SEASONAL VARIATION IN ADAPTATION TO SHIFTWORK

by

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B.A., Okanagan University College, 1996

M.A., Simon Fraser University, 2000

Dissertation Submitted in Partial Fulfilment

of the Requirements for the Degree of

Doctor of Philosophy

in the Department

of

Psychology

SIMON FRASER UNIVERSITY

Spring 2005

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ABSTRACT

This study examined the effects of seasonal changes in daylength on adaptation to shiftwork. Shiftwork can be problematic when it conflicts with our natural daily or circadian rhythms. As synchronization of the internal clock that drives circadian rhythms is achieved primarily through exposure to the light-dark cycle, shiftwork schedules during the winter months, which significantly restrict shiftworkers' exposure to daylight, were expected to have particularly adverse effects on shiftworker health and well-being. A longitudinal study was conducted at the Vancouver International Airport in British Columbia, Canada from December 2001 until January 2003. Eighty-eight shiftworkers completed the Standard Shiftwork Index (SSI) and the 21-item Hamilton Depression Rating Scale in the summer, when daylight hours were longest, and in the winter, when daylight hours were shortest. The SSI provides six measures of shiftwork adaptation and four measures of individual difference factors associated with shiftwork adaptation. As predicted, there was a significant increase in psychological distress and depressed mood during the winter months, while sleep was more disturbed in the summer. Measures of physical health and psychosocial well-being, and relationships among explanatory and outcome variables, showed no seasonal effects. Across both seasons, neuroticism was the strongest predictor of adaptation to shiftwork. Findings provide evidence of a seasonal pattern of shiftwork adaptation and suggest that shiftworkers may be at risk for seasonal-type depression.

DEDICATION

For Ian, Matthew and Emily

who loved and accompanied me on every step of this journey.

And for Buddy,

who lay at my feet,

took me for walks,

and loved me no matter what.

ACKNOWLEDGEMENTS

To Marilyn Bowman, who has been my senior supervisor throughout my graduate career, I extend my sincere appreciation. Your enthusiasm and dedication to scholarship have been an inspiration to me. My deep appreciation also goes to Ralph Mistlberger and Cheryl Bradley, who were instrumental in conceptualising and laying the groundwork for this study. I am truly fortunate to be able to say that I could not have wished for a better team. I thank you all for your guidance, patience, and support.

My sincere gratitude goes to Vancouver International Airport Authority for sanctioning this study and, in particular, to the employees of YVR who were unfailingly good-natured and generous with their time, even at 6 o'clock in the morning. This study would not have been possible without your help and I hope that in some small way it will contribute to our understanding of the many challenges shiftworkers must face.

I have been blessed on this long journey with many fine teachers whose encouragement and belief in me opened up a whole new world of possibilities. There are no words to express what this has meant for me and for my children. Adults now, they too have learned that anything is possible.

And, finally, to my family and friends...two and four-legged...who have pushed and pulled and accompanied me every step of the way...we did it!!

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INTRODUCTION:

SEASONAL VARIATIONS IN ADAPTATION TO SHIFTWORK

Work-life has a significant impact on health and general well-being. Problems in work life that have been related to psychological and other health problems have been attributed to a variety of work-place dimensions, including work schedules. Shiftwork, in particular, has been implicated as a major contributory factor in problems related to employee health, sleep, fatigue, safety, work, and private life.

What is shiftwork and who works shifts?

Shiftwork can be broadly defined as regular employment in which a major portion of the work hours falls before 0700 hours or after 1700 hours. Commonplace in the industrial world, shiftwork facilitates the organization of daily working hours such that different teams work in succession to cover more or all of the 24-hours. There are several types of work schedules that meet this definition, including permanent evening and night shifts, rotating shifts (i.e., switching from day, evening or night work hours at daily, weekly, monthly or irregular intervals), split shifts (two work periods per day) and extended duty hours (work periods of 12 hours or longer). Shift schedules can vary along several other features, including shift changeover time, direction of shift rotation (e.g., forward or backward rotations among day, evening and nightshifts) and number of consecutive work days and days off.

The demand for shiftworkers has been recorded as far back as ancient Rome, when traffic congestion resulted in deliveries of goods being restricted to the night hours (Monk and Folkard, 1992). However, it was the advent of artificial lighting in the late

1800s that made the practice of shiftwork feasible and economically desirable, such that today there are millions of shiftworkers who, for various reasons, find themselves unable to move to a day-working alternative. Estimates of shiftwork prevalence are similar across industrialized nations. In Canada, data from 2001 found that almost 30% of the workforce works shifts, with about 25% of shiftworkers working permanent evening or night shifts and the remainder working rotating or irregular shifts (Shields, 2002). According to the Canadian1995 Survey of Work Arrangements, about four out of ten dual earner couples working full-time had at least one spouse doing shiftwork (Marshall and Robert, 1995). The survey also found that although the majority of Canadian shiftworkers have no choice but to work shifts (a requirement of the job), about one in ten respondents (proportionally more women) stated that they do it by choice – either to earn more money or to enable them to take care of children or other family members. In North America and Western Europe, it also is estimated that 25 to 30% of the work force work shifts or irregular hours outside the 'normal' eight hour day (U.S. Office of Technology Assessment, 1991; Poissonnet and Vernon, 2000). In the late 1980's, the number of shiftworkers in the USA alone was estimated at approximately 20 million, which included about 16% of all full-time employees (U.S. OTA, 1991). Moreover, in the USA it is estimated that nearly one in three families with children has at least one parent working shifts (Mellor, 1986; U.S. OTA, 1991). As we continue the move toward a 24-hour society, it can only be expected that the rates of shiftwork will increase.

Why is shiftwork a problem?

Shiftwork may be problematic when it conflicts with our natural daily or 'circadian' rhythms. The term *circadian* refers to biological rhythms that oscillate with a frequency

close to the 24-hour day. Numerous physiological processes and activities, including body temperature, heart and respiratory rate, blood pressure, digestive activity, appetite and fluid balance, and the secretion of hormones follow a circadian rhythm, as do many psychological processes and mental functions including mood, muscle strength, memory, manual dexterity and alertness (U.S. OTA, 1991). These rhythms are controlled by a circadian "clock" located in the brain, in an area known as the suprachiasmatic nucleus (Harrington and Mistlberger, 2000; Klein, Moore, & Reppert, 1991; Mistlberger and Rusak, 2000). The circadian clock is sensitive to daylight, or very bright indoor light, via a connection with the eyes, and it thereby maintains a tight synchrony between our bodily rhythms and the external day-night cycle. Perhaps the most conspicuous of the daily rhythms is the sleep-wake cycle. There is, over the 24-hour day, a preferable time to sleep with respect to both quantity and quality of sleep, such that humans the world over prefer to sleep at night and be awake during the day.

The central problem with shiftwork is that night shifts create a mismatch between work time and body time. The circadian clock promotes sleep at night and wakefulness in the day, making it difficult for shiftworkers to remain alert all night and to obtain adequate sleep in the day. This problem is greatly magnified by our need for sleep and by difficulties adjusting the circadian clock to night work. Most adults on average require about seven to seven and a half hours of sleep to function optimally (Scott, 1994). Acute overnight sleep deprivation can impair attention and cognitive performance, and chronic sleep reduction (i.e., less than about seven hours of sleep for several days in succession) can result in a serious accumulation of sleep debt (Belenky, et al., 2003; Van Dongen, Maislin, Mullington and Dinges, 2003; Bonnet, 2000). Shiftworkers, however, commonly sleep much less than six hours during the day following a night

shift. Not unexpectedly, numerous studies show that shiftworkers complain of inadequate sleep and of difficulty remaining awake during the night shift (Akerstedt et al., 1991; Akerstedt, 1995; Kogi, 1985; Paley and Tepas, 1994; Torsval, Akerstedt, Gillander, and Knutsson, 1989). Scott (1994) reports that surveys of 4500 shiftworkers over the past 25 years indicate that about 62% of night workers complain about sleep disturbance.

When working night shifts, workers must invert their normal sleep-wake pattern according to the changed activity period, while the light-dark cycle and many social cues remain stable. Sleep debt accumulates on shift schedules because the circadian clock is not easily shifted even when special measures are taken to control outdoor light exposure and other factors (Eastman and Martin, 1999). Field studies show that in workers rotating from the day to the night shift, it may take two weeks or more for the clock to shift sufficiently to permit adequate sleep during the day and optimal alertness at night (Monk, Knauth, Folkard and Rutenfranz, 1978). Thus, during the first four to five night shifts, sleep reduction is typically severe and fatigue on the job accumulates with each shift. Daytime sleep and night time fatigue begin to improve only toward the end of the first week. Remarkably, studies of permanent night workers indicate that the circadian clock often never fully adjusts to night work (Van Cautaer and Turek, 1990). This is thought to be due to competing cues from the environment. For example, regular exposure to daylight during the commute to or from work may prevent the clock from shifting (Eastman and Martin, 1999).

Another important factor that inhibits circadian adjustment is the tendency of night workers, because they are the minority in the greater society of day workers, to revert to daytime activities on their off days and during vacations. Spouses and children

typically work and go to school during the day and eat at regular daytime hours. To share in family activities and responsibilities and partake in many recreational activities, shiftworkers must be awake in the day. In the short term, these activities may create sleep debt and, in the long term, they may prevent or impede adaptation to night work.

What are the adverse consequences of shiftwork?

Given that shiftwork creates a mismatch between the work day and our natural daily rhythms, it is not surprising to find that it can have adverse effects on worker safety, health, family and social relations, and on-the-job productivity. A summary of some of the more commonly reported problems follows, although it is important to keep in mind that many individuals positively enjoy shiftwork and report few, if any, adverse effects.

Safety

Fatigue and sleepiness associated with non-standard work hours have been directly implicated in many industrial disasters, including major accidents at the nuclear power plants at Chernobyl and Three Mile, the chemical factory in Bhopal (thousands of deaths), the grounding of the Exxon Valdez oil tanker in Alaska (environmental disaster), and the loss of the space shuttle Challenger (Scott, 1994; U.S. OTA, 1991). Transportation accidents (airline, railroad, maritime, and highway) peak at night (Lauber and Kayten, 1988; Mitler, et al., 1988), and accident investigations within the transportation industry have found operator fatigue and sleepiness related to shiftwork and extended duty hours to be significant factors in vehicular accidents (for review, see Scott, 1994). Shiftworkers commonly note that they do not feel safe to drive after the night shift, a concern that is empirically validated by the increased incidence of

automobile-related injuries and near-accidents on the commute home (Horne & Reyner, 1999; Steele, Ma, Watson, Thomas and Muelleman, 1999). In some work settings accident rates differ by shift, with rates typically worst for the night shift (Akerstedt, 1995; Smith, Colligan and Tasto, 1982), although controlled comparison studies, in which accident rates are compared before and after changes in shiftwork schedules, are lacking (Frank, 2000).

Health and general well-being

Health problems that are commonly reported by shiftworkers include disturbances in sleep and mood, and gastrointestinal, cardiovascular and reproductive dysfunction (for extensive reviews see Costa, 1996; Harma and Ilmarinen, 1999; Moore-Ede and Richardson, 1995; Richardson and Malin, 1996; Singer, Terborg, & Mayer, 1994). Daytime insomnia and general fatigue are the most immediate health complaints of most shiftworkers and are at the core of what has been called "shiftwork malaise." Daytime insomnia is caused by wake-promoting signals from the circadian clock, coupled with environmental conditions that are not conducive to good sleep (e.g., exposure to light and noise). Some animal research suggests that chronic sleep deprivation also may compromise immune function (for example, see Everson and Toth, 2000), raising concern that chronic sleep loss with shiftwork may impair general health and worsen general fatigue.

Fatigue also may be symptomatic of a psychological disturbance such as depression. While there is some evidence of higher rates of depression in current and former shiftworkers (Scott, Monk, & Brink, 1997), further research is needed on the

implications of shiftwork for affective disorders. In particular, there is a need to identify specific aspects of shiftwork that may place vulnerable individuals at increased risk.

Compared to permanent day workers, it is well documented that shift workers are at higher risk for appetite disturbance, gastritis, and ulcers (for review see Scott and LaDou, 1990). Costa (1996) reported that as many as 20 to 75% of shift workers with night work (in comparison with 10 to 25% of day workers and shift workers without night work) complained of appetite disturbances, dyspepsia, abdominal pain, and other digestive problems. This may be a consequence of ingesting food at times (i.e., the night) when gastrointestinal function is reduced. Poor dietary options and increased caffeine, nicotine and alcohol intake in shiftworkers may also be contributing factors.

While there is no clear evidence that shiftwork is associated with a higher overall rate of mortality (Taylor and Pocock, 1972), shiftworkers do have an estimated 40% increased risk of cardiovascular morbidity and mortality (Waterhouse, Folkard, and Minors, 1992). Lifestyle factors such as diet, smoking, alcohol intake and reduced time for exercise, as well as the general stress of working shifts and possible disruption of the circadian rhythms of cardiovascular function, have been proposed as contributory factors (Boggild and Knutsson, 1999; Harrington, 1994; Ribeiro, Hampton, Morgan, Deacon, and Arendt, 1998).

All of the health risks associated with shiftwork appear to become worse with age and with length of time working shifts (Angersbach, Knauth, Loskant, Karvonen, Undeutsch, Rutenfranz, 1980; Harma, Hakola, Akerstedt, & Laitenen, 1994). A reduced tolerance to shiftwork, a decrease in circadian adjustment, and an increase in sleep and health disorders have all been found to be associated with increased age and duration of exposure to shiftwork (Bourdouxhe and Queinnec, 1999; Harma and Ilmarinen, 1999).

Moreover, there is some suggestion that the negative effects of age and shiftwork may be cumulative and difficult to reverse (Bourdouxhe and Queinnec, 1999). This is of particular concern, as current demographics indicate that the shift-working population is aging, which may point to a major health and safety concern in the near future.

Family

Shiftwork has been identified as a major source of dissatisfaction for spouses and is associated with increased rates of divorce (Colligan and Rosa, 1990; Smith and Folkard, 1993). Three spousal roles most commonly affected by shiftwork are those of caregiver, social companion, and sexual partner. The effects of shiftwork on the children of shiftworkers have not been well studied but, given that for most of the year children are at school and school is inherently day shift orientated, it is generally assumed that parenting roles will be adversely affected by shiftwork. Domestic obligations such as home maintenance, shopping, or cooking may be left unfulfilled or, when given priority, take away rare and valuable time that could be spent with spouses and children. The social companion role also can be very important for couples and the absence of a spouse who is working shifts can disrupt not only the shiftworker's social life but also that of the spouse. Tepas (1985) reported that compared to 45% of permanent day workers, more than 70% of evening shiftworkers were not satisfied with the amount of time they were able to spend with their spouses. Finally, shiftwork can create problems in the sexual partner role as the times when the shiftworker is in bed and sexually most available are often times when the spouse is at her or his day working job or when the presence of children or other daytime distractions make sexual intimacy either difficult or

impossible. Additionally, the chronic partial sleep loss often experienced by shiftworkers can also mean that sexual intimacy is simply neglected.

Performance and productivity

Subjective alertness has been shown to be at its minimum during the early morning hours, when the body temperature rhythm is at its trough (from about 0300 to 0600 hours in habitual day workers). A review of daily rhythms in human physiology indicates that the ability to perform work decreases by approximately five percent at night (Rosa, Bonnett, Bootzin, Eastman, Monk, Penn, Tepas and Walsh, 1990). In addition, performance on vigilance tasks that require sustained alertness tends to be impaired during the early morning hours in workers who are not fully adapted to the night shift. Performance on a variety of other cognitive and memory tasks also exhibits a dependence on time of day, typically in parallel with the body temperature rhythm and, finally, physical performance can also be affected by time of day (Monk, 1994). Given these time-of-day dependencies, job performance and productivity can be expected to vary with shifts in a way that depends on the particular job tasks and on the degree of adaptation to the current shift.

Moderating factors that may affect adaptation to shiftwork

There is considerable variability among people in their ability to adjust to shiftwork, with some individuals suffering few, if any, problems and others finding certain work schedules intolerable. A 1977 study of 9,000 shiftworkers found that about 20% reported considerable difficulty adapting to shift work (Rutenfranz, Colquhoun & Knauth), while Harrington (1978) found that about 10% of shiftworkers prefer shiftwork, about 20

to 30% find it unpleasant enough to have to leave, and the remainder merely tolerate it. Although it is clear that people differ in their ability to adapt to shiftwork, the role that moderator variables, such as workplace characteristics, family or social factors, and individual differences, have on shiftwork adaptation is not well understood. At the present time, not enough is known to make a definite statement about who will or will not be able to cope with shift work, with additional information needed to identify more clearly those variables that might make some individuals better able to cope with shiftwork than others. However, based on current shiftwork literature, some of the factors that appear to be of particular relevance to shiftwork adaptation are: 1) age and shiftwork experience; 2) personality factors (i.e., negative affectivity or neuroticism, and extraversion); 3) circadian type (i.e., morningness/eveningness); and 4) sleep flexibility/rigidity.

Age and shiftwork experience

Both age and experience appear to be negatively related to shiftwork adaptation. Aging decreases the speed of circadian adaptation to night work and has a major impact on sleep, which is the most prominent health complaint of shift workers (Harma & Ilmarinen, 1999). Sleep patterns in older individuals also tend to be more fragile (i.e., shorter and more easily disrupted), thus rendering daytime sleep for night workers even more difficult. Age also tends to be associated with a move towards 'morningness' (i.e., earlier bedtimes and wake times), which, for all age groups, has been demonstrated to be predictive of those who are more likely to have problems coping with shiftwork (Costa, 1997). Research by Nachreiner, Lubeck-Ploger and Grzech-Sukalo (1995) has shown that with increasing shift experience, there is a concomitant increase in the

frequency of health complaints. In addition, there is evidence suggesting that individuals with little shift experience show a somewhat undifferentiated pattern of health complaints, whereas those with 10 or more years of shiftwork experience report a pattern of complaints related specifically to circadian functions (i.e., gastrointestinal and sleep disorders) (Nachreiner, Lubeck-Ploger, and Grzech-Sukalo, 1995; Tepas, Duchon and Gersten, 1993).

Personality Traits

There is evidence that the personality traits of Neuroticism and Extraversion may be related to shiftwork adaptation. Neuroticism is a broad and pervasive dimension of normal personality measured by an individual's propensity to experience negative, distressing emotions and to possess associated behavioural and cognitive traits. It is generally understood to predict an inherent susceptibility to experience negative affect and thus to be associated with, and predictive of, anxiety and depression (Eysenck and Eysenck, 1985; Larsen & Ketelaar, 1991). Neuroticism is of particular relevance to shiftwork because evidence suggests that this trait is associated with poor psychophysiological adaptation to circadian disruption, as assessed objectively by changes in cortisol levels (Hennig, Kieferdorf, Moritz, Huwe and Netter, 1998). It also is relevant in that individuals high in neuroticism tend to use less effective coping strategies and show poorer adaptation to environmental demands (for example, see David and Suls, 1999). While numerous cross-sectional studies have indeed shown that higher levels of neuroticism are associated with poorer shiftwork adaptation (Harma, 1993; Monk and Folkard, 1985), results from some longitudinal studies suggest that neuroticism may have limited value in terms of the ability to predict subjective health

complaints after exposure to shiftwork (for example, see Kaliterna, Vidacek, Prizmic and Radosevic-Vidacek, 1995). Moreover, while it is generally assumed that individual differences in neuroticism are stable, such that mean levels tend not to increase or decline appreciably with age or life change (Costa and McCrae, 1987), some shiftwork researchers have reported small but significant increases in neuroticism scores with shiftwork experience, and have posited that it should therefore be considered a consequence of intolerance to shiftwork, rather than as a predictor (for review, see Bohle and Tilley, 1989; Kaliterna, Vidacek, Prizmic and Radosevic-Vidacek, 1995).

Whereas neuroticism predisposes individuals toward negative affect, extraversion is believed to predispose individuals toward positive affect. Cross-sectional studies have demonstrated better adjustment to shiftwork by individuals scoring high on the stable personality trait of extraversion. For example, Singer and Levens (1990) reported that, compared to introverts, extraverted police workers experienced fewer health problems usually associated with shiftwork and showed overall greater adjustment to shiftwork. As with neuroticism, however, there is some evidence that extraversion has little power to predict tolerance to shiftwork (Kaliterna et al., 1995).

Circadian Type

A distinction has been made by shiftwork researchers between individuals who are morning types and individuals who are evening types. Morning and evening types differ in the phasing of many of their physiological and biochemical rhythms, including body temperature, with the rhythm of body temperature phased earlier than average in morning types and later than average in evening types. As body temperature is related to initiation and maintenance of sleep, morning types will rise earlier and become

fatigued and retire earlier than evening types, who tend to rise, grow fatigued, and retire later in the day. Morning types also tend to report that they feel better earlier in the day, whereas evening types are likely to report that they feel better later in the day (Waterhouse, Folkard, and Minors, 1992).

There is some evidence suggesting that these differences can affect the amount of sleep achieved on different shifts. For example, morning types may be at an advantage with early morning shifts and disadvantaged with night shifts, while evening types may be at a disadvantage with early morning shifts and at an advantage during night shifts (Waterhouse, Folkard and Minors, 1992). Other researchers, however, have suggested that, in general, morning types have more overall difficulty adapting to shiftwork (for example, see Costa, 1997).

Sleep Flexibility

A final personality dimension that has shown some association with shiftwork adaptation is sleep flexibility. Sleep flexibility refers to the ability to overcome drowsiness and to sleep at different times of the day and night, including taking naps. Several studies have demonstrated that individuals with a high "rigidity" score – those with difficulties in changing their sleep times – have greater difficulty tolerating shiftwork than individuals with a high "flexibility" rating. Similarly, flexibility of sleeping habits and the ability to overcome drowsiness have been associated with better tolerance to shiftwork (Waterhouse, Folkard & Minors, 1992; Costa, Lievore, Casaletti, Gaffuri, & Folkard, 1989).

In summary, while shiftwork has been implicated in numerous difficulties related to health, safety, interpersonal relationships, and workplace productivity, there appears

to be considerable variability in the degree to which individuals are able to adapt to varying shift schedules. Several factors appear to moderate the effects of shiftwork, including age, experience, personality, and individual differences in circadian type and sleep flexibility. An additional factor that has not been examined, and yet also appears to have the potential to affect shiftwork adaptation, is seasonal variation in daylight hours.

Daylength and Seasonal Outcomes: The Present Study

The internal clock that drives circadian rhythms in humans is synchronized, or entrained, to the 24-hour rotation of the earth by time cues often referred to as "zeitgebers" (German "time givers"). Several factors have been shown to contribute to the synchronization of the internal clock, including the light/dark cycle, natural noises, social cues, and behavioural patterns such as sleeping and eating schedules (Czeisler and Dijk, 2001; Mistlberger and Skene, 2004; Scott, 1994). Of these, the principal entraining agent is the light-dark cycle. Exposure to bright light can reset or shift the human circadian clock, with the size and direction of the shift dependant upon when, in the clock's cycle, exposure takes place (Czeisler and Dijk, 2001). Nocturnal light exposure before the nadir of the body temperature rhythm, which occurs about two hours before habitual wake-up time, pulls the clock backward in its cycle (a 'phase delay' shift), whereas light exposure after the temperature minimum pushes the clock forward in its cycle (a 'phase advance' shift). The human circadian clock typically runs a bit slow (the current estimate is that the endogenous circadian period is about 24.2 hours; Czeisler et al., 1999); therefore, it must be advanced by approximately0.2 hours each day to maintain synchrony with the solar day. Consequently, morning light exposure,

which causes phase advances, is critical for stable entrainment to local time. In the absence of morning light, the circadian clock drifts later, which can cause sleep-onset insomnia and difficulty waking in the morning.

Given that exposure to early morning light is a particularly important factor in keeping the circadian cycle stabilized, shiftwork schedules that, at certain times of year, significantly restrict exposure to daylight may be expected to have particularly adverse effects on workers. In more northern latitudes, such as Vancouver, British Columbia (BC), sunrise varies from as early as about 0430 hours in June to as late as about 0808 hours in December. Shiftworkers coming off the night shift at 0500 or 0600 hours in the winter may see no bright sunlight before going to bed. In addition, if they sleep long enough or stay indoors that day, they may see no bright sunlight at all prior to the next night shift, as sunset is as early as 1614 hours. Similarly, workers on a 12-hour dayshift may come into work before sunrise and leave for home after the sun has set. If their work does not take them out of doors, they too may see no bright sunlight for several days on end. Thus, in winter shiftworkers may in fact be exposed to very little outdoor light. This may be particularly problematic if shift rotations are rapid (e.g., rotations from night to day at two or four day intervals). On rapid shift rotations, it is generally recommended that efforts be made to prevent "body-clock" shifting, so that body time matches work time on the rotation back to the dayshift. This strategy minimizes the total number of work shifts when work time and body time are significantly out of alignment. The best way to ensure that the clock does not shift substantially during two or four consecutive night shifts is to seek exposure to sunlight each morning, as typical indoor light may be insufficiently bright to serve this synchronizing function. As indicated

above, however, during the winter shiftworkers may have little or no exposure to morning sunlight.

Given the above considerations, the primary purpose of this study was to examine whether the substantial seasonal variations in daylength and weather found in northerly latitudes such as in Vancouver, BC might affect adaptation to shiftwork. My expectation was that shiftworkers would have particular difficulty keeping their circadian clock synchronized to the day-night cycle during the winter, when days are short and overcast. Accordingly, I anticipated poorer adaptation or tolerance for shiftwork during the winter months.

Standard Shiftwork Index (SSI)

A secondary purpose of this study was to contribute to a set of normative data through the use of a recently developed standardized tool for measuring shiftwork adaptation. The Standard Shiftwork Index (SSI) is a comprehensive questionnaire that is comprised of a variety of empirically validated scales for assessing shiftworker health and well-being (Barton, Spelten, Totterdell, Smith, Folkard, & Costa, 1995). The SSI was developed out of the recognition that standardized tools for measuring shiftwork adaptation must be used if scientifically based recommendations are to be made concerning the design of shift systems and the selection of individuals (Barton et al., 1995). Designed to reflect the most pertinent issues within shiftwork research, the SSI can be used to assess the impact of shiftwork on individuals and to identify moderator variables (e.g., age, experience, family status, personality, etc) that may influence adaptation to shiftwork.

Using the SSI, I proposed to evaluate the question of how variations in daylength might affect adaptation to shiftwork in a study of airfield maintenance crews and supervisory staff at Vancouver International Airport. Specifically, I hypothesized that overall shiftworker adaptation would be poorer in the winter than in the summer, as shown by greater disruption in sleep cycles, increased fatigue and physical and psychological complaints, and a more negative impact on job satisfaction and social and family relationships. A second broad question concerned the role of individual differences in responding to shiftwork across the seasons. As previous shiftwork research looking at individual differences suggests that individuals who are older, who score higher on trait neuroticism, who describe themselves as morning types, and who have less flexible sleeping habits are likely to have more difficulty adapting to shiftwork, I also proposed to assess for seasonal patterns in the relationships among these individual difference factors and adaptation to shiftwork.

METHOD

Participants

Ninety of the approximately 100 employees of the Vancouver International Airport (YVR) Authority's airfield, maintenance, and operations crews consented to participate in the study. As two employees returned questionnaires that were incomplete and unusable, the final sample consisted of 88 participants. Eighty participants completed the questionnaires in both Summer and Winter, four completed the questionnaire in Summer only, and four completed the questionnaire in Winter only.

The majority of participants worked an eight-day shift schedule that consisted of four 12-hour shifts that changed over at 0600 hours and 1800 hours, and that rotated from days to nights. Specifically, the eight-day shift cycle consisted of two dayshifts followed by two night shifts, and then four rest days. Sixty-eight participants worked the eight-day shift rotation exclusively and five participants worked the eight-day shift rotation "most of the time". Unexpectedly, there were 15 participants who worked primarily day shifts. Consequently, participants were divided into two groups, reflecting their differential experiences of exposure to night shifts, and allowing for tentative comparisons between day and night shift workers:

1. "Day workers" (n=15) included those individuals who averaged less than one night per shift rotation (i.e., less than 42 night shifts per year). The number of night shifts worked per year by Day workers ranged from 0 (n=1) to 40 (n=3), with a mean of 18 night shifts per year. One respondent in the Day workers group completed the

questionnaire in the summer only and one completed the questionnaire in the winter only. The remainder completed the questionnaire in both summer and winter.

2. "Night workers" (n=73) was comprised of individuals who worked on average more than one night per shift cycle (i.e., more than 42 nights per year). The number of night shifts worked per year by the Night workers group ranged from 46 to 100. The majority of this group (63) worked 84 nights per year or two per shift rotation, and the mean number of night shifts worked per year was 81. Three of the night workers completed the questionnaire in the summer only and three completed the questionnaire in the winter only. The remainder completed the questionnaire in both seasons.

Participants in both groups (i.e., Day workers and Night workers) worked 12-hour shifts, exclusively, that changed over at 0600 hours and 1800 hours. Thus, in the summer months, all participants had exposure to morning and evening light on the commute to and from work. In the winter, however, both commutes would have been done in darkness, making it more difficult to stabilize circadian rhythms to local time. Figure 1 illustrates sunrise/sunset and commute times during the three data collection periods.

Demographic Characteristics of the Sample

Table 1 presents demographic characteristics for the sample. The majority of participants were male (n=68; 77%). The mean age was 38.9 years (SD=9.2) and ranged from 21 years to 58 years. Sixty-seven respondents (76%) were married or co-habitating; of these, 14 (21%) respondents had partners who also worked shifts. About half of all participants (47%) had dependent children. Participants had been in the workforce for an average of 21.3 years and had worked at Vancouver International

Airport (YVR) for an average of 3.98 years. Seventy-four percent had worked at YVR for five years or less and 98% had worked at YVR for 10 years or less. An average of 13.8 years of education was reported, with a range of 10 years to 19 years. Occupationally, the largest proportion of participants was comprised of journeymen level trades workers (e.g., electricians, plumbers, and carpenters) who were employed on the building maintenance crews (48%). The second largest group of participants was comprised of white collar workers employed in airport operations (31%). The remainder of the sample, largely equipment operators and tradesmen, was employed in airfield maintenance (22%).

Figure 1: Sunrise, Sunset and Commute Times During Data Collection Periods

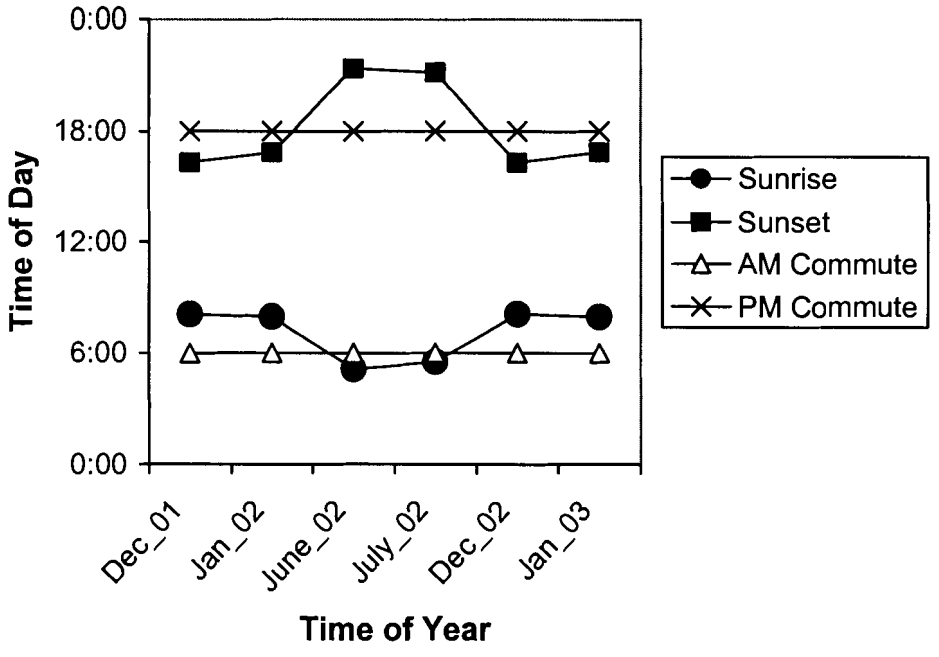

Table 1. Demographic Characteristics of the Sample

Characteristic	*N* or Range	% or Mean (SD)
Age	21-58	38.9 (9.2)
Gender		
Male	68	77%
Female	20	33%
Years @ YVR	.20-27	3.98 (4.0)
Married/Cohabitating	67	76%
Partner Working Shifts	14	16%
Dependents	1-4	47%
Occupation		
Airfield Maintenance	19	22%
Airport Operations	27	31%
Building Maintenance	42	48%
Education	10-19	13.80 (1.76)

Group Differences: Day and Night Workers

Day and Night workers did not differ significantly in terms of age, years of work experience, or years at YVR. They did differ, however, in terms of occupation, education, and gender. The Night workers group was comprised of proportionally more airfield maintenance employees (23% vs. 13%) and building maintenance employees (56% vs. 7%) than the Day workers group, while the Day workers group was comprised of proportionally more airport operations employees (80% vs. 21%). Participants in the Day workers group also reported having more years of education (Mean = 15; SD = 1.46) than respondents in the Night workers group (Mean = 13.5; SD = 1.75). In

addition, the proportion of female participants was higher in the Day workers group (67%) than in the Night workers group (14%). In summary, participants who worked the fewest night shifts per year tended to be better educated, female, "white collar" operations employees, whereas participants who worked the most night shifts per year tended to be male tradesmen or equipment operators with fewer years of formal education.

Procedure

Participants were recruited via the Airport Authority's Health and Safety Division. Data collection took place at meetings that had been scheduled by a health and safety officer. These meetings, which were held at the beginning (i.e., 0600 hours) of the first dayshift of a shift rotation, were held for the sole purpose of data collection. As the meetings were held in restricted areas, the health and safety officer was present during all data collection. The principal investigator began by explaining the purpose of the study, insuring that all potential participants understood that their participation was voluntary, and responding to any questions and comments. On one occasion when the principal investigator was not available, a research assistant met with the crew. Potential participants were advised as to confidentiality of the results and asked not to include any identifying information on the materials. Remuneration was offered to those individuals who completed both parts of the study (i.e., winter and summer) in the form of a lottery with two chances of winning. First prize consisted of two tickets to a Vancouver Canucks' hockey game and second prize was two tickets to a Vancouver Giants' hockey game. Ninety-two of the 94 employees who attended the meetings agreed to participate and gave signed, informed consent. Questionnaires were

completed and collected immediately following the meeting. Completion time averaged about 40 minutes. Due to time and scheduling difficulties, a small number of participants (eight) took the questionnaires away, to be filled in later in the day. Two of these questionnaires were not returned, four were completed and picked up by the health and safety officer on the same day, and two were returned between five and fourteen days later, after a reminder from the health and safety officer.

There were three rounds of data collection, chosen to coordinate with the longest and shortest days of the year: December 14, 2001 to January 15, 2002; June 17 to July 11, 2002; and December 18, 2002 to January 18, 2003. Daylight hours (i.e., sunrise to sunset) averaged 8 hours, 26 minutes during the winter data collection periods and almost doubled to 16 hours, 8 minutes during the summer data collection period (www.timeanddate.com).

To control for possible effects of prior experience with the questionnaire, shiftworkers completed the measures during summer and winter in a counterbalanced order. Approximately half of the participants (Winter first) completed the questionnaires for the first time in Dec 01/Jan 02 and for the second time in June/July 02. The remainder (Summer first) completed the questionnaires for the first time in June/July 02 and for the second time in Dec 02/Jan 03. All continuous variables were examined for order effects between these groups. As there was only one significant difference (Summer first scores on the General Health Questionnaire (GHQ) were greater than the Winter first scores on the GHQ; $t\ (82) = 2.014$; $p < .05$), the groups were collapsed.

Measures

Standard Shiftwork Index

The Standard Shiftwork Index (SSI) was developed by Barton and colleagues in response to a need for greater standardization in shiftwork research (Barton et al., 1995). A battery of self-report questionnaires, the SSI is used to examine specific features of the shift system and work environment, assess shiftworker health and well-being, and evaluate individual and personality differences which may serve to moderate the impact of shiftwork. The SSI consists of both previously developed scales and new scales developed specifically for the study of shiftworking samples. It is approximately 24 pages long and takes between 40 and 60 minutes to complete. A shortened version of the SSI, the Survey of Shiftwork (SOS) was developed in 1998 by the originators of the SSI in an effort to increase compliance and response rates (Tucker, Smith, Macdonald & Folkard, 1998). In developing the SOS, the major revisions were based on psychometric criteria and involved the omission of some of the items and scales from the SSI that related to individual differences.

The original SSI validation study was based upon two different occupational groups working a range of shift systems (Barton et al., 1995). The first occupational group consisted of 1532 predominantly female nurses and midwives from 101 different general hospitals throughout England and Wales. The second group was comprised of 1332 predominantly male industrial and service workers from a range of occupations including air traffic control, chemical, power, steel and glass industries, the police force and the post office. Within the nursing sample, there tended to be a high degree of

irregularity in shift scheduling. In contrast, the industrial and service shift systems were regular in nature and rotated between morning, afternoon and night shifts on a frequent basis. The majority of the respondents in both groups were either married or cohabitating. The mean age of the industrial workers (39.2 years) was higher than that of the nurses (33.2 years), and the industrial workers tended to have been engaged in shiftwork for more years than the nurses, with a mean of 15.9 years compared with 11.8 years. Psychometric testing of each of the scales was performed separately for the nursing and industrial groups, with results largely consistent across the two groups.

For the purposes of this study, a version of the SSI was used that falls in length between the shorter SOS and the longer SSI. Some of the scales that were omitted were unsuitable to this particular work environment (i.e., scales concerned with flexible or alternating shift systems). Other changes were done in accordance with the SOS, and involved the removal of scales or items that had been shown to have less sound psychometric characteristics. Overall, however, there were fewer omissions in this version of the SSI than there are in the SOS. Rationale for the scales chosen or developed for the SSI, along with the psychometric properties of the scales used in the current study, are discussed below. The revised SSI used in this study is presented in Appendix A.

Independent / Explanatory Variables

Variables that examined individual differences and personality factors that are associated with adaptation to shiftwork included three measures from the SSI: 1) the 12-item Eysenck Personality Inventory measuring Neuroticism and Extraversion (EPI;

Eysenck & Eysenck, 1964); 2) the Morningness scale; and 3) the Sleep Flexibility scale, as well as age, years of shiftwork experience, and length of time at YVR.

Extraversion and Neuroticism

The 12-item Eysenck Personality Inventory (EPI) measures two major dimensions of personality, extraversion and neuroticism (six items each). Derived from the longer 57-item EPI, the correlation of the short scale with the long scale is 0.82 for extraversion and 0.79 for neuroticism (Barton et al., 1995). The EPI response format was adapted for the SSI from a dichotomous "yes/no" format to a four-option "almost always, quite often, quite seldom, almost never" rating format, to increase the possible range of scores and to introduce more flexibility into responding. In the original validation study, correlations between the two formats for each item were sufficiently high (i.e., >0.8). Total scores for extraversion and neuroticism are obtained by summing the individual scores.

Historically, neuroticism has been conceptualized as a stable, longstanding trait that is not expected to show significant variations in response to events or conditions (see Costa & McCrae, 1998). However, on the basis of a small number of longitudinal studies of shiftwork adaptation, some shiftwork researchers have postulated that, over time, an increase in reported neuroticism can be one of the adverse effects of shiftwork (see, for example, Bohle and Tilley, 1989). While the length of time between data collection periods in this study was insufficient to assess change over time, the analytic techniques used (specifically, canonical correlation analysis) can be used to examine, alternately, the contribution neuroticism makes to a subset of independent or explanatory variables and the contribution it makes to a subset of dependent or outcome

variables. Thus, using canonical correlations, neuroticism was examined first as an independent variable and secondly as a dependent variable. Extraversion, in keeping with conventional methods and those recommended in the SSI, was examined only as an independent, or explanatory, variable.

Morningness

The morningness scale is a single-item measure derived from the SOS that gives a measure of individual preferences and predisposition toward greater activity earlier or later in the day. Respondents are asked the extent to which they are "the sort of person who feels at their best early in the morning and who tends to feel tired earlier than most people in the evening" on a five-point scale ranging from "Definitely not" to "Definitely yes." Psychometric properties of this single-item measure were not provided with the SOS.

Sleep Flexibility

The sleep flexibility scale is a single-item measure derived from the Circadian Type Inventory (Folkard, Monk, & Lobban, 1979) for use in the SOS. The scale is intended to measure the ability to sleep at unusual times and in unusual locations. Respondents are asked to rate whether they "are the sort of person who finds it very easy to sleep at unusual times or in unusual places" on a five-point scale ranging from "Definitely not" to "Definitely yes." Psychometric properties of this single-item measure were not provided with the SOS.

Demographic and Work Schedule Information

In addition to the above independent variables, respondents were asked to report their sex, age, education level, marital status, number of dependents living in their household, as well as information regarding shift particulars and work experience.

Dependent Variables

Six measures from the SSI were used to assess adaptation to shiftwork: 1) the Sleep Quality and Disturbance Scale; 2) the Chronic Fatigue Scale; 3) the General Health Questionnaire; 4) the Physical Health Questionnaire; 5) the Job Satisfaction Scale; and 6) the Social Disturbance Scale. A seventh measure was added to assess depressed mood: the 21-item Hamilton Depression Rating Scale. Each of these measures is described below.

Sleep Quality and Disturbance

The Sleep Quality and Disturbance Scale was created specifically for the SSI. Based on the sleep section of the "Quality of Life" questionnaire (Wallace, 1990), the 11-item measure comprises two sections. The first section identifies sleep habits (i.e., the timing and duration of sleep, and the frequency and timing of naps) according to each shift that is worked. This section of the scale is used primarily for comparison between varying shift schedules and, therefore, was not pertinent to this study.

Section two of the scale provides a measure of sleep difficulties experienced with each of the shifts worked and on rest days. This section is comprised of six items scored on a five-point scale ranging from "Definitely not rested" to "Extremely rested." The items ask the respondents how they feel about the amount of sleep they normally get, how well they sleep, how rested they feel after sleep, whether they ever wake earlier

than intended, whether they have difficulty falling asleep, and whether they ever feel tired (between successive morning shifts, between successive night shifts, and between successive days off). Participants were directed to respond according to their sleep habits "at this time of year." The recommended scoring method gives a total sleep disturbance score, computed by adding together all responses from the individual shift related scales. A higher score indicates a higher level of sleep disturbance.

In the original validation study, the scale showed moderate internal consistency. Alpha coefficients were calculated separately for early, late, and night shifts, and rest days, and ranged from a low of 0.76 for rest days to a high of 0.83 for early shifts. Principal components analysis of the sleep disturbance items showed a fairly consistent factor structure emerging across the two samples. A one-factor solution accounted for 46% of the total variance on rest days, 49.6% of the variance on late shifts, 54.8% of the variance on early shifts and 58.4% of the variance for night shifts.

Chronic Fatigue Measure

This three-item measure from the Survey of Shiftworkers (SOS; Tucker et al., 1998) was generated from the original 10-item chronic fatigue scale on the SSI. Two of the items examine general feelings of vigour and energy (e.g., "I generally feel I have plenty of energy") and one item, "I feel tired most of the time", taps feelings of tiredness. Respondents are asked to rate how they generally feel, irrespective of whether they have had enough sleep or have been working very hard. Psychometric properties of this three-item measure were not provided with the SOS. Reverse scoring is used such that higher scores indicate greater fatigue.

General Health Questionnaire

A classic scale developed by Goldberg (1978), the General Health Questionnaire (GHQ) is a standardized, self-administered screening test for detecting minor psychiatric disorders (i.e., nonpsychotic psychological impairment) in the general population. The GHQ comes in a number of versions of different lengths and gives a single measure of mental health over the previous few weeks. The 12-item version chosen for use in the SSI and the current study, examines four areas of functioning: self-confidence, depression, sleep loss, and problem solving. Each of the 12 items asks whether the respondent has recently experienced a particular negative (i.e., *lost much sleep over worry*) or positive (i.e., *felt capable of making decisions*) symptom or behaviour *over the past few weeks*, rated on a 4-point scale as follows: *not at all, no more than usual, rather more than usual,* and *more than usual.*

The 4-point response scale of the GHQ can be scored in two ways. The SSI uses a Likert-type scoring system for the GHQ, wherein the participant receives 0 points for a "Not at all" response, 1 point for "Same as usual," 2 points for "Rather more than usual," and 3 points for "Much more than usual." The original scoring method is known as the GHQ or binary method, wherein participants receive 0 points for a "Not at all" response, 0 points for "Same as usual," 1 point for "Rather more than usual," and 1 point for "Much more than usual." Using either method, a total score is computed, with a higher score indicating poorer psychological health. The binary method is designed to identify individuals reporting sufficient psychological distress to be probable cases of minor psychiatric disorder, with a cut-off or threshold score used to decide caseness. A recent, large-scale validation study recommends using a 3/4 cut-off or caseness threshold (i.e., scores of 3 and less are identified as non-cases while scores of 4 or more

are identified as cases; Hardy, Shapiro and Haynes, 1999). For this study, both Likert and binary scoring methods were used to enable comparison with both shiftworking and non-shiftworking populations.

The GHQ has a long history of use in survey studies and has shown good psychometric properties. Internal consistency is high, with studies reporting Cronbach's alpha ranging from .82 to .86 (Goldberg, Gater, Sartorius, Ustun, Piccinelli, Gureje, & Rutter, 1997). Concurrent validity has been investigated in psychiatric and non-psychiatric populations, with sensitivities generally reported in the low to high 80s and specificities from the low 70s to mid 80s, depending on the comparison criteria and location of study (Goldberg & Hillier, 1979; Goldberg et al., 1997). A 1989 study using the 12-item version of the GHQ found that night work had a significant negative impact on psychological well-being (Bohle & Tilley). In the Barton et al. validation study, internal consistency was good with alpha reported at 0.88 and factor analysis yielded a one-factor solution accounting for 43.3% of the total variance.

Physical Health Questionnaire

In developing the SSI a new Physical Health Questionnaire (PHQ) was created, as existing standardized questionnaires did not focus on the measurement of digestive and cardiovascular problems, which are the two health issues of greatest concern to shiftworkers. The PHQ is comprised of two subscales, one for digestive symptoms and one for cardiovascular symptoms. The items were taken from existing health measures, including the Inventory of Subjective Health (Dirken, 1967) and the Health Survey (Spence, Helmreich, & Pred, 1987), in conjunction with recommendations from gastroenterologists, cardiologists, and occupational health specialists (Barton et al.,

1995). Each of the digestive and cardiovascular subscales are comprised of eight items scored on a four-point scale ranging from "Almost Never" to "Almost Always" or "Definitely Not" to "Definitely."

In the validation study, principal components analysis of the digestive and cardiovascular symptoms specifying a two-factor solution identified two distinct factors, with symptoms loading on the appropriate subscales. Alpha coefficients of 0.76 for the cardiovascular scale and 0.86 for the digestive scale indicated good internal consistency. For the purposes of this study the two subscales were combined and an overall physical health score was computed by summing the scores. A higher score is associated with reports of poorer physical health.

Job Satisfaction Scale

The five-item job satisfaction scale measures the degree to which the respondent is satisfied and happy with her/his job. It was included for use in the SSI as there is an extensive literature on the relationship between how individuals feel about their work and their mental health. As shiftwork has often been viewed as a form of stress, it is expected that unusual hours of work may impact job satisfaction.

The items on the job satisfaction scale are scored on a seven-point Likert-type scale, with response options ranging from 'strongly disagree' to 'strongly agree.' Individual scores are summed to give an overall measure of general job satisfaction with higher scores associated with greater satisfaction. In the original SSI validation study, factor analysis found that the scale measures a unidimensional construct, with a one-factor solution explaining 59.7% of the total variance. Internal consistency was high, with an alpha coefficient of 0.83.

Social and Domestic Disruption Scale

Three items on the SSI measure the extent to which shiftwork disrupts leisure time, domestic, and non-domestic (visits to the doctor, banking, etc.) life. Respondents are asked to rate the extent to which their shift system has interfered with these aspects of their lives in the past month on a five point Likert-type scale ranging from "not at all" to "very much." Psychometric properties of this three-item measure were not provided with the SSI. The three items are summed to give a global measure of overall social and domestic disruption.

Hamilton Depression Rating Scale – 21 item

The Hamilton Depression Rating Scale is not a part of the SSI battery. However, to enable comparison with studies that have examined seasonal variations in mood at a similar latitude (e.g., Levitt, Lam, & Levitan, 2002), a pencil and paper version of the original 21-item Hamilton Depression Rating Scale (HAM-21) was added to the SSI battery.

The Hamilton Depression Rating Scale has been described as one of the most widely used depression rating scales in the world (Williams, 2001). It has several variations (e.g., the 17-item HDRS and the 29-item SIGH-SAD used specifically to measure Seasonal Affective Disorder), and a variety of formats, including structured interview, pencil and paper, and computerized administration. The HAM-21 asks respondents, "Compared to how you feel when you are in an even or normal mood state, how would you rate yourself on the following items during the past week?" Participants rate the extent to which they have experienced certain symptoms on a five-point scale ranging from "Not at all" to "Markedly or severely." Overall severity of depressive

symptoms is determined by summing the items, with a higher score indicating greater severity. A recent review of the HAM-21 by Zimmerman, Chelminski, and Pasternak (2004) recommends a cut-off level of 7 for "healthy normals." Studies using the HAM-21 to examine response or remission rates in patients with seasonal affective disorder often use a 50% or more reduction in the HAM-21 score, with a final score of 8 or less as criteria for clinically significant improvement (Levitt, Lam, & Levitan, 2002).

Data Screening

To summarize, the variables used in the analyses were:

- Neuroticism (NEUR) –independent or dependent variable
- Extraversion (EXTR) – independent variable
- Morningness (MORN) – independent variable
- Sleep Flexibility (FLEX) – independent variable
- Age (AGE) – independent variable
- Years of Shiftwork Experience (SW) – independent variable
- Years at Vancouver Airport (YVR) – independent variable
- Sleep Disturbance (SLP) – dependent variable
- Chronic Fatigue (CF) – dependent variable
- General Psychological Health (GHQ) – dependent variable
- Depressed Mood (DEP) – dependent variable
- Physical Health (PHQ) - dependent variable
- Job Satisfaction (SAT) – dependent variable
- Social and Domestic Disruption (SOC) – dependent variable

Appendix B presents descriptive statistics for the whole data set, including mean, standard deviation, median, range, and interquartile range. Appendix C presents

descriptive statistics for the Day workers group and Appendix D presents descriptive statistics for the Night workers group.

Missing Data

One individual item, which was not part of any of the scales, asked respondents to rate their workload in comparison to the average workload of other people performing a similar job. The responses could not be used, however, as a substantial number of respondents had filled it in incorrectly. The remaining scales and items were complete for the 88 individuals who completed the measures.

Outliers

Box plots of the continuous variables were examined for outliers and extreme cases. Twenty-two participants were outliers on at least one variable and three cases (16, 30, and 57) were observed to have multiple outliers. These cases were examined for 1) data error entry; 2) non-typical demographics; or 3) other evidence suggesting these participants should be removed from the sample. Examination of the questionnaires of these individuals indicated that one respondent had recently begun anti-depressant medication and another had reported a marital separation in the time between the first and second data collection periods. Rather than removing these outliers from the analysis, however, they were left in as it was felt that a "shiftwork group" could reasonably be expected to contain a subset of individuals undergoing similar experiences.

Distributions

Histograms and skewness statistics of each variable were examined for evidence of skewness or kurtosis. GHQ-Summer, DEP-Winter and DEP-Summer were moderately positively skewed (significant skewness was judged to be 2.5 times the standard error of the skewness statistic). The distributions for the remaining variables were not significantly skewed. As skewed distributions could cause violations of the assumptions underlying the regression analyses, square root transformations were conducted to reduce skewness. Each of GHQ-S, DEP-W and DEP-S were transformed and regression analyses were repeated with transformed data.

RESULTS

Research Question 1:
Are there seasonal variations in adaptation to shiftwork?

The following section examines the effects of season on seven measures of shiftwork adaptation (i.e., Sleep Disturbance, Chronic Fatigue, General Psychological Health, Depressed Mood, Physical Health, Job Satisfaction, and Social Disruption). Trait Neuroticism, which, as noted earlier has been posited to be a consequence of shiftwork, also is examined for seasonal effects. Results are presented separately for Day and Night workers, although the small sample size of Day workers allows only tentative comment.

Sleep Disturbance

Day Workers

The mean sleep disturbance scores for Day workers were 44.21 (SD=7.06) in winter and 45.64 (SD=6.19) in summer. Seasonal differences were not significant at level required using Bonferroni correction* ($t_{(12)}$= -2.869, p=.014).

Night Workers

The mean sleep disturbance score for Night workers was 48.56 (SD=9.26) in winter and it increased to 55.51 (SD=12.17) in summer. These scores are similar to

* Bonferroni correction applied to all paired samples t-tests; $p \leq .006$ required for significance.

those found by Barton et al. (1995) in their validation study of the SSI (mean=50.05), suggesting a moderate level of sleep disturbance in this sample of shiftworkers that is roughly equivalent to that found in a large sample (n=1864) of European shiftworkers.

A paired samples t-test (n=67) was significant ($T_{(66)}$=-8.156, p=.000) indicating that individuals who regularly work night shifts report that their sleep is significantly more disturbed in the summer than in the winter.

Chronic Fatigue

Day Workers

The mean chronic fatigue scores for Day workers were 8.29 (SD=2.27) in winter and 8.43 (SD=2.03) in summer, showing no significant seasonal difference ($T_{(12)}$= -1.046, p=.316).

Night Workers

The mean chronic fatigue score for Night workers in winter was 7.90 (SD=2.21) and 8.17 (SD=2.13) in summer. Seasonal differences were not significant ($T_{(66)}$ =-.815, p=. 418).

General Psychological Health

Day Workers

Using the Likert scoring system, the mean GHQ scores for Day workers were 12.50 (SD=4.03) in winter and 11.71 (SD=3.17) in summer. Scores using the binary scoring system were 1.86 (SD=2.8) in winter and 1.0 (SD=1.24) in summer, well below caseness. Seasonal differences in this group of predominantly dayshift workers were not significant ($T_{(12)}$=1.27, p=.230).

Night Workers

The mean GHQ score for Night workers in winter was 13.16 (SD=4.28), decreasing to 12.10 (SD=5.77) in summer. These scores are similar to those found by Barton et al. (1995) in their validation study of the SSI (M=12.24), but slightly higher than the mean GHQ score of 10.63 reported by Tucker, Smith, Macdonald and Folkard (1999) in their examination of the effects of 12-hr. shift schedules on health and well-being.

Using the binary scoring method, the mean GHQ score for Night workers in winter was 2.66 (SD=2.8). Although this is somewhat high compared to the mean score reported by Hardy et al. (1999) in their validation study of 551 health care service employees (M=1.27, SD=0.52), it is still below the cut-off score (i.e., greater than 3) that predicts a minor (non-psychotic) psychiatric disorder. The mean score in summer fell to 1.96 (SD=3.2).

Seasonal differences were significant in this group of regular nightshift workers, with winter associated with greater psychological distress ($T_{(66)}$=2.695, p=.006).

Depressed Mood

Day Workers

The mean Depression scores on the HAM-21 for Day workers were 12.07 (SD=7.95) in winter and 13.29 (SD=12.87) in summer, showing no seasonal differences in this group of predominantly dayshift workers ($T_{(12)}$=-.850, p=.412). An examination of the data indicated that there were two outliers in this group that had the effect of raising the mean considerably in the summer. Removing these two scores, resulted in a mean

score of 8.07 (SD=8.9), which is only marginally higher than the cut-off level of 7 recommended by Zimmerman et al. (2004).

Night Workers

The mean Depression score for Night workers in winter was 13.71 (SD=10.94), dropping to 10.76 (SD=12.52) in summer. A paired samples t-test (n=67) indicated that the increase in depression scores in the winter was statistically significant ($T_{(66)}$=3.752, p=.000).

Scores of 7 to 8 on the HAM-21 are considered within normal range. Using 8 as the cut-off score, 47% of night workers scored within normal range in the summer, while only 29% scored within normal range in the winter. Indeed, the mean depression score of night workers in winter (13.71) was only somewhat less than the baseline HAM-21 score (14.7; SD=5.2) reported by a group of subsyndromal Seasonal Affective Disorder (sub-SAD) patients in a Vancouver BC study by Lam, Tam, Yatham, Shiah, and Zis (2001). However, as would be expected, the variability in scores is much larger in the shiftwork population than in the clinical population reported by Lam et al. Moreover, only tentative comparisons can be made between these two studies, as the Lam et al. study used a structured interview format of the 29-item Hamilton Depression Rating Scale (but provided baseline scores for the 21-item HAM scale separately from the additional eight-item scale), whereas a pencil and paper self-report version of the HAM-21 was used in the present study.

Physical Health

Day Workers

The mean Cardio scores for Day Workers were 12.43 (SD=4.36) in winter and 11.71 (SD=3.50) in summer. Seasonal differences were not significant ($T_{(12)}$=1.398, p=.187). The mean Digestion score for Day Workers in winter was 14.79 (SD=5.56) and, again, 14.79 (SD=5.01) in summer.

Night Workers

The mean Cardio scores for Night workers were 10.39 (SD=3.12) in winter and 10.67 (SD=3.47) in summer, showing no seasonal differences ($T_{(66)}$=0.00, p=1.00). These scores were consistent with those reported by Barton et al. (1995) and Tucker et al. (1999) (Means=10.28 and 10.67, respectively). The mean Digestion score for Night workers was 14.27 (SD=4.39) in winter and 14.06 (SD=5.13) in summer. Again, the scores are in keeping with the digestion scores reported by Barton et al. (1995) and Tucker et al. (1999) (Mean scores=13.96 and 14.11, respectively) and there were no effects of season ($T_{(66)}$=1.009, p=.317).

Job Satisfaction

Day Workers

The mean Job Satisfaction score for Day workers was 28.14 (SD=4.28) in winter and 28.29 (SD=4.61) in summer, showing no effects of season ($T_{(12)}$=-.384, p=.708).

Night Workers

The mean Job Satisfaction scores for Night workers were 26.84 (SD=6.09) in winter and 25.94 (SD=5.98) in summer, showing no seasonal effects ($T_{(66)}$=.861, p=.392).

Social Disruption

Day Workers

The mean Social Disruption score for Day workers in winter was 7.21 (SD=2.22) and 7.43 (SD=2.03) in summer. Seasonal differences were not significant ($T_{(12)}$=-1.046, p=.316).

Night Workers

The mean Social Disruption score for Night workers in winter was 8.40 (SD=3.06) and 8.56 (SD=3.01) in summer. Seasonal differences were not significant ($T_{(66)}$=-.170, p=.866).

Neuroticism

Day Workers

The mean Neuroticism score for Day workers in winter was 12.57 (SD=2.10) and 13.00 (SD=2.51) in summer, showing no seasonal differences ($T_{(12)}$=-1.389, p=.190).

Night Workers

The mean Neuroticism score for Night workers in winter was 11.91 (SD=3.21) and 11.99 (SD=3.65) in summer, indicating no seasonal differences ($T_{(66)}$=.025, p=.980).

Summary of the Effects of Season on Adaptation to Shiftwork

To summarize the preceding section, individuals who worked predominantly dayshifts did not report significant seasonal differences on any of the measures of well-being. It should be noted that the small sample size compromised the power of these tests, however, and these results must be interpreted cautiously. In the group of employees that worked regular nightshifts, season affected three aspects of well-being. On the one hand, as hypothesized, psychological distress and depressive symptoms, as measured by the GHQ and HAM-21, were significantly elevated in the winter months. On the other hand, contrary to the hypothesis, sleep disturbance was significantly elevated in the summer months. Day and Night workers both reported relatively consistent levels of fatigue, cardiovascular and digestive problems, job satisfaction, and social and domestic disruption across the seasons. Seasonal differences in neuroticism were not observed.

Research Question 2:
How are individual difference and personality factors related to shiftwork adaptation in this group of night workers, and do these relationships show seasonal differences?

For the remaining analyses, data from the Day workers group were excluded for both theoretical and statistical reasons. Day worker data were not combined with Night worker data as, beyond the disparity in nightshifts, their work schedules differed in several significant ways (i.e., irregular as opposed to regular shifts and casual as opposed to fulltime employment). Additionally, while Day workers could be considered a group of "non-shiftworkers", information regarding employment outside of YVR was not

collected and it is possible that some of these individuals were involved in shiftwork at other places of employment. Finally, the small sample size of Day workers could cause violations of the assumptions underlying the canonical and regression analyses.

Relations Among Individual Difference Explanatory Factors and Shiftworker Well-Being: Canonical Correlations

Canonical correlation analysis (CCA) was used to examine the linear relationships among demographic variables and measures of individual differences (the independent variables), and measures of well-being or shiftwork outcome (the dependent variables). CCA is an analytic method that allows for the comparison between groups of variables. It is similar to multiple regression analysis but, rather than examining one dependent variable at a time, the procedure allows for an explanation of a set of dependent variables taken together. In the current study, I compared two groups of variables: demographic, personality, and individual difference factors (the explanatory variables) and the seven measures of shiftwork adaptation or well-being. The canonical correlation procedure finds the optimum linear combination of the measures in each of the groups of variables, and then calculates the association between the groups of variables. This is called the largest canonical correlation. The procedure then finds a second linear association between the measures in the groups of variables that are not correlated with the first combination and again calculates the association between the two groups of variables. This is called the second canonical correlation. The number of canonical correlations (also called "functions") that the procedure calculates is always equal to the number of variables in the smaller of the two variable sets, and these functions are perfectly uncorrelated (or orthogonal) with each

other. Thus, CCA produces several sets of canonical functions – similar to principal components – that are uncorrelated or orthogonal (Thompson, 1991; Dixon, 1992). CCA can assess the relations among a large number of measures using a relatively small number of statistical tests, thereby controlling the inflation of experiment-wise error rates that can occur when several univariate tests are conducted with a single sample's data (Thompson, 2000).

The correlation matrix for Night worker variables in winter is presented in Appendix E and for Night worker variables in summer in Appendix F.

In order to examine effects of season, separate CCAs were done for effects during winter and summer. Results are presented first for the variables in winter, and then for the variables in summer. For each season, canonical analyses of the full sets of independent and dependent variables are followed by analyses of smaller sets of variables chosen for theoretical reasons.

Whole Data Set

Winter and relations among explanatory factors and shiftwork adaptation

To examine the relationships among the explanatory factors and measures of adaptation to shiftwork, a CCA was run combining all seven measures of well-being (Sleep Disturbance, Psychological Distress, Depressive Symptoms, Fatigue, Physical Health Problems, Work Satisfaction, and Social Disturbance) into the dependent canonical variables, and all seven explanatory factors (Age, Shiftwork Experience, Time at YVR, Neuroticism, Extraversion, Morningness, and Sleep Flexibility) into the independent canonical variables. The results indicated that of the seven canonical

functions extracted, only the first ($r = .795$; χ^2 (49) = 114.33; $p < .0001$) was significant, accounting for 63% of the variance.

Standardized canonical function coefficients and canonical loadings (also known as "structure" coefficients) are presented in Table 2. Canonical function coefficients are analogous to beta weights or factor coefficients, and create the weighting schemes that maximize the canonical correlation (that is, the correlation between the two sets of variables, explanatory and outcome). Structure coefficients, or canonical loadings, show the correlation between scores on the observed variable and scores on the synthetic variable. The coefficients in Table 2 show that most of the relationship between the first and second set of canonical variables can be explained by a small subset of the variables. The independent canonical composite of all seven explanatory variables (AGE, SW, YVR, FLEX, MORN, NEUR, and EXTR) is most strongly correlated with three of the variables: NEUR ($r = -.776$), AGE ($r = -.585$) and EXTR ($r = .535$). In contrast, YVR ($r = -.378$), MORN ($r = -.375$), FLEX ($r = -.235$) and SW ($r = -.216$) correlate with the independent canonical composite to a much lesser extent. In terms of the dependent canonical composite, SLP ($r = -.864$) showed the strongest correlation, while PHQ ($r = -.654$), DEP ($r = -.624$), GHQ ($r = -.604$), SAT ($r = .567$), and CF ($r = -.565$) had more moderate correlations and SOC ($r = -.253$) contributed little. As statisticians generally recommend that CCA variables with canonical loadings $< |.30|$ should not be interpreted (e.g., Hair, Anderson, Tatham, & Black, 1998; Tabachnick & Fidell, 1996), FLEX, SW, and SOC cannot be said to have contributed to the overall relationship among explanatory and outcome variables.

Thus, the cluster of NEUR, AGE, EXTR, YVR, and MORN and the cluster of SLP, PHQ, DEP, GHQ, SAT, and CF accounted for most of the relationship between the

two winter canonical composites. The direction of the relationships suggest that older individuals who are more prone to negative affectivity, who are more likely to describe themselves as 'morning' types, and who have worked longer at YVR, were likely to experience more disturbed sleep, fatigue, physical and psychological difficulties than younger, more extroverted colleagues who describe themselves as 'evening' types.

Table 2. Relations among Explanatory Factors and Shiftwork Adaptation in Winter: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-.627	-.864
Chronic Fatigue	-.224	-.565
General Health Questionnaire	-.127	-.604
Depression Rating Scale	.044	-.624
Physical Health Questionnaire	-.320	-.654
Job Satisfaction	.277	.567
Social Disruption	.331	-.253
Independent Set		
Age	-.413	-.585
Shiftwork Experience	.183	-.216
YVR Experience	-.283	-.378
Neuroticism	-.629	-.776
Extraversion	.241	.535
Morningness	-.156	-.375
Sleep Flexibility	-.066	-.235

Note. Winter – Whole Data Set: $r = .795$; $\chi^2 (49) = 114.33$; $p < .0001$.

Summer and relations among explanatory factors and shiftwork adaptation

As with the winter data, an initial CCA was run combining the adaptation variables of Sleep Disturbance, Psychological Distress, Depressive Symptoms, Fatigue, Physical Health Problems, Work Satisfaction, and Social Disturbance into the dependent

canonical composite, and the explanatory variables of Age, Shiftwork Experience, Time at YVR, Neuroticism, Extraversion, Morningness, and Sleep Flexibility into the independent canonical composite. The results indicated that of the seven canonical functions extracted only the first ($r = .778$; $\chi^2 (49) = 115.694$; $p < .0001$) was significant, accounting for 61% of the variance. Canonical coefficients for both sets of variables are presented in Table 3. Canonical loadings, also presented in Table 3 show that most of the relationship between the first and second set of canonical variables can be explained by a subset of the variables similar to those seen in the winter data. Once again, the independent canonical composite of AGE, SW, YVR, FLEX, MORN, NEUR, and EXTR correlates most strongly with NEUR (r = -.611), EXTR (r = .572), and AGE (r = -.548), correlates more moderately with YVR (r = -.445), SW (r = -.423), and MORN (r = -.409), and correlates very little with FLEX (r = -.278). The dependent canonical composite of adaptative functioning variables SLP, CF, GHQ, DEP, PHQ, SAT, and SOC correlates most strongly with SLP (r = -.812), more moderately with SAT (r = .536), PHQ (r = -.553), CF (r = -.510), GHQ (r = -.468), and DEP (r = -.345) and very little with SOC (r = -.068).

The results of this omnibus test of the relationships among the explanatory and outcome variables in the summer were virtually identical to the results found with the winter data. Once again we see that older individuals who are more prone to negative affectivity, are more likely to describe themselves as 'morning' types, have worked longer at YVR and have more shiftwork experience are more likely to report disturbed sleep, fatigue, physical and psychological difficulties and to be less satisfied with work, than their younger, more extroverted colleagues who describe themselves as 'evening' types. There were two slight differences in the winter/summer data. Firstly, while shiftwork experience contributed very little to the winter canonical (r=.216), it did make a

moderate contribution to the summer canonical (r=.423). Secondly, depression loaded somewhat more on the winter canonical (r=-.624) than on the summer canonical (r=-.345).

Table 3. Relations among Explanatory Factors and Shiftwork Adaptation in Summer: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-.650	-.812
Chronic Fatigue	-.156	-.510
General Health Questionnaire	-.375	-.468
Depression Rating Scale	.412	-.345
Physical Health Questionnaire	-.390	-.553
Job Satisfaction	.315	.536
Social Disruption	.373	-.068
Independent Set		
Age	-.111	-.548
Shiftwork Experience	-.215	-.423
YVR Experience	-.125	-.445
Neuroticism	-.661	-.611
Extraversion	.490	.572
Morningness	-.234	-.409
Sleep Flexibility	-.044	-.278

Note. Summer – Whole Data Set r = .778; χ^2 (49) = 115.694; p < .0001

Relations Among Personality, Morningness, Sleep Flexibility, and Shiftwork Adaptation

Winter

Against the general background of relations among the variables, further canonical correlation analyses were run using subsets of the independent variables.

The first subset examined the relationships among the 'individual differences' variables of neuroticism, extraversion, morningness and sleep flexibility, and the outcome variables of sleep disturbance, chronic fatigue, psychological health, depression, physical health, job satisfaction, and social disruption. The results indicated that of the four canonical functions extracted only the first ($r = .746$; $\chi^2 (28) = 72.768$; $p < .0001$) was significant, accounting for 56% of the total variability extracted by the four roots. Canonical coefficients and canonical loadings are presented in Table 4. An examination of the canonical loadings shows that the independent canonical composite correlates most strongly with NEUR ($r = -.920$), and with EXTR ($r = - .476$) and MORN ($r = -.380$) to a much lesser extent. In turn, the dependent canonical composite correlates more strongly with DEP ($r = -.785$), PHQ ($r = -.754$), GHQ ($r = -.733$), and SLP ($r = -.713$) and more moderately with SAT ($r = .582$) and CF ($r = -.498$). Neither FLEX ($r = -.259$) nor SOC ($r = -.211$) made a significant contribution to their respective canonical composites.

In summary, the individual difference factors of NEUR, EXTR, and MORN, and the adaptation factors DEP, PHQ, GHQ and SLP accounted for most of the relationship between the two canonical composites.

The direction of the relationships once again showed that morning-type individuals who are more prone to experience negative affect are likely to experience greater disturbances in sleep and to report more physical and psychological difficulties than evening-type colleagues who were less prone to negative affectivity. Extraversion appeared to have a moderate buffering effect.

Table 4. Relations Among Personality, Morningness, Sleep Flexibility and Shiftwork Experience in Winter: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-.303	-.713
Chronic Fatigue	-.209	-.498
General Health Questionnaire	-.214	-.733
Depression Rating Scale	-.167	-.785
Physical Health Questionnaire	-.367	-.754
Job Satisfaction	.317	.582
Social Disruption	.328	-.211
Independent Set		
Neuroticism	-.834	-.920
Extraversion	.285	.476
Morningness	-.117	-.380
Sleep Flexibility	-.201	-.259

Note. Winter – Individual Differences: r =.746; χ^2 (28) = 72.768; p < .0001.

Summer

The first subset of summer variables examined the relationships among the 'individual differences' variables NEUR, EXTR, MORN, and FLEX, and the outcome variables, SLP, CF, GHQ, DEP, PHQ, SAT, and SOC. The results indicated that of the four canonical functions extracted only the first (r =.740; χ^2 (28) = 82.122; p < .0001) was significant. The individual differences variables accounted for 54.8% of the total variability extracted by the four roots. Canonical coefficients and canonical loadings are presented in Table 5. An examination of the canonical loadings shows that the independent canonical composite correlates most strongly with NEUR (r = -.730), and with EXTR (r = .514), MORN (r = -.415) and FLEX (r = -.345) to a lesser extent. The

dependent canonical composite correlates strongly with SLP (r = -.790) and moderately with GHQ (r = -.610), SAT (r = .604), PHQ (r = -.585), CF (r = -.577) and DEP (r = -.475), while SOC (r = -.206) contributed little.

Table 5. Relations among Personality, Morningness, Sleep Flexibility and Shiftwork Experience in Summer: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-.574	-.790
Chronic Fatigue	-.220	-.577
General Health Questionnaire	-.466	-.610
Depression Rating Scale	.306	-.475
Physical Health Questionnaire	-.286	-.585
Job Satisfaction	.277	.604
Social Disruption	.258	-.206
Independent Set		
Neuroticism	-.768	-.730
Extraversion	.564	.514
Morningness	-.249	-.415
Sleep Flexibility	-.133	-.345

Note. Summer – Individual Differences r = .740; χ^2 (28) = 82.122; p < .0001

In general, the patterns of interactions among the variables in summer were markedly similar to the patterns in winter, although depression made a smaller contribution to the dependent canonical composite in the summer (r = -.475) than in the winter (r = -.785). Neuroticism continued to be the strongest contributing variable to the independent canonical composite in both summer and winter, while sleep flexibility continued to contribute the least. Overall, the directions of the relationships suggest again that individuals who are more prone to experience negative affectivity and who are morning types, are more likely to report more disturbed sleep, less job satisfaction, and

more physical and mental health difficulties in the summer than their evening-type colleagues who are less prone to negative affectivity. As in winter, extraversion appears to have a moderate buffering effect.

Relations Among Age and Experience and Shiftwork Adaptation

Winter

To examine the ways in which age, shiftwork experience, and years of YVR airport work may be associated with shiftwork outcome, a CCA was run combining AGE, SW, and YVR into the independent canonical composite and SLP, CF, GHQ, DEP, PHQ, SAT, and SOC into the dependent canonical composite. The results indicated that of the three canonical functions extracted only the first ($r = .653$; $\chi^2 (21) = 51.795$; $p < .0001$) was significant. The age and experience variables accounted for 42.6% of the total variability extracted by the four roots. Canonical coefficients and canonical loadings are presented in Table 6. An examination of the canonical loadings shows that the independent canonical composite correlates strongly with AGE ($r = -.974$) and moderately with YVR ($r = -.458$) and SW ($r = -.444$). In turn, the dependent canonical composite correlates most strongly with SLP ($r = -.920$) and less strongly with CF ($r = -.460$). All of the remaining dependent variables (SAT, SOC, PHQ, GHQ, or DEP) had correlations $< |.30|$ and therefore cannot be considered to be significantly correlated with the dependent composite.

Thus, the cluster of AGE, SW and YVR, and the cluster of SLP and CF, appear to account for most of the relationship between the two canonical composites, with older individuals having more shiftwork experience and more years at YVR reporting greater sleep disturbance and fatigue in winter than their younger, less experienced colleagues.

Table 6. Relations Among Age and Experience and Shiftwork Adaptation in Winter: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-1.129	-.920
Chronic Fatigue	-.120	-.460
General Health Questionnaire	.031	-.210
Depression Rating Scale	.412	-.143
Physical Health Questionnaire	-.071	-.255
Job Satisfaction	.017	.285
Social Disruption	.197	-.264
Independent Set		
Age	-.963	-.974
Shiftwork Experience	.140	-.444
YVR Experience	-.271	-.458

Note. Winter – Age and Experience: $r = .653$; $\chi^2 (21) = 51.795$; $p < .0001$

Summer

When a CCA was run combining AGE, SW, and YVR into the independent canonical composite and SLP, CF, GHQ, DEP, PHQ, SAT, and SOC into the dependent canonical composite for effects in summer, the results indicated that of the three canonical functions extracted only the first ($r = .588$; $\chi^2 (21) = 45.513$; $p < .001$) was significant. Canonical coefficients and canonical loadings are presented in Table 7. Canonical loadings indicate that AGE ($r = -.973$) and SLP ($r = -.893$), and to a lesser extent SW ($r = -.536$) and YVR ($r = -.488$), account for most of the relationship between the two canonical composites. None of the remaining outcome variables make a measurable contribution to the dependent canonical composite.

Once again, the findings for the winter and summer data are very similar and indicate that older individuals with more years of shiftwork experience and more years at YVR are more likely to suffer from disturbed sleep in summer. The only difference between the summer and winter subsets was that chronic fatigue made a moderate contribution to the winter (r = -.460), but not the summer canonical (r = -.180).

Table 7. Relations Among Age and Experience and Shiftwork Adaptation in Summer: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-.991	-.893
Chronic Fatigue	.157	-.180
General Health Questionnaire	.052	-.017
Depression Rating Scale	.093	-.111
Physical Health Questionnaire	-.123	-.217
Job Satisfaction	.168	.206
Social Disruption	.446	.207
Independent Set		
Age	-.922	-.973
Shiftwork Experience	.045	-.536
YVR Experience	-.260	-.488

Note. Summer – Age and Experience: r =.588; χ^2 (21) = 45.513; p < .001

Neuroticism as Outcome

Winter

To examine the concept of neuroticism as an outcome of shiftwork, rather than as an enduring personal style, a CCA was run with NEUR removed from the independent canonical variable and combined into the dependent canonical variable for

winter shiftwork. The results indicated that of the six possible pairs of canonical functions only the first was significant (r=.719; χ^2 (48) = 77.237; p < .005), accounting for 52% of the variance. (In comparison, when neuroticism was included in the independent canonical variable, the resulting canonical function accounted for 63% of the variance.) Canonical coefficients for both sets of variables are presented in Table 8.

Table 8. Neuroticism as Outcome in Winter: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-1.024	-.913
Chronic Fatigue	-.155	-.519
General Health Questionnaire	-.023	-.284
Depression Rating Scale	.359	-.224
Physical Health Questionnaire	-.138	-.316
Job Satisfaction	.260	.482
Social Disruption	.288	-.269
Neuroticism	.106	-.312
Independent Set		
Age	-.699	-.850
Shiftwork Experience	.155	-.361
YVR Experience	-.345	-.445
Extraversion	.327	.633
Morningness	-.265	-.387
Sleep Flexibility	.008	-.203

Note. Winter – Neuroticism as Outcome: r=.719; χ^2 (48) = 77.237; p < .005

The standardized function coefficient for neuroticism (.106) shows that when neuroticism is defined as an outcome measure, it makes a weak contribution to the canonical function. Similarly, the canonical loading or structure coefficient (r=-.312) indicates that

neuroticism contributed little to the dependent composite in relation to sleep disturbance (r = -.913), chronic fatigue (r = -5.19), or job satisfaction (r = .482).

Summer

When a CCA was run with NEUR removed from the independent canonical variable and combined into the dependent canonical variable for summer shiftwork, the results indicated that of the six possible pairs of canonical functions only the first was significant (r=.732; χ^2 (48) = 93.119; p < .0001). Canonical coefficients for both sets of variables are presented in Table 9. Canonical loadings show that NEUR contributes less (r = .144) to the dependent canonical composite in the summer than in the winter (r = -.312). Showing a pattern of interrelationships similar to winter, the dependent canonical composite correlates moderately with SLP (r = -.665), SOC (r = .316), CF (r = -.306) and with DEP (r = .179), PHQ (r = -.174), NEUR (r = .144), SAT (r = .132) and GHQ (r = .083) to a lesser extent. The independent canonical composite correlates strongly with EXTR (r = .860) and with AGE (r = -.634), SW (r = -.625), YVR (r = -.488) and MORN (r = -.365) to a lesser extent. As a dependent variable, neuroticism contributes little to the relationship between the outcome and explanatory variables during summer shiftwork. Further, when neuroticism is removed from the independent canonical variable, the remaining explanatory variables show little relationship to levels of mood, physical health or psychological distress.

According to these analyses, neuroticism is a more powerful component in the independent variable composite of longstanding personal style than in the dependent variable composite of adaptive outcome. Indeed, the contribution of neuroticism in the predictor composite is significant enough in both winter and summer that, when

removed, the remaining explanatory variables show little relationship to the outcome composite. Thus, neuroticism appears to be both an independent and significant predictor of shiftwork adaptation in both winter and summer shiftwork.

Table 9. Neuroticism as Outcome in Summer: Canonical Correlations

Canonical Variables	Standardized Function Coefficients	Structure Coefficients
Dependent Set		
Sleep Disturbance	-.805	-.665
Chronic Fatigue	-.165	-.306
General Health Questionnaire	-.265	.083
Depression Rating Scale	.607	.179
Physical Health Questionnaire	-.389	-.174
Job Satisfaction	.252	.132
Social Disruption	.509	.316
Neuroticism	.458	.144
Independent Set		
Age	-.165	-.634
Shiftwork Experience	-.336	-.625
YVR Experience	-.071	-.488
Extraversion	.671	.860
Morningness	-.220	-.365
Sleep Flexibility	.112	-.055

Note. Summer – Neuroticism as DV: r=.732; χ^2 (48) = 93.119; p < .0001.

Summary of Canonical Correlation Analyses

To summarize the results of the canonical correlation analyses, a markedly similar pattern of interrelationships among the explanatory factors and adaptation to shiftwork was found during summer and winter. The analyses suggested that in both winter and summer the strongest relationships exist between 1) individual difference variables of neuroticism, extraversion, morningness and sleep flexibility and outcomes of

depression, physical health, psychological distress, and sleep; and 2) the age and experience variables and sleep outcomes. Most of the findings are consistent with the a priori hypotheses, while some were unexpected. As predicted, the results indicated that individuals scoring higher on negative affectivity (neuroticism) reported overall poorer adaptation to shiftwork, including greater disruption in sleep cycles and poorer physical and psychological health. However, while increased age was associated with higher reported sleep disturbance, its association with the other outcome variables was strong only in combination with the other predictor variables, particularly neuroticism and extraversion. This pattern of results was true in terms of the role of shiftwork experience as well, in which more experience was associated with greater sleep disturbance but was only weakly related to other measures of shiftwork adaptation. Also as predicted, morningness was shown to be associated with poorer shiftwork adaptation overall. Contrary to prediction, sleep flexibility was not associated with better shiftwork adaptation.

Effects of Season

The CCA results suggest that there were only small seasonal differences in the patterns of relationships among the explanatory and outcome variables. Firstly, shiftwork experience was shown to have a somewhat stronger role as an explanatory variable in the summer than in the winter, although across both seasons it had only minimal to moderate predictive value. Secondly, depression was somewhat better predicted by the explanatory variables in the winter, than in the summer, although its contribution in the winter was small compared to that made by sleep disturbance.

Finally, while age and experience had moderate explanatory power in regard to levels of chronic fatigue in the winter, they were not predictive of chronic fatigue in the summer.

Factors that Predict Adaptation to Shiftwork: Multiple Regression Analyses

As a final exploration of the specific relationships between the outcome and explanatory variables, a multiple linear regression analysis was conducted for each dependent measure. Predictor variables entered were AGE, SW, YVR, NEUR, EXTR, MORN, and FLEX. A stepwise regression model was used, with entry criterion set at .05 and removal criterion set at .10. As indicated in the Data Screening section, analyses were run first with the original Night workers data set, then with the removal of multivariate outliers, and finally with the transformed data set. However, as there were no substantial differences in the multiple regression analyses with transformed data, only the results using absolute data are discussed.

Predicting Sleep Disturbance in Winter and Summer

In predicting winter sleep disturbance, of the seven explanatory variables, AGE, NEUR, and EXTR emerged as the best predictors (R^2 = .502). Similarly, summer sleep disturbance was best predicted by the variables AGE, NEUR, and EXTR (R^2 = .455). Table 10 sets out the regression analyses for summer and winter.

Table 10. Predicting Sleep Disturbance in Winter and Summer: Multiple Regression Analysis

Independent Variables	Beta	*t*	sig.
Sleep Disturbance–Winter			
Age	.482	5.220	.000
Neuroticism	.334	3.775	.000
Extraversion	-.188	-2.020	.047
Sleep Disturbance-Summer			
Age	.345	3.447	.001
Neuroticism	.382	4.121	.000
Extraversion	-.330	-3.291	.002

Note. Sleep Disturbance-Winter: Model R2 = .502; F(3,66) = 22.188, p < .001
Sleep Disturbance-Summer: Model R2 = .455; F(3,66) = 18.365, p < .001

Predicting Chronic Fatigue in Winter and Summer

Years of experience at YVR and neuroticism emerged as the best predictors of chronic fatigue in winter (R^2 = .237) and summer (R^2 = .185). Table 11 displays the final regression results.

Table 11. Predicting Chronic Fatigue in Winter and Summer: Multiple Regression Analysis

Independent Variables	Beta	*t*	sig.
Chronic Fatigue-Winter			
YVR Experience	.376	3.502	.001
Neuroticism	.271	2.523	.014
Chronic Fatigue-Summer			
Neuroticism	.343	3.082	.003
YVR Experience	.261	.2.750	.008

Note. Chronic Fatigue-Winter: Model R^2 = .237; F(2, 67) = 10.391, p < .001
Chronic Fatigue-Summer: Model R^2 = .185; F(2, 67) = 7.582, p = .001

Predicting Physical Health in Winter and Summer

In predicting winter physical health, of the seven explanatory variables neuroticism and sleep flexibility emerged as the best predictors (R^2 = .347). Similarly, in the summer, physical health was best predicted by neuroticism, YVR experience, and sleep flexibility (R^2 = .275). Table 12 displays the final results.

Table 12. Predicting Physical Health in Winter and Summer: Multiple Regression Analysis

Independent Variables	Beta	*t*	sig.
Physical Health-Winter			
Neuroticism	.542	5.483	.000
Sleep Flexibility	.206	2.079	.041
Physical Health-Summer			
Neuroticism	.377	3.557	.001
YVR Experience	.233	2.223	.030
Sleep Flexibility	.213	2.008	.049

Note. Physical Health-Winter: Model R^2 = .347; $F(2, 67) = 17.770$, $p < .001$
Physical Health-Summer: Model R^2 = .275; $F(3, 66) = 8.362$, $p < .001$

Predicting Psychological Distress in Winter and Summer

Neuroticism was the sole explanatory variable to account for a significant proportion of the variance in winter-time psychological distress (R^2 = .294). In the summer, neuroticism and sleep flexibility emerged as the best predictors of psychological distress (R^2 = .350). Table 13 displays the final regression analyses.

Table 13. Predicting Psychological Distress in Winter and Summer: Multiple Regression Analysis

Independent Variables	Beta	*t*	sig.
Psychological Distress - Winter			
Neuroticism	.542	5.323	.000
Psychological Distress - Summer			
Neuroticism	.495	4.976	.000
Sleep Flexibility	.261	2.619	.011

Note. GHQ-Winter: Model R^2 = .294; F(1, 68) = 28.336, $p < .001$
GHQ-Summer: Model R^2 = .350; F(2, 67) = 18.027, $p < .001$

Predicting Depressive Symptoms in Winter and Summer

Neuroticism emerged as the best predictor of depressive symptoms in both winter (R^2 = .358) and summer (R^2 = .247). Table 14 displays the final regression analyses.

Table 14. Predicting Depressive Symptoms in Winter and Summer: Multiple Regression Analysis

Independent Variables	Beta	t	sig.
Depression-Winter			
Neuroticism	.599	6.164	.000
Depression-Summer			
Neuroticism	.497	4.727	.000

Note DEP-Winter: Model R^2 = .358; F(1, 68) = 37.995, $p < .001$
DEP-Summer: Model R^2 = .247; F(1, 68) = 22.344, $p < .001$

Predicting Job Satisfaction in Winter and Summer

In both winter and summer, morningness and neuroticism emerged as the best predictors of job satisfaction (R^2 = .211 and .272, respectively). Table 15 displays the final regression analyses.

Table 15. Predicting Job Satisfaction in Winter and Summer: Multiple Regression Analysis

Independent Variables	Beta	t	sig.
Job Satisfaction-Winter			
Morningness	-.336	-3.031	.003
Neuroticism	-.254	-2.297	.025
Job Satisfaction-Summer			
Neuroticism	-.414	-3.968	.000
Morningness	-.295	-2.829	.006

Note. Job Satisfaction-Winter: Model R^2 = .211; F(2, 67) = 8.984, $p < .001$
Job Satisfaction-Summer: Model R^2 = .272; F(2, 67) = 12.545, $p < .001$

Predicting Social Disturbance in Winter and Summer

Neuroticism emerged as the best predictor of social disturbance in the winter (R^2 = .083), while sleep flexibility was the strongest predictor of social disturbance in the summer (R^2 = .082). Table 16 displays the final regression analyses.

Table 16. Predicting Social Disturbance in Winter and Summer: Multiple Regression Analysis

Independent Variables	Beta	t	sig.
Social Disturbance-Winter			
Neuroticism	.288	2.480	.016
Social Disturbance-Summer			
Sleep Flexibility	.286	2.458	.017

Note. Social Disturbance-Winter: Model R^2 = .083; F(1, 68) = 6.151, p = .016
Social Disturbance-Summer: Model R^2 = .082; F(1, 68) = 8.445, p = .017

Summary: Predicting Adaptation to Shiftwork

The multiple regression analyses show a markedly similar pattern of relationships in summer and winter among the predictor variables and sleep disturbance, chronic fatigue, depression, and job satisfaction. The main finding was that neuroticism was the only significant predictor of all outcomes except social disturbance across both seasons.

Some small seasonal differences were apparent in the relationships among the predictor variables and social disturbance, psychological distress, and physical health. Specifically, while neuroticism was the only variable that accounted for a significant amount of the variance in social disturbance in winter, sleep flexibility was the only predictor of social disturbance in summer. However, neither variable accounted for a substantial amount of the variance in social disturbance (i.e., about eight percent). Similarly, sleep flexibility and neuroticism were the best predictors of psychological distress in summer, while only neuroticism was a significant predictor of psychological distress in winter. Again, however, sleep flexibility made only a small contribution to the regression equation. Finally, the length of time that people were employed at YVR

proved to be a minor predictor of physical health in summer but was not a predictor of physical health in winter.

The results suggest that in both summer and winter shiftworkers who are more prone to negative affectivity are more likely to report poorer adaptation to shiftwork. While extraversion appeared to provide somewhat of a buffer against sleep disturbance, it was not a significant predictor of any of the other outcome variables. Similarly, although the regression analyses also indicated that older shiftworkers report a higher level of sleep disturbance than their younger colleagues, age was not a significant predictor of other measures of shiftwork adaptation. An interesting finding was that, contrary to the hypothesis, when social disturbance, physical complaints and psychological distress were analyzed individually, sleep flexibility actually predicted poorer adaptation to shiftwork. Finally, while morningness was predictive of lower job satisfaction, it was not predictive of other measures of shiftwork outcome.

DISCUSSION

In Canada, and across North America and Europe, almost 30% of the work force works some type of shiftwork. While some individuals (about 10%) choose shiftwork over regularly scheduled day work, for most people it is a requirement of the job. It has been well documented that, due to circadian, environmental, and social factors, shiftwork can have deleterious effects on health and well-being, with many shiftworkers exhibiting chronic physical and psychological health problems. However, it also is apparent that individuals differ in their ability to adapt to and tolerate shiftwork. Consequently, substantial research has sought to identify factors within the individual and in the work and home environment that may affect adaptation to shiftwork. This study appears to be the first to empirically examine whether seasonal changes in daylight hours may be a factor in shiftwork adaptation.

Evidence of Seasonality in Shiftwork Adaptation

The results of this study provided support for the hypothesis that adaptation to shiftwork would be more difficult in the winter months when, in Vancouver, BC, daylight hours are at their shortest. There were three aspects of well-being where seasonal differences in shiftwork adaptation were found: general psychological health, depressed mood, and sleep. Seasonal differences in both depressive symptoms and mental health were in the hypothesized direction, with greater disturbances reported in winter than in summer. In contrast, shiftworkers reported that their sleep was more disturbed in the summer.

Psychological well-being or mental health (i.e., self-confidence, depression, sleep loss and problem solving) was measured using the General Health Questionnaire (GHQ), which can be scored using either a Likert (0123) or a binary (0011) scoring system. In comparison to the shiftworker norms available from the Standard Shiftwork Index, the psychological well-being of this group of Canadian shiftworkers was about the same as that reported by large groups of shiftworkers working, primarily, in the United Kingdom (Barton et al., 1995). When the binary scoring method was used to compare participants in the current study with other, non-shiftwork samples, 31% of the night workers exceeded the 3/4 cut-off for distress on the GHQ-12 during the winter months, while fewer than 19% reached that level in the summer. As discussed earlier, an extensive multi-site study found that scores above the cut-off on the GHQ-12 predicted the presence of a minor DSM-IV psychiatric disorder with high accuracy (Hardy, Shapiro and Haynes, 1999). This suggests that during the winter months, 31% of the night workers in this study were suffering from emotional disturbance to the extent that they may have qualified for a diagnosis of an anxiety or mood disorder at the time of the assessment.

A prevalence rate of 31% for emotional disorder is high. In the multi-site Hardy et al. study, the overall prevalence of psychiatric illness in health care workers from 19 health care locations was 22%. Similarly, a 1997 WHO study using the GHQ-12 cited a psychiatric illness prevalence rate of 19.5% across 15 international cities (Goldberg et al., 1997). Thus, while the summer time prevalence rate of minor psychiatric disorders in the current study is about the same as that found in other general populations, the winter rate is substantially higher, at 1.63 times the summer rate.

In summary, it appears that across both seasons nightshift workers in the current study are experiencing levels of psychological distress that are similar to those reported by shiftworkers in the U.K. In the summer months, the rate of distress for these shiftworkers is about the same as that reported in the general population. However, the picture changes considerably in the winter months, when the prevalence rate for a probable minor psychiatric disorder (e.g., anxiety or depression) in this group of Canadian shiftworkers is noticeably higher than expected in the general population.

Nightshift workers in the current study also reported significantly more depressive symptoms in the winter months than in the summer, although across both seasons levels of depressive symptoms were higher than expected in a non-clinical population. The mean depression scores of 10.7 (SD=12.6) in the summer and13.8 (SD=10.9) in the winter, as measured by the 21-item Hamilton Depression Rating Scale, appear high when considering the cut-off score of 7 recommended for "healthy normals" (Zimmerman, Chelminski, and Pasternak, 2004). In their review of 27 studies that measured depression in healthy controls, Zimmerman et al. reported that at least 84% of healthy controls scored 7 or less on the HAM-21, while 97.5% scored 10 or less, on the same measure. In contrast, in the current study, only 47% of shiftworkers scored in the normal range during the summer, and in the winter that figure dropped even further, with only 29% of shiftworkers scoring in the normal range. This means that in the winter months, over 70% of shiftworkers were experiencing depressive symptoms in the higher than normal range. Indeed, the overall level of depressive symptoms in the winter was only somewhat less than the mean baseline HAM-21 score reported for a group of subsyndromal-SAD patients seeking light therapy treatment for depression in a 2001 Vancouver BC study by Lam et al. (M=14.7, SD=5.2), and was higher than that reported

in a similar 2002 study by Levitt et al. (M=12.9; SD=3.0). Of course, it is important to note the high variability in shiftworker scores compared with the clinical sample, reflecting both the homogeneity of the clinical sub-SADs sample and the diversity in shiftworkers' coping and adaptation to shiftwork. As discussed earlier, differences in administration of the HAM-21 do not allow for definitive comparisons to be made regarding the level of depressive symptomatology across these three different studies. Consequently, it is possible that the self-report pencil and paper format used in this study inflated the rate of depressive symptomatology. However, together with the results from the GHQ, these findings do provide further evidence of the negative impact of shiftwork on mood and mental health. Importantly, they also provide strong evidence of seasonal variations in shiftwork adaptation, with mood and overall distress in this group of nightshift workers significantly worse in the winter months.

There may be reasons for the seasonal malaise seen in these shiftworkers that are related to the specific timing of the assessments but are unrelated to daylength. Firstly, winter data was collected shortly before and after the Christmas season, and a holiday-related rise in psychological distress in both clinical and non-clinical populations has been documented in the research literature (for example, see Friedberg, 1991 and Jessen et al., 1999). Varying explanations have been given for this phenomenon, including socioeconomic, physiological, and biological stressors, with the role of the family having been singled out as a particularly salient factor during the Christmas season (David, 1993). Certainly, Christmas is a season that for many people is associated with increased social and family demands, and it is not difficult to imagine that this could be particularly stressful for shiftworkers who routinely state that their relationships already suffer due to their atypical working hours. In addition, given that

shiftworkers often suffer from sleep deprivation, the additional demands on time and energy throughout the holiday season may feel particularly overwhelming. Of course, it also is the case that some people find their mood is uplifted during the holiday season, while still others (including those who do not celebrate Christmas) are relatively unaffected by the holiday. Moreover, some studies dispute the traditional claim that Christmas is a time of increased psychological distress (for example, see, Velamoor, Cernovsky, and Voruganti, 1999). In addition, it should be noted that for the current study data collection stopped about one week before Christmas and did not start again until early January. In any event, while it is unlikely that Christmas alone would be responsible for the high rate of winter distress, the fact that the Christmas season coincides with winter solstice and the shortest day of the year, does add a layer of complexity when trying to parcel out the effects of season and daylength on mood.

Another factor that may have contributed to the seasonal malaise found in this study is the increased workload experienced by airport workers over the Christmas and New Year season. The holiday season in Vancouver frequently brings adverse weather conditions in conjunction with a steep increase in travellers, creating one of the busier and more demanding times of year for airport employees. High job demands (i.e., work overload) can exhaust employees' mental and physical resources and lead to health problems or burnout (e.g., Demerouti, Bakker, Nachreiner, & Schaufeli, 2001). However, other workplace characteristics, such as adequate employee resources, have been shown to act as protective factors against the stress caused by high workplace demands (Bakker, Demerouti, de Boer, & Shaufeli, 2003) and responses on the job satisfaction scale suggest that the majority of participants in this study were reasonably satisfied with their work conditions (e.g., more than 90% of participants agreed that they

were very satisfied with their job). As well, if seasonally related changes in work demands were of significant concern, one would expect to have found some seasonal variation in the measure of job satisfaction.

It seems unlikely, then, that the winter increases in depressed mood and distress reported in this study are entirely attributable to greater social and workplace demands. Moreover, as these factors are not unique to shiftwork, one might expect to see the prevalence of seasonal distress to be similar in non-shiftwork populations. Future studies of seasonal variations in adaptation to shiftwork would benefit from the addition of a non-shiftwork comparison group from a similar work environment. This could help clarify whether particular aspects of the YVR environment contributed to the seasonal effects found in this study, or whether shiftworkers in general may be uniquely vulnerable to seasonal fluctuations in mood and psychological well-being.

Sleep and Seasonality: The Problem of Summer Sleep

One of the interesting findings in this study, contrary to my hypothesis, was that shiftworkers reported sleep that was more disturbed in the summer than in the winter. While mood and mental health were worse in the winter, people still reported that they were sleeping better. Through informal conversations with the participants, it was readily apparent that many people found it more difficult to fall asleep and stay asleep in the summer months. Typically, night workers described feeling that sleep was problematic in summer because of problems with noise, increased social activities, and light. As one worker said, "I just can't seem to get to bed (in the summer)...the kids are outside playing...I can hear them...I just can't sleep." Other shiftworkers described having to sacrifice their sleep if they wanted to have time alone with their partners during

summer when school holidays meant children also were staying up later. Many blamed excess noise from the lawn mowers, weed eaters, and leaf blowers that are ubiquitous throughout the West coast growing season. Although a few participants commented on the excess daylight, most said that they had dark curtains and were able to block out the light when they wanted to sleep. Interestingly, while shiftworkers reported that their sleep was disrupted more frequently during the summer, they also indicated that it didn't "get them down" the way it did in the winter. This seems to suggest a beneficial effect of light on mood, even if sleep is disrupted.

Seasonal Variation in Shiftwork and Seasonal Affective Disorder

Some interesting parallels can be drawn between the mood and sleep disturbances reported by night workers in this study and the symptoms reported by patients suffering from seasonal affective disorder (SAD) or subsyndromal SAD. (Sub-SAD patients show the same pattern of symptoms as SAD patients but do not meet criteria for major depression). Seasonal affective disorder is classified in the DSM-IV as a seasonal pattern of major depressive episodes that typically (but not always) begin in fall or winter and peak in spring. The literature describes atypical depressive symptoms in SAD and sub-SAD patients that include hypersomnia, overeating, and weight gain. Thus, along with lower mood, SAD and sub-SAD patients report that they sleep more, eat more, and gain more weight in the winter.

As discussed earlier, in the present study night workers reported wintertime levels of depressive symptoms roughly equivalent to those reported by sub-SAD patients actively seeking help for depression. One of the criteria used to assess remission in SAD patients is a 50% or greater reduction in HAM-21 scores, with a final score within

normal range (Levitt, Lam & Levitan, 2002). Using this benchmark, about 22% of night workers in this study experienced a remission in their depressive symptoms in the summer months. Specifically, they scored within the depressed range in the winter months and had at least a 50% reduction in symptoms in the summer months sufficient to bring their scores into the normal range. Participants in the current study were not diagnosed for SAD; however, the fact that 22% of night workers reached criteria for the seasonal mood changes associated with SAD is striking, particularly given that the prevalence rate of sub-SAD has been estimated to be between 5 and 10% in the general population (e.g., Chotai, Smedh, Nilsson, & Adolfsson, 2004; Haggarty et al., 2002; Levitt et al., 2002).

A parallel also can be drawn between the seasonal sleep patterns reported by SAD patients and the seasonal sleep disturbance reported by shiftworkers in the current study. SAD patients typically report that they "sleep more than usual" in the winter months while, in a somewhat similar vein, shiftworkers reported that their sleep was less disturbed in the winter. Whether shiftworkers, too, would report that they sleep more than usual in the winter and, importantly, whether this would be reported as problematic is unclear and awaits further study.

Finally, as with SAD, concerns about weight gain and overeating are frequently reported in shiftwork literature. Unfortunately, there is no valid way of assessing seasonal differences in weight gain or eating habits from this study. One question on the physical health questionnaire is related to weight gain, but refers to changes noted since beginning shiftwork (i.e., "Do you feel you have put on too much weight since beginning shiftwork?"). Participants responded to this question in much the same way in summer as in winter, and in the main they reported that they did feel they had put on too

much weight. Whether or not there is a seasonal pattern in the eating habits and weight gain of shiftworkers is another question that calls for further study.

It is important to note that this study did not specifically assess shiftworkers for SAD or symptoms of SAD. Moreover, the intent of this study was neither to pathologize the routine difficulties workers have in adapting to shiftwork, nor to minimize the debilitating effects of SAD. However, the similarities between seasonal affective disorder and the mood, appetite, and sleep dysregulation reported by this group of shiftworkers are compelling and suggest some potentially important avenues of research. While researchers have compared depressive symptoms in shiftworkers and "traditional" workers (e.g., Goodrich and Weaver, 1998), there do not appear to be any studies comparing the prevalence, expression, or course of SAD in shiftwork and non-shiftwork populations. This seems surprising given that researchers have delineated both a circadian rhythm-shiftwork-depression connection (see Healy, Minors, and Waterhouse, 1993) and a circadian rhythm-SAD connection (see Lewy, Sack, Singer, White and Hoban, 1988). At the very least, this study suggests that shiftwork may be acting as a confounding variable in research on SAD, if work schedules are not taken into consideration. Certainly, the indirect evidence available from this study suggests that the role that shiftwork may play in the development, or maintenance, of SAD merits further exploration.

Seasonal Stability in Chronic Fatigue, Physical Health, Job Satisfaction, and Social Disruption

The remaining measures of well-being used in the current study looked at three different aspects of physical health (chronic fatigue, and digestive and cardiovascular

disturbances) and two different aspects of social functioning (job satisfaction and social disruption). As with sleep disturbance and psychological well-being, all of these variables were consistent with normative data available from other studies using the SSI. Thus, across all measures of well-being on the SSI, night workers in the current study were functioning at a level that is comparable to other large groups of shiftworkers in the U.K. and elsewhere.

There was virtually no change on measures of chronic fatigue, cardiovascular functioning, or digestive health across the seasons. There are several possible reasons for these findings. In terms of chronic fatigue, there is evidence that this disease is not prone to seasonal fluctuations and, moreover, that seasonal changes in mood, energy, and appetite, normally seen in healthy individuals are actually reduced in patients with chronic fatigue (e.g., see Garcia-Borreguero et al., 1998; Zubieta, Engleberg, Yargic, Pande & Demitrack, 1994). Indeed, it has been suggested that chronic fatigue patients can be distinguished from patients with affective disorders, including SAD, by the lack of seasonal variation in symptoms. Cardiovascular functioning, unlike chronic fatigue, has been shown to have a seasonal pattern, with a winter peak and summer trough in coronary heart disease incidence and mortality (Sher, 2001). It is likely that the lack of significant findings in this study are a result of the relatively small sample of healthy workers, as most participants reported that they "almost never" experienced any of the cardiovascular symptoms. Digestion also showed no seasonal effects but, as with chronic fatigue, there is no previous evidence of a seasonal trend in digestive difficulties *per se*. As with measures of physical health, neither social disruption nor job satisfaction showed seasonal effects.

In summary, this study suggests that compared to the general population, night shift workers may be more vulnerable to seasonal changes in mood and sleep disturbance than non-shiftworkers. However, other important indicators of shiftwork well-being, including physical health symptoms and psychosocial well-being, do not appear to respond to seasonal factors but, rather, remain stable throughout the year.

Can We Explain Individual Differences In Shiftwork Adaptation?

Among all of the explanatory variables looked at in this study, neuroticism proved to be the most potent and consistent predictor of self-reported adaptation to shiftwork. Indeed, in both winter and summer, neuroticism predicted almost all aspects of shiftworker well-being, including sleep disturbance, physical complaints, and psychological health. These results are consistent with previous shiftwork studies that have demonstrated a large correlation between neuroticism and poor adaptation to shiftwork. As discussed earlier, there is evidence showing that poor psychophysiological adaptation to circadian disruption is associated with neuroticism. This relationship has been demonstrated by objective assessment of changes in cortisol levels in shiftworkers (Hennig et al., 1998) and, more recently, by measuring core body temperature in a non-shiftwork sample (Murray, Allen, Trinder, & Burgess, 2002). That said, these results should not be over-stated, and care should be used when interpreting the relationship between neuroticism and shiftwork adaptation. A large body of literature (both shiftwork and otherwise) shows that individuals high in neuroticism report more health complaints but, as Costa and McCrae argue, the meaning and interpretation of the association between neuroticism and self-reported health is "profoundly ambiguous" and demands careful consideration (p. 303, 1987). This is because neuroticism has a considerable

influence on the perception, recollection, and reporting of symptoms. Individuals who are high in neuroticism are more likely to notice and attend to normal body sensations and minor discomforts, and interpret them as signs of illness (Watson and Pennebaker, 1989). However, while neuroticism is clearly related to somatic complaints, its relationship to actual health status is much murkier. Indeed, research shows that neuroticism is neither strongly nor consistently related to long-term, objective health status as measured by indicators such as health-related behaviours (e.g., absenteeism, physician visits), biological markers (e.g., blood pressure levels, immune system functioning, etc.) or health outcomes (e.g., disease diagnosis, mortality rates; Watson and Pennebaker, 1989). Thus, it appears that individuals high in neuroticism report more health complaints but do not necessarily suffer from significantly poorer physical health. As the current study (like much shiftwork research) used only subjective (self-report) measures of health, the more parsimonious interpretation would be to link neuroticism to health complaints. That is, shiftworkers who are high in neuroticism complain more, and feel more distressed and less satisfied than their low neuroticism colleagues; however, whether these differences hold true when using objective indicators of health status awaits further study.

A large body of personality research has demonstrated life-long stability in the trait neuroticism, suggesting that it is relatively independent of life-situation. In contrast, some often-cited longitudinal studies in the shiftwork literature have found that neuroticism scores tend to increase with shiftwork experience (e.g., Bohle and Tilley, 1989), or increase in comparison with pre-shiftwork scores (Kaliterna et al., 1995). Although the length of time between reporting periods in this study (six months) was too short to be able to comment on long-term effects of shiftwork, the present results do not

provide evidence of any seasonal variability in neuroticism and appear to lend more support to its conceptualization as a relatively stable trait.

Along with neuroticism, age proved to play a significant role in quality of sleep, with older individuals reporting that they had trouble falling asleep, that they woke up too early, that they did not get enough sleep, and that they felt tired between shifts. This was not unexpected. Research suggests that circadian adaptation to night work becomes slower with increasing age, and that the quality and duration of sleep among shiftworkers generally decreases with age (e.g., Parkes, 2002). It is also the case that complaints about sleep disturbance tend to increase with age in the non-shiftworking population, as well. Interestingly, the relationship between age and sleep quality appeared to be relatively stable across summer and winter.

When looking at other measures of shiftwork adaptation, older shiftworkers did not appear to be feeling better or worse than their younger colleagues. Previous research has linked gastrointestinal/digestive problems with younger shiftworkers, and cardiovascular disorders with older shiftworkers (see Harma and Ilmarinen, 1999 for review). Similarly, some shiftwork studies have reported that the prevalence of psychosomatic complaints such as chronic fatigue and depression increased steadily with age (Harma and Ilmarinen, 1999). These relationships, however, were not borne out in this study. As the age distribution in this group of night workers is sufficiently heterogeneous for any real differences to be apparent, the lack of age-related findings may be due to a selection bias known as the "healthy worker effect." The healthy worker effect reflects the fact that people often leave shiftwork because of poor health; thus experienced shiftworkers are sometimes referred to as a "survivor population" (Tepas, Duchon, and Gersten, 1993). Evidence of the healthy worker effect comes from studies

that show a higher prevalence of shiftwork-related health issues (i.e., digestive, cardiovascular, and psychological disorders) in former shiftworkers than in current shiftworkers (e.g., Bourdouxhe and Queinnec, 1999). Thus, it may be that those individuals whose health was most compromised by shiftwork had found other jobs that did not require shiftwork. It also may be the case that work strategies at YVR are sparing older workers. At the time of data collection, there were no explicit strategies for older workers in place, however, discussions with employees and union officials indicated recognition that shiftwork may be more difficult for older employees and thus there may be some implicit strategies in place that benefit older shiftworkers. Two age-related variables, namely years of shiftwork experience and length of time employed at YVR, were not significantly associated with any measures of shiftwork adaptation, including sleep disturbance. Again, this may reflect a healthy worker effect.

Other individual difference factors seemed to play minor roles in shiftwork adaptation. Extraversion did appear to be somewhat of a protective factor against reports of sleep disturbance, although the positive impact of extraversion was never as large as the negative impact of neuroticism. The remaining personality or individual difference factors, morningness and sleep flexibility, were only weakly associated with some measures of shiftwork adaptation. For example, employees who scored high on morningness were likely to report being more dissatisfied with their work than employees who described themselves more as evening types. This relationship held true across both winter and season. Morningness was not strongly associated with other measures of shiftwork adaptation. Some studies have shown that morning-type employees will find it easier to adjust to early morning shift starts but more difficult to adjust to afternoon or evening shifts because of a tendency to wake early regardless of work schedule or

duration of sleep (Waterhouse, Folkard, and Minors, 1992). As described earlier, YVR employees work two (early start) day shifts followed by two night shifts and four days off. This particular shift schedule might actually work best for morning types, as they may be quicker to adjust back to a typical diurnal schedule at the end of the work week and, compared to evening types, may find the early morning start at the beginning of the work week relatively easy. Nevertheless, the generally weak association between morningness and shiftworker well-being in this study supports Waterhouse et al.'s observation that perhaps neither morning nor evening types are advantaged in rotating shift systems.

Perhaps more surprising was the lack of effect of sleep flexibility on overall adaptation. Previous studies have found a fairly reliable relationship between sleep flexibility and increased tolerance to shiftwork. In the current study, however, greater flexibility in sleeping habits was associated (albeit weakly) with poorer adaptation to shiftwork. Specifically, shiftworkers who described finding it easy to sleep at unusual times or in unusual places were also likely to report more physical complaints, more psychological distress and more sleep and social disturbance. It may be that these findings reflect a measurement problem. The original SSI uses the 30-item Circadian Type Inventory (CTI) to assess flexibility of sleeping habits and ability to overcome drowsiness. The revised version of the SSI, however, measures sleep flexibility with a single question: "*Are you the sort of person who finds it very easy to sleep at unusual times or in unusual places?*" As discussed earlier, this study used the abridged single question measure of sleep flexibility, however, there is no information available on the psychometric properties of this measure of sleep flexibility. Moreover, the question itself seems to be open to varying interpretations. For example, shiftworkers who are having

problems sleeping at home, in bed (i.e., the 'usual' place), may find they are taking naps on the job, or falling asleep at 'unusual' times or in 'unusual' places. Accordingly, they would be likely to respond affirmatively to the question, thereby getting a higher sleep flexibility score. However, this is not what the question is intended to measure as, in contrast, several questions on the longer Circadian Type Inventory refer to the ability to fall asleep or stay asleep *in bed.* Given this, it is difficult to interpret the meaning and validity of the "sleep flexibility" scores of these shiftworkers. Until work is done to address these concerns, the full-length Circadian Type Inventory would appear to be a better choice for researchers seeking a valid measure of sleep flexibility.

Seasonal Stability in Relationships Among Individual Difference Factors and Shiftwork Adaptation

Despite the considerable impact that time of year had on some measures of shiftwork adaptation, the relationships among individual difference factors and tolerance to shiftwork were remarkably stable from summer to winter. There were some small seasonal differences in the contributions made by depression and chronic fatigue to the summer and winter canonicals, which could perhaps be interpreted as evidence that age and individual differences were less predictive of depression and chronic fatigue in the summer than in the winter. However, a more parsimonious explanation for these findings is that the very large contribution that sleep disturbance made to the summer canonical masked the contributions of these variables. In either event, the seasonal differences in loadings were very small and caution must be taken in not over-interpreting them, particularly given the small sample size. Moreover, seasonal differences in the relationships among the explanatory and outcome variables were not

seen in the multiple regression analyses. Indeed, the similarity in regression analyses across the two seasons for all outcome variables (except social disturbance, which was poorly predicted in both winter and summer) was striking, as almost every measure of shiftwork adaptation was predicted by virtually the same small subset of explanatory variables in both summer and winter.

Limitations of the Study

The findings of the present study suggest a seasonal fluctuation in some measures of shiftwork adaptation including mood, psychological distress, and sleep disturbance. In contrast, other measures of shiftwork adaptation, including physical health, chronic fatigue, job satisfaction, and social disturbance, showed stability across winter and summer. However, some caveats must be offered. Firstly, this study was conducted over the course of only one year and employees were only followed for six months of the year, so it is unclear the extent to which these results might reflect unusual occurrences rather than stable phenomena. The limitations of the study design were necessitated by requirements of timely data collection. In the ideal situation, a more extended longitudinal design would be employed with employees tested at multiple time periods over the course of several years.

Secondly, attempts were made throughout to compare the results found in the current study to results reported in other studies. However, differences in assessment methods, populations, and other unknown factors, limit the reliability of such comparisons. As mentioned previously, this study would have benefited from the use of an adequately-sized comparison group, such as non-shiftworkers in the airport operations department at YVR. However, this was not possible as, during data

collection, it became apparent that the number of non-shiftworkers would be too small to allow for this. Other possible comparison groups (e.g., non-shiftwork employees in other sectors of YVR) were not investigated but may have increased the reliability of conclusions drawn. This study has limited generalizability to women, as well, in that the final group of night workers was comprised of only 10 (13%) women.

Another limitation of the study was the use of one-item scales for measuring morningness and sleep flexibility. As one-item measures can only assess one component of a construct, they may have limited content validity. Thus, given the lack of psychometric data for these two scales, it is unclear whether the results describe accurately the relationships among morningness, sleep flexibility, and adaptation to shiftwork, or whether they are more reflective of a measurement problem.

Finally, a potential confounding factor in this study was the amount of light that participants were exposed to on the job. While there are no bright light strategies currently in use at YVR, some shiftworkers worked steadily in one (indoor) location, others had work that moved them throughout the airport, and still others held positions that required them to spend much of their time out-of-doors. Individual differences in light exposure on the job were probably of minor importance in the summer months, as morning and evening light exposure are most important for stabilizing circadian rhythms to local time, and all participants would have been exposed to morning and evening light during the commute. In the winter, however, individual differences in light exposure on the job would likely be more significant. Although it would be impossible to standardize light exposure across these employee groups, future studies would benefit from the monitoring of variability in light exposure in order to measure potential effects on shiftwork adaptation.

Directions for Future Research

This study has expanded the existing field of shiftwork research by investigating seasonal variations in shiftwork adaptation in a sample of Northern latitude, Canadian shiftworkers. Using standardized assessment instruments and a longitudinal design, the study allowed within-subject investigation of mental and physical health, and psychosocial well-being, over three time periods that coincided with the longest and shortest days of the year. The results provide ideas for future research. Firstly, further research is needed, using larger samples of shiftworkers in a variety of work environments, and across a variety of shift systems, to assess whether the winter malaise reported in this study is unique to this particular work environment, or whether it is experienced by shiftworkers in other work environments, working under other shift systems, as well. A second avenue of research is needed to determine whether certain shiftworkers, regardless of work or environmental conditions, are more susceptible to seasonal changes in daylength. For example, shiftworkers could be assessed for individual differences in seasonality (i.e., using the Seasonal Pattern Assessment Questionnaire; Rosenthal, 1993), to see whether there is an intrinsic individual style that predicts better adaptation to shiftwork across seasons. A final, potentially important direction for future research would be to assess for the prevalence of SAD or subSAD in various shiftworker populations. This would help determine whether shiftwork, in general, increases vulnerability to seasonal depression. The inclusion of a non-shiftworking comparison group from a similar work environment would allow for comparison of prevalence rate, presentation, and course of seasonal depression in shiftworkers and non-shiftworkers.

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APPENDIX A. STANDARD SHIFTWORK INDEX

Please answer the following questions as accurately as possible, remembering that the information you give will be treated as strictly confidential.

1.1 Age: _____

1.2 Sex: Male Female
(circle one)

1.3 Education: _____

1.4 Occupation: _____

Your Domestic Situation

1.5 Are you: (a) Married/Living with a partner _____
(*tick one*) (b) Separated/Divorced _____
(c) Widowed _____
(d) Single _____

1.6 On average, how many hours per week does your partner work in paid employment? _____ hours

1.7 What is your partner's usual work pattern?

(a) Daytime-no shifts _____
(b) Rotating shifts with nights _____
(c) Rotating shifts without nights _____
(d) Permanent nights _____
(e) Other (*Please specify*)..... _____

	Extremely Unsupportive	Fairly Unsupportive	Quite Indifferent	Fairly Supportive	Extremely Supportive
1.8 How does your partner feel about you working shifts? (*circle one*)	1	2	3	4	5

1.9 How many persons in your household are in each of the following age groups (excluding yourself)?

(a) 0 to 5 years _____

(b) 6 to 12 years _____

(c) 13 to 18 years _____

(d) 19 to 24 years _____

(e) 25 to 60 years _____

(f) 60 years + _____

1.10 How many of these need looking after by you? _____

1.11 How long have you worked altogether? _____years

1.12 How long have you worked in your **present** shift system? _____years _____months

1.13 How long **altogether** have you been working shifts? _____years _____months

1.14 On average, how many hours do you work each week excluding overtime? _____hours _____minutes

1.15 On average, how many hours **paid** overtime do you work each week? _____hours _____minutes

1.16 On average, how many hours **unpaid** overtime do you work each week, (e.g., over-run of shifts)? _____hours _____minutes

1.17 Do you have a second paid job in addition to your main one? _____yes _____no

1.18 If you have taken a career break (or breaks), how long was this for in total? _____years _____months

1.19 On average, <u>at this time of year</u>, how long does it take you to travel to and from work?

(a) Day shift _____ mins to work _____ mins from work

(b) Night shift _____ mins to work _____ mins from work

1.20 How do you normally travel to work? (*tick one*)

By public transport _____

By private transport _____

By a combination of public and private _____

By company transport _____

By foot _____

	Almost Never	Quite Seldom	Quite Often	Almost Always
1.21 Do you ever feel unsafe when travelling to and from work on the following shifts? (*circle*)				
(a) Day Shift	1	2	3	4
(b) Night Shift	1	2	3	4

Your Shift Details

1.22 What is the maximum number of shifts of any kind you have worked **between** days off in the past month? _____

1.23 On average, how many days off in succession do you normally have? _____

1.24 On average, how many nights do you work per year? _____

1.25 On average, how many weekends do you have off per 28 days? _____

	None	Not Very Much	A Fair Amount	Quite a Lot	Complete
1.26 To what extent do you feel you have control over the specific shifts that you work?	1	2	3	4	5
1.27 To what extent do you feel you have control of the specific start & finish times of the shifts you work?	1	2	3	4	5

1.28 How much advance notice of your roster are you normally given? _____weeks _____days

1.29 For each of the following, please indicate how often you:	Almost Never	Rarely	Sometimes	Frequently	Almost Always
(a) Are required to change your roster at short notice	1	2	3	4	5
(b) Swap shifts with colleagues	1	2	3	4	5
(c) Make a request to work specific shifts	1	2	3	4	5

1.30 Use the numbers 1 – 5 to rate **your** workload, at this time of year, in comparison to the average workload of other people performing a similar job in others parts of your organization:

1 = Extremely light
2 = Quite light
3 = About the same
4 = Quite heavy
5 = Extremely heavy

		Dayshift	**Nightshift**
(a)	Physical workload	_____	_____
(b)	Mental workload	_____	_____
(c)	Time pressures	_____	_____
(d)	Emotional stress	_____	_____

1.31 What are your main reasons for working shifts? (*please circle one number for each)*	**Not a reason for me**		**Partly a reason for me**		**Very much a reason for me**
(a) It is part of the job	1	2	3	4	5
(b) It was the only job available	1	2	3	4	5
(c) More convenient for domestic responsibilities	1	2	3	4	5
(d) Higher rates of pay	1	2	3	4	5

(e) Other (*please give your reasons*)

	Definitely Not	Probably Not	Maybe	Probably Yes	Definitely Yes
1.32 All other things being equal, would you prefer to give up working shifts and get a daytime job without shifts? (*circle one*)	1	2	3	4	5

1.33 What are the three main **advantages** of your shift system for you?

(a) _____

_____

(b) _____

_____

(c) _____

_____

1.34 What are the three main **disadvantages** of your shift system for you?

(a) _____

_____

(b) _____

_____

(c) _____

_____

	Definitely Not	Probably Not	Maybe	Probably Yes	Definitely Yes
1.35 Do you feel that overall the advantages of your shift system outweigh the disadvantages?	1	2	3	4	5

1.36 If you were entirely free to choose the start and finish times of your shifts, what times would you choose?

(a) Day shift _____ start _____ finish

(b) Night shift _____ start _____ finish

1.37 The following questions relate to **general job satisfaction** and not to your satisfaction with your shift system. Please circle the appropriate answer for each question.

	Disagree Strongly	Disagree	Disagree Slightly	Neutral	Agree Slightly	Agree	Agree Strongly
(a) Generally speaking, I am very satisfied with this job	1	2	3	4	5	6	7
(b) I frequently think of quitting this job	1	2	3	4	5	6	7
(c) I am generally satisfied with the kind of work I do	1	2	3	4	5	6	7
(d) Most people on this job are very satisfied with the job	1	2	3	4	5	6	7
(e) People on this job often think of quitting	1	2	3	4	5	6	7

2. Your Sleep and Fatigue

2.1 At this time of year, what time do you normally fall asleep and wake up at the following points within your shift system? Please use 24 hour time or clearly indicate 'am' or 'pm.'

		Fall Asleep	Wake up
DAY SHIFT			
(a)	Before your first morning shift	_____	_____
(b)	Between two successive morning shifts	_____	_____
(c)	After your last morning shift	_____	_____
NIGHT SHIFT			
(d)	Before your first night shift	_____	_____
(e)	Between two successive night shifts	_____	_____
(f)	After your last night shift	_____	_____
DAY OFF			
(g)	Before your first day off	_____	_____
(h)	Between two successive days off	_____	_____
(i)	After your last day off	_____	_____

2.2 If you normally take a nap/naps in addition to your main sleep, either at work or at home, at what time do you take it/them?

(a) On morning shifts from _____ to _____ and from _____ to _____

(b) On night shifts from _____ to _____ and from _____ to _____

(c) On days off from _____ to _____ and from _____ to _____

2.3 How many hours sleep do you feel you usually need per day, irrespective of which shift you are on? _____ hours _____ minutes

2.4 How do you feel about the amount of sleep you normally get? (*Circle one number for each*)	Nowhere near enough	Could do with a lot more	Could do with a bit more	Get the right amount	Get plenty
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.5 How well do you normally sleep? *(Circle one number for each)*	Extremely badly	Quite badly	Moderately well	Quite well	Extremely well
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.6 How rested do you normally feel after sleep? *(Circle one number for each)*	Definitely not rested	Not very rested	Moderately rested	Quite rested	Extremely rested
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.7 Do you ever wake up earlier than you intended? *(Circle one number for each)*	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.8 Do you have difficulty in falling asleep? *(Circle one number for each)*	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.9 Do you take medication to help you sleep? *(Circle one number for each)*	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.10 Do you use alcohol to help you sleep? *(Circle one number for each)*	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.11 Do you ever feel tired on: *(Circle one number for each)*	Almost never	Rarely	Sometimes	Frequently	Almost always
Between successive morning shifts	1	2	3	4	5
Between successive night shifts	1	2	3	4	5
Between successive days off	1	2	3	4	5

2.12 The following items relate to how tired or energetic you **generally** feel, irrespective of whether you have had enough sleep or have been working very hard. Some people appear to "suffer" from permanent tiredness, even on rest days and holidays, while others seem to have limitless energy. Please indicate the degree to which the following statements apply to your own normal feelings. *(Circle one number for each)*

	Not at all		Somewhat		Very Much
(a) I generally feel I have plenty of energy	1	2	3	4	5
(b) I feel tired most of the time	1	2	3	4	5
(c) I usually feel lively	1	2	3	4	5

2.13 Do you have any other comments or observations relating to your sleep and fatigue that have not been covered in the above section? If so, please try to describe them here:

_____

_____

_____

_____

_____

_____

_____

_____

3. Your Health and Well-Being

3.1	**In the past month** how frequently did you experience the following? Please indicate by circling the appropriate number:	Almost Never	Quite Seldom	Quite Often	Almost Always
(a)	How often was your appetite disturbed?	1	2	3	4
(b)	How often did you have to watch what you ate to avoid stomach upsets?	1	2	3	4
(c)	How often did you feel nauseous?	1	2	3	4
(d)	How often did you suffer from heartburn or stomach-ache?	1	2	3	4
(e)	How often did you complain of digestion difficulties?	1	2	3	4
(f)	How often did you suffer from bloated stomach or flatulence?	1	2	3	4
(g)	How often did you suffer from pain in your abdomen?	1	2	3	4
(h)	How often did you suffer from constipation or diarrhoea?	1	2	3	4
(i)	How often did you suffer from heart palpitations?	1	2	3	4
(j)	How often did you suffer from aches and pains in your chest?	1	2	3	4
(k)	How often did you suffer from dizziness?	1	2	3	4
(l)	How often did you suffer from sudden rushes of blood to your head?	1	2	3	4
(m)	Did you suffer from shortness of breath when climbing the stairs?	1	2	3	4
(n)	Were you aware that you have high blood pressure?	1	2	3	4
(o)	Were you aware of your heart beating irregularly?	1	2	3	4
(p)	Did you suffer from swollen feet?	1	2	3	4
(q)	How often did you feel "tight" in your chest?	1	2	3	4
(r)	Did you feel you have put on too much weight since beginning shiftwork?	1	2	3	4
(s)	Did you feel you have lost too much weight since beginning shiftwork?	1	2	3	4

3.2 Have you taken any of the following medications

	Before starting shiftwork	Since starting shiftwork	In the past month
(a) Tranquilizers	_____	_____	_____
(b) Sleeping medications	_____	_____	_____
(c) Antidepressants	_____	_____	_____
(d) Antacids	_____	_____	_____
(e) Antispasmodics	_____	_____	_____
(f) Laxatives	_____	_____	_____
(g) Drugs to control high blood pressure	_____	_____	_____
(h) Diuretics	_____	_____	_____
(i) Heart medicines	_____	_____	_____
(j) Vasodilators	_____	_____	_____
(k) Bronchodilators	_____	_____	_____
(l) Vitamins, tonics	_____	_____	_____
(m) Pain killers	_____	_____	_____
(n) Steroids	_____	_____	_____
(o) Anti-inflammatory medicines	_____	_____	_____
(p) Hormones (except contraceptives)	_____	_____	_____
(q) Others	_____	_____	_____

	Before starting shiftwork	Since starting shiftwork	In the past month
3.3 On average, how many cigarettes have you smoked per week?	_____	_____	_____
3.4 On average, how many units of alcohol have you drunk per week? (e.g. 1 unit = 1 bottle beer or 1 glass wine or 1 ounce hard alcohol)	_____	_____	_____
3.5 On average, how many cups of caffeinated coffee/tea/cola have you drunk each day?	_____	_____	_____

3.6 If appropriate, and you are not taking a birth control pill, has your menstrual cycle been:	Extremely irregular	Fairly irregular	Fairly regular	Extremely regular
(a) Before starting shiftwork	1	2	3	4
(b) Since starting shiftwork	1	2	3	4

3.7 The following questions deal with **how you have felt in general over the past few weeks.** Please **circle** the most appropriate answer for each question. Remember to concentrate on present and recent complaints, not those that you have had in the distant past. **Have you recently:**

(a) Been able to concentrate on what you are doing?	Better than usual	Same as usual	Less than usual	Much less than usual
(b) Lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
(c) Felt that you are playing a useful part in things	More so than usual	Same as usual	Less than usual	Much less than usual
(d) Felt capable of making decisions about things	More so than usual	Same as usual	Less than usual	Much less than usual
(e) Felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
(f) Felt you could not overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
(g) Been able to enjoy your normal day-to-day activities?	More so than usual	Same as usual	Less than usual	Much less than usual
(h) Been able to face up to your problems?	More so than usual	Same as usual	Less than usual	Much less than usual
(i) Been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
(j) Been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
(k) Been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
(l) Been feeling reasonably happy all things considered	More so than usual	About the same	Less so than usual	Much less than usual

3.8 Compared to how you feel **when you are in an even or normal mood state**, how would you rate yourself on the following items **during the past week?**

I have been feeling...	**Not at all**	**Just a little**	**More than just a little**	**Quite a bit, moderately**	**Markedly or severely**
Down and depressed					
Less interested in doing things					
Less interested in sex					
Less interested in eating					
That I've lost some weight					
That I can't fall asleep at night					
That my sleep is restless					
That I wake up too early					
Heavy in my limbs or aches in back, muscles, or head; more tired than usual					
Guilty or like a failure					
Wishing for death or suicidal					
Tense, irritable, or worried					
Sure I'm ill or have a disease					
That my speech and thought are slow					
Fidgety, restless, or antsy					
That morning is worse than evening					
That evening is worse than morning					
Unreal or in a dream state					
Suspicious of people/paranoid					
Preoccupied/obsessed that I must check things a lot					
Physical symptoms when worried					

4. YOUR SOCIAL AND DOMESTIC SITUATION

	Not at all		Some-what		Very Much
4.1 **In the past month** how much has your shift system interfered with your **leisure time**?	1	2	3	4	5
4.2 **In the past month** how much has your shift system interfered with **domestic life?**	1	2	3	4	5
4.3 **In the past month** how much has your shift system interfered with your **non-domestic life** (e.g., going to doctor, library, bank, hairdresser, etc.)?	1	2	3	4	5

5. THE TYPE OF PERSON YOU ARE

	Definitely not	Probably not	In between	Probably yes	Definitely yes
5.1 Are you the sort of person who feels at their best early in the morning and who tends to feel tired earlier than most people in the evening?	1	2	3	4	5
5.2 **In the past month** have you found it very easy to sleep at unusual times or in unusual places?	1	2	3	4	5

5.3 Here are some questions regarding the way you behave, feel, and act. Try to decide which response option represents your usual way of acting or feeling. There are no right or wrong answers to any of the questions: your immediate reaction is what we want. Please check that you have answered all the questions. *Circle one number for each.*

	Almost never	Quite seldom	Quite often	Almost always
(a) Do you like plenty of excitement and bustle around you?	1	2	3	4
(b) Does your mood go up and down?	1	2	3	4
(c) Are you rather lively?	1	2	3	4
(d) Do you feel 'just miserable' for no good reason?	1	2	3	4
(e) Do you like mixing with people?	1	2	3	4
(f) When you get annoyed do you need someone to talk to?	1	2	3	4
(g) Would you call yourself happy-go-lucky?	1	2	3	4
(h) Are you troubled about feelings of guilt?	1	2	3	4
(i) Can you let yourself go and enjoy yourself a lot at a lively party?	1	2	3	4
(j) Would you call yourself tense or "highly strung"?	1	2	3	4
(k) Do you like practical jokes?	1	2	3	4
(l) Do you suffer from sleeplessness?	1	2	3	4

5.4 Have you ever sought out information, either formally or informally, regarding strategies to help counter the effects of shiftwork? If so, where?

___ Co-workers
___ Internet
___ Friends/Family members
___ Training sessions
___ Media (television/radio/newspaper)
___ Books/Journals/Magazines
___ Other (please specify) _____

5.5 What, if any, specific steps do you take to counter the effects of shiftwork?

_____

_____

_____

_____

_____

_____

_____

_____

GENERAL INFORMATION

Some people experience severe health, sleep or emotional problems as a result of working shifts. It is possible that completing this questionnaire may have drawn your attention to problems you experience as a result of shiftwork and/or other factors. If you feel that talking to someone might help with these problems we would strongly advise you to contact your GP. If they cannot help they should be able to put you in contact with someone who can.

Can you please check that you have answered all the questions, but please do not alter any of your answers.

Thank you for filling in this questionnaire.

APPENDIX B. DESCRIPTIVE STATISTICS FOR ALL PARTICIPANTS

Variable	*N*	Mean	*SD*	Median	Range	Interquartile Range
AGE	88	38.92	9.21	39.50	21 - 58	31.25 - 46
S/W	88	8.46	7.53	6.00	16 - 30	3 – 10.75
NEUR-W	84	12.02	3.05	12.00	7 – 21	9 – 14
NEUR-S	84	12.16	3.50	12.00	6 – 23	9 – 15
EXT-W	84	15.99	2.84	16.00	9 – 22	14 – 18
EXT-S	84	16.38	2.88	16.50	9 – 22	15 – 18
MORN-W	84	2.98	1.21	3.00	1 – 5	2 – 4
MORN-S	84	2.93	1.11	3.00	1 – 5	2 – 4
FLEX-W	84	2.82	1.24	3.00	1 – 5	2 – 4
FLEX-S	84	2.90	1.24	3.00	1 – 5	2 – 4
SLP-W	84	47.83	9.04	47.00	29 – 78	41 – 54
SLP-S	84	53.87	11.95	52.50	26 – 79	44 – 64
CF-W	84	7.96	2.21	8.00	0 – 14	6 – 9
CF-S	84	8.21	2.11	8.00	3 – 14	6 – 9
GHQ-W	84	13.05	4.22	12.00	4 –24	10 – 16
GHQ-S	84	11.95	5.44	12.00	3 – 32	8 – 14
DEP-W	84	13.44	10.48	11.00	0 – 50	6 – 19
DEP-S	84	11.18	12.54	8.00	0 – 64	2 – 14
CARD-W	84	10.73	3.42	9.50	8 –21	8 – 12
CARD-S	84	10.85	3.48	9.00	8 - 21	8 - 12
DIG-W	84	14.36	4.57	13.00	8 – 26	11 – 17
DIG-S	84	14.18	5.09	14.00	8 - 27	10 - 18
JOB-W	84	27.06	5.83	28.00	10 – 51	24 – 30
JOB-S	84	26.33	5.82	28.00	9 - 35	22 - 31
SOC-W	84	8.20	2.96	8.00	3 – 15	6 – 10
SOC-S	84	8.37	2.89	8.00	3 - 15	6 - 11

APPENDIX C. DESCRIPTIVE STATISTICS FOR DAY WORKERS

Variable	*N*	Mean	*SD*	Median	Range	Interquartile Range
AGE	15	35.93	11.84	38.00	21 - 55	23 - 45
S/W	15	7.85	9.11	6.00	.16 - 30	.5 - 16
NEUR-W	14	12.57	2.10	13.00	8 – 15	11.5 -14
NEUR-S	14	13.00	2.51	12.50	9 - 17	11 - 15
EXTR-W	14	15.79	3.19	16.00	9 – 21	14-17.75
EXTR-S	14	16.57	3.08	16.50	9 – 22	15 – 18
MORN-W	14	2.50	1.34	2.50	1 - 4	1 – 4
MORN-S	14	2.86	1.23	3.00	1 - 5	2 – 3.25
FLEX-W	14	2.50	1.09	2.00	1 – 4	2 – 4
FLEX-S	14	2.50	0.94	2.00	1 – 4	2 – 3.25
SLP-W	14	44.21	7.06	43.50	34 – 56	39 – 49.25
SLP-S	14	45.64	6.19	45.00	36 – 58	42 – 48.25
GHQ-W	14	12.50	4.03	11.50	7 – 22	10.75 -16
GHQ-S	14	11.71	3.17	11.50	4 – 14	9.0 -13.25
DEP-W	14	12.07	7.95	12.50	0 – 25	4.75 – 19.25
DEP-S	14	13.29	12.87	9.50	0 – 39	2.75 – 24.25
CF-W	14	8.29	2.27	9.00	3 – 12	6.75 – 10
CF-S	14	8.43	2.03	8.50	6 – 11	6 – 11
CARD-W	14	12.43	4.36	12.00	8 –21	8-15.25
CARD-S	14	11.71	3.50	11.00	8 - 18	8.75-15.25
DIG-W	14	14.79	5.56	14.00	8 – 24	10 – 19
DIG-S	14	14.79	5.01	15.00	8 - 24	9.5-18.25
JOB-W	14	28.14	4.28	30.00	18 – 33	24.5 – 31
JOB-S	14	28.29	5.99	28.00	9 - 35	21.75 - 31
SOC-W	14	7.21	2.22	8.00	3 – 10	5.75 – 9.0
SOC-S	14	7.43	2.03	7.50	4 - 11	6.0 – 8.25

APPENDIX D. DESCRIPTIVE STATISTICS FOR NIGHT WORKERS

Variable	*N*	Mean	*SD*	Median	Range	Interquartile Range
AGE	73	39.53	8.54	40.00	25 - 58	32.5 – 46.5
S/W	73	8.58	7.23	6.00	1 - 28	3.5 – 10.5
NEUR-W	70	11.91	3.21	12.0	7 – 21	9 – 14.63
NEUR-S	70	11.99	3.65	11.5	6 - 23	8.75 – 15
EXTR-W	70	16.04	2.79	16.0	10 – 22	14 – 18
EXTR-S	70	16.34	2.86	16.5	10 – 22	14.75 – 18
MORN-W	70	3.07	1.17	3.0	1 – 5	2 – 4
MORN-S	70	2.94	1.09	3.0	1 – 5	2 – 4
FLEX-W	70	2.89	1.27	3.0	1 – 5	2 – 4
FLEX-S	70	2.97	1.29	3.0	1 – 5	2 – 4
SLP-W	70	48.56	9.26	48.5	29 – 78	41 – 54.25
SLP-S	70	55.51	12.17	55.5	26 – 79	45.5 – 66.25
GHQ-W	70	13.16	4.28	13.0	4 – 24	9.75 – 16
GHQ-S	70	12.10	5.77	12.0	3 – 8	8 – 15
DEP-W	70	13.71	10.94	11.0	0 – 50	6 – 20.25
DEP-S	70	10.76	12.52	8.0	0 – 64	1.75 – 14
CF-W	70	7.90	2.21	8.0	0 – 14	6 – 9
CF-S	70	8.17	2.13	8.0	3 – 14	6 – 9
CARD-W	70	10.39	3.12	9.0	8 – 20	8 – 11.25
CARD-S	70	10.67	3.47	9.0	8 - 21	8 - 12
DIG-W	70	14.27	4.39	13.0	8 – 26	11 – 17
DIG-S	70	14.06	5.13	14.0	8 – 27	0.75 – 16.5
JOB-W	70	26.84	6.09	27.5	10 – 51	24 – 30
JOB-S	70	25.94	5.98	28.0	9 - 35	21.75 - 31
SOC-W	70	8.40	3.06	9.0	3 – 15	6 – 11
SOC-S	70	8.56	3.01	9.0	3 - 15	6 – 11

APPENDIX E. CORRELATION MATRIX:

NIGHT WORKERS IN WINTER

	S/W	AGE	YVR	MORN	FLEX	NEUR	EXTR	SLP	SAT	CF	PHQ	GHQ	DEP	SOC
S/W	1	.435**	.552**	-.081	.057	.067	-.101	.225	-.009	.108	-.001	.048	-.071	.098
AGE		1	.265*	.071	.155	.120	-.334**	.585**	-.139	-.300	.118	.129	.081	.128
YVR			1	-.078	.230	.108	-.050	.256*	-.196	.164	.197	.072	.021	.230
MORN				1	.093	.200	-.269*	.230	-.386**	-.126	.114	.119	.142	.081
FLEX					1	.047	-.025	.156	-.242*	-.031	.231	.113	.131	.288*
NEUR						1	-.186	.427**	-.321**	.286	.552**	.542**	.599**	.087
EXTR							1	-.411**	.253*	-.108	-.150	-.202	-.151	-.063
SLP								1	-.357**	.294	.460**	.473**	.482**	.437**
SAT									1	-.084	-.233	-.277*	-.290*	-.373**
CF										1	.500	.362	.370	.414
PHQ											1	.572**	.687**	.324**
GHQ												1	.750**	.253*
DEP													1	.238*
SOC														1

Note. ** Correlation is significant at the 0.01 level (2-tailed).
• Correlation is significant at the 0.05 level (2-tailed).

S/W = Shiftwork Experience
AGE = Age
YVR = YVR Experience
MORN = Morningness
FLEX = Sleep Flexibility
NEUR = Neuroticism
EXTR = Extraversion
SLP = Sleep Disturbance
SAT = Job Satisfaction
CF – Chronic Fatigue
PHQ = Physical Health
GHQ = General Health
DEP = Depression
SOC = Social Disturbance

APPENDIX F. CORRELATION MATRIX: NIGHT WORKERS IN SUMMER

	S/W	AGE	YVR	MORN	FLEX	NEUR	EXTR	SLP	SAT	CF	PHQ	GHQ	DEP	SOC
S/W	1	.435**	.552**	.107	.135	-.105	-.242*	.175	-.087	.065	.152	-.044	-.112	-.238*
AGE		1	.265*	.199	.105	.091	-.392**	.509**	-.102	.089	.073	-.006	.069	-.138
YVR			1	.043	.036	.042	-.242*	.247	-.119	.105	.257*	.053	-.011	-.020
MORN				1	.268*	.056	-.154	.234	-.319**	.098	.176	.131	.063	.112
FLEX					1	.142	-.064	.041	-.264*	.155	.275*	.331**	.233	.143
NEUR						1	.126	.372**	-.431**	.304*	.417**	.532**	.497**	.286*
EXTR							1	-.417**	.002	-.263*	-.057	.060	.137	.203
SLP								1	-.318**	.375**	.335**	.220	.321**	.207
SAT									1	-.254*	-.263*	-.535**	-.379**	-.463**
CF										1	.335**	.256*	.326**	.168
PHQ											1	.514**	.639**	.321**
GHQ												1	.719**	.436**
DEP													1	.376**
SOC														1

Note. ** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

S/W = Shiftwork Experience
AGE = Age
YVR = YVR Experience
MORN = Morningness
FLEX = Sleep Flexibility
NEUR = Neuroticism
EXTR = Extraversion
SLP = Sleep Disturbance
SAT = Job Satisfaction
CF – Chronic Fatigue
PHQ = Physical Health
GHQ = General Health
DEP = Depression
SOC = Social Disturbance