air Force personnel. If Air Force supervisors and workers were more aware of their daily biological rhythms and the effect of rotating shift work on those rhythms, they could better plan their shift work schedules. This report illustrates some of the basic biological rhythms of the body and how knowledge of those rhythms can be used to determine a "best" rotating shift work schedule, "best" shift tour length, "best" shift work sleeping time and "best" shift work eating time.

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PREFACE

Rotating shift work causes fatigue and other physical problems in many Air Force personnel. If Air Force supervisors and workers were more aware of their daily body rhythms and what effect rotating shift work has on those rhythms, they could better plan their shift work schedules, as well as sleeping and eating times. This report illustrates some of the basic biological rhythms of the body and how knowledge of those rhythms can be used to determine a "best" rotating shift work schedule, "best" shift tour length, "best" shift work sleeping time and "best" shift work eating time.

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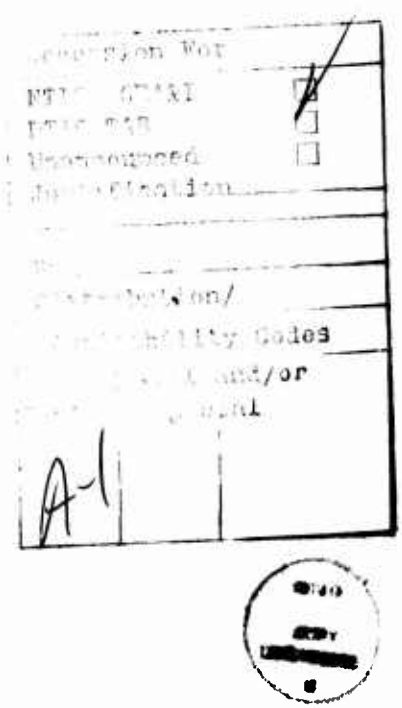

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"insights into tomorrow"

REPORT NUMBER 85-0870

AUTHOR(S) MAJOR MICHAEL F. FUKEY, USAF

TITLE SHIFT WORK: IS THERE A BETTER WAY?

I. Purpose: To determine, considering human biological rhythms, if there is a best way to schedule continuous rotating shift work, tour lengths and sleeping and eating patterns.

II. Problem: There are many Air Force activities that are manned 24 hours on rotating shift schedules, e.g., watch desks, command posts, etc. Generally, there are fatigue and health problems associated with rotating shift work which affect worker satisfaction and productivity. The task is to find a better way to schedule rotating shift work or find a best sleeping or eating time for workers, considering biological rhythms, which will help solve these job-related problems. The investigation is limited to those workers involved in chiefly mental activities.

III. Data: Many of the body's functions are affected by circadian rhythms. Similarly, many functions seem to fluctuate with the body's natural temperature cycle which varies during the day. Performance at mental and mechanical tasks will, for example, be different at different times of the day. Best performance typically occurs when body temperature is highest--during the day. This performance curve unfortunately presents a problem to the rotating shift worker who does not work days. The rotating shift worker must phase-shift their entire daily schedule to have their

peak performance occur during working hours. If the worker can maintain a phase-shifted schedule and the supervisor allows sufficient time between rotating shifts for the worker to adjust to the new schedule, the worker can work during their best performance period. Similarly, for the individual to be well-rested, biological rhythms dictate he/she follow a sleep schedule adjusted for the phase-shifted worker. The worker's adherence to this schedule is necessary to prevent fatigue. A person's eating patterns may also be changed to reflect biological rhythms. It is possible to be healthy and trim, eat well, and still work a rotating shift schedule.

IV. Conclusions: It is possible to reduce, sometimes eliminate, the fatigue and health problems which affect productivity in rotating shift work. This can be done by proper application of biological-rhythm principles to shift-work schedules and to the daily lives of shift workers. The body can be ertrained to a new "shifted" schedule if given time and a willingness by the worker to change some habits, e.g., sleeping, eating, etc. By "shifting" their biological rhythm schedule, the worker can insure that he/she is working during a period of optimum performance and low fatigue. Adherence to these principles will ensure increased productivity and greater mission accomplishment.

INTRODUCTION

The physiological problems of rotating shift work; fatigue, gastrointestinal disturbances and a loss of alertness, have existed since the beginning of continuous 24-hour shift-work schedules (20:22). Since the United States Air Force has many functions which require continuous 24-hour shift work, such as command-post duty, watch desks and security-police details, these problems and possible remedies greatly impact Air Force readiness. This paper relates mainly to those jobs requiring chiefly mental and little physical activity, e.g., watch desks. The thesis of this paper is "when schedules are introduced which take into account the properties of the human circadian system, subjective estimates of work schedule satisfaction and health improve, personnel turnover decreases, and worker productivity increases" (12:460). My purpose is to provide Air Force intermediate management with non-technical knowledge of basic human physiological conditions which bear on how they schedule people and on how their people can better prepare themselves for rotating shift work. This paper, however, will not deal with the more personal, social and family aspects of rotating shift work. I will first examine some of the properties of the human circadian system to acquaint the reader with the general subject, and then look specifically at shift-work schedules, shift-tour lengths, sleeping schedules and eating schedules to determine if there is a "best" solution, considering human biological rhythms.

GENERAL

Nearly everyone has heard of circadian rhythms. The word "circadian" comes from two Latin words: "circa" meaning "about" and "dies" meaning "day." Circadian rhythms thus define biological rhythms which occur on a daily basis. Scientists have now found over 100 bodily functions directly related to this 24-hour clock (23:16). Researchers have found that free-running human subjects have circadian periods of approximately 25 hours (19:32). Nevertheless, the body has adapted to a 24-hour day. Take, for example, the body's temperature cycle. Human body temperature rises and falls 1 or 2 degrees each 24 hours and it appears that this fluctuation may signal an individual's natural rhythm for many bodily processes (8:55). Body temperature is usually

lowest in the early morning and rises to a high in mid-afternoon around 3:30 p.m. before falling again in the late evening (4:156).

Likewise, many human functions flow with this schedule. The "highest body temperature, best performance rate, and lowest fatigability are all reached almost synchronously in the afternoon." Similarly, "the temperature is lower, performance worse and fatigability greater immediately upon getting up in the morning than at night just before bed" (4:156-157). There is a direct relationship between the rise in body temperature and increased sensitivity to painful stimulation. The teeth, for example, are much less sensitive to pain between 8 p.m. and 8 a.m., than during the daily office hours of the dentist (6:122). Testing has also shown an unmistakable connection between body temperature and the speed and accuracy of responding and performing (4:160). Such items as the response time to a light signal while driving, calculation speed in addition, steadiness of the hand, vigilance in monitoring a radar screen and sonar, and memorization ability are all rhythmic and almost all closely resemble the tested individual's daily temperature curve (6:139). Mental skills, such as speed and accuracy in multiplication, reach their high point around midday and decline during the afternoon (9:5). Mechanical skills, however, rise to their peak in the afternoon (9:5). Memory works best in the morning, but trails off around noon (9:4). As might be expected, fatigue varies inversely with body temperature: as the body temperature declines, the sense of fatigue rises (9:60). Another study revealed that moods changed over the day in a rhythmic fashion. Anxiety and depression were highest in the morning and dropped continuously during the day. Cheerfulness and friendliness were just the opposite, while alertness peaked at midday (5:143). Introverts are usually "morning" people and extroverts are usually "evening" people (6:140). Vital capacity and ventilation of the lungs, i.e., respiration, is maximum in the afternoon and minimal after midnight (4:163). A daily rhythm is also present in a person's heartbeat, with the heart beating faster during the daytime than at night (6:145).

Other circadian rhythms may or may not be body temperature related. A person on a standard, nighttime sleep schedule will reach a high point of sensory sharpness about 3 a.m., when steroid levels are lowest. After that there is a drop in sensitivity as steroid levels rise. Senses then become gradually more acute again, reaching another high point around 5 to 7 p.m. (8:58). In addition to the rhythm in the total volume of urine excreted each day, various components also oscillate in concentration over 24 hours. Sodium, potassium, chloride and phosphate, plus certain

hormones are excreted in lesser amounts at night than during the daytime (6:149). There are many other examples of circadian rhythms affecting bodily processes and influencing behavior. This listing of effects is shown to demonstrate how extensively circadian rhythms influence people, positively and negatively, and therefore how and why circadian rhythms must be considered when analyzing shift work.

SHIFT WORK SCHEDULES

Is there a "best" rotating shift work schedule? When answering this question from a circadian-rhythm viewpoint, the best solution would be to eliminate 24-hour continuous rotating shift work. Man has been entrained over the years to work during the day and sleep during the night and it is under this regimen that he functions best. Given, however, the necessity of continuous rotating shift work, there are certainly some biological-rhythm inputs that will increase worker satisfaction and productivity.

In a typical rotating shift schedule, an employee works a certain 8-hour shift (8 a.m. to 4 p.m.) one or two weeks and then "rotates" to a new shift (midnight to 8 a.m.). If we shift our habits, e.g., eating and sleeping, this 8-hour time change also involves an 8-hour phase-shift for our circadian rhythms. By "phase-shifting," I mean the changing of those bodily functions and responses affected by biological rhythms by a certain number of hours--a phase. The daily, cyclical biological-rhythm pattern remains the same; the highs and lows merely shift by a certain "phase" of time. For example, if a person was most accurate at noon, and then phase-shifted forward 8 hours, his best accuracy would then occur around 8 p.m. While it is fairly easy to change the phase of circadian rhythms (9:59), as far as the person's body rhythms are concerned, this treatment is like transporting them from Chicago to the same shift in New Zealand (6:169).

The worker, however, does not travel to New Zealand and after three days to two weeks (depending on the body process) on the phase-shifted schedule, the person's rhythms would be expected to shift appropriately, but usually they do not. They fail to complete a phase-shift and to attain an acceptable circadian-rhythm pattern for two reasons: on weekends (days off) they return to their old sleeping patterns so as to rejoin the rest of the world's social activities, and for the single person there are always opportunities for disrupting this shifted schedule to join in the social life of the day-shift crowd at the expense of lost sleep (6:169). Because humans are diurnal in nature, the worker who has to work at night and sleep by day and doesn't

phase-shift will suffer two forms of stress: stress in having to work during a period of deactivation, which will entail extra exertion; and stress in having to sleep during a period of activation (2:21). What this means is additional fatigue. Likewise, additional fatigue results when the body is not permitted sufficient time to re-establish its usual phase relationships. This can occur with a constantly changing schedule where a person might work a week on the night shift followed by a week on the day shift and subsequent reversals (2:189). There are, however, some answers to these problems.

Dr Charles A. Czeisler, a noted authority on physiology from Harvard University, in designing a rotating work schedule, "focused on two key issues: the direction of rotation and the interval between phase-shifts." An analysis of human free-running periods and the typical range of entrainment in man led him to conclude "that work schedules that rotate should do so by successive phase delays [or forward rotation] and that the interval between phase-shifts should be as great as is practical" (12:461). When his principles were applied in a Utah factory, the workers clearly preferred the phase-delay direction of rotation (day shift to evening shift to night shift), "personnel turnover decreased and productivity increased 22 percent" (12:462; 17:69). These results "indicate that work schedules that rotate by phase delay with an extended interval between each rotation are most compatible with the properties of the human circadian timing system" (12:462).

What if you have some workers who can't or won't follow the requirements (sleeping, etc.) of their new phase-shifted schedule? They may still be helped by applying biological-rhythm principles. Nathaniel Kleitman of the University of Chicago points out that instead of 8 a.m. to 4 p.m., 4 p.m. to midnight and midnight to 8 a.m. shifts, "a more physiological timing would provide for shift hours of 4 a.m. to noon, noon to 8 p.m. and 8 p.m. to 4 a.m., doing away with the graveyard shift" (body temperature lowest, sleepiness greatest) (4:316). An Australian study showed the "arousal of employees and performance at their tasks varied significantly with poorest performance and lowest arousal over the period 2 a.m. to 6 a.m. on the night shift" (3:45). Ideally, however, people should phase-shift and your schedule should not be planned around those who can't accommodate.

Likewise, common sense also plays a role. Two or more free days, such as a long weekend, should precede a shift change. During this time the individual should begin conditioning, eating and sleeping according to their new work schedule. If this doesn't happen, one can expect "a certain level of inefficiency until adjustment takes place" (8:103). During the initial several work periods when the body feels

that it should be sleeping, a person will have no trouble with short, highly interesting tasks. The boring routines, however, can put an individual right to sleep until he/she finally learns to adjust (14:35).

Based on these facts, certain "truths" regarding scheduling rotating shift work are evident.

1. Insure the interval between shift changes is as great as possible, three-four weeks minimum.

2. Rotate shifts by phase delay (forward rotation) only.

3. Avoid, if possible, scheduling a shift which runs exclusively through the early morning hours (for those who won't phase shift), e.g., a good schedule might be: 4 a.m.-noon, noon-8 p.m. and 8 p.m.-4 a.m.

4. Encourage workers to stick with the proper phase-shifted, sleep-wake schedule, not only during the week, but even on their days off.

SHIFT TOUR LENGTH

Is there a "best" shift tour length? Probably not. Although from a biological-rhythms' viewpoint, when individuals are working at a time when their clock says they should be sleeping, it's true that the less time and the shorter tour length they work, the better off they'll be. "Experimentation shows that for an equal output, night work demands a greater expenditure of physical and nervous energy, especially in mental activities, and that this produces overtiredness, unless of course the hours of work on the night shift have been reduced" (3:26). The increased benefits in productivity generated by shorter tour lengths, however, can be offset somewhat by more work breaks on a longer shift length tour. In the United States, "a 5-day workweek of 8-hour days is the most prevalent schedule for day, evening and night workers alike" (16:16). Likewise, in the Air Force most unit manning tables are based on 8-hour work days. If one decides to reduce the length of the work day, e.g., 6-hour tour lengths, then additional personnel will be required. Since the Air Force is "doing more with less," the addition of more people is unlikely.

The civilian community is also trying new schedules to improve worker satisfaction and productivity. "Rotating shifts of up to 12 hours per day with alternating 3- and 4-day workweeks. . .are being introduced" (16:16). This schedule, however, leaves someone at work for a longer period during a poor biological-rhythm time. It also leaves more

free time and weekends during which individuals on the evening shift would be likely to lose any phase-shifting they might have acquired, and will therefore never get "acclimatized" to night work. With the coAstraints listed above, the 8-hour shift tour length, with plenty of breaks and pleasant surroundings to reduce fatigue, is probably still our best option.

SLEEPING SCHEDULE

Is there a "best" sleeping schedule for rotating shift workers? This is a most critical question.

> Lack of adequate sleep and poor quality sleep have been implicated in a number of adverse health and safety consequences, including physical disorders, nervous problems, and deficits in mental and psychomotor performance which can lead to on-the-job accidents. Fatigue is the most commonly encountered and upsetting reaction shift workers experience from sleep deprivation. This is particularly true of. . .rotating shift workers. (13:33).

To further complicate the problem, "the time that shift workers spend with their families may prove less satisfying than it could be because the worker's fatigue from poor sleep or lack of sleep can prevent normal social activity" (13:33). This will cause further fatigue at work, since "sleep can. . .be unsettled by over-fatigue, restlessness and tension" (13:33).

Why do rotating shift workers not get enough sleep? As Harvard researcher, Charles A. Czeisler explains,

> For most people the body temperature cycle is synchronized with the normal nocturnal sleep cycle. When workers are forced to go to sleep at abnormal hours--[if they haven't been able to phase shift] early morning, for example, which normally comes well after the trough of the core temperature oscillation--they are apt to sleep poorly and wake poorly rested a few hours later. (18:7).

Czeisler found in analyzing subjects' sleep periods for over six months that core body temperature is the trigger that controls waking (18:7). Regardless of whether subjects had slept 4, 8 or 12 hours, they tended to wake spontaneously as their temperature began to rise (18:7). This lesson is critical in determining when individuals should go to bed in order to be fully rested, since they are likely to wake as their core temperature begins to rise. Sleep duration

depends not on how long the person has been awake, but on when he/she went to sleep (22:392).

If the person has or intends to phase-shift, this knowledge can be put to good use. For example, "a few older studies of workers on the. . .midnight to 8 a.m. [shift] show that their temperatures are lowest during the early evening hours, rise sharply between 1 and 3 a.m., and peak about 6 a.m.--almost a mirror image of the normal cycle" (21:45). This shows that these workers have phase-shifted their biological rhythms, with peak temperatures and peak performance during their working hours. In such a case, they wake from sleep when their body temperature begins to rise, probably during the mid-evening hours. When should they go to sleep then? That depends on the individual.

"The average time that people sleep is 7 1/2 hours. But statistically, 3 hours on either side is within the normal range" (14:31). How do you know if you're getting enough sleep? "The rule of thumb is very simple. If you wake up spontaneously, feeling well rested, and if you don't struggle through periods of intense sleepiness during the day, then you're getting enough sleep" (14:31). In our example above, the average-time individual should go to sleep around 1:30 p.m. to wake up spontaneously around 9 p.m. What if the worker in our example is not phase-shifted? As expected,

> the worker who has just rotated to the night shift and come home at 7 or 8 in the morning may find it hard to go to sleep on the rising slope of his body temperature rhythm. If he stays awake until the late afternoon, however, he will find that sleep will come more easily, and indeed, if he is not aroused by family or alarm clock, he will sleep all through the evening and night and not spontaneously awaken until the next morning upswing of the body temperature rhythm. (20:24).

However, if he is working a night shift, he must awaken prior to the next morning. What does this do to him? To find out we have to examine the basic mechanics of sleep more closely.

"We sleep in regularly recurring cycles of 90 to 120 minutes each,,with marked stages in each cycle. A healthy person will sleep through four to six cycles throughout the night" (8:69). There are four different stages in each cycle with changes in brain wave patterns marking each stage. Rapid eye movement (REM) sleep of stage four characterizes the deepest sleep of all. The REM dream sleep typically lasts 10 to 20 minutes (8:71). This dream sleep plays a

specific role in the correction of mental fatigue.

> The laborer stands up to night work better than the worker whose activity is mainly mental for the simple reason that sleep by day, which comprises much deep sleep, can replenish the stores of energy and correct physical fatigue whereas it cannot correct mental fatigue owing to the curtailment of indisposable paradoxical [dream] sleep. (1:33).

This is why REM sleep is so important to the Air Force individual whose shift work is mainly mental. "Both REM-deprived animals and humans tend to respond to stress with aggression, even when relaxation would be more effective" (15:29). Because of the different stages of sleep, sleeping in an area free from disturbance and noise will foster good sleep. Everytime you are awoken, you begin the stages of sleep over again and it will probably take close to 90 minutes before you get back to REM sleep. Before you go to bed, "do whatever relaxes you. Although no ideal temperature for sleep has been determined, temperatures above 75 degrees reduce REM sleep and cause more awakenings. As temperatures drop into the 50s, the dream content becomes more unpleasant and filled with emotional conflict" (9:61). The best thing for promoting good sleep is regular exercise. The most beneficial time to exercise is well before going to bed, since exercise at bedtime causes stimulation that will disturb sleep (9:62).

To correlate all this sleep data then, and answer our "best" sleep schedule question; yes, there is a best sleep schedule. It encompasses sleeping to accommodate your biological rhythms. Simply put, go to bed at such time as to insure your individual sleep length requirement is met and to insure you will awaken on the rise of your core body temperature. This will allow you to get sufficient sleep and be well-rested. If you wish to have maximum performance capability (maximum productivity) during the shift working hours, sufficient good sleep can be obtained only if you have phase-shifted to your new schedule. If you have not yet phase-shifted, and don't sleep on this schedule, you will be fatigued. The supervisor must expect and accept some degraded performance until the individual has phase-shifted and is correctly sleeping on that schedule. The person who decides not to phase-shift, obviously from a biological rhythms viewpoint, will never be in peak operating condition. Not only will their performance suffer because they are working at off-performance times, but, because their sleep is apt to be disjointed and not very "mentally" (REM sleep) refreshing, they will become very fatigued on the job.

Waking on the rise of your body temperature is a biological rhythm answer to the question. The individual can also insure this is the best sleep schedule by eliminating

distractions and noises which will wake them, by getting regular exercise, by sleeping at the best range of room temperatures and by trying to relax. Trying to sleep with the tension and fatigue of the day's activities is almost an impossible task. As mentioned earlier, when you know a shift change will occur, e.g., over a weekend, prepare for it by adjusting your sleeping patterns to reflect the new schedule.

EATING SCHEDULE

Is there a "best" eating schedule for rotating shift workers? Certainly. Human biological rhythms affect many aspects of eating.

> Regular night work disrupts the circadian rhythm of nutrition. As a rule [but depending on local practice], it involves a meal during the night--that is, during a period of digestive de-activation--with the two main diurnal meals [of which the one taken in the middle of the day may interrupt sleep] being maintained; the night meal, usually cold, is eaten without any appetite and is apt to be seasoned with condiments and taken with stimulants [coffee, . . .]. (1:27).

The time of day you eat combined with what you eat will drastically affect your physical well-being. Consider that most people bolt a light breakfast, eat a variable lunch and then a heavy dinner. This schedule may be opposite to the body's natural rhythms, because protein-rich foods produce greater nutritional value at one time than at another. This is because the enzyme which converts amino acids into body fuel functions on a 24-hour cycle. Animal tests have shown that protein utilization fluctuated as much as 400 percent from one part of the day to another. The best use of protein is made of that consumed in the morning. The best cycle of protein conversion may result from eating the largest meal at breakfast, a lighter lunch and an even lighter dinner (8:58). Since "the chemical pathways of activity are facilitated by protein," it follows that breakfast should be high in protein. Likewise, the evening meal should be high in starch and low in protein to help the changeover to the sleep transmitters (9:94). Two carefully performed experiments provided further substantiation and showed "quite clearly that persons having only one daily meal at breakfast time lost weight while these same persons tended to gain weight or not to lose as much weight when the only meal was taken in the evening." The results could be generalized to the general adult population because the sample was diverse. A computer-run regression analysis told the researchers that the time of a meal was twice as important as the number of

calories consumed (2:162-163). In fact, the human body is pretty flexible regarding what you eat. Given an adequate supply of protein, you can vary carbohydrate and fat intake within wide limits to obtain the rest of your total energy intake within your preferences. Typically, an American diet furnishes about half its total energy from carbohydrates, just over one-third from fats and approximately one-sixth from proteins (7:257).

These data indicate that just because you work a rotating shift work schedule doesn't mean you can't be as healthy and trim as you want to be. A knowledge of your internal clock may help you derive greater value from food and, if you consider when your senses are keenest, as discussed earlier, a greater enjoyment from food. You may be your own worst enemy.

Don't let a lack of time keep you from getting a good breakfast. Studies show that the "omission of breakfast [or its reduction to a cup of black coffee] caused a decrease in the maximal work output. . .and increases in reaction time and muscle tremor" (5:191).

The matter of evening meals and sleep, however, involves differing viewpoints. Some writers blame bad dreams and restlessness during sleep not so much to eating as to unwise eating or overeating; or state that more restful sleep can be obtained if nothing is eaten just before going to bed; or find that a light snack decreases the movement of their subjects. What is probably true is some people will sleep better if they eat something, while other people will sleep better if they eat nothing before going to bed (4:309). Some foods, however, do have definite effects on the body.

Most people think coffee can overcome fatigue. While coffee is a stimulant, it's effects last only 3 to 5 hours in the normal individual. After this time, you are subjected to a lower than normal level of alertness. What if you drink more coffee? Well, although your level of alertness is brought up by a new cup of coffee, it never reaches the previous level of alertness (23:17). Some people think that coffee or tea doesn't affect their sleep. Wrong. "They may or may not have trouble going to sleep, but the sleep will be fragmented. There will be less deep sleep, more awakenings during the night, and the total sleep time will be reduced" (9:62). "In addition, the body, when at work, struggles to retain water, and coffee is counterproductive: for every cup of coffee drunk, a cup and a half of water will be passed, thereby dehydrating the body" (9:91). People also need to be aware that drugs and alcohol cause serious disturbance to biological rhythms, chiefly by affecting dream sleep (8:75). Alcohol deprives "the user of the proper amount of REM.

Being deprived of REM sleep. . .reduces concentration, impairs the memory, and brings tiredness, anxiety, and irritability" (9:92). Drugs can be used to control rhythms. Lithium carbonate, for example, appears to slow biological clocks, whereas imipramine may speed the biological clock (11:124).

From a biological-rhythms' viewpoint then, how can one "best" eat. For non-phase-shifted individuals who intend to accept degraded performance and maintain a non-shifted schedule, they can eat the same on all shift schedules according to the body's food utilization I've indicated. The person who has phase-shifted or who intends to phase-shift to a new schedule can still use the principles of food metabolism with their schedule. The rotating shift worker who phase-shifts their biological clock and works 4 p.m. to midnight will want to eat a big, high-protein "breakfast" at about 3 p.m., a high protein lunch about 8 p.m. and a high-carbohydrate meal about 2 a.m. (dinner) (10:52). Again, once you've phase-shifted, every biological function still exists, it is just phase-shifted. The "best" eating schedule to feel satisfied and trim encompasses not only when to eat, but what to eat and how much to eat.

As mentioned earlier, the sooner individuals can prepare for a shift change the fewer problems they'll have when it becomes time to rotate. This applies to eating as well as sleeping. Charles F. Ehret, a biologist specializing in natural rhythms, offers this advice for workers going from Friday's day shift (8 a.m. to 4 p.m.) to Monday's afternoon shift (4 p.m. to midnight):

> Sleep late on Saturday and eat sparingly all day: soups, salads and fruits. Avoid carbohydrates.
>
> Sleep late Sunday. Eat a big, high-protein meal about 3 p.m. (breakfast time on Monday) and have a high-protein lunch about 8 p.m. (Monday's lunch time).
>
> Eat a big, high-carbohydrate supper about 2 a.m. Monday. Go to bed about 7 a.m.. (15:52).

EFFECTS

In answering the "best" sleeping and eating questions, we see that just like the day-shift, 8-hour worker, the night-shift worker who has phase-shifted will sleep a normal well-rested amount and rise several hours before he/she begins work. The worker should eat a big, protein-filled breakfast after rising and eat lunch about 5 hours later at

work. Their dinner, which should be fairly light, will occur a couple of hours after getting off work. They can then relax and enjoy themselves for 4-5 hours before going to bed in preparation for another day. This sounds normal and is until you place times into the schedule. People who don't work shifts and aren't phase-shifted cannot conceive of breakfast at 3 p.m.

There are, however, several aspects of shift work which may not be normal and need to be mentioned. In adapting to shift work "there is no significant sex difference, although women tend to adapt slightly slower. Older people tend to have more difficulty adapting to a. . .phase-shift" (23:18). Certain types of people adapt to shift work better than others. "Extroverts, for one; others who are less neurotic but more impulsive seem to adapt better. Those who use fewer medications [for illnesses] also make the adjustment more easily. . ." (9:87). Diabetics and epileptics may be adversely affected by shift work because these illnesses are related to the body's rhythms. "People with hypertension and cardiac problems should. . .avoid rotational shift work" (9:87). Also, field studies have shown that some people are unable to tolerate rotating shift-work schedules (12:462).

SUMMARY

Because the body's circadian rhythms influence our performance and personality differently at various times during the day, we must insure we are working during those peak performance times and not when our body thinks it should be sleeping. This work schedule occurs routinely for those with day jobs. Unfortunately, however, for those working shift or rotating shift schedules during other than daytime, they must either accept lowered performance, fatigue and errors or change their biological rhythm. They change their biological rhythm by phase-shifting it to put their sleep during the day and their work at night. A strict adherence to the phase-shifted schedule insures the individual will perform at his best. The person must be certain that their sleeping, eating, recreation, social habits, etc., all seek to entrain their body to maintain a phase-shifted schedule. Some rotating shift work "truths" to insure optimum performance are as follows:

1. Rotate shifts by phase delay only.

2. Have as great an interval between shift changes as possible, 3-4 weeks minimum.

3. Stay on the proper sleep-wake schedule.

4. Stay on the sleep-wake schedule even on days off to maintain the phase-shift.

5. Ensure you're getting enough sleep.

6. Ensure you're waking on the rise of your core body temperature.

7. Ensure your sleep is free from disturbance.

8. Eat three good meals: times, amounts and types according to body metabolic processes.

People don't realize how much control they have in establishing new rhythms and building new "clocks." Virtually everything you do will help entrain your body to it's new clock. The time when you eat, drink, sleep, exercise, work and relax all act as time cues for the circadian system.

By entraining the body to a new schedule and sticking to that schedule, the rotating night shift need not have the fatigue, poor performance and errors normally associated with night work. Increased productivity is possible with the use of biological principles. It only remains for people to be aware of these principles and apply them.

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