Seasonal Mood Change

A Study of the Effects of Season and
Regular Exercise on Mood in the General Population

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Abstract

Seasonal affective disorder (SAD) is a condition characterised by regularly recurring episodes of depression with an onset during autumn or winter and remission in spring or summer. Previous studies have suggested that seasonal variation in mood and behaviour are not limited to individuals with SAD, but may also be experienced by normal members of the general population. At present, these studies have been limited to northern hemisphere samples.

The aim of this study was to explore the relationships between seasonal change, weather, exercise and mood in a southern hemisphere general population sample from two regions. Two questionnaires were completed by 176 subjects. The first questionnaire consisted of the Beck Depression Inventory (BDI), Hopkins Symptom Checklist-21 (HSCL-21), and an Exercise Inventory mailed to subjects in the last week of August, while the second questionnaire also included the Seasonal Pattern Assessment Questionnaire (SPAQ) mailed to subjects in the last week of February.

Seasonal variation in mood, sleep, energy, appetite, weight and social activity was reported by a large proportion of the sample. SPAQ criteria for SAD were met by 5.8% of the sample, and 12% of subjects met criteria for S-SAD. The degree of seasonal variation in mood and behaviour reported on the SPAQ, and prevalence of SAD and S-SAD found in this study, were similar to those reported in northern hemisphere general population samples. Subject's reports of seasonal symptoms on the SPAQ however, were not supported by significant differences in winter and summer BDI, HSCL-21, or Exercise scores for the total sample, males and females, or the SAD, S-SAD or normal subject groups, although significant differences in BDI and HSCL-21 scores between these groups were found. Differences in weather variables across seasons and between regions for the period of the study were not reflected in significant regional or seasonal differences in BDI, HSCL-21 or Exercise Scores, however fewer sunshine hours and more rainfall were associated with increased HSCL-21 scores in summer, but not in winter for the total sample. Significant interaction effects of Global Seasonality Scores (GSS) and weather variables suggest that individuals with higher seasonality scores may differ from those with lower seasonality scores in their sensitivity to the effect of weather variables.

The results of this study suggest caution in the use of self-report measures to investigate seasonal variations in mood and psychological distress. Limitations of this study and suggestions for future research are discussed.

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CHAPTER 1

INTRODUCTION

Scientific interest in the psychological effects of seasonal change has existed since ancient times, but it is only in the last decade that the link between environmental variables and affective illness has received formal recognition. With the publication of DSM-III-R in 1987, *'Major Depression: Seasonal pattern'* became a new and controversial diagnostic entity. Definition of this disorder emerged largely as a result of pioneering research conducted by Rosenthal and colleagues in 1984 (See Chapter 3) who discovered that a regular relationship between seasonal change and the onset and remission of affective episodes could be observed in a subgroup of individuals with major depression. This type of affective illness with a regular seasonal cycle has come to be known as Seasonal Affective Disorder (SAD).

History of Seasonal Influences on Mood

Although SAD is a relatively new concept, observations of the influence of season on psychological well-being have been recorded by writers, scientists, philosophers and poets for centuries. One of the earliest and most influential systems for conceptualising the relationship between mental illness and seasonal variation was developed in the 4th century B.C. by Hippocrates who taught that 'it is chiefly the changes of seasons which produce diseases, and in the seasons the great changes from cold to heat' (Jones, 1923-1931, p.123). According to Hippocrates the body consisted of four 'humours' or fluids: yellow bile, black bile, blood, and phlegm; which when heated or cooled according to the season, were more likely to result in certain mental illnesses. Mania (atrabilia) was linked to the hot and dry conditions of summer and a predominance of yellow bile; depression (melancholia) to an excess of black bile and the coldness and dryness of autumn; and lethargy (lethargus) to the cold and moist conditions of winter and a predominance of phlegm (Wehr, 1989). Implicit in the humoural system, which remained the dominant medical nosology for centuries, was an acceptance of the inter-relatedness of seasonal environmental influences and psychological well-being.

While the humoural system ultimately did not survive closer scientific scrutiny, consideration of the psychological effects of seasonal variables remained a part of medical practice for some time. Physicians of the 19th century such as Phillipe Pinel continued to note in detail the effect of seasonal change on the mood of their patients (Wehr, 1989), and in the early 1800's Pinel and his pupil Julien Esquirol published the first known description of a specific winter depression syndrome (as distinct from affective illness exacerbated by seasonal change) resembling SAD as we know it today (Hill, 1992).

Over the last century, modern lifestyles have become more distanced from the direct effects of environmental variables. For a large part of history, fluctuations in day length and temperature dictated the timing of daily activities, and therefore had a more direct impact on human lives. Since that time, the invention of electric heating and light has extended day length beyond its natural limits and distancing us from experiencing the more extreme effects of seasonal change. Nevertheless, seasonal patterns in many human behaviours persist (See Chapter 2).

Overview of the Present Study

Currently, '*Major Depression: Seasonal pattern*' is reserved for those individuals whose affective illness meets diagnostic criteria for Major Depression and shows a regularly recurring seasonal pattern. The extent to which the mood of members of the general population may also be affected by seasonal change is only now beginning to be investigated, and has almost exclusively involved northern hemisphere samples. The first aim of this thesis is to evaluate the extent to which normal individuals in a New Zealand general population sample are affected by seasonal change.

The second aim of this thesis is to look at factors influencing SAD by examining the effect of climate on psychological well-being. In the past, efforts to link aspects of seasonal change that were thought to affect mood with a treatment based on those factors, have led scientists to experiment with various regimes based on the manipulation of environmental variables. One of these regimes, termed 'climatotherapy', was based on the premise that seasonal environmental change varies with latitude, therefore exposure to a more temperate climate at one latitude might help relieve seasonal symptoms associated with another. A popular notion illustrated by Robert Burton in the *Anatomy of Melancholy* (1621/1989) held that 'hot countries are most troubled with....great numbers of madmen' while 'Cold air in the extreme is almost as bad as hot....In those northern countries, the people are therefore generally dull, heavy, and ....ascribe to melancholy' (pp.237-239). 'Climatotherapy' was successfully utilised by many physicians including Esquirol who prevented a patient from experiencing repeated episodes of winter depression by advising him to 'be in Italy before the close of October, from whence you must not return until the month of May' (1845; cited in Wehr & Rosenthal, 1989; p. 226).

Early scientists such as Hippocrates and Esquirol largely attributed seasonal affective illness to climatic changes in temperature (Wehr, 1989; Hill, 1992). Current etiological and therapeutic interest however centres around the role of light in SAD. References to light as a treatment for depression and lethargy date back to the second century AD (Hill, 1992), but it was more recent work by Norman Rosenthal and colleagues, (Rosenthal *et al.*, 1984) who were able to demonstrate that the affective symptoms of a group of SAD patients responded well to treatment with bright artificial light, that generated much scientific excitement.

Light, with its seasonal variations, was thought to be the mechanism behind SAD, and light also proved to be an effective mode of treatment. Thus it appeared that a concrete link between theory and empirical observation had been successfully made. We now know that the relationship between light and the mechanism underlying SAD is not as straightforward as it first seemed, and a theory which will accommodate all the findings of current research has yet to be generated. In addition, the impact of latitude and climate, once recognised as important factors in seasonal affective illness, has yet to be fully explored. The second part of this thesis attempts to investigate the relative influence of climate and light levels on mood in the general population.

The third aim of this thesis is to investigate the relationship between physical activity and affective illness, seasonal or otherwise. For some time, researchers have been interested in the potential for physical activity, particularly aerobic exercise (Dyer & Crouch, 1988), to have a positive effect on mood. Short term effects have been widely documented (Choi, Van Horn, Picker, & Roberts, 1993; Maroulakis & Zervas, 1993; McGowan, Pierce, & Jordan, 1991*a*), although longer term benefits have yet to be consistently established (Plante & Rodin, 1990). As with seasonal affective disorder, it is not yet known what mechanism in exercise has a positive effect on mood, although various biophysiological models have been suggested. Seasonal patterns in exercise behaviour have been found in Scotland (Uitenbroek, 1992) and there is evidence that continuous physical activity over the entire year may help prevent mood fluctuations associated with seasonal change (Suter, Marti, Tschopp, & Wanner, 1991). This thesis explores the relationships between season, mood, and physical activity in a New Zealand general population sample.

CHAPTER 2

SEASONAL RHYTHMS AND AFFECTIVE DISORDERS

Although modern society does not readily acknowledge seasonal rhythms in human activity, many aspects of our physiology, psychology, and behaviour show regular seasonal patterns. Studies of a wide range of variables such as personality, sleep, food preferences, thermoregulation, cardiovascular function, pupil size, CNS monoamines, growth rates in children, onset of menstruation, incidents of violence and rape, mortality, conception rates, suicide, and the onset of depression and mania have all found evidence of seasonal rhythms (Aschoff, 1981; Lacoste & Wirz-Justice, 1989). Onset of depressive and manic episodes and season of suicide are of particular interest to the study of SAD as they provide evidence in support of a seasonal rhythm in human affective disorders.

Mania and Season

In an examination of records of admissions for mania to the University Department of Psychiatry in Galway over the period 1980-1984, Carney, Fitzgerald and Monaghan (1989) found significant peaks in admissions in the spring and summer months, with a decrease over autumn and a low in admissions occurring during winter. Sex differences in peak month of admission were also found, with more males being admitted during spring (March peak) and more females during summer (July).

A summer peak and winter low in admissions for mania was also reported by Myers and Davies (1978) who looked at monthly admissions to psychiatric hospitals in England, Wales and Scotland over a ten year period. Analysis of three weather variables - mean daily temperature, mean day-length and mean daily hours of sunshine - found that temperature accounted for most of the variation in admission rates. Some evidence for a latitude effect has also been found, as Eastwood and Peter (1988) noted a spring peak in hospital admissions for mania that was correlated with latitude, and occurred earlier in samples from more southern latitudes of the northern hemisphere.

Suicide and Season

Although a link between affective illness and suicide cannot be presumed, Barraclough, Bunch, Nelson, and Sainbury (1974) estimate that around 70% of suicides are associated with depression. In a longitudinal study suicide rates, as well as conception and mortality for Japan and ten European countries over the last century, Aschoff (1981) found seasonal rhythms in all three variables for each country, with variations between countries in the amplitude (maximum variation from the mean) of rhythms and season in which peaks and falls occurred.

Although the amplitude of suicide rhythms was found to have declined steadily over the last 100 years, the rhythms continued to peak consistently in May or June throughout. Aschoff (1981) suggests that the decrease in amplitude of suicide rhythms may indicate a decrease in the 'effectiveness' of environmental factors influencing the rhythm, and cites industrialisation, an increase in the standard of living, and central heating as possible influencing factors.

Similar suicide rhythms to those reported by Aschoff (1981) were found in an earlier study by Takahashi (1964; cited in Eastwood & Peter, 1988) who examined suicide data for 16 northern hemisphere countries and found peaks between March and July for 15 of the 16 countries, with the majority of suicides occurring between April and June.

If the spring peaks in suicide observed in northern hemisphere samples have a physiological basis that is associated with environmental change, similar peaks in suicide in the southern hemisphere should be found during the southern hemisphere spring. Some evidence in support of this hypothesis is presented by Thompson (1989) who conducted a review of northern and southern hemisphere suicide studies and found that suicides peaked in spring in each of the hemispheres. Although non-biological seasonal factors which are common across hemispheres (eg. seasonal unemployment) could account for some of the seasonal variation in suicide behaviour, Aschoff (1981) concludes that definite seasonal suicide rhythms exist, that these rhythms must be influenced by factors in the environment, and that socio-cultural variables, which may modify seasonal rhythms, do not nullify their biological basis.

Depression and Season

Attempts have been made to explore the seasonality of depression by examining data on hospital admissions for depression, month of onset of depressive episodes, and consultations to general practitioners for depression. Thompson (1989) reviewed studies which looked at data from these sources, and found that overall, peaks in hospital admissions and consultations to general practitioners for depression in the northern hemisphere tended to occur in spring (May-June) and autumn (November-January). Onset of depressive episodes was however, approximately one month earlier, occurring between March and May and again in September to October.

Wehr and Rosenthal (1989) reviewed eight studies that examined the month of onset for depression in a total of eleven patient groups. The study included around 2,400 patients who experienced a total of 4,667 depressive episodes. Month of onset in each study showed a bimodal distribution with a spring peak in admissions for depression occurring between March and May, and an autumn peak occurring in September through to November, slightly earlier than the peak in admissions and GP consultations reported by Thompson (1989).

As an indirect measure of the seasonality of depression, Eastwood and Peacocke (1976) examined the frequency of ECT treatment at in-patient facilities in Ontario for each month between 1969 and 1973. ECT was most often administered during the spring (May) with a secondary peak in the autumn period (November to January).

Conclusion

The incidence of mania, depression and suicide found in these studies all show regular seasonal patterns occurring at a similar time to the seasonal patterns in symptoms reported by patients with SAD (Rosenthal *et al.*, 1984). Suicides occur most often in spring, in accordance with spring and autumn peaks found in the onset of depression, while admissions for mania peak in spring and summer. These patterns may reflect a general tendency for affective illness to exhibit seasonal cycles, or they may be influenced by a sub-group of patients with SAD. Thase (1989) observed seasonal patterns of depression in around 4-6% of an out-patient population with recurrent depression, and current estimates of the prevalence of SAD in clinical samples of unipolar and bipolar patients range from 16-28% (Faedda *et al.*, 1993; Garvey, Wesner, & Godes, 1988; Kasper & Kamo, 1990; Rosenthal *et al.*, 1984; Thase, 1989).

Although the above studies involve clinical samples, seasonal mood rhythms can also be found in general population samples (See Chapter 4) and studies of normal samples inevitably show some degree of seasonal variation (Eastwood, Whitton, Kramer, & Peter, 1985). Kasper *et al.* (1989*a*) have described a sub-group of individuals within the general population who experience mild mood difficulties with seasonal change, but for whom seasonal symptoms are not as severe as patients with SAD. Kasper *et al.* have demonstrated that these individuals with 'subsyndromal- SAD' (S-SAD) as they have been termed, also respond to treatment with bright artificial light (see Chapter 3).

If seasonal mood cycles exist for patients with affective disorders such as SAD, and to a lesser degree, those with S-SAD, then it is possible that these individuals represent the upper end of a continuum, with varying degrees of seasonal sensitivity evident in the rest of the population. Eastwood *et al.* (1985) suggest that it is the amplitude of seasonal rhythms (or degree of seasonal variation in symptoms) that differentiates patients with affective disorders from normals. The following chapter describes the history and typical features of SAD and S-SAD, while a summary of studies of seasonality in general population samples is presented in Chapter 4.

CHAPTER 3

SEASONAL AFFECTIVE DISORDER

History of Seasonal Affective Disorder

In mammals, the timing of seasonal cycles is set by the duration of light (photoperiod) an organism is exposed to in a single day. Melatonin, a hormone produced by the pineal gland during darkness, acts as a chemical moderator between the organism and its exposure to changing environmental light. After extensive study, it was established that the production of melatonin in mammals is suppressed by light. As day length increases, the duration of nocturnal melatonin secretion is reduced (and vice versa) so that suppression of melatonin during the day mimics day length (Wehr & Rosenthal, 1989; see Chapter 5 for a more detailed explanation of the role of melatonin in seasonal cycles).

Although these findings were confirmed in animal studies, research prior to 1980 had failed to show that light had a similar effect on melatonin levels in human subjects. Lewy, Wehr, Goodwin, Newsome, and Markey (1980) discovered that the intensity of light required for melatonin suppression in humans was greater than light used in previous studies with animals, and that light of sufficient intensity 'unequivocally' suppressed melatonin secretion in their 6 subjects (a response was obtained at 1500 lux). Furthermore, the degree of melatonin suppression shown by these subjects was positively correlated with intensity of light.

Based on these findings, Lewy, Kern, Rosenthal and Wehr (1982) postulated that the mood cycle of a manic-depressive patient, which had shown a regular seasonal pattern for a period of 13 years (Case study presented by Rosenthal, Lewy, Wehr, Kern, & Goodwin, 1983), might be modified by exposure to bright fluorescent light (2000 lux), and this treatment proved to be successful after around only four days of light therapy. Subsequent research has confirmed the efficacy of 'phototherapy', with consistent relapses to pre-treatment levels of depression shown by patients after withdrawal of light treatment (Rosenthal *et al.*, 1984; Rosenthal, Sack, Skwerer, Jacobsen, & Wehr, 1988*c*; Wirz-Justice *et al.*, 1986).

The results of these studies, along with other findings that supported the presence of seasonal variation in affective disorders, led Rosenthal *et al.* (1984) to conduct a landmark study which defined Seasonal Affective Disorder (SAD) for the first time.

Description and Symptomatology

Seasonal affective disorder (SAD) is a condition characterised by recurrent depressive episodes that occur regularly during autumn or winter, with or without periods of hypomania or mania in the spring or summer (Jacobsen & Rosenthal, 1988). Patients with SAD experience the same kind of symptoms associated with episodes of major depression - sadness, irritability and anxiety, work and interpersonal difficulties - as well as symptoms more usually associated with 'atypical' depression such as increased appetite, weight gain, hypersomnia and fatigue (Davidson, Miller, Turnbull, & Sullivan, 1982; Garvey *et al.*, 1988; Kaplan & Sadock, 1991). Many patients also report carbohydrate craving and daytime drowsiness which are not features of major or atypical depression but may occur in sleep or eating disorders (Jacobsen & Rosenthal, 1988).

Rosenthal *et al.* (1984) recruited 29 subjects who had a history of major affective disorder, and at least two consecutive years where depression had occurred during the autumn or winter with remission during the following spring or summer. Eighty-six percent of the sample were female and 14% male. For most of the subjects, seasonal depressions had begun after the age of 20 years, and half the subjects reported that their depressive episodes had changed over time, becoming longer in duration or more severe.

All of the subjects in the study reported sadness and a decrease in physical activity during their depressions, while 90% experienced irritability, 72% anxiety, and 69% decreased libido (See Table 1). Sixty-six percent said that their appetite increased with depression, while 28% experienced a decrease in appetite. Seventy-nine percent reported carbohydrate cravings and 76% reported weight gain. The patients' sleep patterns were also altered with 97% of the subjects sleeping longer when depressed but not sleeping as well as usual (90%), 79% going to sleep earlier, and 77% waking later. Seventy-four percent of subjects felt drowsy during the day, and all but one of the subjects said that their ability to perform at work was impaired during their depressions. All experienced interpersonal difficulties with a general tendency to withdraw from others during depressive episodes. Table 1 shows the percentage of subjects reporting each symptom in this study, along with comparative data from subsequent research. The level of symptomatology reported by subjects in the Rosenthal *et al.* (1984) study has been largely replicated by subsequent research in the northern hemisphere and one study with a southern hemisphere sample.

Given the similarity of symptoms experienced by patients with SAD and individuals with other non-seasonal depressions, there has been considerable debate as to whether SAD constitutes a distinctly different disorder from that of other affective disorders. The strongest evidence for the differentiation of SAD from non-seasonal depressions comes from the fact that patients with SAD respond well to phototherapy (Kasper *et al.*, 1989*a*; Rosenthal, Kasper, Schulz, & Wehr, 1989; Rosenthal *et al.*, 1988*c*; Sack *et al.*, 1990; Wirz-Justice *et al.*, 1986; Wirz-Justice *et al.*, 1993) whereas individuals with non-seasonal depression and normals do not (Genhart, Kelly, Coursey, Datiles, & Rosenthal., 1993; Kasper *et al.*, 1989*b*; Mackert, Volz, Stieglitz, Müller-Oerlinghausen, 1991; Yerevanian, Anderson, Grota, & Bray, 1986).

Table 1 - Symptoms of Seasonal Affective Disorder in 7 Studies (%)

Variables	Bethseda (n=29) 39°N	New York (n=163) 41°N	Britain (n=51) 51°N	UK (n=45) -	Japan (n=28) 31-43°N	Switzerland (n=22) 47°N	Australia (n=23) 35°S
Age							
Mean age (±SD)	36 ± 11	39 ± 11.1	41	47 ± 11	39 ± 17	42 ± 10	39 ± 13
Mean age onset (±SD)	27 ± 13	21 ± 11	24	28 ± 11	34 ± 16	27 ± 13	-
Sex, No.,(%)							
Male	4 (14)	28 (17)	6 (12)	13 (29)	10 (36)	6 (27)	3 (13)
Female	25 (86)	135 (83)	45 (88)	32 (71)	18 (64)	16 (73)	20 (87)
Ratio	6.2:1	4.8:1	9:1	2.5:1	1.9:1	2.7:1	6.7:1
Affect							
Sadness	100	95	96	100	100	91	78
Anxiety	72	76	86	91	93	86	83
Irritability	90	84	77	90	18	82	83
Appetite							
Increased	66	77	74	40	21	45	48
Decreased	28	9	16	49	57	54	35
Mixed	3	2	-	8	-	0	-
No Change	3	12	-	9	-	9	-
Carbohydrate Craving	79	88	82	47	32	77	78
Weight							
Increased	76	77	84	40	25	55	48
Decreased	17	63	6	38	25	23	31
Mixed	0	71	-	2	-	0	-
No Change	3	84	-	20	-	23	-
Sleep							
Earlier onset	79	78	-	47	-	-	65
Later waking	76	63	-	44	-	-	48
Increased sleep time	97	71	78	60	54	82	39
Change in quality (interrupted, not refreshing)	90	84	-	64	_	82	70
Daytime drowsiness	72	83	-	-	-	-	-
Decreased Physical Activity	100	97	100	100	100	100	87
Decreased Libido	69	87	-	68	-	77	65
Difficulties Around Menses	71	90	-	22	-	67	70
Work Difficulties	97	75	100	96	100	100	96
Interpersonal Difficulties	100	-	98	96	96	86	96
Family History							
Affective Disorder	69	51	25	47	-	67	-
Alcohol Abuse	7	20	8	13	-	28	-
SAD	17	23	14	7	-	8	-

Bethseda - Rosenthal *et al.*, 1984; New York - Terman *et al.*, 1989; Britain - Thompson and Isaccs., 1988; UK - Winton and Checkley, 1989; Japan - Sakamoto, Kamo, Nakadaira, Tamura, and Takahashi, 1993; Switzerland - Wirz-Justice *et al.*, 1986; Australia - Boyce and Parker, 1988.

Gender and Age Differences

Most studies of SAD patients conducted to date report a significantly higher frequency of female SAD sufferers in their samples than males. Table 1 shows female to male ratios in the studies reported to range from 1.9-9.0:1, with an average of 4.8:1 - a higher ratio than is generally reported for atypical depression (1.5-2.3:1; Davidson *et al.*, 1982). Rosenthal *et al.* (1984) suggest that women may be more vulnerable to SAD. However, some general population studies which have drawn on samples with an equal number of males and females have failed to find significant sex differences in rates of SAD and S-SAD (Rosen *et al.*, 1989; Terman, 1988; See Chapter 4). In addition, more recently Rosenthal *et al.* (1989) have noted that the number of men entering the National Institute of Mental Health SAD programme has been rising.

Some critics have suggested that media descriptions of SAD, which have often referred to the higher rate of females found in earlier studies, may have discouraged men from responding to requests for participants, thus producing a sex bias in the samples. Other researchers such as Schlager, Schwartz, and Bromet (1993) suggest that women may be more self analytical and report more symptoms because they have self perceptions which are more accommodating of affective variations than men. It is still unclear whether the prevalence of SAD and S-SAD in females is greater than that of other affective disorders.

The mean age of SAD patients in the studies reported in Table 1 ranged from 36 to 47 years. An age and sex effect for SAD has been found in several studies, with younger subjects (under 40) of both sexes being more likely to have higher seasonality scores, and younger females having higher scores than young males (Booker & Helleckson, 1992; Garvey *et al.*, 1988; Rosen *et al.*, 1989; Rosenthal *et al.*, 1988*c*). A more distinct age and sex effect was noted by Spoont, Depue, and Kraus (1991) who found that women aged 20-40 years had a significantly higher degree of seasonality than men, although another study by Magnússon and Stefánsson (1993) failed to find any significant interaction between age, sex and seasonality scores. No other demographic variable has emerged as significant in the study of SAD.

Family History

Several SAD studies have reported data on the prevalence of SAD, affective disorders, and alcoholism in the first degree relatives of SAD patients (See Table 1). Seven to 23% of subjects in these studies reported that a first degree relative also suffered from SAD. Family history of affective disorders tended to be relatively high, ranging from 25% to 69%. However these figures are comparable to samples of major depressed patients, as were figures for alcoholism (Thase, 1989). Alcoholism in a first degree relative was reported by 7-28% of the subjects in these studies.

In most cases, family history data is obtained from the patient themselves, and Allen, Lam, Remick, and Sadovnick (1993) suggest that this may result in inflated estimates. Using the family history method where information was obtained from a knowledgeable family member as well as the patient themselves, and validated by psychiatric records where possible, no significant differences between seasonal and non-seasonal patient groups were found. Twenty-seven percent of the seasonal patients and 38% of the non-seasonal group reported a family history of affective disorder, and these rates were lower than those found in previous studies using clinical interview of the patient alone (See Table 1). Based on reported histories however, there was significantly more alcoholism reported in the family history of seasonal patients (48%) than that of the non-seasonal patients (18%), and these figures are higher than those reported in previous studies. Allen *et al.* (1993) note that seasonal patterns in alcoholism and substance abuse have been reported in previous studies, and suggest that there may be a connection between seasonal mood and alcoholism that has yet to be explored.

Based on family history figures, Allen *et al.* concluded that the genetic loading for SAD is similar to other mood disorders, and does not provide any distinguishing characteristics in terms of etiology.

Summer-SAD

About 5% of the people who responded to Rosenthal *et al.*'s (1984) request for participants in their original SAD study reported a pattern of seasonal symptoms opposite to that characteristic of winter SAD - that is their depressions began in the spring or summer and remitted in autumn or winter. This pattern has now emerged as a subtype of SAD which has yet to be thoroughly investigated.

In northern hemisphere studies, summer-SAD, like winter-SAD, also seems to be influenced by latitude, but in the opposite direction to that of winter-SAD. While winter-SAD subjects have reported a worsening of symptoms on travelling north (Rosenthal *et al.*, 1984), summer-SAD subjects report longer lasting and more severe depressions when travelling to more southerly latitudes of the northern hemisphere. Many patients report an improvement in symptoms after travelling north in the summer (Wehr & Rosenthal, 1989).

Wehr, Sack, and Rosenthal (1987) studied 12 patients with a summer-SAD pattern and found them to be clinically and demographically similar to patients with winter-SAD. Summer-SAD patients however, were more likely to experience insomnia and a decrease in appetite rather than hypersomnia and appetite gain. Summer-SAD patients complained more of afternoon exacerbation of mood and fatigue while winter types were worse in the evening, and patients with summer-SAD reported more suicidal ideation than patients with winter-SAD. Rosenthal *et al.* (1989) suggest that this might explain the major peak in suicides in late spring and early summer found in suicide studies (Aschoff, 1981; Eastwood & Peter, 1988; Thompson, 1989*a*).

Wehr *et al.* (1989) note that summer depression tends to be associated with more endogenous symptoms, whereas winter depression is more usually atypical in nature (Wehr & Rosenthal, 1989). In a comparison of 20 patients with summer-SAD and 20 with winter-SAD, winter-SAD patients were more likely to have atypical depressive symptoms such as anergia, fatigue, increased appetite, carbohydrate craving, weight gain, hypersomnia, and decreased libido, while patients with summer depression were more likely to experience endogenous symptoms such as agitation, decreased appetite, weight loss, and insomnia. Consistent with the findings of Wehr *et al.* (1987), suicidal thoughts and suicide attempts in first-degree relatives were also reported more by patients with summer depression. The authors liken these differences in patients with summer and winter SAD to other dichotomous types of depression.

While winter-SAD patients tend to feel their depressions are dependent on light, Rosenthal *et al.* (1989) noted that summer-SAD patients tend to feel they are more sensitive to the influence of changes in temperature. Some support for this observation is provided by Wehr *et al.* (1989) who reported that the seasonal symptoms of a female subject with a 20 year history of recurrent summer depression responded well to isolation from sources of heat and repeated cold showers.

Clinical Findings in SAD Patients

Sleep Studies

Increased total sleep time (consistent with the hypersomnia reported by a majority of SAD patients), increased sleep latency, and a general tendency towards more frequent waking during the winter have been found in sleep studies of SAD subjects (Rosenthal *et al.*, 1984; Thase, 1989). EEG readings have also shown decreased delta sleep and increased REM density (Rosenthal *et al.*, 1985), patterns which are consistent with the sleep profiles of patients with major depression. However, decreases in REM latency, which are also characteristic of depression, were not found.

Partially contradictory findings were reported by Anderson *et al.* (1994) who found that SAD subjects did not tend to oversleep more than normal subjects, although their sleep was marked by decreased sleep efficiency, decreased delta sleep percentage, and increased REM density, which were returned to normal by phototherapy.

Increased sleep time in winter is not unique to SAD patients but is also found in patients other major depressive disorders (Rosenthal *et al.*, 1984). Conversely however, the SAD patients included in these studies did not exhibit shortened REM latency, a sleep feature typical of depression. As yet, the significance of these findings is not known.

Neuroendocrine studies

Neuroendocrine studies of patients with affective disorders commonly include the thyrotropin-releasing hormone (TRH) stimulation test, and dexamethasone suppression test (DST). Rosenthal *et al.* (1985) studied the neuroendocrine function of patients with SAD and found responses on the TRH stimulation test to be normal. Only two subjects failed to suppress dexamethasone - a proportion of subjects comparable with normal populations (Thase, 1989).

Immunological Findings

Previous studies have found peripheral blood lymphocyte response to mitogen to be reduced in patients with depression (Skwerer *et al.*, 1988). Skwerer *et al.* examined the response of peripheral blood lymphocytes to stimulation with mitogens in nine SAD patients and found that mitogen stimulation produced a greater response in SAD patients than that of normal controls. This response could be returned to normal levels by exposure to bright light. Rosenthal *et al.* (1989) suggest that mitogen stimulation may have potential as a discriminator between seasonal and non-seasonal depression.

Hormones and Neurotransmitters

Hormone and neurotransmitter functions in SAD patients are discussed in Chapter 5.

Diagnosis of SAD

Although most commonly referred to as 'Seasonal Affective Disorder', SAD is not a separate diagnostic entity but is incorporated into DSM-IV (APA, 1994) under the category of Major Depression with a 'seasonal pattern' modifier. Some changes to DSM-III-R criteria have been made in DSM-IV, including elimination of the 60 day window period (which required onset and remission of symptoms to occur within the same annual 60 day period but had no basis in clinical observations), and inclusion of a requirement that the number of seasonal episodes of depression outnumber non-seasonal episodes. Prior to the publication of DSM-IV dissatisfaction with DSM-III-R (1987) diagnostic criteria led most SAD research subjects to be selected on the basis of criteria suggested by Rosenthal and colleagues (1984). Table 2 compares these criteria with criteria from DSM-IV.

TABLE 2 - Diagnostic Criteria For 'Seasonal Affective Disorder' and DSM-IV 'Seasonal Pattern'

Seasonal Affective Disorder Rosenthal *et al.* (1984)	Seasonal pattern DSM-IV
1. Recurrent autumn-winter depressions	1. Regular temporal relationship between onset of Major Depressive Episodes in Bipolar I or Bipolar II Disorder or Major Depressive Disorder, Recurrent, and a particular time of the year (e.g. regular appearance of the Major Depressive Episode in the autumn or winter)
2. No seasonally varying psychosocial variables that might account for the recurrent depressions	2. Do not include cases in which there is an obvious effect of seasonal-related psychosocial stressors (e.g. being regularly unemployed every winter).
3. Regularly occurring non-depressed periods in the spring and summer.	3. Full remissions (or a change from depression to mania or hypomania) also occur at a characteristic time of the year (e.g. depression disappears in the spring).
4. At least two of the depressions occurred during consecutive years.	4. In the last two years, two Major Depressive Episodes have occurred that demonstrate the temporal seasonal relationships defined in criteria 1 and 2, and no non-seasonal Major Depressive Episodes have occurred during that same period.
5. At least one of the depressions met Research Diagnostic Criteria (Spitzer *et al.*, 1978) for depression.	5. Seasonal Major Depressive Episodes (as described above) substantially outnumber the non-seasonal Major Depressive Episodes that may have occurred over the individual's lifetime.
6. No other Axis I pathology	

Adapted from Rosenthal *et al.* (1989).

Subsyndromal SAD

Studies of the epidemiology of SAD have found varying degrees of seasonal mood and behaviour changes in normal members of the general population (Kasper *et al.*, 1989*a*; Terman, 1988). Kasper *et al.* (1989*a*) have suggested the term 'subsyndromal-SAD' (S-SAD) to refer to a subgroup of these individuals who experience difficult yet 'subsyndromal' symptoms associated with seasonal change.

Researchers have found that individuals with S-SAD often report significant levels of the vegetative symptoms typical of SAD (increased appetite, weight gain, hypersomnia, lethargy), but may never have experienced a major depressive episode (Rosenthal *et al.*, 1989; Wirz-Justice *et al.*, 1989). The symptoms are usually too mild to induce the person to seek help, but unlike normals who do not report seasonal symptoms to such a degree, individuals with S-SAD appear to be responsive to light therapy (Kasper *et al.*, 1989*a*). S-SAD sufferers appear to be intermediate between SAD sufferers and normals in terms of severity of difficulties associated with seasonal change (see Table 3).

Estimates of the prevalence of S-SAD in the northern hemisphere vary from 2.6% of the general population (Rosen *et al.*, 1989) to 19.1% (Booker & Hellekson, 1992; see Table 4), and like SAD, incidence of S-SAD appears to increase with latitude and is more commonly found in females.

Table 3 - Characteristics of Patients with SAD, Individuals with S-SAD, and Controls

Variable	SAD (n=20)	S-SAD (n=20)	Controls (n=20)
Changes with the seasons are a problem, (%)	100	80	0
Mild	0	25	0
Moderate	25	40	0
Marked	45	15	0
Severe	25	0	0
Disabling	5	0	0
Change with the seasons in; (%)			
Social activity	100	100	30
Mood	100	95	30
Weight	100	85	55
Sleep length	95	80	30
Appetite	95	95	55
Food preference	85	75	40
Energy	95	95	25
Weight fluctuations during the course of the year, (%)			
0 - 1.35 kg	0	10	35
1.8 - 3.15 kg	25	45	50
3.6 - 4.95 kg	20	40	15
5.4 - 6.75 kg	30	5	0
7.2 - 9 kg	5	5	0
>9 kg	20	0	0
The following weather changes negatively affect mood (%)			
Short days	100	95	30
Foggy, smoggy days	100	90	60
Grey cloudy days	95	95	55
Cold weather	65	80	30
Humid days	55	50	65
Hot weather	40	25	25
High pollen count	40	40	30
Dry days	5	5	0
Sunny days	0	0	0
Long days	0	0	0
Sleep length, Mean ± SD			
Winter	9.0 ± 2.0	9.0 ± 1.7	7.2 ± 0.9
Spring	7.3 ± 1.0	7.8 ± 0.9	7.0 ± 0.7
Summer	6.4 ± 1.1	7.3 ± 0.8	7.0 ± 0.6
Autumn	8.3 ± 1.6	7.9 ± 1.0	7.1 ± 0.8

From Kasper *et al.* (1989*a*).

Seasonal Variation in Normal Subjects

Seasonal patterns in SAD patients and individuals with S-SAD have been described in various studies, but seasonal cycles are also evident in normal populations. Eastwood *et al.* (1985) asked a group of affective disorder patients and a group of normal subjects to complete daily self-ratings of hours slept, mood, anxiety, and energy level each morning for 14 months. Significant periodicities in self-ratings were found for 81% of all subjects, and 35% of all significant cycles were found to be seasonal. Affective disorder subjects and normal subjects exhibited similar patterns of seasonal change, which differed only in amplitude (or severity) of the seasonal cycles. Further findings in normal subjects from general population samples are described in Chapter 4.

Conclusion

Seasonal cycles have been found in a sub-group of clinically depressed patients - those with SAD - as well subjects with more moderate seasonal symptoms (S-SAD), and normal individuals. Evidence suggests that sensitivity to seasonal change may be normally distributed throughout the general population, with the degree to which seasonal cycles vary lending clinical significance to the symptoms reported by individuals with SAD and S-SAD. Studies of seasonality in general population samples are reviewed in the following chapter.

CHAPTER 4

GENERAL POPULATION STUDIES

Estimates of the prevalence of SAD and S-SAD in the general population are difficult to establish, and only a few studies, almost exclusively from northern hemisphere samples, have addressed this issue to date. In each case, the instrument of assessment has been the Seasonal Pattern Assessment Questionnaire (SPAQ: Rosenthal, Genhart, Sack, Skwerer, & Wehr, 1987a), a self-administered retrospective measure of seasonal variations in mood and behaviour designed for screening patients entering SAD and phototherapy research at the National Institute of Mental Health, Bethseda, USA. Questions from the SPAQ about the severity of seasonal change in sleep, socialising, mood, weight, appetite and energy are totalled to give a Global Seasonality Score (GSS) for each subject, with higher scores indicating a greater degree of seasonal change in these variables. These scores have been used to differentiate potential SAD and S-SAD subjects from normals, with cut-off scores suggested by Kasper *et al.* (1989*c*) on the basis of their clinical experience with the instrument (See Chapter 9 for a more detailed description of the SPAQ). Although not originally designed as a diagnostic or epidemiological instrument, the SPAQ has been widely utilised in evaluating prevalence rates of SAD and S-SAD in the general population.

General Population Studies

Kasper *et al.* (1989*c*) conducted a random telephone survey of 416 residents of Montgomery County, Maryland, using a telephone version of the SPAQ. Twenty-seven percent of the sample felt that seasonal changes were a problem for them, and only 7.6% of the sample said they did not experience any seasonal variation in mood or behaviour. In the total sample, 17.3% had Global Seasonality Scores (GSS) of 10 or more, and this score reflected the degree of seasonality found in 91% of winter SAD subjects studied by Kasper *et al.* Five percent of respondents met SPAQ criteria for SAD (4.3% winter-SAD and 0.7% summer-SAD; see Chapter 9 for criteria) and 13.5% of the sample met criteria for S-SAD (see Table 4).

Seventy-one percent of winter-SAD subjects, 66% of summer-SAD subjects, and 55% of S-SAD subjects were female, despite even numbers of males and females being included in the sample. A negative correlation between age and GSS was found, with younger respondents tending to express more seasonal difficulties, and women scoring higher than men. There appeared to be a relationship between feeling worst in winter, ambient temperature and photoperiod, with most respondents feeling worst when temperature and light levels in the region were lowest. A small number of subjects, consistent with the number of summer-SAD subjects found in this study, reported feeling worst in the summer months.

A subset of 40 subjects from the sample were personally interviewed to compare their outcomes on the SPAQ with diagnoses based on clinical criteria for SAD (Rosenthal *et al.*, 1989). Using clinical criteria, 10% could be diagnosed as having SAD and 35% diagnosed as S-SAD, which suggests that the SPAQ may underestimate the prevalence of SAD and S-SAD in general population samples.

In a smaller study, Terman (1988) sent a mail version of the SPAQ to 400 households randomly selected from the Manhattan telephone directory and obtained 212 completed questionnaires. In order to increase the chances of obtaining a sex-balanced sample, half of the cover letters accompanying the questionnaires requested an adult male at the address to complete the questionnaire, and half asked for it to be completed by an adult female. Fifty-one percent of questionnaires were returned by males and 49% by females (see Table 4).

Fifty percent of the sample reported lowered energy levels in winter, 31% experienced decreased social activity, 47% weight gain, and 42% slept more during the winter months with sleep length oscillating with changes in hour of sunrise (day length). Vegetative symptoms were more common than mood disturbances in this study. Thirty-one percent of the sample said that they felt worst in winter, and a quarter of the sample indicated that seasonal change was a problem for them. Global Seasonality Scores reported by these subjects matched those of the S-SAD group reported by Kasper *et al.* (1989*a*) in severity. Similar patterns in seasonal mood variations were shown by subjects who complained of severe winter symptoms and subjects who did not, and these mimicked the seasonal patterns exhibited of a sample of SAD patients (Terman *et al.*, 1989) but with less amplitude. The seasonal cycles observed in this study showed peaks around early to late winter, with a slight summer peak on the mood variable, similar to that observed by Kasper *et al.* (1989*a*), probably reflecting the mood cycles of a small number of summer-types in the sample.

Unlike many studies of both SAD samples and general population samples (Kasper *et al.*, 1989*c*; Rosen *et al.*, 1989; Rosenthal *et al.*, 1984) there were no statistically significant sex differences found in this study. GSS scores were higher than the mean SAD group score (16.7) for 2.4% of the sample, and there were no differences in the number of males and females in this high GSS group. Although there were more female subjects in the SAD group, mean GSS scores show that females did not experience more severe symptoms than males (mean GSS 16.7 for females, 16.9 for males). There were no significant sex differences in the severity of symptoms reported by the total sample.

Terman *et al.* (1989) suggest that the higher rates of women found in other studies may be an artifact produced by sociocultural factors with women more readily acknowledging mood changes and being more willing to seek medical intervention.

Table 4 - Prevalence of SAD and S-SAD at 7 Latitudes

Variable	Sarasota (n=426) 27°N	Mont. (n=416) 39°N	MC (n=576) 39°N	New York (n=212) 41°N	Nashua (n=382) 42.5°N	Canada (n=252) 50.5°N	Iceland (n=587) 62°-67°N	Alaska (n=283) 65°N
Sex, (%)								
Female	47.0	49.6	47.0	49.0	62.0	50.4	50.8	48.8
Male	53.0	50.4	53.0	51.0	38.0	49.6	49.2	51.2
Mean Age, (±SD)	58.7±16	46.4±16.5	47.2±16	43.3±14	40.5±14	47.1±15	37.8±14	40.1
Mean GSS, (±SD)	6.1	5.43±3.9	6.7±0.2	7.4	7.1	4.9±3.4	5.5±4.2	-
Seasonal Change a problem, (%)	13.5	27.0	22.0	24.2	26.1	-	-	-
Feel worst in; (%)								
Winter	17.6	43.2	47.7	46.9	48.7	-	-	-
Summer	18.5	9.6	11.6	14.1	6.5	-	-	-
Disorder, (%)								
SAD	2.6	5.0	7.5	8.3	10.2	1.2	3.8	9.2
Winter	1.4	4.3	6.3	4.7	9.7	1.2	3.8	9.2
Summer	1.2	0.7	1.2	3.6	0.5	0	0	-
S-SAD	2.6	13.5	10.4	12.5	11.0	3.3	7.5	19.1
Winter SAD or S-SAD	4.0	17.8	16.7	17.2	20.7	4.5	11.3	28.3

Sarasota-Rosen *et al.*, 1989; Mont.: Montgomery County - Kasper *et al.*, 1989*a*; MC: Montgomery County - Rosen *et al.*, 1989; New York - Terman, 1988; Terman et al., 1989; Nashua - Rosen *et al.*, 1989; Canada - Magnússon and Axelsson, 1993; Iceland: Magnússon and Stefánsson, 1993; Alaska - Booker and Hellekson, 1992.

Rosen *et al.* (1989) pooled the data obtained by Terman (1988) and Kasper *et al.* (1989*c*) with data obtained from the general populations of Nashua (n=382), Sarasota (n=426), and a further sample from Montgomery County (n=576). The procedure outlined by Terman was used to encourage equal responses from males and females. A total of 1576 completed SPAQ questionnaires were included in the study (see Table 4 for data from each region).

Rates for SAD ranged from 2.6% in Sarasota to 10.2% in New York. Prevalence of S-SAD ranged from 2.6% in Sarasota to 12.5% in New York. Seasonal change was regarded as a problem by 13.5% to 26.1% of the samples from each region. Analysis of the total sample revealed that around 40% of respondents reported feeling worse in winter. More symptoms were reported by females than males, except in New York, and 65% of subjects who met SPAQ criteria for SAD were female. A negative correlation between age and GSS was found for both sexes.

Booker and Hellekson (1992) report on an Alaskan sample of 283 residents who answered the SPAQ as part of a larger community health survey. Nine percent met SPAQ criteria for SAD, 19% met criteria for S-SAD, and there were more females than males in both groups (see Table 4). An age effect was also found with SAD and S-SAD subjects tending to be younger (mean age 34.8 and 35.8 years) and non-seasonal subjects older (42.0). Women were 2.96 times more likely to have SAD than men, and the under 40's of both sexes were 2.84 times more likely to have SAD than the over 40's.

In a more recent study, Magnússon and Stefánsson (1993) found that only 10% of subjects in a randomly selected sample of 587 residents of Iceland indicated that they did not experience any symptoms associated with seasonal change. SPAQ criteria for SAD were met by 3.8% of the sample, and 7.5% of the sample met criteria for S-SAD (see Table 4). Seasonal symptoms were more common in young female respondents who had higher GSS scores (6.0 ± 4.4) than males (4.8 ± 3.9). Sixty-one percent of SAD and S-SAD subjects were female, while the male-female ratio for normal subjects was almost even (51% female, 49% male). Unlike Booker and Hellekson (1992), Magnússon and Stefánsson did not find any significant interaction between age, sex and seasonality scores.

An assessment of seasonality in a general population sample using an alternative instrument to the SPAQ, the Inventory of Seasonal Variation (ISV), was conducted by Spoont *et al.* (1991). The ISV provides a dimensional measurement of seasonal variation in mood and behaviour, and asks respondents to estimate their level of change in energy, sleep, pleasure, mood, elevated and depressed mood, sociability, sensation seeking, sensory vividness, physical activity, optimism, mood swings, appetite, and a bogus item - entertainment preference - during each season. Using the ISV with a group of 463 university students, Spoont *et al.* found that 82% of the sample exhibited seasonal patterns in these variables. Lower rates of activity occurred in winter and higher levels in summer. Like Booker and Hellekson (1992), Spoont *et al.* found that women aged 20-40 years had a significantly higher degree of seasonality than men.

Latitude

In the original study conducted by Rosenthal *et al.* (1984), 83% of winter SAD patients reported experiencing an improvement in mood (and in some cases a complete remission) by travelling South within the northern hemisphere, while travelling North tended to exacerbate their symptoms (the opposite is found in summer SAD patients; Wehr & Rosenthal, 1989). Hellekson (1989) also notes that seasonal symptoms appear to last longer at higher latitudes.

If current theories about the etiology of SAD and S-SAD are considered, then presumably this latitude effect is influenced by the differences in light levels available at each latitude (see Chapter 5 for more detail of the role of light in seasonal affective disorders). Table 4 shows the prevalence of SAD (winter and summer types) and S-SAD from seven locations ranging in latitude from 27°-67° North of the equator. Many researchers have now observed that the incidence of SAD in the northern hemisphere appears to increase with latitude (Rosen *et al.*, 1989; Rosenthal *et al.*, 1989). However, lower prevalence rates of SAD and S-SAD in the Canadian (50.5°N) and Icelandic (62°-67°N) samples do not fit this pattern. While SAD and S-SAD show an increasing trend from 2.6% of the sample for both SAD and S-SAD in Sarasota (27°N), to 10.2% and 11.0% in Nashua (42.5°N), figures for Canada (50.5°N) and Iceland (62°-67°N) are lower than would be expected given the latitude hypothesis (1.2 and 3.8% for SAD; 3.3 and 7.5% for S-SAD).

Magnússon and Stefánsson (1993) suggest that natural selection processes may be taking place or that a small emigration effect may be selecting for individuals who are less susceptible to seasonal change (emigration from Iceland is rare). The hypothesis of natural selection assumes that SAD and S-SAD somehow limit reproductive capabilities - an assumption which has no support as yet.

In order to test the hypothesis that there is a genetic component to SAD in which descendants of the northern-most light-starved regions may be more resistant to SAD, Magnússon and Axelsson (1993) mailed the SPAQ to a random sample of 252 direct descendants of Icelandic immigrants living in the Interlake district of Manitoba, Canada. Only 1.2% of the sample met SPAQ criteria for SAD, and only 3.3% met criteria for S-SAD, rates significantly lower than those found in Montgomery County, New York, and Nashua (Rosen *et al.*, 1989; See Table 4). Magnússon and Axelsson conclude that the lower prevalence rates found in this study could not explained by climate as the Manitoba district experiences extreme variations in temperature between summer and winter. This study is the first of its kind and the impact of genetic variables on prevalence rates for SAD and S-SAD remains to be further explored.

Conclusion

Each of the studies reviewed in this chapter found varying numbers of respondents who met criteria for SAD and S-SAD, but they also found seasonal cycles in the majority of normal subjects. Consistent with the continuum hypothesis, sensitivity to seasonal change appears to be a universal trait which reaches clinical significance only when the degree of seasonal variation in symptomatology is severe. Epidemiological studies so far suggest that sensitivity to seasonal change increases with latitude, although results from studies in Canada and Iceland (Magnússon & Axelsson, 1993; Magnússon & Steffansson, 1993) are contradictory. It is not yet known whether genetic factors may influence these results.

CHAPTER 5

SAD AND THEORIES OF MECHANISM

After the discovery that phototherapy was an effective treatment for SAD (Lewy *et al.*, 1982; Rosenthal *et al.*, 1984), and S-SAD (Kasper *et al.*, 1989*a*), researchers also speculated as to whether phototherapy might also prove beneficial in the treatment of non-seasonal depressions. Since that time however, it has become clear that changes in mood and behaviour as a result of phototherapy only occur in individuals who normally experience seasonal variation in these factors (Kasper *et al.*, 1989*b*) and that phototherapy has no effect on patients with non-seasonal depression (Kripke, 1985; Mackert *et al.*, 1991; Yerevanian *et al.*, 1986), atypical depression (Stewart, Quitkin, Terman, & Terman, 1990), or normal subjects (Genhart *et al.*, 1993; Rosenthal, Rotter, Jacobsen, & Skwerer, 1987*b*).

Recently, a study by Meesters, Jansen, Beersma, Bouhuys, and van den Hoofdakker (1993) found that 5 days of phototherapy administered at the first sign of winter SAD symptoms could successfully prevent the development of a full-blown depressive episode throughout the total winter period. These findings have left researchers with important questions which have yet to be fully answered: if phototherapy is an effective treatment only for those individuals who experience seasonal variation in symptoms, in what way do these individuals differ from the normal population?; and secondly, how does phototherapy act on these differences to relieve the seasonal symptoms associated with SAD? The following is a summary of the major theories of mechanism and supporting research which have been examined to date.

The Melatonin Hypothesis

Inspired by animal models of seasonality, the melatonin hypothesis suggests that changes in day length (photoperiod) trigger winter depression by altering nocturnal patterns of melatonin secretion (Wehr & Rosenthal, 1989). Since photoperiod is supposedly the critical factor in this hypothesis, phototherapy administered before dawn or after dusk (thus extending the photoperiod) should effectively relieve depression, while phototherapy administered during the day, where photoperiod remains unaffected, should have no clinical or physiological effect. In addition, some abnormality in melatonin rhythms should be found in patients with SAD. This reasoning is not supported by experimental evidence. No physiological differences in the circadian melatonin rhythms or melatonin response to light of SAD patients compared to normals have been found (Checkley *et al.*, 1989, 1993; Murphy *et al.*, 1993).

Rosenthal and colleagues (1986, 1988*b*; Wehr *et al.*, 1986) conducted a series of studies to examine the role of melatonin in the etiology of SAD. Wehr *et al.* compared phototherapy administered in the early morning and late evening (when the normal secretion of melatonin would be suppressed) with phototherapy administered in the late morning and late afternoon (when melatonin would not be produced and therefore not be suppressed) for effectiveness in the relief of symptoms associated with SAD. Both forms of light therapy, independent of time of day and circadian melatonin cycle, proved effective forms of treatment.

After successfully treating SAD subjects with phototherapy, Rosenthal *et al.* (1986) studied the effect of melatonin administered orally in order to determine whether the effects produced by phototherapy would be reversed. Oral administration of melatonin resulted in a small increase in depression scores, but these were far less dramatic than relapses to clinical depression seen in patients after withdrawal of phototherapy (Rosenthal *et al.*, 1984; Rosenthal *et al.*, 1988c; Wirz-Justice *et al.*, 1986).

To test the hypothesis that the antidepressant effect of light is dependent on suppression of melatonin secretion, Rosenthal and colleagues (1988*b*) conducted a double-blind crossover study where 19 SAD patients were given atenolol (a melatonin blocker) or placebo while undergoing a course of phototherapy. No significant difference in the antidepressant effect of phototherapy was found between subjects in the atenolol and placebo conditions.

On the basis of these studies, Rosenthal and Wehr (1992) conclude that 'melatonin secretion does not play a critical role in the pathogenesis of SAD, nor does its modification appear to be the critical element in the mechanism of action of light therapy' (p. 56).

The Circadian Rhythm Phase Shift Hypothesis

The circadian rhythm phase shift hypothesis is based on the observation that SAD patients tend to want to sleep longer in the morning during winter. This led researchers to suggest that winter depression may be the result of a circadian rhythm phase delay (with respect to sleep) brought on by the shorter days of winter (Blehar & Lewy, 1990; Rosenthal & Wehr, 1992; Wehr & Rosenthal, 1989). According to this theory, morning light should improve winter depression by advancing the circadian rhythm phase, while evening light should delay the phase with the opposite effect.

These hypotheses are supported to some extent by experimental evidence. Lewy, Sack, Miller, and Hoban (1987) found that patients with winter depression have abnormally phase-delayed circadian rhythm melatonin secretion, that morning light advances and evening light delays phase position, and that morning light is more effective as a treatment than evening light. Similar results are reported in several studies (Elmore, Dahl, Avery, Savage, & Brengelmann, 1993; Lewy, Sack, & Singer, 1985; Sack *et al.*, 1990), but others have failed to find abnormally phase-delayed rhythms in SAD patients, phase shift responses to phototherapy (Checkley *et al.*, 1993; Murphy *et al.*, 1989), or superior responses to treatment with morning versus evening light (Hellekson, Kline, & Rosenthal, 1986; Wirz-Justice *et al.*, 1986; Wirz Justice *et al.*, 1993; Yerevanian *et al.*, 1986). In addition, phototherapy administered in the evening, which should have a negative effect on mood according to the phase shift hypothesis, has also been found to be an effective antidepressant in some subjects (Hellekson *et al.*, 1986; Wirz-Justice *et al.*, 1993; Yerevanian *et al.*, 1986).

Rosenthal and Wehr (1992) suggest that requiring patients who would normally sleep longer to wake for early morning light therapy may in itself cause a shift in melatonin secretion rhythms. This effect was noted by Sack *et al.* (1990) where phase shifts in melatonin secretion occurred during a one week sleep-wake adaption period before light therapy was initiated.

Rosenthal and Wehr (1992) conclude that 'while it is possible and even likely that a circadian variation in light responsiveness exists, this does not necessarily imply that improvement in symptoms is the result of a shift in circadian rhythms'(p. 57). The hypothesis remains uncertain.

The Circadian Rhythm Amplitude Hypothesis.

According to the circadian rhythm amplitude hypothesis, winter depression is the result of lowered amplitudes (maximal values) of circadian rhythms, rather than abnormal phase (timing). Phototherapy would therefore improve mood by increasing the amplitude of circadian rhythms (Wehr & Rosenthal, 1989). Exposure to light during the day increases circadian rhythm amplitudes, while light during the night decreases amplitude, so exposure to daytime light should improve symptoms associated with SAD.

Circadian amplitudes have been found to be abnormally low in major depression, but Rosenthal and Wehr (1992) do not report finding reduced amplitude of temperature rhythms in SAD patients compared to normals, although rhythms were amplified by light therapy. A follow-up study during summer, when normal light levels were expected to act on circadian amplitudes in the same way as phototherapy, found that amplitudes were unaffected and remained identical for both SAD patients and normals

(Levendosky, Joseph-Vanderpool, Hardin, Sorek, & Rosenthal, 1991). In this study, summer and phototherapy, which both relieve symptoms associated with SAD, effectively produced different circadian amplitude responses. These findings have complicated the theory behind the circadian rhythm amplitude hypothesis and it is currently still under investigation.

Photon Counting

The photon hypothesis essentially states that winter depressive episodes are brought on by a lack of light, and that the therapeutic effect of phototherapy is provided by replacement of light (Thompson & Silverstone, 1989). According to this hypothesis, photoperiod is not important (ie extension of the photoperiod by administering phototherapy in the early morning or late evening is not necessary) but rather the intensity of light is the important factor. Evidence in support of this theory is the observation that response to phototherapy increases as light intensity increases (Lewy *et al.*, 1980).

Neurotransmitter Theories

Serotonin

Serotonin is implicated in the regulation of appetite and sleep, and given the disturbances in both factors associated with SAD, serotonin was therefore one of the primary foci of early attempts to explain the mechanism behind SAD symptomatology (Rosenthal & Wehr, 1992). Serotonin synthesis can be increased by the consumption of carbohydrates, and it is possible that the carbohydrate craving experienced by SAD patients is a correctional response to abnormal levels of serotonin in the body (Rosenthal & Wehr, 1992).

In order to test the involvement of serotonin in SAD symptomatology, O'Rourke, Wurtman, Wurtman, Chebli, and Gleason (1989) administered *d*-Fenfluramine (a serotonin-releasing drug which suppresses carbohydrate craving) to 18 SAD patients in a placebo-controlled crossover study. Symptoms were significantly decreased in subjects who were receiving *d*-Fenfluramine, but not during administration of the placebo. *d*-Fenfluramine was also effective in relieving SAD symptoms throughout the winter months in 9 patients tested the following year.

Administration of L-Tryptophan, the precursor of 5-HTP from which serotonin is formed has been reported as being as effective in relieving SAD symptoms as phototherapy (Jacobsen, Murphy, & Rosenthal, 1989). Conversely, Jacobsen *et al.* (1989) found that administration of m-chlorophenylpiperazine (m-CCP), a serotonin agonist, induced depression, elation, and activation in SAD patients, with increased secretion of prolactin and cortisol compared with controls.

Jacobsen *et al.* (1989) also report on an experiment where SAD patients and normals were given a carbohydrate rich and a protein rich meal. SAD patients reported feeling more energetic after the carbohydrate meal, whereas normal subjects experienced drowsiness, suggesting that SAD patients have an alteration in their general serotonergic function. However, Rudorfer, Skwerer and Rosenthal (1993) failed to find any differences in the primary metabolites of serotonin, dopamine, or norephinephrine between patients and controls, nor any change in these after phototherapy, despite a therapeutic response.

Some evidence for the interaction between light therapy and the serotonergic and noradrenergic systems is provided by Mason (1989) who reported that rats exposed to continuous bright light or an extended photoperiod show enhanced sensitivity to serotonin and altered sensitivity to noradrenaline. The mechanism behind these alterations in function is not known.

Overall, the evidence suggests that serotonin is in some way implicated in SAD symptomatology and that the serotonergic systems of SAD patients may exhibit abnormalities of function. As yet, it is not known what form these abnormalities may take or what role serotonin plays in SAD symptoms and their response to phototherapy.

Dopamine

Depue *et al.* (1990) suggest that deregulation of the dopaminergic systems of SAD patients may explain their lack of energy and motivation during winter, as these functions have been shown to be regulated by the dopamine system in animals. Dopamine is thought to be the primary substance involved in several functional systems in the human body, and measurement of these functions (e.g. prolactin secretion, thermoregulation, and eye-blink rates) therefore provides indirect information about the human dopamine system.

Both serotonin and dopamine are implicated in the production of prolactin in the human body, but dopamine is thought to be the primary substance involved (Depue, Arbisi, Spoont, Leon, & Ainsworth, 1989*a*). Depue, Arbisi, Spoont, Leon, and Ainsworth (1989*b*) found significantly lower prolactin concentrations in both winter and summer in SAD patients compared with controls. Low prolactin levels and elevated eye blink rates (a function also mediated by the dopaminergic system) have been shown to persist in SAD patients even when successfully treated with phototherapy (Depue *et al.*, 1989*a*) and are therefore regarded as trait markers of SAD by some researchers (Depue *et al.*, 1989*b*, 1990; Rosenthal & Wehr, 1992).

Studies of the thermoregulatory systems of SAD patients after physical activity have also found that SAD patients are slower to return to normal temperature than controls. However, these thermoregulatory abnormalities disappear after treatment with phototherapy (Depue *et al.*, 1989*a*, 1990). Although it would appear that the dopaminergic systems of SAD patients show distinctions from those of control subjects, as yet, no satisfactory explanation for the above findings exists (Rosenthal & Wehr, 1992).

Norephinephrine

Skwerer *et al.* (1988) and Rudorfer, Skwerer, and Rosenthal (1993) failed to find any differences in norephinephrine levels between patients with SAD and normals; however plasma norephinephrine levels in 14 SAD patients were found by Skwerer *et al.* to be inversely related to the severity of their depressive symptoms. Treatment with phototherapy produced increases in norephinephrine which corresponded to improvements in mood, but it is unclear whether increases in norephinephrine are produced by, or result from, the antidepressant effect of light. Rosenthal and Wehr (1992) conclude that a relationship between severity of symptoms in SAD and the noradrenergic system may exist, but the nature of this relationship is currently unknown.

Other Approaches

The link between light and the symptoms of SAD has prompted investigators to examine the light sensitivity of SAD patients. Oren, Joseph-Vanderpool and Rosenthal (1991) suggested that retinal subsensitivity to light may account for SAD, but found that rather than being subsensitive to light, 10 SAD subjects adapted more quickly to dim light than did controls. Murphy *et al.* (1989) found no significant differences in the light sensitivity of patients and controls.

Another area which has been tentatively investigated is that of geomagnetism. Based on growing evidence that the retina and pineal gland in birds, mammals, and humans is magnetosensitive, Sandyk, Anninos, and Tsagas (1991) proposed the hypothesis that geomagnetic fields, in addition to light, may play a role in the etiology of SAD. Magnetic fields, like light, show seasonal variation in intensity, with a decrease in the winter months. Exposure to acute magnetic fields has a similar effect on melatonin secretion (suppression of melatonin) as phototherapy, leading Sandyk *et al.* to suggest that phototherapy may be enhanced by concurrent exposure to magnetic fields. This hypothesis has yet to be tested on patients with SAD.

Conclusion

As yet, no one explanation for SAD or the effectiveness of phototherapy on patients with SAD emerges from research so far. Somewhat frustratingly, the observation that led researchers to discover phototherapy as an effective treatment for SAD - that bright artificial light suppresses melatonin - has failed to provide any adequate explanation of the etiology of SAD. It now seems fairly certain that melatonin is not the crucial factor in either the clinical effect of phototherapy or the etiology of SAD, and given the variety of outcomes from current research, the likelihood that only a single functional system will be implicated appears to be remote.

CHAPTER 6

WEATHER AND MOOD

Weather Sensitivity and SAD

Several of the SAD patients in the original study conducted by Rosenthal *et al.* (1984) related their depressions to changes in day length and the quality of light at different times of the year. One patient called the illness 'the grey sky syndrome', and several subjects reported feeling low after a three or four consecutive days of overcast skies at any time of the year. Other patients regarded cold to be as equally significant as light in affecting mood state, and a high correlation between the number of patients depressed in a given month and mean monthly temperature and photoperiod was found in the study.

Other studies have also reported negative mood in SAD patients as a result of cloudy days. Winton and Checkley (1989) interviewed 45 SAD patients and found that 6 patients (all female) felt their depressive symptoms were related more to weather than to a particular season. In these patients, cloud cover brought on depression whether it occurred in winter or summer. Many of the other winter depression patients also reported sensitivity to cloud cover during the winter, but were unaffected by cloud cover in summer.

A cloud cover effect was also noted by Kasper and Kamo (1990) who found that 11.4% of patients who met criteria for winter-SAD reported feeling worse on short, grey, cloudy, or foggy days, significantly more often than controls. Jacobsen and Rosenthal (1988) noted that cloud cover over several days preceded relapse in some SAD patients after successful treatment with phototherapy, and Rosenthal *et al.* (1989) mention two research groups who have found greater numbers of unipolar depressed patients in Oregon and Rochester where there is a high degree of cloud cover throughout the year. Sensitivity to cloudy days does not however appear to be unique to SAD patients, as Garvey *et al.* (1988) noted that both seasonal and non-seasonal depressed patients were more likely to suffer from cloudy day dysphoria during remission from depressive episodes than controls.

Other weather variables including temperature and sunshine have also been noted by SAD patients as having an effect on mood. Of 22 SAD subjects in a study by Wirz-Justice *et al.* (1986), most subjects noted changes in their mood state in response to weather variables on a day to day basis, and elevated mood was experienced by some after alpine holidays or visits to a solarium. Depression in any given month was highly correlated (-0.94) with mean monthly temperature after a lag period of 1-2 months. Sakamoto *et al.* (1993) surveyed 53 outpatient university psychiatric clinics in Japan which were divided into 9 groups on the basis of winter hours of sunshine averaged over the last 30 years, and found the prevalence of SAD in each group to have a negative correlation (-0.66) with total hours of sunshine over the last 30 years.

Studies of the effect of weather variables on SAD patients however, may be confounded by the fact that weather also tends to vary with season. In an attempt to separate out the relative influences of seasonal change and weather variables (temperature, precipitation, barometric pressure, and relative humidity) on SAD symptoms, Albert, Rosen, Alexander, and Rosenthal (1991) examined daily energy and sleep ratings made by 10 SAD patients over at least a two year period. Weather effects were present for only four of the 10 patients after controlling for season, and it appeared that seasonal change had a greater influence on energy than day to day changes in weather. To date, this study has not been replicated, nor has the impact of weather variables on mood in S-SAD patients been examined. Further studies are needed to clarify the relative influence of weather variables and seasonal change on the symptoms associated with SAD.

Weather Sensitivity in Non-Clinical Samples

Very few studies to date have looked at the effect of climatic variables on mood in non-clinical samples, and those that have been conducted are limited by small sample sizes and lack of uniformity in the selection of psychometric measures. The following is a review of existing studies.

The first study of the effect of weather variables on mood was conducted by Goldstein in 1972. Seven students completed twice-weekly mood ratings on scales representing 'mood evaluation', 'activity', and 'potency' for eleven consecutive weeks. Each scale was correlated with six weather variables - temperature, barometric pressure, humidity, clearness, temperature deviation from normal for the date, and wind speed. Positive mood was found to be significantly related to low humidity, high barometric pressure, and cooler temperature deviation from normal. High activity was significantly related to low humidity, high barometric pressure, and low wind speed, and high potency was significantly related to cool temperatures, high barometric pressure and cooler temperature deviation from normal for the date.

In a later study, Sanders and Brizzolara (1982) obtained daily ratings on the Mood Adjective Checklist (Nowlis, 1965; cited in Sanders & Brizzolara, 1982) from 30 subjects enrolled in a five week summer course, which were compared with weather data (relative humidity, temperature, and barometric pressure). Relative humidity was the only weather variable to have a significant relationship with mood ratings, and was inversely correlated with 'Vigour' (diminished physical energy), 'Social affection' (reduced interest in social interaction), and 'Elation' (somewhat flattened affect).

A study by Persinger (1975) failed to find any significant relationships between mood and weather variables. Ten university students were asked to complete the Doorland mood rating scale (Doorland & Brinker, 1973; cited in Persinger, 1975) four times a day over a 90 day period. These ratings were correlated with mean daily barometric pressure, greatest change in barometric pressure for 2 hour and 24 hour periods, daily mean wind speed, hours of sunshine, mean and range of daily temperature, mean and range of daily relative humidity, and a measure of daily global geomagnetic activity. A degree of mood sensitivity to weather variation was shown by the subjects, with mood scores being inversely related to relative humidity and positively related to hours of sunshine, but not at a statistically significant level, and weather variables explained only 35% of mean mood ratings. A lag effect was observed between weather from the preceding two days and subjects' mood ratings.

Data collected in the above study were than reanalysed by Persinger and Levesque (1983) to examine the hypothesis that weather may be a temporal matrix with weather variables having an additive or substitutive effect on mood. In this analysis, 40% of the daily variation in mood evaluations could be explained by the weather variables with varying lag periods. The most powerful effects were noted for mean barometric pressure (lag period of 2-4 days), mean sunshine hours (no lag), and geomagnetic measures (lag period of 1-3 days). The average lag value for all weather variables in this study was 3.4 days.

Whitton, Kramer, and Eastwood (1982) speculated that weather variables may account for the infradian rhythms in mood, physical well-being, hours of sleep, and anxiety observed in some individuals. Eighteen subjects made twice-daily self assessments of these variables which were then compared with eight weather variables: solar flux, maximum and minimum temperature, humidity, number of sun spots, wind, precipitation, and barometric pressure readings. Only solar flux, 8.00 a.m. barometric pressure, maximum daily temperatures, and 8.00 a.m. relative humidity correlated with subjects' self-ratings. Greater correlations with weather variables were found in the group of subjects who began their self-ratings in February, when there is considerable variance in weather, than in the group who began their self-ratings in December, when monthly weather readings are more consistent. The time lag for weather variables in this study ranged from 2 to 7 weeks, longer than that reported in previous studies (Persinger, 1975; Persinger & Levesque, 1983).

Howarth and Hoffman (1984) obtained mood ratings from 24 subjects using yet another rating scale - the Howarth Multiple Adjective Checklist ratings (HMACL-3; Howarth

& Schokman-Gates, 1981; cited in Howarth & Hoffman, 1984) - over 11 consecutive days. The HMACL-3 contains the mood dimensions concentration, cooperation, anxiety, aggression, depression, sleepiness (fatigue), optimism, potency, scepticism, and control. These ratings were compared with number of hours sunshine, precipitation, humidity, wind direction and velocity, and barometric pressure (absolute barometric pressure and pressure change) for the month of the study. High humidity and low barometric pressure were associated with lower concentration scores, and humidity was the only significant predictor variable for potency (self-confidence and self assurance). Scepticism was positively related to temperature and negatively related to hours of sunshine, and optimism increased with increasing hours of sunshine. Sleepiness was predicted only by level of humidity, and aggression, depression, and anxiety were not predicted by any weather variable. In a regression and canonical correlation analysis of the data, humidity emerged as the most significant predictor of mood states in this study, consistent with several previous studies (Sanders & Brizzolara, 1982; Persinger, 1975; Whitton *et al.* 1982).

In the only study of a large sample, Schlager *et al.* (1993) interviewed 1870 employees of an electric company (n=1870) at different times over a year-long period to investigate the relationship between seasonal symptom reporting and day length. There was a significant negative correlation between symptom score and mean day length for women. Women also reported significantly more symptoms in months where daylight was at a minimum (Dec-Feb).

Conclusion

The relationship between mood, season, and weather variables remains speculative at this stage. Definite weather effects, particularly with regard to cloudy days, are claimed by some SAD patients, and these claims have received some support from the observation that several consecutive days of cloud cover may induce a depressive episode in some SAD patients (Jacobsen & Rosenthal, 1988). In the few studies that have been conducted with non-clinical samples, modest effects of barometric pressure, relative humidity, and sunshine hours on psychological variables have been suggested. However, almost all these studies are considerably limited by small sample sizes, non-comparative psychometrics, and incomplete reporting of methodologies. The generally inadequate standard of research in this area prevents formation of any firm conclusions from these studies.

CHAPTER 7

EXERCISE AND MOOD

Numerous studies have attempted to lend scientific credibility to the widely held conviction that exercise 'makes you feel better'. Although elevated mood states have been found immediately following exercise (Choi *et al.*, 1993; Maroulakis & Zervas, 1993; McGowan *et al.*, 1991*b*), the long term effects of a regular exercise programme have yet to be consistently established. In addition, although various physiological and psychological processes have been studied, no one explanation for exercise-induced mood enhancement has emerged from research. As in the studies reviewed in the previous chapter, the use of varied subject pools, measures of psychological variables, and a diverse range of methodologies in existing research (often inadequately described) has made comparison of outcomes across existing studies difficult.

This chapter presents firstly an overview of exercise in psychological research. Secondly, theories of the mood enhancing effects of exercise are examined, followed by a review of studies which have attempted to evaluate the psychological benefits of adhering to a programme of regular physical activity.

Exercise - An Overview

There are three basic types of exercise: that which is essentially aerobic like jogging, aerobic classes, or swimming (exercise sustained for a long period of time designed to increase aerobic capacity); anaerobic exercise which is low duration but high in intensity where the aim is to increase muscle strength (such as weight lifting or sprinting); or flexibility training such as yoga (de Coverley Veale, 1987).

Different types of physical activity have different physiological outcomes depending on the nature, intensity and duration of the activity. A wide range of exercise programmes of varying duration have been included in research to date, making it difficult to determine which form of exercise produces maximum psychological benefits. In early studies, aerobic exercise and increased aerobic fitness were regarded as prerequisites to positive mood change, but more recent work has shown that other forms of exercise which do not enhance physical fitness may also produce positive psychological effects. The following is a review of studies which have compared the relative efficacy of aerobic versus non-aerobic exercise as a treatment for depression.

Aerobic Versus Non-Aerobic Exercise

Several studies have compared the relative effectiveness of aerobic training versus other forms of physical activity. Martinsen (1988) compared the effectiveness of aerobic and non-aerobic forms of exercise in the treatment of 99 patients with clinical depression. Although physical fitness was improved only in the aerobic condition, both conditions produced an equal reduction in depression scores. Martinsen concluded that psychological factors must therefore have an important role to play, and that increasing physical fitness is not essential to obtain beneficial psychological effects from exercise.

Mutrie (1988) found aerobic exercise to be more effective than non-aerobic exercise in the reduction of moderate depression in 36 patients after four weeks, however no difference in depression levels remained after an eight week period. These effects occurred independently of changes in fitness level indicating that psychological variables may have had an impact on outcomes in this study.

Dyer and Crouch (1988) compared the mood and variations in mood of runners, participants in an aerobics class, weight-lifters, and non-exercising controls to assess the relative effectiveness of aerobic versus non-aerobic exercise. No significant differences in depression were found between runners, aerobic class participants, or weight-lifters, although there was a significant difference in depression between runners and controls suggesting that exercise may have a positive effect on mood.

McCann and Holmes (1984) compared outcomes for 43 depressed women who were randomly assigned to either an aerobic exercise treatment condition, a relaxation condition, or a no-treatment control. Changes in physical fitness occurred only in the aerobic exercise condition, and subjects in the aerobic condition had reliably lower depression scores than subjects in either the relaxation condition or control.

Choi *et al.* (1993) compared the mood of 97 exercising women before and after their aerobics classes who were either high frequency exercisers (exercised three or more times per week) or low frequency exercisers (exercised less than 3 times per week). Positive mood increased and negative mood decreased after the exercise class for both groups, and there were no differences in the degree of mood change between the high and low frequency exercising groups.

Moses, Steptoe, Mathews, and Edwards (1989) conducted a two part study where the psychological benefits of high intensity and moderate intensity exercise were also compared. No significant differences between groups were found. In the second part of the study, subjects were randomly assigned to either an aerobic conditioning or a moderate intensity aerobic programme to test the hypothesis that the psychological effects of exercise may be due to participation in a structured programme, with physical achievement as its goal. Positive psychological responses were reported by subjects in the moderate exercise groups but not the high intensity or attention-placebo conditions suggesting that the psychological benefits of exercise are not related specifically to aerobic conditioning. Moses *et al.* suggest that the psychological effects of exercise may arise out of increasing physical activity levels per se rather than actual level of fitness. However, increased positive psychological effects were not observed in the attention placebo condition suggesting that some element of an aerobic component is necessary to produce positive psychological benefits.

Williams and Getty (1986) examined the effect of a 10 week aerobic (jogging or aerobic dance) or non-aerobic (placebo control of bowling or recreational games) exercise programme with a no-exercise control on the mood of 430 non-depressed and 41 depressed college students. Decreases in measures of depression occurred equally for both depressed and non-depressed subjects in both the aerobic and non-aerobic groups.

The authors also investigated the beta-endorphin hypothesis (see following section) by predicting that decreases in depression for depressed subjects in the aerobic group would be accompanied by an increase in plasma beta-endorphin levels. This hypothesis was not supported as no relationship between depression and beta-endorphin levels was found.

Given the problems in making comparisons across studies outlined at the beginning of the chapter, it is difficult to evaluate outcomes from these studies with any certainty. It would appear that an improvement in aerobic capacity is not necessary to effect an improvement in psychological variables, although the degree to which one form of exercise may produce positive psychological change more rapidly and effectively than another remains uncertain.

Effect of Exercise on Depressed Mood

A number of studies have attempted to evaluate the efficacy of exercise as a treatment for depression in clinical samples. In a study of 24 depressed patients, Mutrie (1988) found that subjects assigned to an aerobic exercise programme showed a reduction in depression scores on the Beck Depression Inventory (BDI) while those in the waiting list group did not. The positive effect of exercise was maintained twenty weeks later by subjects who continued to exercise.

McCann and Holmes (1984) randomly assigned 43 depressed women to one of experimental conditions - an aerobic exercise, relaxation training, or no-treatment condition. Aerobic capacity was improved only in the aerobic exercise group and subjects in the aerobic condition showed a greater reduction in depressive symptomatology than subjects in the relaxation or no-treatment conditions after the first 5 weeks of treatment. The next five weeks of treatment did not add to this effect.

Two reviews of studies involving exercise treatment with clinical samples have suggested grounds for cautious optimism. In a review of seven studies, Simons, McGowan, Epstein, and Kupfer (1985) reviewed found support for the notion that exercise may be a useful treatment for clinical depression, although exercise did not produce strong evidence of improvement in mood in normal samples.

In a review of 13 studies selected on the grounds that they examined both short-term and longer term outcomes from physical activity, Plante and Rodin (1990) concluded that the immediate effects of exercise include improved mood and well-being, and reduced anxiety, depression, and stress. Evidence for the longer term effects of exercise on mood and well-being is not as strong as that found immediately after physical activity.

Effect of Exercise on Mood in Normal Populations

Although studies of the psychological benefits of physical activity in the treatment of clinically depressed populations have yielded fairly consistent positive results (McCann & Holmes, 1984; Mutrie, 1988; Plante & Rodin, 1990; Simons, McGowan, Epstein, Kupfer, & Robertson, 1985), research with normal non-depressed samples has been less promising.

Hughes, Casal, and Leon (1986) conducted a randomised cross-over study of the effects of a 12 week exercise or no-exercise programme on 14 normal sedentary men. Mood did not improve more in the exercise condition than the control and mood changes were not correlated with initial fitness level or amount of change in fitness over the exercise period.

Lennox, Bedell, and Stone (1990) matched 47 subjects for sex, positive and negative mood, depression, and physical fitness level before randomly assigning each subject to either a 13 week walk/jog, volleyball/weightlifting, or waiting-list control group experimental condition. Although physical fitness was improved for both exercise groups, no differences in pre- or post-treatment mood measures were found for any treatment group. Lennox *et al.* concluded that normal subjects, unlike subjects with clinical depression, do not experience mood enhancing effects from regular aerobic exercise. Similar conclusions were reached by Frazier and Nagy (1989) and Cramer, Nieman, and Lee (1991) who failed to find any significant relationship between exercise training and mood states in women who participated in a 15 week aerobic exercise programme.

Maroulakis and Zervas (1993) measured the mood state of 77 women who were new members of a fitness club and had been exercising regularly for about one month at the time of the study. A control group of 22 sedentary women with clerical jobs was also included. Subjects completed measures of mood before and after each aerobic class (or at similar times for control subjects), and again at the same time the following day. Mood measures were significantly improved by exercise, and remained slightly higher than pre-exercise levels 24 hours later. Mood was positively affected by exercise, but had significantly regressed toward pre-exercise levels 24 hours later.

Buchman, Sallis, Criqui, Dimsale, and Kaplan (1991) studied the physical activity, fitness, and psychological well-being of 207 first year medical students to assess the impact of involvement in physical activities on the current mood state. Cardiovascular fitness, frequency and duration of participation in vigorous physical activities and depression level of each subject were determined. The degree of involvement in physical activity and cardiovascular fitness of subjects was not significantly associated with current levels of depression.

However, in a much larger study (n=55,979) in which data from four surveys carried out in the United States and Canada to determine the relationship between physical activity and mental health were examined, Stephens (1988) found that level of physical activity was positively associated with well-being, lower levels of anxiety and depression, and positive mood in the general population.

Exercise as a Preventive Measure

Although immediate and longer term psychological benefits of exercise have been extensively investigated, few studies have looked at the potential for regular exercise to prevent depressive episodes. A review of two studies by Martinsen (1993) indicated that subjects who engaged in physical activities were less likely to report depressive symptoms 12 weeks after exposure to a stressful event, and had better mental health one year after discharge from hospital for a depressive or anxiety disorder.

Conclusion

In general, positive psychological benefits associated with physical activity have been found in clinically depressed patients, while the majority of studies of the effect of exercise on mood in non-depressed samples have produced negative results. Tentative evidence that exercise may be a useful buffer against the development of depressive episodes has also been presented (Martinsen, 1993). In general however, these studies have been based on restricted time frames and often do not include a follow-up period to determine whether the positive effects noted are maintained in the long term. As such, the long term psychological benefits of exercise have yet to be determined.

Seasonal Variation in Physical Activity

Like many other human behaviours (see Chapters 2 and 4), exercise has also been found to exhibit regular seasonal variation. Uitenbroek (1992) conducted a longitudinal study of the exercise behaviour of 16,486 respondents from Glasgow and Edinburgh and found a regular seasonal pattern for both high frequency exercisers (more than three times per week) and low frequency exercisers (less than three times per week) with peaks occurring in early to mid-July. Both indoor and outdoor activities were affected by this seasonal variation suggesting that inclement weather and unavailability of playing fields does not account for all of the variation in exercise activity.

Interestingly, the peaks in physical activity observed by Uitenbroek (1992) occur at similar times of the year to those found in the reports of SAD symptomatology (Hardin *et al.*, 1991; Kasper *et al.*, 1989*a*; Kasper *et al.*, 1989*b*; Rosenthal *et al.*, 1984; Terman, 1988; Thompson *et al.*, 1988). Whether the seasonal patterns found by Uitenbroek may be mediated by seasonal mood cycles (depressed mood leading to a decrease in physical activity, or vice versa) is impossible to determine. During their depressions, winter-SAD subjects regularly report fatigue, and this may result in a reduction in physical activity during this time. The impact of seasonally dependent mood changes on physical activity levels in the general population has not been determined.

One study with a clinical SAD sample has attempted to look at the effect of exercise on winter mood ratings. Suter *et al.* (1991) randomly assigned 94 winter SAD subjects to an exercise (jogging) or no exercise (control) condition. SAD subjects in the jogging condition experienced less winter deterioration in mood than did non-exercising controls, indicating that regular exercise may have the potential to reduce the severity of seasonal mood changes in clinical samples. It is unclear whether similar benefits might be experienced by the general population.

Conclusion

Physical activity, whether it leads to increased cardiovascular fitness or not, appears to have the potential to elevate mood, at least in the short term. Longer term benefits may be experienced by continuation of an exercise programme, and preliminary evidence suggests that participation in regular physical activity may help prevent depressive episodes. Although the mood enhancing effects of physical activity are not fully understood, it seems likely that a number of interacting physiological and psychological factors are involved.

CHAPTER 8

SUMMARY AND OBJECTIVES

The influence of seasonal change on human behaviour has been observed and recorded for centuries, and was once regarded as being instrumental in the etiology of psychological and physical illness (Chapter 1). Modern interest in seasonality and affective disorders has only recently resurfaced, and there is now strong evidence to suggest that seasonal cycles exist in human as well as animal behaviours (Chapter 2).

Rosenthal *et al.* (1984) have described a subgroup of the general population who regularly experience depression, hypersomnia, increased appetite, carbohydrate craving, weight gain, and fatigue during autumn or winter each year, with a return to normal mood or hypomania in the spring or summer (Chapter 3). The term 'seasonal affective disorder' (SAD) has been coined to describe these recurrent seasonal depressions. Another group, those with 'subsyndromal SAD' (S-SAD), or SAD symptoms of a lesser severity, have also been described (Kasper *et al.*, 1989*a*), while studies of general population samples have found widespread reporting of change in SAD-like symptoms associated with the seasons (Chapter 4). The evidence suggests that sensitivity to seasonal change may be a universal human trait that exists on a continuum, with SAD at the upper end, subsyndromal SAD located midway, and low seasonality at the bottom end of the spectrum.

To date, the majority of previous studies of the demographic characteristics of SAD patients and general population samples have found a higher proportion of female SAD and S-SAD subjects than males, and it has been suggested that females may be more sensitive to seasonal change than males. In addition, some studies have found the incidence of SAD to decrease with age. This study aims to explore the extent to which seasonal symptoms, reported in northern hemisphere studies, may also be reported by a southern hemisphere general population sample from two regions in New Zealand. The study also aimed to further investigate the gender and age differences in rates of seasonal sensitivity reported in previous studies.

Sensitivity to changes in weather have also been reported by some SAD patients and in a small number of studies with normal subjects (Chapter 6). In previous studies, some SAD subjects have reported being extra sensitive to certain types of weather, particularly cloudy days. While light is regarded as having the greatest role to play in the etiology of SAD (Chapter 5), the impact of weather remains to be explored, as weather, as well as light, also varies with the seasons. This study will examine the impact of weather variables on mood by sampling subjects from two regions which experience significantly different climatic conditions.

In addition, interest in the potential for regular physical activity to have beneficial psychological effects has grown over the last 20 years along with the exercise industry. Physical activity has been shown to produce mood enhancing effects immediately after exercising, but longer term effects have yet to be adequately demonstrated (Chapter 7). Seasonal variation in patterns of physical activity have been found in one northern hemisphere study, and these patterns have been noted to coincide with patterns of seasonal variation in mood, sleep, energy, appetite, weight, and socialisation reported by subjects in SAD and S-SAD studies. It was also anticipated that given the outdoor nature of many physical activities, that weather variables may influence subjects patterns of exercise behaviour. The present study aims to explore the relationships between exercise and mood, and to examine the seasonal exercise behaviour of subjects in a southern hemisphere sample.

The study of seasonal affective disorders in general population samples remains a relatively new area in the field of psychology, and one which has largely involved northern hemisphere samples. As such, this study is intended as an attempt to explore aspects of seasonal affective disorder that have emerged as significant from previous literature, and to add to existing studies from northern hemisphere populations.

CHAPTER 9

METHOD

Subjects

An initial sample of 500 suburban residential addresses from Palmerston North and 500 from Hastings was selected from each regional telephone directory using computer generated random numbers (page number, column, and line of directory to be selected). Addresses were included on the basis that they were located within Palmerston North or Hastings city limits.

Two hundred and fifty subjects from the initial sample of 1000 returned the first questionnaire (25%). After one subject with excessive missing data was excluded, 176 subjects (70.4% of subjects who responded to the first questionnaire) remained who had completed questionnaires in both August and February. The overall response rate from the original sample of 1000 was therefore 17.6%.

Regional Characteristics

The city of Palmerston North is situated 40.5° latitude south of the equator and has a population of 70 317. The region has a strong agricultural base, as well as accommodating a large population of university students in the central city during the academic year.

Hastings city is located 39.5° latitude south of the equator on the east coast of New Zealand and has a population of 64 692 people. The region is best known for its farming and horticultural produce, but also supports an active professional and commercial business community. Approximately 80% of the population from each region are European. Both regions have seen substantial commercial development in the last 5 years.

Psychometric Measures

Subjects completed two identical questionnaires, with the addition of the Seasonal Pattern Assessment Questionnaire (Rosenthal *et al.*, 1987*a*; see Appendix F) in summer. The questionnaires were based on the following psychometric measures:

Demographic Data

Participants were asked to state their age, sex, occupation, education level, and marital status, and to indicate any previous psychiatric history.

The Beck Depression Inventory (BDI).

The Beck Depression Inventory (BDI) is a quick, widely used 21-item self-report measure of depression derived from general clinical observations of the cognitive, behavioural, and somatic symptoms frequently found in depressed psychiatric patients (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Each of the 21 items has four alternative responses relating to the intensity of each item experienced by the respondent.

Scores on the BDI range from 0-63 with arbitrary cut-off points designating 'Minimal' to 'Severe' levels of depression depending on the characteristics of the subjects in the sample and purpose for which the instrument is being used. Higher scores reflect higher reporting of depressive symptomatology. Scores of 0-9 are considered to be in the 'Minimal' range, 10-16 'Mild', 17-29 'Moderate', and 30-63 'Severe' (Beck & Steer, 1993).

Evaluation of long term use of the BDI in a wide variety of psychiatric and non-psychiatric populations has found it to be a reliable and valid measure of self-reported depressive symptomatology, sensitive to change over time (Beck, Steer, & Garbin, 1988). A correlation of .72 between the BDI and clinical ratings of depression in psychiatric patients from 35 studies has been reported (Beck *et al.*, 1988). The BDI requires a reading age of only 12-13 years (Godfrey & Knight, 1986) making it a suitable instrument for use with a general population sample of individuals with varying educational levels.

<u>Extra Items</u>

Commonly observed symptoms associated with seasonal affective disorder, but not included in the BDI, are weight gain as well as weight loss, increased rather than decreased sleep and appetite, and carbohydrate craving (Jacobsen & Rosenthal, 1988; Rosenthal *et al.*, 1985; Rosenthal, Genhart, Sack, & Skwerer, 1987). Items were added to some of the existing symptom groups of the BDI to accommodate these features and to allow participants to indicate change in a positive direction (See Appendix C).

The Hopkins Symptom Checklist - 21 (HSCL-21)

The HSCL-21 is a shortened form of the 56 item Hopkins Symptom Checklist (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974) designed as a self-report measure of general symptoms of psychological distress to evaluate clinical change in psychotherapy patients (Green, Walkey, McCormick, & Taylor, 1988; See Appendix D). The HSCL-21 has a replicable, discrete, three-factor structure producing three sub-scales of seven items each: General Feelings of Distress (GFD); Somatic Distress (SD); and Performance Difficulty (PD) which can be summed to obtain a Total Distress Score (TDS). Higher scores indicate higher levels of psychological distress. A full copy of the HSCL-21 is provided by Green *et al.* (1988).

Chronbach alpha reliability coefficients for total HSCL-21 scores of .90 in a student sample (Green *et al.*, 1988) and .89 in a sample of psychotherapy clients (Deane, Leathem, & Spicer, 1992) have been reported. Given the transient nature of the symptoms of general psychological distress intended to be measured by this instrument, adequate test-retest reliabilities at intervals of one week (.57), one month (.61) and two months (.57) have also been reported.

Studies of the validity of the HSCL-21 have found higher scores in psychotherapy clients compared to nurses, changes in scores over the course of therapy, and significant correlations between HSCL-21 scores and other psychometric measures (Deane *et al.*, 1993). Normative data from several general population and clinical samples are available (Deane *et al.*, 1993; Green *et al.*, 1988; Deane, unpublished manuscript).

Exercise Data

A list of physical activities common in New Zealand was derived from the Questionnaire of Leisure Time Activities (LTA) developed by Taylor *et al.* (1978), and from those listed in a study by Shamir and Ruskin (1983; see Appendix E). Activities unique to New Zealand were added, and in some cases New Zealand terms for particular activities substituted. Participants were asked to indicate which types of physical activity they had engaged in in the last month, and for how long (hours/minutes). They were also asked to gauge their fitness level on a likert scale of 1 ('not at all fit') to 7 ('very fit'), and to indicate in which months of the calendar year they exercised most and least.

Miscellaneous

Items asking participants about their sensitivity to climactic conditions and the occurrence of recent stressful events were composed in a style similar to the question structure of the BDI (See Appendix C).

The second questionnaire also included:

***The Seasonal Pattern Assessment Questionnaire* (SPAQ)**

The Seasonal Pattern Assessment Questionnaire (SPAQ; Rosenthal *et al.*, 1987*a*) is a retrospective self-report inventory originally developed as a screening instrument for SAD and phototherapy studies to assess the severity and pattern of seasonal variations in mood and behaviour of prospective participants. Although a relatively new instrument which has yet to be subjected to rigorous psychometric evaluation, the SPAQ has become the most widely used measure of seasonality in recent research.

The SPAQ has three sections: (1) *Severity of seasonal change* including questions about seasonal changes in sleep, socialising, mood, weight, appetite and energy. Scores on these six items are summed to give a total Global Seasonality Score (GSS) out of 24, with a higher score indicating a greater degree of seasonal change; (2) *Pattern of seasonal change* where respondents are asked to indicate in which months of the year they feel best and worst, eat most and least, socialise most and least, sleep most and least, and gain and lose the most weight; and (3) *Sensitivity to climate and weather changes* which includes questions about the effect on mood of cold, hot, humid, dry, sunny, cloudy, foggy, long and short days and days with a high pollen count.

Other questions in the SPAQ ask the respondent to indicate number of hours slept each season, amount of annual weight fluctuation, changes in food preference during the different seasons, and the degree to which seasonal changes are experienced as problematic. Items pertaining to demographic data which had been obtained by the first questionnaire were omitted. The original format of the SPAQ (designed for computer scoring) was altered slightly to allow for hand scoring of the questionnaire.

The SPAQ has been validated as a measure of the severity of seasonal symptoms by correlation with Research Diagnostic Criteria Major and Minor Depression diagnoses of SAD patients (Terman, 1988). GSS scores have been found to be reliable over time in winter-SAD patients (r=0.79: Thompson, Stinson, Fernandez, Fine, & Isaacs, 1988; r=0.80: Hardin *et al.*, 1991), and normals (r=0.61: Hardin *et al.*, 1991), but to a lesser degree for S-SAD patients (.44: Kasper *et al.*, 1989*a*). Hardin *et al.* reported that there were no significant difference was found between global seasonality scores obtained during autumn and winter and those obtained during spring and summer.

SPAQ criteria for SAD and S-SAD were developed by Kasper *et al.* (1989*c*) on the basis of an analysis of 168 profiles of patients diagnosed with SAD. S-SAD criteria emerged from a study by Kasper *et al.* (1989*a*) of patients who did not meet criteria for full-blown SAD, but nevertheless experienced some positive benefit from treatment with phototherapy. Although these criteria were based on the SPAQ scores of SAD and S-SAD patients, the two groups did not overlap (Kasper *et al.*, 1989*c*).

The following criteria are suggested by Kasper *et al.* (1989*c*):

SAD - A Global Seasonality Score (GSS) of more than or equal to 10 is required, with a 'moderate' to 'disabling' level of problems experienced in response to seasonal change. This estimate was based on a telephone version of the SPAQ which yielded scores approximately 1 point lower than the self administered version. Therefore, a score of 10 on the telephone version of the SPAQ is equivalent to an 11 on the self administered form. Cut-off points in the present study have therefore been adjusted accordingly. The cut-off point is based on the fact that 91% of 168 SAD patients seen by Kasper *et al.* (1989*c*) scored 11 or more on the SPAQ.

The criteria for winter-SAD requires in addition that the participant indicate feeling worst in June, July or August (with or without any other affected months), while summer-SAD requires feeling worst in December, January and/or February (with or without any other affected months).

S-SAD - A Global Seasonality Score (GSS) of more than or equal to 10, with 'mild' or no problems experienced with seasonal change; or a Global Seasonality Score of 8 or 9 and at least 'mild' problems with seasonal change is required.

Weather Data

Daily readings of daylight hours (photoperiod), sunshine hours, rainfall (mm), maximum temperature (°C), minimum temperature (°C), barometric pressure (hPa), wind speed (knots), and relative humidity (%) were obtained for Palmerston North (reading site: Palmerston North Aerodrome) and Hawke's Bay (reading site: Napier Aerodrome) for August to early September 1993 and February to early March 1994.

Procedure

A repeated measures design was used in this study. Subjects completed the first questionnaire in the last week of August 1993, and the second in the last week of February 1994.

The first questionnaire, along with an information sheet detailing the nature and requirements of the study (See Appendices) was delivered to each residential address in the initial sample of 1000 on the same day. The information sheet included with the questionnaire invited the adult (18 years or over) in the household who had the next birthday to participate anonymously in the study. This procedure was used to increase the likelihood of obtaining responses from participants of both sexes and a wide age range. The questionnaire took about 20 minutes to complete, and participants were asked to fill it out on the day of delivery, or the day after, and return it in the freepost envelope provided. They were informed that a second questionnaire would follow in 6 months time, and that a copy of the results would be available to those who completed the second part of the study.

The second questionnaire was delivered in February 1994. An information sheet reminding participants about the study and asking for the second questionnaire to be completed by the same person as before, on the day of delivery or the next day, was included with the questionnaire (see Appendix B). Instructions were the same for the second questionnaire and participants were asked not to try to remember what answers they had given previously, but to answer according to the way they had been feeling 'during the past week, including today'. A freepost envelope was included for the return of the second questionnaire.

Statistical Methods

Total exercise scores were calculated from the sum of the number of minutes spent on each activity per month multiplied by an intensity rating for that activity (Taylor *et al.*, 1978). Scores on the BDI were adjusted to account for the extra items added for this study (endorsed added items were scored as zero). Total BDI, HSCL-21, and Exercise scores, and differences between each score over winter and summer were computed for each subject. A Global Seasonality Score (GSS) ranging from 0 to 24 was computed from the sum of six items from the SPAQ (amount of seasonal change in sleep, social activity, mood, weight, appetite, and energy level) which were rated as either no change (0), slight (1), moderate (2), marked (3), or extreme (4). Frequencies were also calculated for demographic and descriptive data, and for each month in which subjects indicated that they felt worst and best, ate most and least, sleep best and worst, socialised most and least, gained and lost most weight, and exercised most and least over the calendar year. Prior running averages for the 7 days prior to the date that each questionnaire was filled in were derived for each of the weather variables.

Paired t-tests were used to compare differences between mean BDI, HSCL-21 and subscales, Fitness Level and Exercise scores in winter and summer. Differences between gender and region for each of these variables were examined using independent t-tests. Pearson's correlation matrices were used to explore the relationships among the dependent variables, gender and age, and between the dependent variables and weather. A series of all-in multiple regression analyses were used to further investigate relationships between the dependent variables, gender, region, and each of the weather variables. Each of the dependent variables were examined for interaction effects with gender, region, and GSS. The weather variables, gender, and region were entered on step one of the regression, while all two way interactions of gender, region, or GSS and the weather variables were entered on step two. Where significant interaction effects were found, separate regressions were performed for groups (Low GSS, High GSS), using *B* values for comparison of variables between groups, without reference to significance levels (Jaccard, Turrisi, & Wan, 1990).

CHAPTER 10

RESULTS

Characteristics of the Survey Sample

Sample characteristics for subjects who completed both questionnaires (n=176) are presented in Appendix G. The sample was predominantly middle-aged (Mean age of 46.1 years; 47% of the sample were aged between 30 and 50 years), female (62.5%), European (92.4%), and married (63.6%), and 25.4% of the sample were retired.

A number of respondents in this study completed the first questionnaire but did not complete the second (n=74). A comparison of the demographic characteristics of these individuals with the rest of the sample (n=176) showed no significant differences in age between the two groups, although males and females were more evenly distributed in the non-completing group than in the final sample. Subjects who did not complete the study had significantly higher winter BDI scores (mean 7.9 ± SD 8.6, versus 5.1 ± SD 5.5: t=-3.13; df=245; p<.01) and winter HSCL-21 scores (mean 35.4 ± SD 10.3, versus 31.6 ± SD 8.0: t=-2.43; df=81.19; p<.05) than subjects who completed both questionnaires. No significant differences in Exercise scores or Fitness Level between non-completers and the final sample were found.

Seasonality

Table 5 compares seasonal characteristics reported on the SPAQ by 176 subjects in the present study with those reported by 416 members of the general population of Montgomery County, Maryland, USA (Kasper *et al.*, 1989*c*). Montgomery County is located at a similar latitude north of the equator (39°N) as Hastings and Palmerston North are located south (39.5°S and 40.5°S). The present study consisted of a smaller, more female predominant sample than the Montgomery County sample, but subjects in the two samples are similar in age and number of years resident in the sample region.

Twenty percent (n=30) of the sample in the present study reported experiencing difficulty with seasonal change - a slightly lower rate than that reported by subjects in Montgomery County (27%). Of these subjects, 13 (8%) regarded the problem as 'Mild', 11 (6%) 'Moderate', 7 (4%) 'Marked', 2 (1%) Severe, and 1 (1%) 'Disabling'. Slightly more 'Moderate' and 'Severe' problems with seasonal change were reported in Montgomery County than in the present study (see Table 5).

Table 5 - Seasonal Characteristics of Total Sample Compared With Sample from the General Population of Montgomery County, USA*

Variable	Total Sample (n=176) 39.5°-40.5°S	Montgomery (n=416) 39°N
Sex, (%)		
Female	110 (62.5)	206 (49.6)
Male	66 (37.5)	210 (50.4)
Mean age (±SD)	46.1 ± 16.6	46.4 ± 16.5
Mean years lived in area (±SD)	22.7 ± 18.3	22.8 ± 14.5
Changes with the seasons are a problem, (%)	34 (20)	112 (27)
Mild	13 (8)	30 (7)
Moderate	11 (6)	47 (11)
Marked	7 (4)	16 (4)
Severe	2 (1)	15 (4)
Disabling	1 (1)	2 (1)
Change with the seasons in: (%)		
Mood	115 (66)	266 (64)
Energy	127 (72)	384 (92)
Sleep length	134 (76)	175 (42)
Social activity	111 (69)	250 (60)
Appetite	97 (65)	195 (47)
Weight	100 (67)	202 (49)
Food preference	115 (68)	273 (66)
Weight fluctuations during the course of the year, (%)		
0 - 1.35 kg	72 (42)	176 (42)
1.8 - 3.15 kg	65 (37)	47 (35)
3.6 - 4.95 kg	29 (17)	66 (16)
5.4 - 6.75 kg	6 (3)	17 (4)
7.2 - 9 kg	2 (1)	6 (1)
>9 kg	0 (0)	3 (1)
Sleep length, Mean (SD)		
Winter	8.06 (1.23)	7.41 (1.26)
Spring	7.62 (1.06)	7.13 (1.21)
Summer	7.21 (1.19)	7.05 (1.27)
Autumn	7.65 (1.05)	7.22 (1.19)
The following weather changes negatively affect mood, (%)		
Short days	57 (33)	196 (47)
Foggy, smoggy days	72 (42)	230 (55)
Grey cloudy days	68 (39)	243 (58)
Cold weather	101 (58)	178 (58)
Humid days	112 (66)	319 (77)
Hot weather	62 (36)	199 (48)
High pollen count	49 (28)	211 (51)
Dry days	9 (5)	16 (4)
Sunny days	9 (5)	4 (1)
Long days	23 (14)	7 (2)
Pattern type, (%)		
Winter Pattern	43 (24)	180 (43)
Summer Pattern	8 (4)	40 (10)
Mean ± SD seasonality score	6.1 ± 4.0	5.43 ± 3.9
Meets criteria for:		
SAD, (%) Total	10 (5.8)	21 (5.0)
Female (% SAD Group)	6 (60)	17 (81)
Male (% SAD Group)	4 (40)	4 (19)
S-SAD, (%) Total	21 (12)	56 (13.5)
Female (% S-SAD Group)	16 (76)	31 (55)
Male (% S-SAD Group)	5 (24)	25 (45)

* Kasper *et al.* (1989*c*).

A large percentage of subjects from both samples reported experiencing change with the seasons in mood, energy, sleep length, social activity, appetite, weight and food preference. Sixty-six percent of subjects in the present study reported seasonal changes in mood, 72% changes in energy, 76% sleep length, 69% social activity, 65% appetite, 67% weight, and 68% food preference. These figures were higher than those reported in Montgomery County for all variables except seasonal change in energy, which was endorsed by more subjects in Montgomery County (92%) than in Hastings and Palmerston North. The amount of annual weight fluctuation experienced by subjects in each sample was comparative.

Subjects from both studies indicated that they slept most in winter and least in summer, and throughout the year subjects in the present study reported sleeping slightly longer in each season than subjects from Montgomery County (M.C.). Average (± SD) sleep time for subjects in this study was 8.06 ± 1.23 hours in winter (7.41 ± 1.26 hours in M.C.), 7.62 ± 1.06 hours in spring (M.C.: 7.13 ± 1.21 hours), 7.21 ± 1.19 hours in summer (M.C.: 7.05 ± SD 1.27 hours), and 7.65 ± 1.05 hours (M.C.: 7.22 ± 1.19 hours) in autumn.

Changes in weather affected subjects in both samples with subjects reporting being most negatively affected by humid days (66% in this study, 77% in M.C.) and cold days (58% in both studies). In this study, foggy days affected 42% of the sample, grey, cloudy days 39%, hot weather 36%, short days 33%, and days with a high pollen count 28%. In Montgomery County, grey cloudy days (58%) followed by foggy days (55%), days with high pollen count (51%), hot days (48%), and short days (47%) ranked as weather having a negative effect on mood by the most subjects. A small number of subjects in both samples also endorsed dry days (5% in this study, 4% in M.C.), sunny days (5%, 1%) and long days (14%, 2%) as having a negative impact on mood.

Six items from the SPAQ total to give a Global Seasonality Score (GSS) for each subject. As GSS is used to determine which subjects meet criteria for SAD and S-SAD, an alpha reliability test of the internal consistency of these six items in the present study was conducted. The internal consistency reliability of the six components of GSS was found to be good (alpha =.83).

Mean Global Seasonality Scores for subjects in the present study were slightly higher in the present study (6.1 ± 4.0) than for subjects in Montgomery County (5.43 ± 3.9). SPAQ criteria for SAD were met by 5.8% of the sample, and 12.3% met criteria for S-SAD. These figures were similar to prevalence rates for SAD and S-SAD reported in Montgomery County (SAD, 5%; S-SAD, 13.5%). Twenty-four percent of subjects in the present study were winter types and 4% were summer types. These figures were lower than those reported in Montgomery County (43% and 10% respectively).

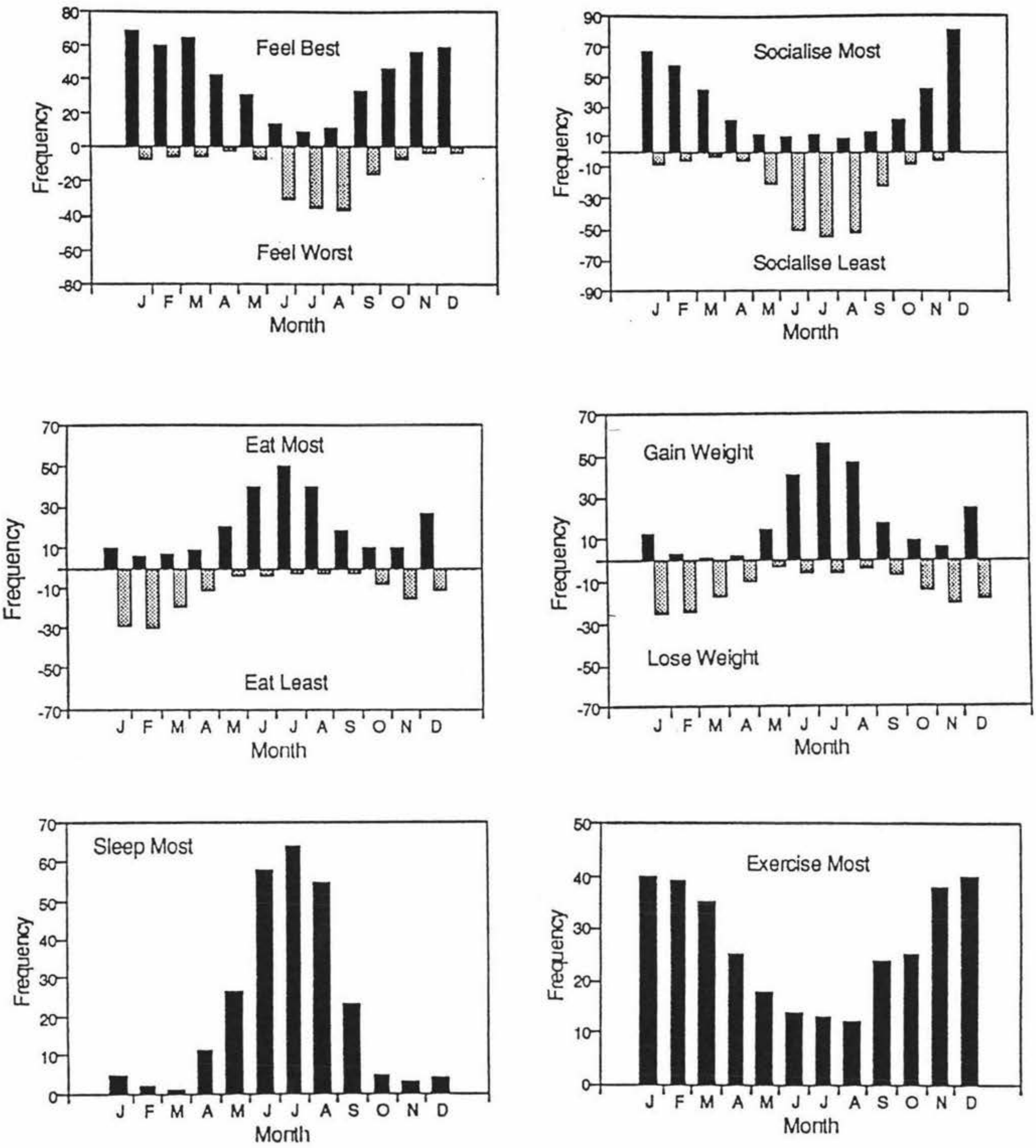

Figure 1. Frequency distribution of months in which subjects indicated that they feel best/worst, socialise most/least, eat most/least, gain and lose most weight, sleep most and exercise most (n=176). Subjects who reported no particular month(s) as standing out were excluded from the figure.

Subjects in this study were also asked to indicate in which months of the year they feel best and worst, socialise most and least, eat most and least, gain and lose most weight, sleep most and exercise most. Figure 1 shows the frequency distribution of these responses over a calendar year. A tendency to feel worst, eat most, gain most weight, sleep most, socialise least, and exercise least in the winter months (June, July, August) was reported by the sample. When subjects' 'Feel worst' responses from the present study were compared with mean photoperiod for each month of the year from the Palmerston North region (see Figure 2.), subjects reported feeling worst in June, July and August, the months in which mean monthly photoperiod was also the shortest.

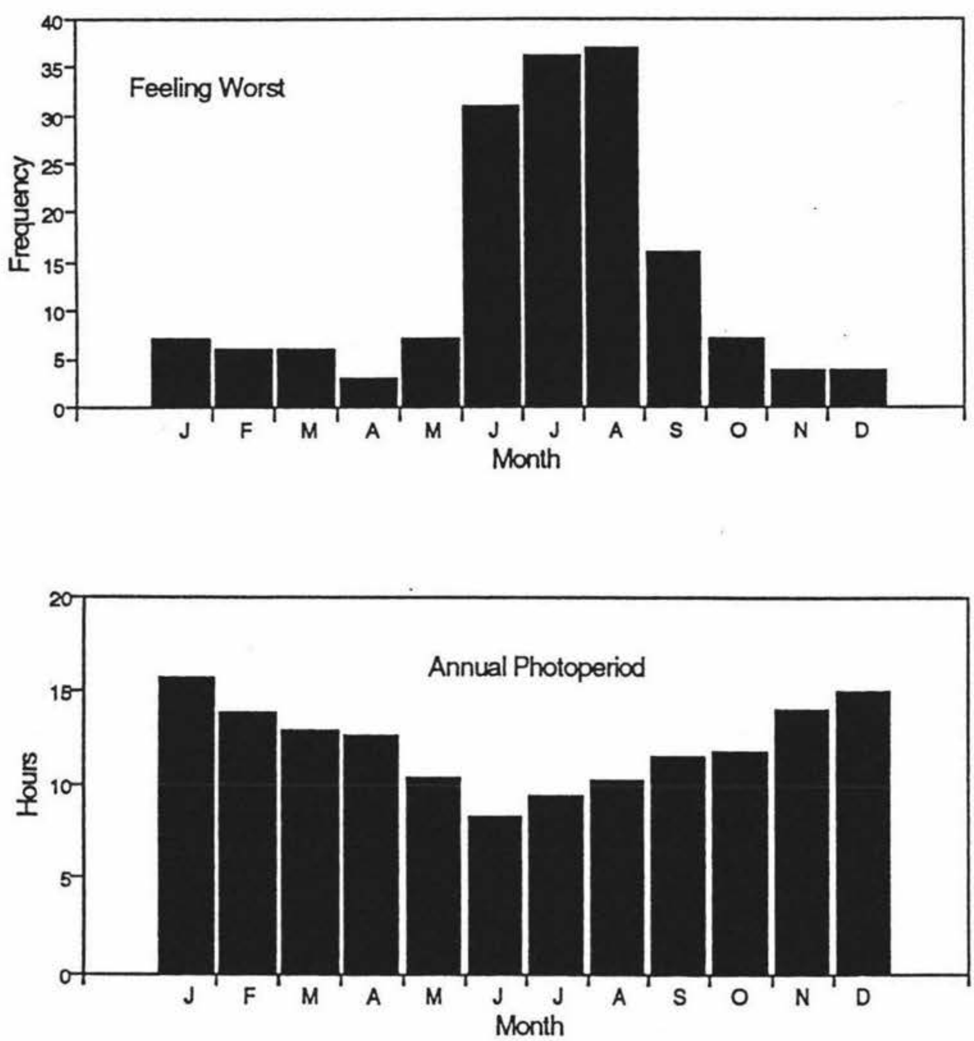

Figure 2. Frequency of individuals in a random sample of the populations of Hastings and Palmerston North City (n=176) who report 'feeling worst' per month compared with fluctuations in monthly photoperiod (Reading site: Palmerston North Aerodrome).

Global Seasonality Scores

Figure 3 shows the frequency distribution of Global Seasonality Scores (GSS) in this study. Scores ranged from 0 to a high of 21 out of a maximum score of 24. The majority of subjects scored between 1 and 7 (*n*=123, 70.3%) . Twenty-six subjects (14.7%) scored 11 or above which is comparable with the degree of seasonal change reported by 91% of patients with winter SAD (*n*=168) studied by Norman Rosenthal and colleagues over a 7 year period at the National Institute of Mental Health (Kasper *et al.*, 1989*c*). Only one subject in the present study did not notice any changes of mood or behaviour with the seasons.

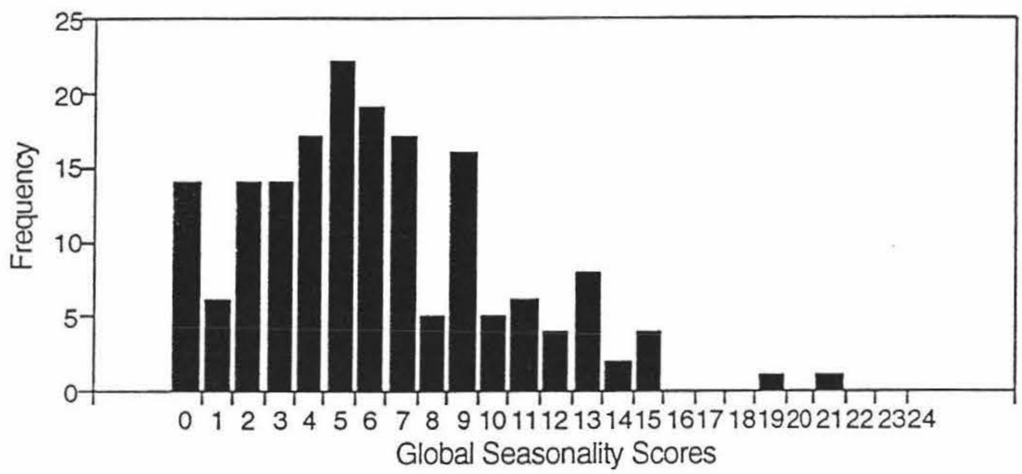

Figure 3.- Frequency distribution of Global Seasonality Scores (see text for definition) in a random sample of the general population from two regions (n=176).

The seasonal characteristics reported by SAD, S-SAD and normal subjects in the sample are shown in Table 6. There were no significant differences in age or gender between groups, although S-SAD subjects had lived in their region for fewer years (16.2 ± 13.4) than SAD subjects (18.1 ± 17.7) and normal subjects (23.7 ± 18.7). As might be expected, SAD subjects reported more severe difficulties with seasonal change than the S-SAD and Normal groups, although there were some subjects in the normal group who reported 'marked' and 'disabling' difficulties with seasonal change which were not combined with high Global Seasonality Scores. Difficulty with seasonal change was reported by all 10 SAD subjects, 7 (33.3%) of the S-SAD subjects, and 17 (12.1%) subjects from the normal group.

Table 6 - Seasonal Characteristics of SAD, S-SAD and Normal Groups

Variable	Normal Group (n=140)	S-SAD Group (n=21)	SAD Group (n=10)
Sex No. (%)			
Female	85 (60.7)	16 (76.2)	6 (60)
Male	55 (39.3)	5 (23.8)	4 (40)
Ratio Female:Male	1.5:1	3.2:1	1.5:1
Age			
18-24	11 (8)	4 (19)	1 (10)
25-34	25 (18)	5 (24)	0
35-44	37 (27)	4 (19)	5 (50)
45-54	20 (14)	3 (14)	2 (20)
55-64	18 (13)	3 (14)	2 (20)
65+	28 (20)	2 (10)	0
Mean ± SD	46.7 (16.6)	41.7 (17.1)	43.4 (10.9)
Mean Seasonality Score (±SD)	4.7 (2.7)	11.8 (1.6)	14.9 (3.0)
Mean years lived in area (±SD)	23.7 (18.7)	16.2 (13.4)	18.1 (17.7)
Changes with the seasons are a problem, (%) Total	17 (12.1)	7 (33.3)	10 (100)
Mild	7 (5.0)	5 (23.8)	0 (0)
Moderate	5 (3.6)	2 (9.5)	4 (40)
Marked	3 (2.1)	0 (0)	4 (40)
Severe	1 (0.7)	0 (0)	2 (20)
Disabling	1 (0.7)	0 (0)	0 (0)
Change with the seasons in; (%)			
Mood	82 (58)	21 (100)	10 (100)
Energy	92 (66)	21 (100)	10 (100)
Sleep length	101 (72)	19 (90)	10 (100)
Social activity	87 (62)	19 (90)	10 (100)
Appetite	65 (46)	19 (90)	10 (100)
Weight	69 (49)	20 (95)	8 (80)
Food preference	91 (67)	15 (71)	6 (60)
Annual weight fluctuation,(%)			
0-1 kg	62 (44.9)	4 (19.0)	2 (20)
2-3 kg	48 (34.8)	12 (57.1)	4 (40)
4-5 kg	23 (16.7)	4 (19.0)	2 (20)
6-7 kg	3 (2.2)	1 (4.8)	2 (20)
8-9 kg	2 (1.4)	0 (0)	0 (0)
Mean hours sleep, (SD)			
Winter	8.0 (1.0)	8.1 (1.2)	8.9 (1.2)
Spring	7.7 (1.1)	7.4 (1.3)	7.9 (0.3)
Summer	7.2 (1.2)	7.2 (1.2)	7.8 (1.1)
Autumn	7.6 (1.0)	7.8 (1.2)	8.1 (1.1)
Previous psychiatric history, (%)			
Self	12 (8.6)	2 (9.5)	4 (40)
Family member	28 (20.1)	2 (9.5)	3 (30)
The following weather changes negatively affect mood, (%)			
Short days	39 (28)	10 (48)	6 (60)
Foggy, smoggy days	54 (39)	9 (43)	6 (60)
Grey cloudy days	50 (36)	12 (57)	4 (40)
Cold weather	76 (54)	14 (67)	7 (70)
Humid days	88 (63)	16 (76)	4 (40)
Hot weather	48 (34)	8 (38)	3 (30)
High pollen count	36 (26)	9 (43)	2 (20)
Dry days	9 (6)	0 (0)	0 (0)
Sunny days	7 (5)	1 (5)	0 (0)
Long days	16 (11)	4 (19)	1 (10)

Almost all SAD and S-SAD subjects experienced change with the seasons in mood, appetite, energy, social activity, sleep length, weight and food preference. Although a lesser proportion of subjects in the normal group reported seasonal variation in these variables, changes in mood, energy, social activity, sleep length, appetite, weight or food preference were reported by at least 46.3% of subjects in the normal group. Small annual fluctuations in weight were found in all groups, with a few subjects in the normal group experiencing greater weight change than in the SAD and S-SAD groups. There were no significant differences between number of hours slept in each season or annual weight fluctuation between groups (winter: F=2.529; *df*=170; *p* not significant; spring: F=0.961; *df*=170; *p* not significant; summer: F=1.193; *df*=170; *p* not significant; autumn: F=1.208; *df*=169; *p* not significant; weight: F=2.808; *df*=168; *p* not significant).

The type of weather reported by the greatest proportion of SAD subjects as having a negative effect on mood was cold days (70%) followed by short days (60%) and foggy days (60%). Humidity was the weather variable reported by the greatest number of S-SAD (76%) and Normal subjects (63%) as affecting mood, followed by cold days (67% of S-SAD subjects; 54% of the Normal group). Sensitivity to weather variables was reported by a greater proportion of S-SAD subjects than subjects in the SAD or Normal groups for six of the ten weather variables.

Depression, Symptom Reporting, and Exercise Scores

Table 7 shows mean BDI, HSCL-21 and subscales (Somatic Distress: SD; Performance Difficulty: PD; General Feelings of Distress: GFD) Exercise and Fitness scores for the total sample in summer and in winter. Mean Difference scores (winter score - summer score) were calculated for each variable. Higher BDI and total HSCL-21 scores, and lower Exercise scores were found in winter than in summer, but these differences were not statistically significant. Of the HSCL-21 subscales, Somatic Distress scores were

Table 7 - Means, SDs, Paired *t*-Tests and Mean Difference Between Winter and Summer Dependent Variable Scores for Total Sample (N=175).

	Winter		Summer		Mean Difference				
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	***t***	***df***	***p***
BDI	5.2	5.5	4.6	5.1	0.6	5.2	1.47	172	.144
HSCL-21	30.6	6.6	30.1	5.7	0.2	7.7	0.32	174	.748
SD	9.9	3.2	10.1	3.0	-0.2	3.2	-.76	174	.446
PD	11.2	3.0	11.2	3.0	-0.2	2.9	-.11	174	.916
GFD	10.5	3.6	10.1	3.4	-0.4	3.4	1.51	174	.133
Exercise	74.6	54.0	80.6	55.9	6.1	57.6	-1.39	172	.167
Fitness Level	3.7	1.6	3.7	1.7	0.0	1.5	.00	173	1.00

higher in summer than in winter, while mean Performance Difficulty did not vary between seasons. General Feelings of Distress scores were slightly higher in winter than in summer, but none of the scores on each of these subscales differed to a statistically significant degree between seasons. Fitness Level estimates for the total sample were largely unchanged from winter to summer. Table 8 shows the range of BDI scores for the total sample in both winter and summer. Scores for the majority of subjects fell into the 'minimal depression' range in both winter (86%) and summer (87%), while 9% of the sample had scores in the 'mildly depressed' range in both seasons. Four percent of subjects reported 'moderately depressed' scores in winter and 3% in summer, and only 1 subject (1%) in each season obtained scores on the BDI indicating a 'severe' level of depression.

Table 8 - Range of BDI Scores in Winter and Summer for Total Sample (n=174).

Depression Level, (Score)		Winter	Summer	Mean (SD) GSS	SAD Group*	S-SAD Group*
Minimal	(0-9)	149 (86)	152 (87)	5.9 (3.9)	7	21
Mild	(10-16)	16 (9)	15 (9)	7.4 (4.7)	4	10
Moderate	(17-29)	8 (4)	6 (3)	9.2 (3.1)	3	3
Severe	(30-63)	1 (1)	1 (1)	6	1	0

* Note: Total no. of subjects exceeds no. of SAD and S-SAD subjects in study as subjects may have different depression levels during each season.

Table 9 shows the means and standard deviations for BDI, total HSCL-21, the SD, PD and GFD subscales, and Exercise and Fitness level scores in winter and summer for each of the SAD, S-SAD and Normal Groups. There were no significant differences for any group between winter and summer scores on any of the dependent variables.

Oneway ANOVA with controlled contrasts and Bonferoni adjustments for multiple comparisons was used to examine group differences between the SAD, S-SAD and normal groups on the dependent variables. Significant differences between groups were found for winter BDI (F=13.1; *df*=169; *p*=.0001), summer BDI (F=7.2; *df*=169; *p*=.001), winter HSCL-21 (F=13.1; *df*=169; *p*=.0001), and summer HSCL-21 (F=10.9; *df*= 169; *p*=.0001; See Table 10).

The SAD group had significantly different winter BDI scores (*t*=-2.83; *df*=9.3; *p*<.05) winter HSCL-21 scores (*t*=-4.56; *df*=167; *p*<.001), and summer HSCL-21 scores (*t*=-2.33; *df*=9.3; *p*<.05) from those of the Normal group. SAD subjects differed from S-SAD subjects group only in winter HSCL-21 scores (*t*=-2.22; *df*=167; *p*<.05).

The S-SAD group had significantly different scores from the normal group on the BDI in summer (*t*=-2.24; *df*=25; *p*<.05) HSCL-21 in winter (*t*=-2.74; *df*=167; *p*<.01) and summer (*t*=-2.39; *df*=24.7; *p*<.05). Both the SAD and S-SAD groups combined had

Table 9 - Variable Means, SDs, Paired t-Tests and Mean Difference Between Winter and Summer Dependent Variable Scores for SAD, S-SAD and Normal Subjects

	Winter		Summer		Mean Difference				
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	***t***	***df***	***p***
SAD Group (n=10)									
BDI	12.2	8.8	9.2	9.3	3.0	4.81	.99	9	.077
HSCL-21	41.5	7.8	40.4	13.7	1.1	9.40	.37	9	.720
SD	12.8	4.0	12.7	4.8	0.1	4.0	.08	9	.939
PD	13.9	3.5	13.8	5.4	0.1	3.1	.10	9	.921
GFD	14.8	3.5	13.9	5.1	0.9	4.8	.59	9	.571
Exercise	71.0	45.3	68.8	31.4	-2.1	25.7	.26	9	.800
Fitness	3.4	1.3	4.3	1.2	-0.9	1.3	-2.21	9	.054
S-SAD Group (n=21)									
BDI	7.1	6.6	6.6	5.1	0.6	8.1	.32	20	.750
HSCL-21	35.0	10.8	34.6	7.9	0.5	12.4	.18	20	.862
SD	10.5	4.8	10.9	3.5	-0.4	5.5	-.35	20	.727
PD	12.5	3.2	12.0	2.6	0.5	3.8	.58	20	.568
GFD	12.0	4.4	11.6	4.5	0.4	4.9	.40	20	.695
Exercise	74.9	45.9	84.5	62.5	9.6	55.6	-.80	20	.436
Fitness	3.0	1.5	3.0	1.8	0.0	1.5	.00	20	1.00
Normal Group (n=140)									
BDI	4.2	4.6	3.9	4.5	0.3	4.5	.83	137	.410
HSCL-21	30.2	6.9	30.2	6.7	0	6.7	-.08	138	.940
SD	9.7	2.7	9.8	2.7	-0.2	2.6	-.75	138	.456
PD	10.6	2.7	10.8	2.8	-0.1	2.7	-.70	138	.488
GFD	9.9	3.2	9.6	2.9	0.3	3.1	1.07	138	.287
Exercise	74.5	55.5	79.8	56.2	5.3	59.6	-1.06	138	.291
Fitness	3.9	1.6	3.8	1.7	0.1	1.5	.51	137	.608

significantly different scores from the normal group on the BDI in winter (t=-3.39; df=15.7; p<.01) and in summer (t=-2.43; df=13.0; p<.05), and for HSCL-21 in winter (t=-5.08; df=167; p<.001) but not summer (t=-3.02; df=13.4; p not significant).

No significant differences in winter or summer Exercise, Fitness Level, or Exercise Difference scores were found between groups.

Seasonality and Gender Differences

Table 11 shows the seasonal characteristics reported by males and by females in the present study. Difficulty with seasonal change was reported by 17.2% of males and 22% of females. Females reported more seasonal variation in mood (73% females versus 55% males), energy (80% versus 59%), sleep length (82% versus 67%), social activity (73% versus 62%), appetite (61% versus 45%), weight (65% versus 42%) and food preference (75% versus 48%) than males. Amount of annual fluctuation in weight was similar for males and females.

Table 10 - Oneway ANOVA of Dependent Variables Between Groups

Contrast	*t*	*df*	*p*
Winter BDI			
SAD vs S-SAD & Normals	2.255	10.3	.047 *
SAD vs S-SAD	-1.612	13.9	.129
SAD vs Normals	-2.827	9.3	.019 *
S-SAD vs Normals	-1.964	23.0	.062
SAD & S-SAD vs Normals	-3.368	15.7	.004 **
F-Ratio: 13.1	P=.0001		
Summer BDI			
SAD vs S-SAD & Normals	1.309	9.7	.221
SAD vs S-SAD	-.830	11.6	.423
SAD vs Normals	-1.767	9.3	.110
S-SAD vs Normals	-2.245	25.0	.034 *
SAD & S-SAD vs Normals	-2.434	13.0	.030 *
F-Ratio: 7.2	P=.001		
Winter HSCL-21			
SAD vs S-SAD & Normals	3.478	167	.001 **
SAD vs S-SAD	-2.218	167	.028 *
SAD vs Normals	-4.561	167	.000 ***
S-SAD vs Normals	-2.738	167	.001 ***
SAD & S-SAD vs Normals	-5.082	167	.000 ***
F-Ratio: 13.1	P=.0001		
Summer HSCL-21			
SAD vs S-SAD & Normals	1.809	9.8	.101
SAD vs S-SAD	-1.252	11.9	.235
SAD vs Normals	-2.329	9.3	.044 *
S-SAD vs Normals	-2.386	24.7	.025 *
SAD & S-SAD vs Normals	-3.022	13.4	.009 **
F-Ratio: 10.9	P=.0001		

* $p<.05$
** $p<.01$
*** $p<.001$

Females reported sleeping more in the winter (mean 8.1 ± 1.2 hours for females, 7.9 ± 1.2 hours for males; t=-.86; df=172; p not significant) and less in summer (mean 7.1 ± 1.2 hours versus 7.3 ± 1.2 hours for males; t=.91; df=172; p not significant) than males, but not to a statistically significant degree. Hours slept in autumn and spring were comparable for both sexes.

Sensitivity to weather changes were similar for males and females, with the greatest difference between the two groups in the effect of grey, cloudy days. Almost half of the female subjects (46%) reported that cloudy days had a negative effect on mood, while fewer, but nevertheless a large group of male subjects (29%) reported a similar effect.

Table 11 - Seasonal Characteristics of Males and Females from the Total Sample

Variable	Males (n=66)	Females (n=110)
Mean age (±SD)	48.6 (17.3)	44.6 (16.1)
Mean years lived in area	23 (16.3)	22.6 (19.4)
Changes with the seasons are a problem, (%)	11 (17.2)	24 (22.0)
Mild	4 (6.3)	8 (7.4)
Moderate	3 (4.7)	8 (7.4)
Marked	3 (4.7)	4 (3.7)
Severe	1 (1.6)	1 (0.9)
Disabling	0	1 (0.9)
Change with the seasons in: (%)		
Mood	35 (55)	81 (73)
Energy	39 (59)	88 (80)
Sleep length	44 (67)	90 (82)
Social activity	41 (62)	80 (73)
Appetite	30 (45)	67 (61)
Weight	28 (42)	72 (65)
Food preference	32 (48)	83 (75)
Weight fluctuations during the course of the year, (%)		
0 - 1.35 kg	32 (48)	40 (36)
1.8 - 3.15 kg	21 (32)	44 (41)
3.6 - 4.95 kg	11 (17)	18 (17)
5.4 - 6.75 kg	2 (3)	4 (4)
7.2 - 9 kg	0	2 (2)
> 9 kg	0	0
Sleep length, Mean (SD)		
Winter	7.9 (1.2)	8.1 (1.2)
Spring	7.6 (0.9)	7.6 (1.1)
Summer	7.3 (1.2)	7.1 (1.2)
Autumn	7.6 (0.9)	7.6 (1.1)
The following weather changes negatively affect mood, (%)		
Short days	19 (29)	38 (36)
Foggy, smoggy days	28 (42)	44 (42)
Grey cloudy days	19 (29)	49 (46)
Cold weather	38 (58)	65 (60)
Humid days	41 (64)	71 (68)
Hot weather	21 (32)	41 (39)
High pollen count	15 (23)	34 (32)
Dry days	4 (6)	5 (5)
Sunny days	2 (3)	7 (7)
Long days	8 (13)	15 (14)
Pattern type, (%)		
Winter Pattern	16 (94)	27 (79)
Summer Pattern	1 (6)	7 (21)
Mean ± SD seasonality score	5.0 ± 4.2	6.7 ± 3.9
Meets criteria for:		
SAD, (%) Total	4 (2.3)	6 (3.4)
S-SAD, (%) Total	5 (2.8)	16 (9.1)

Of the 10 subjects who met SPAQ criteria for SAD, 6 (60%) were women. Twenty-one subjects met criteria for S-SAD of which 16 (76.2%) were women (see Table 6). Sixteen males and 27 females were winter pattern types, while only 1 male and 7 females were summer types.

Table 12 - Variable Means, SDs, and Independent Samples *t*-Tests, Grouped by Sex

	Women (n=110)		Men (n=66)					
Variable	**Mean**	**SD**	**Mean**	**SD**	***t***	***df***	***p***	
BDI (Winter)	5.7	5.8	4.1	4.9	-1.96	153.62	.052	
BDI (Summer)	4.7	5.1	4.3	5.2	-0.43	172	.807	
BDI Difference	1.0	6.0	-0.2	3.0	-1.71	167.81	.088	
HSCL-21 (Winter)	32.8	8.7	29.5	6.3	-2.88	173	.005	**
SD	10.3	3.3	9.4	2.8	-1.69	173	.093	
PD	11.4	3.1	10.7	2.7	-1.39	173	.166	
GFD	11.1	3.9	9.3	2.6	-3.61	170.1	.000	***
HSCL-21 (Summer)	31.9	8.5	30.5	6.5	-1.14	173	.254	
SD	10.2	3.2	10.0	2.6	-0.59	173	.571	
PD	11.2	3.2	11.1	2.6	-0.15	173	.882	
GFD	10.5	3.7	9.4	2.7	-2.00	173	.047	*
HSCL-21 Difference	0.9	9.0	-1.0	4.6	-1.83	169.36	.069	
Exercise (Winter)	74.5	54.2	74.7	53.6	0.02	172	.980	
Exercise (Summer)	76.1	54.4	87.9	57.5	1.35	172	.178	
Exercise Difference	1.8	56.1	13.2	59.7	1.26	171	.208	
Fitness (Winter)	3.4	1.6	4.2	1.4	3.34	173	.001	**
Fitness (Summer)	3.5	1.6	4.1	1.7	2.27	173	.024	*
Fitness Difference	-0.1	1.4	0.1	1.6	0.95	172	.342	
GSS	6.8	3.9	5.0	4.2	-2.83	173	.005	**

* $p<.05$ ** $p<.01$ *** $p<.001$

In order to explore gender differences in scores on the dependent variables further, data were analyzed separately for women and men (see Table 13). No significant differences between winter and summer BDI, HSCL-21 or Exercise scores were found for men or women.

A correlation between gender and each of the dependent variables (See Table 16) showed that gender was significantly correlated with Global Seasonality Scores (r=.21; p<.01), Fitness Level in winter (r=-.26; p<.01), Exercise Score in summer (r=.46; p<.001), and Exercise Difference (r=-.52; p<.001). Table 12 shows the means and standard deviations for each of the dependent variables by gender. Women had higher BDI and HSCL-21 scores than men in both summer and winter, but these differences in scores were only statistically significant for winter HSCL-21 (t=-2.88; df=173; p<.01), and GFD in both winter (t=-3.61; df=170; p<.001) and summer (t=-2.00; df=173; p<.05).

Women had significantly higher GSS scores than men (t=-2.83; df=173; p<.01). Men reported higher levels of fitness than women in both winter and summer, and there were statistically significant differences between the sexes in both summer and winter Fitness Level (summer: t=2.37; df=173; p<.05; winter: t=3.34; df=173; p<.01). No significant differences between men and women for Fitness Difference, Exercise or Exercise Difference scores were found.

Seasonality and Age

Mean (SD) age for the total sample was 46.1 (16.6). There were no significant differences in age between subjects in the SAD, S-SAD and Normal groups, or between males and females. However, subjects from Hastings were significantly older than those from Palmerston North (mean (SD) age Hastings, 51.0 (14.1); Palmerston, 41.9 (17.5); p=-3.73; df=173; p<.001). Age was significantly correlated with region (r=.27 p<.001), but not with any of the other dependent variables (see Table 16). A Oneway ANOVA

Table 13 - Means, SDs, Paired t-Tests and Mean Differences Between Winter and Summer Scores by Gender

Variable	Winter		Summer		Mean Difference				
	Mean	SD	Mean	SD	Mean	SD	t	df	p
Females									
BDI	5.7	5.8	4.7	5.1	1.0	6.0	1.75	108	.082
HSCL-21	32.8	8.7	31.9	8.5	0.9	9.0	1.03	109	.306
SD	10.3	3.3	10.2	3.2	0.0	3.5	0.08	109	.936
PD	11.4	3.1	11.2	3.2	0.2	3.3	0.61	109	.546
GFD	11.1	3.9	10.4	3.7	0.7	4.0	1.77	109	.080
Exercise	74.5	54.2	76.3	54.6	1.8	56.1	-0.33	107	.740
Fitness	4.2	1.4	4.1	1.7	-0.1	1.4	0.70	65	.485
Males									
BDI	4.2	4.9	4.3	5.2	-0.2	3.0	-0.45	63	.654
HSCL-21	29.5	6.3	30.5	6.5	-1.0	4.6	-1.77	64	.082
SD	9.4	2.8	10.0	2.6	-0.5	2.3	-1.86	64	.068
PD	10.7	2.7	11.1	2.6	-0.4	1.9	-1.67	64	.100
GFD	9.3	2.6	9.4	2.7	-0.1	2.2	-0.28	64	.781
Exercise	74.7	54.0	87.9	57.5	13.2	59.7	-1.78	64	.080
Fitness	3.4	1.6	3.5	1.6	0.1	1.6	-0.61	107	.540

with Bonferoni adjustments for multiple comparisons was performed to examine differences in GSS between age groups by decade. No significant differences between groups were found.

Regional Differences

Table 14 shows the means and standard deviations for each of the dependent variables by region. No significant differences in scores on any of the dependent variables except the Somatic Distress subscale of the HSCL-21 in summer (t=-1.99; df=173; p<.05) were found between Palmerston North and Hastings.

When data were analyzed separately for each region, no significant differences between scores on the dependent variables in winter and summer were found, except for Somatic Distress which differed significantly across season for subjects in Hastings (t=-2.18; df=79; p<.05). There were no significant differences in any of the dependent variable scores between region for females, but males in Hastings had significantly greater HSCL-21 Difference scores than males from Palmerston North (t=3.27; df=63; p<.01). No other significant difference in scores was found for males.

Table 14 - Mean, SD, and Independent Samples t-Tests, Grouped by Region

	Palmerston (n=95)		Hastings (n=81)				
Measure	**Mean**	**SD**	**Mean**	**SD**	*t*	*df*	*p*
BDI (Winter)	4.9	5.4	5.4	5.7	-0.55	172	.580
BDI (Summer)	4.3	4.6	4.9	5.7	-0.81	172	.421
BDI Difference	0.6	4.9	0.5	5.5	0.18	171	.858
HSCL-21 (Winter)	31.5	7.9	31.7	8.3	-0.13	173	.897
SD	9.9	3.1	10.0	3.2	0.30	173	.763
PD	11.2	3.0	11.1	3.0	-0.16	173	.871
GFD	10.6	4.0	10.4	3.2	-0.42	173	.675
HSCL-21 (Summer)	30.7	7.3	32.2	8.3	-1.29	173	.200
SD	10.6	3.1	9.7	2.9	-1.99	173	.048*
PD	11.3	3.2	11.1	2.9	-0.37	173	.713
GFD	10.3	3.8	9.9	3.0	-0.87	173	.385
HSCL-21 Difference	0.8	7.2	-0.5	8.4	1.16	173	.249
Exercise (Winter)	69.9	57.4	79.9	49.1	-1.22	172	.226
Exercise (Summer)	75.7	48.6	86.1	62.9	-1.21	147.32	.228
Exercise Difference	6.0	59.2	6.2	56.0	-0.03	171	.977
Fitness (Winter)	3.7	1.6	3.8	1.5	-0.46	173	.645
Fitness (Summer)	3.6	1.6	3.9	1.7	-1.06	173	.292
Fitness Difference	0.1	1.4	-0.1	1.5	0.72	172	.472
GSS	6.5	4.1	5.6	4.0	1.41	173	.161

* p<.05

Table 15 shows the distribution of SAD Group, S-SAD Group and Normal subjects within each region. Eight of the subjects (4.7% of the total sample) in the SAD group were from Palmerston North and 2 (1.2%) were from Hastings. Eleven S-SAD subjects

(6.4% of the total sample) were from Palmerston North and 10 (5.8%) were from Hastings.

Table 15 - Distribution of SAD, S-SAD, and Normal Subjects by Region

Group	Palmerston (n=93)	(%) Total Sample	Hastings (n=78)	(%) Total Sample
SAD Group	8	(4.7)	2	(1.2)
S-SAD Group	11	(6.4)	10	(5.8)
Normal Group	74	(43.3)	66	(38.6)

Physical Activity, Mood, and Seasonality

No significant difference in Exercise scores, the amount of change in Exercise scores (Exercise Difference) or Fitness Level in winter and summer were found for the total sample, SAD, S-SAD, and Normal Groups, or males and females (see Tables 7, 8,10, and 12). Exercise was not significantly correlated with any other dependent variable or any of the weather variables for the total sample, males and females, or between regions (see Tables 17 and 18). Level of fitness reported by subjects was significantly different for males and females in both winter (t=3.34; df=173; p<.01) and summer (t=2.27; df=173; p<.05), but the amount of change in fitness level (Fitness Difference) did not vary between the sexes.

Fitness in winter showed a significant negative correlation with gender (r=-.26; p<.001) winter BDI scores (r=-.27; p<.001) and winter HSCL-21 scores (r=-.32; p<.001). The amount of change in Fitness Level scores (Fitness Difference) was significantly related to winter HSCL-21 scores (r=-.27; p<.001) and the amount of change in HSCL-21 scores (HSCL-21 Difference: r=-.22; p<.01). Exercise was not significantly correlated with any of the psychological variables.

Other Relationships Among Dependent Variables

Table 16 shows Pearson's r correlations among the dependent variables. Significant positive correlations between Global Seasonality Scores (GSS) and BDI scores (winter: r=.29; p<.001; summer: r=.35; p<.001), and HSCL-21 scores (winter: r=.32; p<.001; summer: r=.41; p<.001) were found. BDI scores and HSCL-21 scores, BDI Difference and HSCL Difference were also highly positively correlated with each other, as expected.

Table 16 - Pearson Correlation Matrix for Dependent Variables (n=167)

Correlations:	Age	Sex	Region	BDI (W)	BDI (S)	BDI Diff	HSCL-21 (W)	HSCL-21 (S)
Age	1.0000							
Sex	-.1065	1.0000						
Region	.2706**	-.1074	1.0000					
BDI (W)	.0689	.1223	.0374	1.0000				
BDI (S)	.1013	.0325	.0750	.5548**	1.0000			
BDI Difference	-.0281	.1007	-.0357	.5277**	-.4139**	1.0000		
HSCL-21 (W)	.0134	.1876	.0032	.7972**	.3533**	.5115**	1.0000	
HSCL-21 (S)	.1108	.0807	.0975	.5573**	.7494**	-.1553	.5325**	1.0000
HSCL-21 Difference	-.0993	.1136	-.0963	.2636**	-.3969**	.6936**	.5010**	-.4657**
Exercise (W)	.0716	-.0134	.1136	-.0522	.0086	-.0659	-.0510	.0164
Exercise (S)	.1841	-.1078	.1377	.0086	-.0315	.0416	.0112	.0030
Exercise Difference	.1082	-.0908	.0229	.0587	-.0386	.1036	.0601	-.0129
Fitness Level (W)	.0260	-.2563**	.0739	-.2716**	-.1276	-.1669	-.3188**	-.1370
Fitness Level (S)	.1363	-.1503	.0789	-.0858	-.1236	.0323	-.0662	-.1478
Fitness Difference	-.1327	-.1051	-.0118	-.1985	.0055	-.2228*	-.2739**	.0238
GSS	-.1511	.2098*	-.1150	.2913**	.3527**	-.0413	.3150**	.4153**

Correlation:	HSCL-21 Diff	Ex. (W)	Ex. (S)	Ex. Diff	Fitness (W)	Fitness (S)	Fitness Diff	GSS
HSCL-21 Difference	1.0000							
Exercise (W)	-.0701	1.0000						
Exercise (S)	.0086	.4624**	1.0000					
Exercise Difference	.0760	-.5203**	.5166**	1.0000				
Fitness (W)	-.1932	.1976	.2208*	.0218	1.0000			
Fitness (S)	.0820	.0540	.2314*	.1707	.6206**	1.0000		
Fitness Difference	-.3107**	.1544	-.0302	-.1781	.3698**	-.4990**	1.0000	
GSS	-.0952	.0005	-.0237	-.0233	-.2095*	-.1100	-.1011	1.0000

2-tailed Significance: * - .01 ** - .001

Weather, Mood, Seasonality and Exercise

Means for each of the weather variables and day length were calculated for the seven days prior to the date each questionnaire was completed. Independent t-tests were used to test for differences in weather variables between season, and between regions (See Appendix H). All the weather variables differed significantly between season ($p<.001$) except barometric pressure ($p<.066$). Significant differences in each variable, except sunshine hours, barometric pressure, and relative humidity in winter, and sunshine hours and rainfall in summer, were found between regions for the seven days prior to the date each questionnaire was completed (see Appendix for p values). For the seven days in winter, Palmerston North had slightly longer days, more sunshine, less rainfall, higher minimum and lower maximum temperature, higher barometric pressure and wind speed, and less relative humidity than Hastings. For the seven days in summer, Palmerston North had longer days, more sunshine hours and rainfall, lower minimum temperature, higher maximum temperature and barometric pressure, and greater wind speed and relative humidity than the Hastings region.

A correlation between the dependent variables and all the weather variables for summer and winter was performed (see Table 17). No correlation between weather variables or any of the dependent variables were found for the total sample in winter.

In summer, BDI scores were positively correlated with rainfall (r=.29; p<.001). HSCL-21 scores were positively correlated with rainfall (r=.24; p<.01) and minimum temperature (r=.29; p<.001) and negatively correlated with wind speed (r=-.29; p<.001) and relative humidity (r=-.30; p<.001). The HSCL-21 subscales were not significantly correlated with any weather variables in winter, but in summer, Performance Difficulty (PD) was positively correlated with minimum temperature (r=.23; p<.01) and negatively correlated with wind speed (r=-.28; p<.001). General Feelings of Distress (GFD) were positively correlated with rainfall (r=.25; p<.01), and minimum temperature (r=.26; p<.01), and negatively correlated with wind speed (r=-.23; p<.01), and humidity (r=-.25; p<.01). Somatic Distress (SD) was negatively correlated with humidity (r=-.25; p<.01). No other significant correlation between Exercise, GS, or Difference scores and any weather variables were found.

Table 17 - Pearson Correlation Matrix (n=167)

Winter	**BDI**	**HSCL-21**	**PD**	**SD**	**GFD**	**Exercise**	**Fitness**	**GSS**	**BDI Dif.**	**HSCL Dif.**	**Ex. Dif.**
Day Length	.1031	.0797	.1007	.0180	.0794	-.0077	-.1590	.1075	.1031	.0764	-.0608
Sunshine	.0037	.0491	.0261	-.0166	.1025	.0543	.0298	-.0231	.0037	-.0475	.0235
Rainfall	.0308	.0086	.0165	-.0148	.0186	.0488	.0511	-.0913	.0308	-.0497	.0285
Min. Temp.	-.0633	-.0851	-.0492	.0123	-.1600	.0631	-.0739	.0271	-.0633	-.0416	-.0566
Max. Temp.	.0457	.0447	.0790	.0076	.0285	.0393	.0041	.0862	.0457	-.0606	.0873
Barometric	.0194	.0181	-.0200	-.0144	.0692	-.0301	-.0165	-.0180	.0194	.0365	-.0363
Wind Speed	.0243	.0436	.0677	.0399	.0066	-.0633	-.0852	.1751	.0243	.0784	-.0003
Humidity	-.0553	-.1405	-.1289	-.0575	-.1566	-.0570	.1035	-.1915	-.0553	-.0680	-.0034
Summer (n=140)											
Day length	-.0446	-.0265	.0377	-.1344	.0227	-.1007	-.0491	.1371	.0094	.0664	-.1302
Sunshine	-.1699	-.0922	-.0581	-.0916	-.0738	-.0461	.0039	-.1500	.1342	.1034	-.0472
Rainfall	.2957**	.2367*	.1470	.1622	.2533*	-.0429	-.0479	.1955	-.1364	-.1045	-.0062
Min Temp.	.1966	.2916**	.2336*	.2108	.2570*	.0479	-.0036	.0742	-.0986	-.1790	-.0281
Max Temp.	.0809	.1171	.0712	.0378	.1625	-.0522	-.0018	.0198	-.0919	-.0918	-.0812
Barometric	-.0403	.0663	.1221	-.0258	.0606	.0494	-.0511	.1169	.0203	-.0409	-.0138
Wind Speed	-.1500	-.2923**	-.2785**	-.2003	-.2283*	-.0951	.0134	-.0262	.0569	.1357	-.0423
Humidity	-.2164	-.2983**	-.2163	-.2502*	-.2535*	-.0903	-.0206	.0046	.0959	.1660	-.0417

2-tailed Significance: * - .01 ** - .001

Subjects in the present study were also asked to indicate to what degree weather affected the way they felt over the previous seven days. In winter, 115 subjects (66.1%) of the total sample) reported that they were sometimes affected by weather variables, 23 (13.2%) said that the weather usually affected the way they felt, and 8 subjects (4.6%) reported that their mood changed with the weather. Similar figures were reported in summer (63.1%, 10.2%, and 4% respectively). Only 16.1% of the total sample in winter and 22.7% in summer did not report being affected to some degree by weather over the previous seven days.

Multiple Regression Analysis of Weather Variables

Weather vs Mood, Psychological Distress and Exercise

An 'all-in' multiple regression analysis was used to examine associations between the weather variables and BDI, HSCL-21 and Exercise Scores controlling for sex and region (see Table 18). GSS was not included as a dependent variable as it was regarded as a trait measure.

Table 18 shows results of significant regression analyses which were found for summer BDI, winter HSCL-21, and summer HSCL-21. In summer, 8% of the variance in BDI was predicted by the total variable pool, and this was mainly due to the positive correlates of minimum temperature (B=1.416; *Beta*=.628; p<.064) and rainfall (B=2.093; *Beta*=.246; p<.071).

In winter, a significant correlation between HSCL-21 scores and gender was found (B=-3.717; *Beta*=-.222; p<.003), with a total of 4% of the variance in winter HSCL-21 scores being predicted by gender. In summer, rainfall was a significant positive correlate (B=4.176; *Beta*=.342; p<.010) and maximum temperature a significant negative correlate (B=-2.537; *Beta*=-.551; p<.029) of summer HSCL-21. Overall, the significance level of the regression was p<.0008, with 13% of the variance in summer HSCL-21 being accounted for by the total variable pool.

There were no significant associations between the weather variables and winter BDI, winter or summer Exercise scores, or Difference scores.

Interaction Effects with Gender and Region

Previous studies have suggested that there may be gender differences in sensitivity to seasonal change. As weather also varies with season, it is possible that sensitivity to weather change may also show a gender effect. A series of all-in multiple regressions were performed to examine each of the dependent variables for interaction effects with gender. There were no significant interaction effects for any dependent variable (See Appendix I).

Table 18 - Results of an 'All-in' Multiple Regression Analysis of the Association of Dependent Variables, Weather Variables, Gender and Region

Variable	*B*	Beta	*p*	
Summer BDI (n=173)				
Gender	-.233	-.022	.7917	
Region	.598	.058	.9004	
Day Length	1.225	.118	.8019	
Sunshine	.142	.024	.8589	
Max Temp.	-.931	-.290	.2635	
Min Temp.	1.416	.628	.0643	
Rainfall	2.093	.246	.0710	
Humidity	.200	.087	.7770	
Wind Speed	.063	.029	.9060	
Barometric Pressure	-.433	-.241	.2037	
Adjusted Squared Multiple *R*: 0.08	*F*-ratio: 2.252	$p<.0182$		
Winter HSCL-21 (n=174)				
Gender	-3.717	-.222	.0035	**
Region	-4.862	-.300	.4452	
Day length	-7.166	-.099	.6981	
Sunshine	2.169	.178	.2244	
Min Temp.	-1.498	-.125	.5354	
Max Temp.	-3.662	-.271	.2446	
Rainfall	3.057	.418	.3215	
Humidity	-.776	-.222	.1309	
Wind Speed	1.448	.691	.2077	
Barometric Pressure	.134	.059	.9057	
Adjusted Squared Multiple *R*: 0.04	*F*-ratio: 2.004	$p<.0359$		
Summer HSCL-21 (n=147)				
Gender	-1.451	-.095	.2368	
Region	-8.826	-.603	.1853	
Day Length	11.581	.778	.0893	
Sunshine	.741	.088	.5046	
Max Temp.	-2.537	-.551	.0292	*
Min Temp.	1.439	.444	.1741	
Rainfall	4.176	.342	.0100	**
Humidity	-.097	-.029	.9215	
Wind Speed	.245	.081	.7401	
Barometric Pressure	-.184	-.071	.6970	
Adjusted Squared Multiple *R*: 0.13	*F*-ratio: 3.258	$p<.0008$		

*$p<.05$ ** $p<.01$

Interaction Effects with Seasonality

Several studies have noted a greater degree of sensitivity to weather variables in some SAD subjects. Since SAD subjects in this study, and previous studies, have been defined by their Global Seasonality Scores (GSS), a series of all-in multiple regression analyses were performed to examine subjects' scores on the BDI, HSCL-21 and Exercise Inventory in summer and winter for interaction effects with GSS. Significant regressions were found for Winter BDI and HSCL-21, and Summer HSCL-21, and these were further explored using separate regressions controlling for all other variables with a median split of GSS into low and high GSS groups.

Table 19 displays the results of this series of analyses. For winter BDI, significant interaction effects for Sunshine x GSS, Rainfall x GSS, and Minimum temperature x GSS were found, and accounted for an additional 18.9% of explained variance in winter BDI scores. Separate regressions for subjects with low GSS and high GSS showed that sunshine (B = 4.342), rainfall (B = 4.268), and minimum temperature (B = 4.730) were positively related to winter BDI in subjects with low GSS. In the high GSS group, sunshine (B = -2.827) and minimum temperature (B = -3.564) were negatively related to BDI, while rainfall showed a weak negative relationship to BDI (B = -0.451).

Significant interaction effects for winter HSCL-21 were found for Sunshine x GSS and Minimum temperature x GSS, accounting for an additional 10.8% of the variance in winter HSCL-21 scores. Separate regressions for low GSS and high GSS subjects showed that sunshine hours (B = 5.033) and minimum temperature (B = 2.059) were positively related to HSCL-21 scores for the low GSS group, and negatively related to summer HSCL-21 for the high GSS group (sunshine: B = -2.877; minimum temperature B = -3.449).

The only significant interaction for summer HSCL-21 was Humidity x GSS which accounted for an additional 8.3% of variance in summer-HSCL-21 scores. Separate analysis of this interaction by low and high GSS showed a small positive relationship between humidity and summer HSCL-21 for the low GSS group (B = 0.372), and an similarly small negative relationship between humidity and summer HSCL-21 for the high GSS group (B = -0.220).

No significant interaction effects of weather variables with GSS were found for summer BDI or Exercise scores in winter or summer.

Table 19 - Results of an 'All-in' Multiple Regression Analysis of Interaction Effects Between Dependent Variables, GSS and Weather

Variable	Beta	p
Winter BDI (n=172)		
Sunshine x GSS	-4.718	.0000
Rainfall x GSS	-1.209	.0285
Minimum Temperature x GSS	-1.975	.0077
R^2 Change = 0.189	F Change = 7.145***	

	Low GSS B	p	**High GSS** B	p
Sunshine	4.342	.0018**	-2.827	.1625
Rainfall	4.268	.1283	-0.451	.8860
Min Temp.	4.730	.0363*	-3.569	.1416
	Adjusted R^2 = 0.134 F = 2.445*		Adjusted R^2 = 0.058 F = 1.587	

Variable	**Beta**	p
Winter HSCL (n=173)		
Sun x GSS	-3.086	.0041
Min. x GSS	-1.884	.0120
R^2 Change = 0.108	F Change = 3.853**	

	Low GSS B	p	**High GSS** B	p
Sunshine	5.033	.0145*	-2.877	.3103
Min Temp.	2.059	.5466	-3.449	.3101
	Adjusted R^2 = 0.205 F = 3.402**		Adjusted R^2 = 0.004 F = 1.037	

Variable	**Beta**	p
Summer HSCL-21 (n=145)		
Humidity x GSS	-3.802	.0281
R^2 Change = 0.083	F Change = 2.926*	

	Low GSS B	p	**High GSS** B	p
Humidity	.372	.6836	-.220	.9382
	Adjusted R^2 = 0.147 F = 2.342*		Adjusted R^2 = 0.189 F = 2.922**	

* p<.05 ** p<.01 *** p<.001

CHAPTER 11

DISCUSSION

This study was of an exploratory nature and had three general aims; firstly, to examine the epidemiology of seasonal sensitivity in a southern hemisphere sample; secondly, to explore the impact of weather on mood, symptom reporting and physical activity; and thirdly, to investigate the inter-relationships between physical activity, mood, and sensitivity to seasonal change.

Seasonality

Seasonal affective disorder (SAD) was first identified as a specific type of clinical depression characterised by regular seasonal cycles in the onset and remission of depressive episodes (Rosenthal *et al.*, 1984). Subsequent studies of both clinical and general population samples have suggested that sensitivity to seasonal change is not limited to individuals with major affective disorders, but may be a universal trait expressed to varying degrees throughout the population.

Seasonality and the SPAQ

To date, several studies in the northern hemisphere have examined seasonality in general population samples and found seasonal variation in mood and behaviour in normal subjects as well as subjects who meet criteria for SAD and its less severe form, subsyndromal-SAD (S-SAD; Booker & Hellekson, 1992; Kasper *et al.*, 1989*a*; Magnússon & Axelsson, 1993; Magnússon & Stefánsson, 1993; Rosen *et al.*, 1989; Terman, 1988). The aim of the present study was to explore whether similar patterns of seasonal change occurring in synchronisation with southern hemisphere seasons would be found in a general population sample from two regions in New Zealand.

The results show that seasonal changes in mood, sleep, energy, appetite, weight and social activity were reported by a large proportion of the sample. Twenty percent of subjects regarded the extent to which they experience seasonal fluctuation in these factors during the year to be problematic. The majority of subjects were 'winter types' and reported feeling worst in the winter months (June, July and August). This was also the time of year when subjects indicated increased sleep, appetite, and weight, and reduced social activity. A small number of subjects (n=8) who reported a pattern of seasonal change opposite to that experienced by the majority of subjects - that is, they felt worse in summer rather than winter - were also found in this study. These results are consistent with the patterns of seasonal change reported by subjects in Montgomery County (Kasper *et al.*, 1989*c*) and previous studies of general population samples from the northern hemisphere (Booker & Hellekson, 1992; Kasper et al., 1989*a*; Magnússon & Axelsson, 1993; Magnússon & Stefánsson, 1993; Rosen *et al.*, 1989; Terman, 1988).

Montgomery County (Kasper *et al.*, 1989*c*) was selected as a comparison for the present study as it is located at a similar latitude in the northern hemisphere as Palmerston North and Hastings are located in the southern hemisphere. Although the influence of latitude on the prevalence of seasonal affective disorders remains undecided, the majority of general population studies have suggested that prevalence increases with latitude, except perhaps at extremes (Booker & Hellekson, 1992; Kasper *et al.*, 1989*c*; Rosen *et al.*, 1989; Terman, 1988).

Ten subjects (5.8%) in this study met SPAQ criteria for SAD, and 21 subjects (12%) met criteria for S-SAD. The prevalence of SAD and S-SAD in this study was most comparable to that reported in Montgomery County than any other study. As this study is the first epidemiological study of a southern hemisphere sample using the SPAQ, comparative studies at differing latitudes in the southern hemisphere are lacking. One southern hemisphere study that has been reported (Boyce & Parker, 1988) found that the symptom patterns of winter and summer SAD patients from Australia were similar to those reported in northern hemisphere samples. However Boyce and Parker used an adapted unpublished screening questionnaire developed by the National Institute of Mental Health (NIMH) research group and did not attempt to evaluate the prevalence of seasonal sensitivity in the general population. Without further data from southern hemisphere samples at different latitudes, it is impossible to add further to the latitude debate, although the finding of similar prevalence rates in both Montgomery County and the present study does not preclude a latitude effect.

Subjects also reported being affected to varying degrees by changes in the weather, with humid days (66%) and cold days (58%) affecting the most subjects in this study, and in Montgomery County (77% and 58% respectively). The effect of sunny, cloudy, short and long days on mood is of particular interest in the study of seasonal affective disorders, as each involves some change in the intensity or duration of exposure to light. In this study, reduced photoperiod (short days) was reported to have a negative effect on mood by 33% of the subjects, while 39% reported lowered mood in response to reduced light intensity (cloudy days). Sunny days (4%) and long days (14%) had a negative effect on mood in a small number of subjects, and it seems likely that these responses largely reflect the seasonal mood patterns exhibited by 'summer types'. Responses to weather variables noted in this study were similar to those reported by subjects in Montgomery County.

In is interesting to note that June, July and August, the months in which the majority of subjects in this study reported feeling worst, are also the months in which day length (photoperiod) is shortest in the Hastings and Palmerston North regions. Similarities between regional photoperiod and the months in which subjects report 'feeling worst' on the SPAQ have been found in previous studies (Kasper *et al.*, 1989*c*; Rosenthal *et al.*, 1984; Terman 1988). However, subjects' ratings of mood and psychological distress on the BDI and HSCL-21 were not significantly correlated with day length in winter or summer in this study.

While seasonal changes were reported more consistently by SAD and S-SAD subjects, seasonal variation in mood, sleep, energy, appetite, weight and social activity were also reported by at least 49% of subjects in the Normal group, and only one subject from the total sample did not experience any changes in mood or behaviour associated with the seasons. These results would tend to support the notion that sensitivity to seasonal change is widespread and not limited to subjects with SAD or S-SAD.

The patterns of seasonal variation in mood, sleep, energy, appetite, weight gain, and social activity reported by subjects in this study occurred six months later than those reported in northern hemisphere studies, in accordance with the six month lag in seasons between the two hemispheres. Seasonal patterns in symptom reporting which differed from those of northern hemisphere samples by six months were also found by Boyce and Parker (1988). These results suggests that seasonal affective disorders and the seasonal variation in symptoms reported by subjects in this study are linked to an environmental mechanism that varies with seasonal change.

Seasonality and Other Dependent Measures

Subjects' self-reports of symptomatology on the SPAQ discussed in the previous section suggest a wide degree of sensitivity to seasonal change in the sample. This observation was not however, supported by results obtained from the other dependent measures in this study. Although a large proportion of the sample reported seasonal changes in mood and symptomatology on the SPAQ (66%), these reports were not reflected in significantly different BDI or HSCL-21 scores across season. Mean BDI scores for the total sample were 5.2 ± 5.5 in winter and 4.6 ± 5.1 in summer, while HSCL-21 scores were virtually unchanged over season (30.6 ± 6.6 in winter; 30.1 ± 5.7 in summer). Separate analysis of the data for the SAD, S-SAD and Normal groups also failed to find any significant differences in dependent variable scores over season, although SAD subjects followed by the S-SAD group reported the greatest amount of seasonal variation in mood and psychological distress.

There are several possible explanations for this result. Firstly, the reliability of retrospective self-report measures such as the SPAQ may not be high. Although reasonable test-retest reliabilities for the SPAQ have been found (Thompson *et al.*, 1988), few studies have attempted to evaluate the SPAQ against other measures, and there have been no longitudinal studies which have attempted to validate the accuracy of subjects' self-reports of seasonality on the SPAQ.

Since Global Seasonality Scores and outcomes on the BDI and HSCL-21 were highly correlated in this study, it seems unlikely that failure to find the seasonal variation in symptoms subjects reported on the SPAQ was due to the instruments measuring different constructs. The six items from the SPAQ which total to give Global Seasonality Scores - changes in mood, sleep, appetite, weight, energy and socialisation - are similar to items on the BDI, and while items from the HSCl-21 appear to measure different constructs than those encompassed by Global Seasonality Scores, items from the HSCL-21 were nevertheless highly correlated with GSS in this study.

It has been argued that the nature of the SPAQ itself may encourage subjects to report seasonal variation in symptoms (Terman *et al.*, 1989). Although respondents are presented with the option to select 'No change' in symptoms over the seasons, or 'No particular month stands out', instructions for the SPAQ assume a seasonal effect (eg. 'In the following questions circle the numbers for all applicable months. This may be a single month, a cluster of months, or any other grouping'). In addition, the SPAQ asks subjects to make retrospective ratings of their seasonality over a twelve month time frame, whereas the BDI and HSCL-21 ask for ratings that are applicable only to 'the past week, including today'. For this reason, it seems likely that scores on the BDI and HSCL-21 which operate in a more immediate time frame, are more accurate than the retrospective self-reports provided by the SPAQ.

Although significant differences between winter and summer BDI and HSCL-21 scores were not found for the total sample or for any of the SAD, S-SAD or Normal groups, there were significant differences in BDI and HSCL-21 scores *between* groups. SAD subjects had significantly higher BDI and HSCL-21 scores in winter and summer than the Normal group, as did the SAD and S-SAD groups combined. S-SAD subjects had significantly higher BDI scores in winter and HSCL-21 scores in both seasons than the Normal group. These results suggest that the SAD, S-SAD and Normal groups in this study, as defined by Global Seasonality Scores, are qualitatively different from each other, with the SAD group experiencing the highest level of depression, psychological distress and seasonal variability in scores, followed by the S-SAD group and the Normal group, as would be expected. This result lends support to the validity of the SPAQ as a discriminatory instrument between groups.

The level of depression found in this study using the BDI were comparable to incidence rates for major depression in the general population cited in DSM-IV (1994). Fourteen percent of the sample in winter and 13% in summer obtained BDI scores in the Mild to Severe depression range, and these figures are within the range of the incidence rate cited in DSM-IV (7-12%). HSCL-21 scores for the total sample and males and females separately in this study were lower than those reported in previous normative data studies. While total HSCL-21 scores in six previous studies have averaged 36.6 (SD 8.2; Deane *et al.*, 1992; Green *et al.*, 1988; Deane, unpublished manuscript), mean HSCL-21 scores for the total sample in the present study were 30.6 (SD 6.6) in winter and 30.1 (SD 5.7) in summer. Only SAD subjects obtained HSCL-21 scores which were above those reported in previous studies (41.5, SD 7.8 in winter and 40.4, SD 13.7 in summer). Respondents who completed the first questionnaire but not the second had significantly higher BDI and HSCL-21 scores in winter than subjects who completed the study, which suggests that the level of psychological distress reported by the final sample in this study may slightly underestimate levels in the general population.

Gender Differences and Seasonality

Previous studies of both patient populations and general population samples have suggested that women may be more susceptible to seasonal change than men (Boyce & Parker, 1988; Rosenthal *et al.*, 1984; Sakamoto *et al.*, 1993; Terman *et al.*, 1989; Thompson & Isaacs, 1988; Winton & Checkley, 1989; Wirz-Justice *et al.*, 1986). A female to male ratio of between 1.5-2.3:1 has been reported for major depression (Davidson *et al.*, 1982), but the female to male ratio in many SAD studies has been much higher (Boyce & Parker, 1988; Kasper *et al.*, 1989*c*; Rosenthal *et al.*, 1984; Terman, 1988; Thompson & Isaacs, 1988). Some critics have argued that this effect may be an artifact of sampling procedures which have tended to advertise a female predominance of the disorder and to recruit subjects from articles in women's magazines, while other researchers have suggested higher Global Seasonality Scores may be obtained from women because women may be more self-reflective and more willing to report symptoms (Schlager *et al.*, 1993). Studies which have specifically targeted an even number of males and females however (Rosen *et al.*, 1989; Terman, 1988) have failed to find more females than males with high seasonality scores.

In the present study, 60% of subjects who met criteria for SAD and 76% of subjects who met criteria for S-SAD were women, but given the disproportionate number of women in the total sample (62.5%), it is possible that this finding is an artifact of sex bias. It is interesting to note that the proportion of males and females in the sample who reported experiencing difficulty with seasonal change was similar (17.2% of males, 22% of females). Seasonal variation in mood, energy, sleep length, social activity, appetite, weight, and food preference was however, reported by more females than males, and this was reflected in significantly higher Global Seasonality Scores for women than men. Women also reported significantly higher scores on the General Feelings of Distress subscale of the HSCL-21 in winter and summer than males. It is difficult to determine whether this result suggests that women in the this study were more affected by seasonal change and experienced greater variation in symptoms, specifically the winter months, than men, or whether differences in the reporting of symptoms as Schlager *et al.* (1993) suggest may account for the results.

Although significant differences in seasonality, mood and symptom reporting between males and females were found, analysis of the dependent variables for men and for women as separate groups failed to find any significant changes in mood or psychological distress over season for either gender. This suggests that although males and females reported significantly different levels of mood and seasonal sensitivity from each other, scores for each gender group across season showed little variation. It may be that women experience consistently more symptoms than men during both winter and summer, but the degree to which these symptoms fluctuate during the year is not great, or women may, as Schlager *et al.* (1993) suggest, report more symptomatology than men, either because they are more aware of symptoms or more willing to report them. Evaluation of these hypotheses is beyond the scope of this study.

Age and Seasonality

Some studies of both clinical and general population samples have suggested that SAD may be more prevalent in younger individuals, particularly in the 30-40 year old age group (Booker & Helleckson, 1992; Garvey *et al.*, 1988; Rosen *et al.*, 1989; Rosenthal *et al.*, 1988*c*). In the present study, 50% of SAD subjects were aged 35-44 years, but the size of the group (*n*=10) is insufficient to provide support for an age effect in this sample. The number of S-SAD subjects in each of the age groups was similar in this study, but only two S-SAD subjects and no SAD subjects were aged over 65 years, despite 19% subjects in the total sample being over 64 years of age. Although the total sample size in the present study was smaller than previous general population studies, the trends in age distribution of SAD and S-SAD subjects found in this study were similar to those reported by Rosen *et al.* (1989) in a study of four larger population samples from the northern hemisphere. The relationship between age and seasonal affective disorders remains inconclusive and requires further investigation.

Regional Differences

Palmerston North and Hastings are located at 39.5° and 40.5° South of the equator. Although there is only a difference of 1° latitude between the two regions, considerable differences in climate and photoperiod are experienced by residents in each region throughout the year. One aim of this study was to investigate whether there were any significant differences between regions in mood, seasonality and psychological distress which might be related to regional differences in climate and day length.

Means for the seven days prior to completion of the questionnaire were calculated for each of the weather variables. For the period of the present study, Hastings had a harsher winter and a milder summer than Palmerston North. Despite differences in climate and day length however, there were no significant differences in any of the dependent measures between region, except for scores on the Somatic Distress (SD) subscale of the HSCL-21 in summer. Somatic Distress scores were significantly higher in Palmerston North than in Hastings, but this was at best a weak effect. This result suggests that the degree of difference in weather between each region did not influence subjects' ratings of mood, psychological distress, and physical activity in this study.

Interestingly, more SAD subjects were found in Palmerston North (n=8) where the photoperiod was longer in both winter and summer than in Hastings (n=2); however the small number of subjects in the SAD group precludes interpretation of this result as a regional effect. Respondents from Hastings were significantly older than those from Palmerston North, and given the decreased incidence of SAD with age suggested in the above section, this may have contributed to the lower prevalence rates of SAD found in the Hastings region. The number of S-SAD subjects in each region was much more evenly distributed (11 subjects in Palmerston and 10 subjects in Hastings).

Weather

In previous studies, some SAD patients have reported particular sensitivity to changes in the weather - most notably increases in cloud cover (Kasper & Kamo, 1990; Rosenthal *et al.*, 1984; Winton & Checkley, 1989). Studies of the effects of weather on non-clinical samples have also suggested weak relationships between a range of weather variables and mood; however the use of non-parallel psychometric measures and insufficient sample sizes in these studies have made evaluation of their outcomes difficult. This study aimed to explore the relative influence of weather variables on mood in a larger population sample using recognised psychometric measures.

Only 16.1% of the sample in winter and 22.7% of the sample in summer reported being unaffected by weather over the previous seven days. On the SPAQ, subjects reported humid days as the weather they were most affected by (64%), followed by cold days (58%), foggy days (42%), cloudy days (39%), hot days (36%), short days (33%), and days with a high pollen count (28%). A few subjects reported being adversely affected by dry days (5%), sunny days (5%), and long days (14%), although the latter item is open to misinterpretation.

An analysis of day length and weather data from the seven days prior to completion of each questionnaire in winter and summer showed that these variables were not associated with subjects' self reported mood or psychological distress in winter. Significant associations were however found in summer. Rainfall, higher minimum temperatures, and a decrease in wind speed and humidity were associated with increases in total HSCL-21 scores and scores on the General Feelings of Distress subscale, while rainfall was also significantly associated with an increase in BDI scores.

When multiple regression analysis was used to examine the associations between day length, weather variables and BDI, HSCL-21, and Exercise scores controlling for gender and region, the only significant remaining association between day length, weather and the dependent variables was for summer HSCL-21 scores. Cooler temperatures and increased in rainfall were associated with increases in summer HSCL-21. Failure to find any significant association between weather and mood or psychological distress in winter may have several explanations. The effect of weather variables may be greater in summer than in winter, although the nature of the weather sampled during the time frame of this study may have influenced this result; psychological effects of weather variables may operate at optimum levels which occurred during summer but not in winter in this study; or it may be that the association between rainfall, cooler temperatures and psychological distress in summer noted in this study, may be due to the contrasting nature of these variables with 'normal' summer weather. This might explain why the relationship was found only in summer, but not in winter where cool temperatures and rainfall are the norm.

A noteworthy factor in these results is the lack of associations between subjects' self-reported mood, level of psychological distress, and day length or sunshine hours, since variations in the intensity or duration of environmental light are thought to underlie seasonal symptoms. A large number of subjects in this study reported seasonal variations in mood which were not supported by significant seasonal differences in mood ratings on the BDI or HSCL-21. This result suggests that subjects in this study could be less sensitive to seasonal change than they report, and as such, associations between photoperiod and sunshine hours for the sample would not necessarily be expected.

The physical activity levels of subjects in this study were not affected by weather in summer or in winter. Physical activity levels remained fairly constant, and there were no relationships between weather variables and Exercise Scores. Since many physical activities take place outdoors, it was anticipated that the weather variables in this study may have had an impact on subjects' exercise scores in winter, when inclement weather is more common, however this was not the case. The nature of both the type of physical activities subjects' were participating in, and the weather during the period sampled by the study may have affected this result.

Weather and Gender

Several studies have reported increased sensitivity to weather variables in some of their SAD patients. In one study (Winton & Checkley, 1989), all 6 SAD subjects who reported weather sensitivity were females (although the sample size was small; n=45), however no significant interaction effects of gender and weather variables were found for any of the dependent variables in this study. It may be that gender differences in sensitivity to weather may be limited to individuals with high seasonality scores, but this hypothesis was not examined in this study.

Weather and Seasonality

As mentioned above, previous studies with SAD patients have suggested that some individuals with SAD may be particularly sensitive to the effect of weather variables. As SAD subjects in this and previous studies were defined using GSS scores from the SPAQ, a multiple regression analysis was used to examine whether the effect of weather variables on BDI, HSCL-21, or Exercise scores might be mediated by subjects' degree of seasonality measured by GSS.

Some interesting results were produced. Significant interaction effects for sunshine hours and GSS, minimum temperature and GSS, and rainfall and GSS were found for winter BDI, while winter HSCL-21 showed significant interactions for sunshine and GSS and minimum temperature and GSS. The only significant interaction effect in summer found in this study was between humidity and GSS and winter HSCL-21 scores. The most striking finding from further investigation of these results was that each of the significant weather variables had an opposite effect on subjects, depending on whether they had high or low GSS scores. Subjects with high GSS scores showed negative associations with the weather variables, with fewer sunshine hours, less rainfall, and cooler temperatures in winter being associated with lower mood. Less sunshine and rainfall in winter, and decreased humidity in summer were associated with increases in psychological distress. These associations were reversed for subjects with lower GSS scores.

If GSS is a valid measure of seasonality, it would seem that subjects who reported more seasonal symptoms in this study may also differ from other subjects in their sensitivity to the effects of weather, as previous studies have suggested (Jacobsen & Rosenthal, 1988; Winton & Checkley, 1989; Wirz-Justice *et al.*, 1986). It is possible however, given that the ratings of mood and psychological distress for each of the SAD, S-SAD and Normal groups in this study as defined by GSS did not show seasonal variation, that GSS is not a valid measure of seasonality *per se*, but may be measuring some other construct. This hypothesis suggests that the interaction effects between weather sensitivity and the construct measured by GSS warrant further investigation.

Physical Activity

In previous studies of clinically depressed samples, regular physical activity has been correlated with decreases in depression (Mutrie, 1988; Plante & Rodin, 1988; Simons, McGowan, Epstein, & Kupfer, 1985). Preliminary studies have also suggested that participation in regular physical activity may help prevent depressive episodes from occurring (Martinsen, 1993). While the majority of studies with depressed samples have found in favour of physical activity as a useful concomitant to other therapies in the treatment of depression, the effect of exercise on mood in non-depressed samples has been less clear.

One northern hemisphere study has also reported seasonal variation in physical activity (Uitenbroek, 1992). These patterns of seasonal variation were noted to vary at similar times of the year as the seasonal cycles in mood, sleep, energy, weight, appetite, and socialisation reported by SAD subjects in other studies. Given that seasonal mood cycles and seasonal patterns of physical activity have been found to coincide in northern hemisphere studies, and that exercise has also been associated with improved mood in depressed subjects, this study aimed to explore the relationships between physical activity, seasonal change and mood in a southern hemisphere sample.

In this study, Exercise scores were not significantly correlated with mood or psychological distress in winter or in summer. However, a negative correlation between winter Fitness Level and winter HSCL-21 scores was found, suggesting that increased fitness was associated with decreased psychological distress for subjects in this study during winter. Whether psychological distress may decrease as a result of an increase in Fitness Level for subjects in this study, or whether individuals experiencing less psychological distress are more likely to engage in fitness enhancing physical activity and view themselves as physically fit cannot be determined from this study.

Women in this study reported less physical activity and less fitness in winter and summer than men, and men showed a greater degree of change in their physical activity levels from winter to summer than women. Fitness Level ratings did not differ between season for the total sample, for males, females, or for any of the SAD, S-SAD or Normal groups. There were significant differences in Fitness Level reported by each sex, with men reporting significantly higher fitness levels than women in both seasons.

Seasonal variation in physical activity, noted by Uitenbroek (1992) in a northern hemisphere sample was also reported by subjects in the present study. The majority of subjects reported exercising most during the period from November through to March (late spring to early autumn) with fewer subjects reporting June, July and August (winter) as the time they exercised most frequently. As noted in a previous study (Uitenbroek, 1992), this pattern of physical activity, with higher levels of activity in late spring to early autumn, closely mirrors the months in which subjects also report feeling best on the SPAQ.

However, as with subjects' self-reported mood and psychological distress in this study, the seasonal variation in physical activity that subjects reported retrospectively was not supported by a significant variation in Exercise Scores between winter and summer for the total sample or any other group. In addition, no relationship between physical activity levels and mood or psychological distress in winter or summer were found.

The sample in this study consisted mainly of subjects with normal mood. Previous studies have found decreased levels of depression in clinically depressed samples following participation in regular physical activity (McCann & Holmes, 1984; Plante & Rodin, 1990; Simons *et al.*, 1985) but the effect of regular exercise on normal population samples has been less certain (Cramer *et al.*, 1991; Frazier & Nagy, 1989; Hughes *et al.*, 1986; Lennox *et al.*, 1990; Simons *et al.*, 1985). Failure to find any significant relationships between activity levels and measures of mood or psychological distress in this study may be a reflection of the number of non-depressed subjects in the sample.

Several other factors may have influenced these results. In a study which examined the accuracy of subjects' self reports of physical activity during a one hour period while surreptitiously observing the subjects and recording actual activity levels, subjects tended to overestimate the length of time they engaged in aerobic activities to a significant degree (Klesges *et al.*, 1990). In addition, men in the study tended to overestimate their amount of physical activity in relation to women. It is possible that a similar gender effect with regard to subjects' estimates of their Fitness Level may have been operating in the present study. While the Klesges *et al.* study required subjects to remember their activities during the previous hour in some detail (in minutes), ratings were made immediately after exercising. These results raise the question as to whether retrospective ratings of physical activity over a longer period of time, such as the month-long period used in the present study, is a reliable measures of physical activity. As the Exercise

Inventory compiled for this study was a composite of two existing questionnaires (Taylor *et al.*, 1978; Shamir & Ruskin, 1983) with the addition of other items relevant to New Zealand generated by the researcher, the reliability of data obtained by this method is unknown.

Methodological Limitations

A mail-out approach was used to obtain subjects for this study. This approach was selected as the length of the questionnaire used in this study and number of subjects to be sampled made personal interviewing of the subjects impractical. In addition, given the intimate nature of some questions contained in the questionnaire (eg. 'I would like to kill myself'; 'I have lost interest in sex completely') it was felt that preserving the anonymity of both the subjects and the researcher would enhance the accuracy of responses.

The mail-out approach has been criticised on the grounds that it tends to produce low response rates with an increased chance of sample bias, as subjects who take part in the study are self-selected. It is therefore possible that those subjects from the initial sample of 1000 who choose to participate in the study may differ significantly from those who did not.

Target addresses for the initial sample pool in this study were randomly selected from the telephone directory listings for each region. Selection of subjects using this method inherently produces a sample bias against those households not listed in the directory, and it may be that individuals who do not have a telephone or have unlisted numbers differ significantly from those who's telephone numbers are listed. Potentially, individuals from lower socio-economic groups who cannot afford telephone services may be over-represented in this exclusion group. However, subjects from the lowest socio-economic level on the Elley-Irving Socio-Economic Index (Elley & Irving, 1985; Irving & Elley, 1977) were well represented in the present study making up 27.8% of the total sample (see Appendix G).

The random sampling procedure used in this study requested that the questionnaire be completed by the adult from each household whose birthday occurred next. It was anticipated that this procedure would yield a similar number of male and female respondents; however the final sample consisted of considerably more females (62.5%) than males (37.5%). Although it is possible that the sampling procedure did not equally target both sexes, it seems likely that other factors may have acted to produce this sex bias. Schlager *et al.* (1993) have suggested that women may be more introspective and willing to report symptoms, and it may be that the type of questions contained in the questionnaire compiled for the present study appealed more to women in this light, therefore increasing responses from women, or conversely discouraging response from men. Interpretation of results from this study must therefore take into account the greater proportion of women in the sample.

The results of this study were based entirely on the retrospective self-reported mood, level of psychological distress, seasonality and physical activity of the participants. The reliability of data obtained by this method may not be high. Psychometric data for the BDI, HSCL-21 and SPAQ indicate adequate levels of test-retest reliability for each instrument; however the accuracy of the Exercise Inventory compiled for this study is not known (see subsequent section for further discussion).

The Sample

The initial response rate in this study was 25% (*n*=250) from a total of 1000 randomly selected addresses, with 176 subjects (17.6%) remaining after completion of the second questionnaire. The initial response rate was lower than rates obtained in previous seasonal studies using mail-out of the Seasonal Pattern Assessment Questionnaire (SPAQ) alone (40.1%-82%; Magnússon & Axelsson, 1993; Magnússon & Stefánsson, 1993; Rosen *et al.*, 1989; Terman *et al.*, 1989), however the questionnaire used in this study included the BDI, HSCL-21, and an Exercise Inventory as well as the SPAQ, and required considerably more time to complete. This may have had an impact on the response rates obtained.

The size of the final sample in this study (*n*=176) is considerably smaller than samples from previous northern hemisphere studies. Although similar levels of symptomatology and prevalence rates for SAD and S-SAD to those reported in Montgomery County, USA (*n*=416) were found in this study, the sex bias contained in the sample suggests that the sample is non-representative of the general population. This factor may limit the generalisability of the results from this study.

A large number of subjects who completed the first questionnaire (*n*=74) did not return the second. Although changes of address may have accounted for some of these subjects, the reason for discontinuation with the study for the majority of subjects cannot be ascertained. A comparison of data from individuals who did not complete the study (non-completers) with that obtained from subjects in the final sample (completers) showed that non-completers had significantly higher BDI and HSCL-21 scores in winter than subjects who were included in the final sample. As subjects who did not complete both questionnaires were excluded from further data analyses, it is possible that the degree of winter depression and psychological distress reported in this study may under-represent the severity of symptoms experienced during winter in the general population.

Kasper *et al.* (1989*c*) note that having heard of SAD has been associated with increased Global Seasonality Scores in their studies, which suggests that prior knowledge of SAD may confound GSS results. A number of previous studies have obtained their samples by publishing information about SAD in popular media and inviting readers to participate in research. Respondents obtained in this manner may be biased by the information provided about SAD, and it is possible that individuals who perceive themselves as experiencing symptoms associated with seasonal change are more likely to respond to such studies. In this study, subjects were not provided with any specific information about SAD, nor was 'seasonal affective disorder' referred to in the information sheet or questionnaire. As such, the sample in this study is less likely to have been affected by this source of bias than overseas study samples.

The Instruments

The Seasonal Pattern Assessment Questionnaire (Rosenthal *et al.*, 1987) is the most widely used measure of seasonal sensitivity in general population studies to date. Criteria for SAD and S-SAD, (which are based the degree to which respondents experience seasonal change as a problem and on Global Seasonality Scores) were established on the basis of extensive experience with the SPAQ ratings of a large number of SAD and S-SAD patients (Kasper *et al.*, 1989*c*; Rosenthal *et al.*, 1987). Preliminary studies with small samples of SAD, S-SAD, and normal subjects indicate that the test-retest reliability of GSS scores from the SPAQ is good for SAD subjects (Hardin *et al.*, 1991; Thompson *et al.*, 1988) and normals (Kasper *et al.*, 1989*a*), but less reliable for S-SAD subjects (Kasper *et al.*, 1989*a*). Scores have not been found to be affected by the time of year in which the questionnaire was completed (Hardin *et al.*, 1991). In the present study, the internal consistency reliability of the six items making up GSS was high, however test-retest reliability was not investigated.

In this study, subjects' self-reports of seasonal variation in mood and symptomatology were not supported by significant differences in BDI and HSCL-21 scores over season. However, Global Seasonality Scores and scores from the BDI and HSCL-21 were highly correlated in this study. It is possible that the construct measured by subjects' self reports of seasonal symptoms on the SPAQ may not be seasonality as such, but rather a more general tendency toward psychological distress.

The psychometric properties of the Beck Depression Inventory (Beck *et al.*, 1961) have been extensively investigated over the last 25 years. In comparison, the Hopkins Symptom Checklist-21 (Green *et al.*, 1988) is a relatively new instrument but one which has performed well in existing reliability and validity studies. The BDI and HSCL-21 differ from the SPAQ in that they are state measures covering a discrete time period (one week), whereas the SPAQ is a retrospective instrument designed to evaluate seasonality as a trait. Inclusion of the BDI and HSCL-21 in the present study had two purposes. Firstly, to provide a measure of subjects' mood and psychological distress current at the time each questionnaire was completed, and secondly, to cross-validate subjects' retrospective reports of seasonal variation in mood and symptomatology on the SPAQ. An overlap in the constructs each instrument was intended to measure was expected, and this was reflected in highly significant correlations between the measures.

The psychometric properties of the Exercise Inventory used in the present study are not known as the inventory was constructed for the purpose of this study from two existing questionnaires (Taylor *et al.*, 1978; Shamir & Ruskin, 1983), together with extra items relevant to a New Zealand sample generated by the researcher. Studies suggest that the accuracy of self-reports of physical activity may be fairly low (Klesges *et al.*, 1990; Shamir & Ruskin, 1983). Accordingly, the Exercise Inventory used in this study can not be regarded as an accurate measure of participants' physical activity levels. However, it may have provided an indication of the differences in activity levels between subjects.

Timing of the Survey

Seasonal variation in mood and symptomatology reported by subjects on the SPAQ were not supported by outcomes on the BDI or HSCL-21 in this study. While timing of the questionnaires should not have had an impact on data obtained from the SPAQ (Hardin *et al.*, 1991), scores on the BDI and HSCL-21 may have been significantly affected. As these instruments sample discrete time-periods, it is possible that the timing of questionnaires in this study did not coincide with the seasonal variations in mood participants were reporting. However, some validation for the selection of August and February as the target months for the survey is provided by a peak in subjects' ratings of August as the month in which they feel worst.

The delivery dates for each survey (last week of August 1993, last week of February 1994) were selected to maximise the chances of obtaining responses from seasonally depressed individuals, while at the same time allowing a sufficient period for weather variables in each season to impact on the sample. In New Zealand, August is the last month of winter and February the last month of summer. Selection of the final week of each of these months for delivery of the questionnaires allowed subjects to be exposed to extremes in weather during each season before completing the questionnaires, however this may have been at some cost to the detection of seasonal depression in the sample. In the northern hemisphere, seasonal depressions generally have their onset in autumn (Rosenthal *et al.*, 1984), with a mean length of between 3.9 (SD 1.5) months and 5.2 (SD 1.2) months (Rosenthal *et al.*, 1984; Wirz-Justice *et al.*, 1989) so that depressions beginning in the spring should show some overlap into the winter months. For the purpose of the present study, similar patterns in the onset and duration of seasonal depression were assumed to occur in the southern hemisphere.

Previous studies have indicated that there may be a lag period between photoperiod, weather, and its impact on psychological variables, but estimates of the lag between mood and weather variables have ranged from between two days to two months (Persinger, 1975; Persinger & Levesque, 1983; Whitton *et al.*, 1982; Wirz-Justice *et al.*, 1986). In this study, selection of the mean for each of the weather variables over a seven-day period was therefore made on an arbitrary basis and may have had a significant impact on the results. Further analysis of the data from this study using different time periods would therefore be warranted.

Summary of Findings

A large proportion of subjects in this study reported seasonal variation in mood, sleep, energy, appetite, weight, and social activity on the SPAQ at rates comparable to those found in northern hemisphere studies. However, these self-reports of seasonal symptoms were not supported by a significant seasonal variation in mood or psychological distress measured by the BDI and HSCL-21. The timing of the study and reliability of the instruments may have contributed to this result.

Regional differences in weather for the seven days prior to completion of each questionnaire were found in the study, but these were not reflected in significantly different mood, psychological distress or Exercise scores between regions, suggesting that differences in weather between the regions did not impact on outcomes in the sample. Analysis of the data with differing weather time-frames may produce more significant results.

Results of regression analysis in this study suggest that the effect of weather variables on mood and psychological distress may be related to Global Seasonality Scores. Mood and psychological distress ratings for subjects with high GSS were associated with cooler temperatures, rainfall, and higher minimum temperatures in winter, and decreased humidity in summer. No significant relationships between day length and sunshine hours, and subjects ratings of mood and psychological distress were found.

No relationships between exercise scores and the degree of depression, psychological distress, or seasonal sensitivity reported by subjects were found in this study, and the amount of physical activity reported by subjects in each season was not influenced by weather variables to a significant degree.

Recommendations for Future Research

This study was the first study of a southern hemisphere general population sample using the SPAQ known to the author at the time of writing. Similar degrees of seasonal sensitivity were reported by subjects in this sample as those reported by subjects in northern hemisphere studies; however the sample contained a significant sex bias and was of an insufficient size to be regarded as representative of the general population. In addition, although this study sampled subjects from two regions, they were not located at sufficiently different latitudes to be able to examine the sample for a latitude effect. Further studies of larger samples from different locations, both within New Zealand and throughout the southern hemisphere are needed to determine whether results from northern hemisphere studies can be equally applied to general populations in the southern hemisphere. At present, the results of this study stand in isolation.

The question as to whether females are more susceptible to the effects of seasonal change than males remains undecided. As the sample used in this study contained significantly more females than males, the gender based prevalence rates of SAD and S-SAD found in this study remain ambiguous. Studies with an equal number of male and females respondents are needed in order to determine true gender prevalence rates.

An attempt was made in this study to provide some external validation for subjects' self-reports of seasonality on the SPAQ by inclusion of both the BDI and HSCL-21 as measures of mood and psychological distress current during each season. While the results of this study do not support the validity of subjects' self-reports on the SPAQ, the timing of the questionnaires and discrete time period measured by the BDI and HSCL-21 were recognised as significant sources of error in this study. The psychometric properties of the SPAQ remain underinvestigated, despite its widespread use. It may be that the SPAQ is a more reliable measure of seasonal sensitivity in SAD subjects than in general population samples. Further test-retest studies are need to establish the reliability of the SPAQ across samples. In addition, this study has also questioned the construct validity of the SPAQ, suggesting that the psychometric properties of the instrument require more thorough investigation. Longitudinal studies of seasonal mood changes in general population samples which include completion of the SPAQ are required in order to provide strong evidence for the validity of the instrument.

This study has also suggested a relationship between Global Seasonality Scores and sensitivity to weather variables. Several researchers have noted that some SAD subjects report a high degree of sensitivity to weather change, but so far this observation has not been formally investigated in SAD or S-SAD samples. Interestingly, although a greater proportion of SAD and S-SAD subjects in this study reported mood changes in association with changes in the weather, it was the subjects in this study with lower

Global Seasonality Scores (GSS<6) who showed the strongest relationships between weather variables and symptom scores. This result suggests some interesting avenues for further study.

Finally, the seven day time period selected to examine the effect of weather variables on the mood and symptomatology of participants in this study may have had a significant effect on the results. While this time frame was based loosely on the results of previous studies, lag periods for the effect of weather variables of between three days and six weeks have been cited (Persinger & Levesque, 1983; Whitton *et al.*, 1982). Further studies using a range of time frames and lag periods are recommended to explore weather effects more fully.

CHAPTER 12

CONCLUSION

Since 'seasonal affective disorder' (SAD) was first described by Rosenthal *et al.* in 1984, studies of general population samples have suggested that seasonal symptoms are not limited to individuals with SAD or S-SAD, but are also experienced by normal members of the general population. Epidemiological studies estimate that between 1.2% and 10.2% of the population may meet criteria for SAD, with a further 2.6% to 19.1% meeting criteria for subsyndromal SAD (S-SAD), a less severe form of the disorder (Booker & Hellekson, 1992; Kasper *et al.*, 1989; Rosen *et al.*, 1989; Terman *et al.*, 1989; Magnússon & Axelsson, 1993; Magnússon & Stefánsson, 1993).

Estimates of seasonality in clinical samples suggest that between 4% and 28% of patients with unipolar or bipolar depression may exhibit a seasonal pattern in their depressive episodes (Faedda *et al.*, 1993; Garvey *et al.*, 1988; Kasper & Kamo, 1990; Rosenthal *et al.*, 1984; Thase, 1989). The differentiation of SAD from non-seasonal depressions is of particular importance, as an effective non-pharmacological treatment in the form of phototherapy is available to individuals with seasonal depression. A recent study (Meesters *et al.*, 1993) has shown that one course of treatment with phototherapy administered at the onset of seasonal symptoms may have the potential to prevent a full-blown episode of seasonal depression from occurring throughout the winter months, with obvious benefits to both the patient and mental health resources. The prevalence of seasonal patterns in clinical samples suggests that there may be grounds for the routine screening of psychiatric inpatients presenting with recurrent depression.

Epidemiological studies suggest that individuals with S-SAD constitute a much larger group than those with full-blown SAD. While SAD patients are likely to experience a major depressive episode during the winter months if left untreated, the seasonal symptoms of S-SAD patients may be less severe, but nevertheless a source of psychological distress. These individuals may present to general practitioners or clinicians with a variety of symptoms, in the absence of a clear episode of depression (Kasper *et al.*, 1989*a*). Kasper *et al.* have shown that the seasonal symptoms associated with S-SAD also respond to treatment with bright artificial light; however S-SAD subjects in this study were less likely to have sought help for their seasonal difficulties. Individuals with S-SAD therefore represent a group for whom an effective treatment exists, but for whom psychological distress related to seasonal change may go undetected.

Seasonal variation in normal subjects has been reported in a number of previous epidemiological studies. Normal subjects do not experience seasonal changes in mood, sleep, energy, appetite, weight, and social activity to the same degree as SAD and S-SAD subjects, but there is nevertheless a relationship between the changing seasons and subjects' perceptions of their own mood and behaviour. Although these variations may be subtle, the extent to which seasonal change may interfere with performance and everyday functioning in normal subjects remains to be fully explored.

Many aspects of affective disorders associated with seasonal change remain unclear. The disorder has a recognised treatment in the form of phototherapy, but the role of light in the etiology of the disorder has yet to be clearly established. Although the body of research in this area continues to grow, there is clearly room for further studies of this disorder and its implications for both clinical and general population samples.

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Appendix A

Information Sheet
(August)

Dear Householder,

My name is Jane Mckenzie and I am a graduate student doing some research at Massey University with Malcolm Johnson, senior lecturer in psychology. We know that both the weather and seasons have an important effect on how we feel - our mood. What I am trying to discover is how important these two things are, and whether exercise helps with the way seasons affect some people. We hope that this research will help find new ways of assisting people who suffer severe seasonal effects on their mood. To do this we need to find out about people's patterns of exercise, and how they are feeling during two seasons.

We have chosen your address at random from the telephone directory, and we are looking for a person living at your address to help us with the research. Because of the way we are selecting people, the person we want to fill in the questionnaires is the adult (18 years or over) who is a permanent resident in your house who has the next birthday. Please pass this letter and the questionnaire on to this person.

If you agree to participate in the study, we have two questionnaires to be completed - the first one now and the second in 6 months time. The first questionnaire has been included with this letter and I would like you to complete it **today or tomorrow** - simply fill it out and return it in the envelope provided. The second questionnaire, exactly the same as the first, will be sent in six months time. Each questionnaire takes around 20 minutes to complete. I will have no other contact with you, answers will be confidential, and we do not need your name.

If you take part in this study, you may refuse to answer any question you do not wish to answer and you may withdraw from the study at any stage. Those who do choose to participate will be given the opportunity to ask for a copy of the results when the second questionnaire is sent out.

If, as a result of participation in this study, you feel there are any issues you need to discuss with someone, there are a number of agencies you can approach. Your family doctor can give you advice about the options available.

If for some reason you do not wish to participate in the study, simply disregard this letter. Any further questions about the study can be addressed to either myself or Malcolm Johnson C/o Massey University Psychology Department at the above address.

Your participation would be appreciated.

Yours sincerely,

Jane Mckenzie	Malcolm Johnson
(Graduate student)	(Senior lecturer in Psychology)

PLEASE DETACH THIS PAGE AND KEEP IT FOR FUTURE REFERENCE

Appendix B

Information Sheet
(February)

Dear Householder,

Six months ago, a person in your household completed a questionnaire about their mood and exercise habits as the first part of some research we are conducting at Massey University. Now it is time for the second part of the study. We would like the **SAME PERSON** who filled out the questionnaire last time to complete a second questionnaire which has been included with this letter. It is vital to the study that no one but the original participant fill in the questionnaire. Please pass this letter and the questionnaire on to this person. If they are not available, **PLEASE DO NOT ANSWER FOR THEM.**

This second questionnaire is very similar to the last one, with a few extra questions at the end. **Please do not try to remember what answers you gave last time**, but answer the questions according to the way you have been feeling during the past week, including today. Again, we would like you to complete the questionnaire **today or tomorrow** and return it in the envelope provided, as you did last time. Please read the instructions for each section carefully as some have been altered slightly.

As with the first questionnaire, your answers are completely confidential and you may refuse to answer any question you do not wish to answer (but please be assured that all questions are asked for a legitimate reason). You may still withdraw from the study at this stage if for some reason you wish to do so. A brief copy of the results from this study will be available to participants who complete the second questionnaire in about 4-5 months time and may be requested by ticking the appropriate box at the end of the questionnaire.

Any further questions about the study can be addressed to either myself or Malcolm Johnson C/o Massey University Psychology Department at the above address.

Your participation is appreciated.

Yours sincerely,

Jane Mckenzie
(Graduate student)

Malcolm Johnson
(Senior lecturer in Psychology)

PLEASE DETACH THIS PAGE AND KEEP IT FOR FUTURE REFERENCE

Appendix C

(added items in italics)

On this questionnaire are groups of statements. Please read each group of statements carefully. Then pick out the one statement in each group which best describes the way you have been feeling the **PAST WEEK INCLUDING TODAY!** Circle the number beside the statement you picked. If several statements in the group seem to apply equally well, circle each one. **Be sure to read all the statements in each group before making your choice.**

1
- 0 I do not feel sad.
- 1 I feel sad.
- 2 I am sad all the time and I can't snap out of it.
- 3 I am so sad or unhappy I can't stand it.
- *4 I feel happier than usual lately.*

2
- *0 I feel more optimistic about the future than I used to.*
- 1 I am not particularly discouraged about the future.
- 2 I feel discouraged about the future.
- 3 I feel I have nothing to look forward to.
- 4 I feel that the future is hopeless and that things cannot improve.

3
- 0 I do not feel like a failure.
- 1 I feel I have failed more than the average person.
- 2 As I look back on my life, all I can see is a lot of failures.
- 3 I feel I am a complete failure as a person.

4
- *0 I get more satisfaction out of things than I used to.*
- 1 I get as much satisfaction out of things as I used to.
- 2 I don't enjoy things the way I used to.
- 3 I don't get real satisfaction out of anything any more.
- 4 I am dissatisfied or bored with everything.

5
- 0 I don't feel particularly guilty.
- 1 I feel guilty a good part of the time.
- 2 I feel quite guilty most of the time.
- 3 I feel guilty all of the time.

6
- 0 I don't feel I am being punished.
- 1 I feel I may be punished.
- 2 I expect to be punished.
- 3 I feel I am being punished.

7
- 0 I don't feel disappointed in myself.
- 1 I am disappointed in myself.
- 2 I am disgusted with myself.
- 3 I hate myself.

8
- 0 I don't feel I am worse than anybody else.
- 1 I am critical of myself all the time for my faults.
- 2 I blame myself all the time for my faults.
- 3 I blame myself for everything bad that happens.

9 0 I don't have any thoughts of killing myself.
1 I have thoughts of killing myself, but I would not carry them out.
2 I would like to kill myself.
3 I would kill myself if I had the chance.

10 0 I don't cry any more than usual.
1 I cry more now than I used to.
2 I cry all the time now.
3 I used to be able to cry, but now I can't even though I want to.

11 0 I am no more irritated now than I ever am.
1 I get annoyed or irritated more easily than I used to.
2 I feel irritated all the time now.
3 I don't get irritated at all by the things that used to irritate me.

12 0 I have not lost interest in other people.
1 I am less interested in other people than I used to be.
2 I have lost most of my interest in other people.
3 I have lost all of my interest in other people.
4 I am more interested in other people than I used to be.

13 *0 I find I can make decisions better now than I used to.*
1 I make decisions about as well as I ever did.
2 I put off making decisions more than I used to.
3 I have greater difficulty in making decisions than before.
4 I can't make decisions at all any more.

14 *0 I feel more attractive now than I used to.*
1 I don't feel I look worse than I used to.
2 I am worried that I am looking old or unattractive.
3 I feel that there are permanent changes in my appearance that make me look unattractive.
4 I believe that I look ugly.

15 *0 I can work better now than I used to.*
1 I can work about as well as before.
2 It takes an extra effort to get started at doing something.
3 I have to push myself very hard to do anything.
4 I can't do any work at all.

16 0 I can sleep as well as usual.
1 I don't sleep as well as I used to.
2 I wake up 1-2 hours earlier than usual and find it hard to get back to sleep.
3 I wake up several hours earlier than I used to and cannot get back to sleep.
4 I sleep more now than I used to.

17 0 I don't get more tired than usual.
1 I get tired more easily than I used to.
2 I get tired from doing almost anything.
3 I am too tired to do anything.
4 I have much more energy than I used to.

18 0 My appetite is no worse than usual.
1 My appetite is not as good as it used to be.
2 My appetite is much worse now.
3 My appetite is much stronger now.
4 I have no appetite at all any more.
5 I have such an appetite now that I am always thinking of food.

19 0 I am eating the same foods as I usually do.
1 I am eating more sweets and starches than I used to lately.
2 I am eating much more sweets and starches than I used to.
3 I have an irresistible craving for sweets and starches lately.

20 0 I haven't lost much weight, if any, lately.
1 I have lost more than 5 pounds (2.5 kilograms).
2 I have lost more than 10 pounds (4.5 kilograms)
3 I have lost more than 15 pounds (6.5 kilograms).

I am purposely trying to lose weight by eating less. Yes/No *(please circle one)*

21 0 I haven't gained much weight, if any, lately.
1 I have gained more than 5 pounds (2.5 kilograms).
2 I have gained more than 10 pounds (4.5 kilograms).
3 I have gained more than 15 pounds (6.5 Kilograms).

I am purposely trying to gain weight by eating more. Yes/No *(please circle one)*

22 0 I am no more worried about my health than usual.
1 I am worried about physical problems such as aches and pains, upset stomach, constipation.
2 I am very worried about physical problems and its hard to think of much else.
3 I am so worried about my physical problems that I cannot think about anything else.

23 0 I am more interested in sex than I used to be.
1 I have not noticed any recent change in my interest in sex.
2 I am less interested in sex than I used to be.
3 I am much less interested in sex now.
4 I have lost interest in sex completely.

24 0 My life is no more stressful now than it used to be.
1 My life is more stressful now than it used to be.
2 So many stressful things have happened lately it's hard to cope.
3 So many extremely stressful things have happened lately I can't think about anything else.

25 0 The weather does not affect the way I feel.
1 The weather sometimes affects the way I feel.
2 The weather usually affects the way I feel.
3 My mood changes with the weather.

APPENDIX D

Hopkins Symptom Checklist-21

DIRECTIONS: Now, I would like to know how you have been feeling over the PAST WEEK INCLUDING TODAY! Below is a list of things you may have been feeling over this time. Please **circle** the appropriate number to describe how distressing you have found these things over this time.

	Not at all	*A little*	*Quite a bit*	*Extremely*
Difficulty in speaking when you are excited	1	2	3	4
Trouble remembering things	1	2	3	4
Worried about sloppiness or carelessness	1	2	3	4
Blaming yourself for things	1	2	3	4
Pains in the lower part of your back	1	2	3	4
Feeling lonely	1	2	3	4
Feeling blue	1	2	3	4
Your feelings being easily hurt	1	2	3	4
Feeling others do not understand you or are unsympathetic	1	2	3	4
Feeling that people are unfriendly or dislike you	1	2	3	4
Having to do things very slowly in order to be sure you are doing them right	1	2	3	4
Feeling inferior to others	1	2	3	4
Soreness of your muscles	1	2	3	4
Having to check and double check what you do	1	2	3	4
Hot or cold spells	1	2	3	4
Your mind going blank	1	2	3	4
Numbness or tingling in parts of your body	1	2	3	4
A lump in your throat	1	2	3	4
Trouble concentrating	1	2	3	4
Weakness in parts of your body	1	2	3	4
Heavy feelings in your arms and legs	1	2	3	4

APPENDIX E

Exercise Inventory

NEXT, I would like to know which of the recreational activities listed below you have taken part in over the last month. Please indicate how many hours/minutes per day OR week OR month (whichever suits best) you have participated in each activity in the space provided. ADD any other activities you are involved in, that are not included in the list, at the end. TRY TO BE AS ACCURATE AS YOU CAN!

	Hours/Mins per day (please specify)	**OR**	*Hours per week*	**OR**	*Hours per month*
Aerobics	_____		_____		_____
Circuit/Gym training	_____		_____		_____
Cycling	_____		_____		_____
Dancing	_____		_____		_____
Jogging	_____		_____		_____
Walking	_____		_____		_____
Yoga	_____		_____		_____
Badminton	_____		_____		_____
Baseball	_____		_____		_____
Basketball	_____		_____		_____
Boxing	_____		_____		_____
Cricket	_____		_____		_____
Handball	_____		_____		_____
Hockey	_____		_____		_____
Netball	_____		_____		_____
Rugby	_____		_____		_____
Soccer	_____		_____		_____
Softball	_____		_____		_____
Squash	_____		_____		_____
Table tennis	_____		_____		_____
Tennis	_____		_____		_____
Underwater team games	_____		_____		_____
Volleyball	_____		_____		_____
Any other____________	_____		_____		_____

	Hours/Mins per day (please specify)	**OR**	*Hours per week*	**OR**	*Hours per month*
Hiking	_____		_____		_____
Horse riding	_____		_____		_____
Hunting	_____		_____		_____
Mountain climbing	_____		_____		_____
Orienteering	_____		_____		_____
Rowing or canoeing	_____		_____		_____
Sailing	_____		_____		_____
Scuba diving	_____		_____		_____
Snorkelling	_____		_____		_____
Snow skiing	_____		_____		_____
Swimming	_____		_____		_____
Water skiing	_____		_____		_____
White-water rafting	_____		_____		_____
Bowling	_____		_____		_____
Diving	_____		_____		_____
Fencing	_____		_____		_____
Golf	_____		_____		_____
Gymnastics	_____		_____		_____
Martial arts	_____		_____		_____
Roller skating	_____		_____		_____
Track and Field	_____		_____		_____
Weight lifting	_____		_____		_____
Gardening	_____		_____		_____
Lawn mowing	_____		_____		_____
Physical housework	_____		_____		_____
Any other	_____		_____		_____

APPENDIX F

Demographic Data Questions

FINALLY, a few questions about yourself....

1. How old are you? ______________

2. Are you: 1. male 2. female *(please circle one)*

3. To what ethnic group do you belong?

   ____

4. What is your occupation?

   ____

5. What is the occupation of the major income earner in your family home?

   ____

6. What is your highest educational qualification? (school, university, polytech, etc)

   ____

7. Have you lived out of town for more than 1 week at a time in the last 3 months?

   1. Yes 2. No *(please circle one)*

8. Have you ever had a psychiatric illness or mood problem?

   1. Yes 2. No *(please circle one)*

9. Have any of your blood relatives (including grandparents, uncles and aunts, cousins etc) ever had a psychiatric illness or mood problem?

   1. Yes 2. No 3. Don't know *(please circle one)*

10. How fit do you consider yourself to be?

    not at all fit 1 2 3 4 5 6 7 very fit *(please circle one)*

11. What is today's date?______________

APPENDIX G

Seasonal Pattern Assessment Questionnaire

The purpose of this form is to find out how your mood and behaviour change over time. Please fill in all the relevant answers. Note: We are interested in your experience; not others you may have observed.

1.To what degree do the following change with the seasons?

(please circle one number for each item)

	No Change	Slight Change	Moderate Change	Marked Change	Extremely Marked Change
A. Sleep length	0	1	2	3	4
B. Social Activity	0	1	2	3	4
C. Mood (overall wellbeing)	0	1	2	3	4
D. Weight	0	1	2	3	4
E. Appetite	0	1	2	3	4
F. Energy level	0	1	2	3	4

2. In the following questions, circle the numbers for all applicable months. This may be a single month, a cluster of months, or any other grouping. At what time of the year do you.....

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		No particular months stand out as extreme
A. Feel best	1	2	3	4	5	6	7	8	9	10	11	12		0
B. Gain most weight	1	2	3	4	5	6	7	8	9	10	11	12		0
C. Socialize most	1	2	3	4	5	6	7	8	9	10	11	12		0
D. Sleep best	1	2	3	4	5	6	7	8	9	10	11	12		0
E. Eat most	1	2	3	4	5	6	7	8	9	10	11	12	**OR**	0
F. Exercise most	1	2	3	4	5	6	7	8	9	10	11	12		0
G. Lose most weight	1	2	3	4	5	6	7	8	9	10	11	12		0
H. Socialize least	1	2	3	4	5	6	7	8	9	10	11	12		0
I. Feel worst	1	2	3	4	5	6	7	8	9	10	11	12		0
J. Eat least	1	2	3	4	5	6	7	8	9	10	11	12		0
K. Sleep most	1	2	3	4	5	6	7	8	9	10	11	12		0
L. Exercise most	1	2	3	4	5	6	7	8	9	10	11	12		0

3. Using the scale below, indicate how the following weather changes makes you feel. (ONE CIRCLE ONLY FOR EACH QUESTION).

-3 In very low spirits or markedly slowed down
-2 In moderately low spirits or moderately slowed down
-1 Mildly low spirits or mildly slowed down
0 No effect
1 Slightly improves your mood or energy level
2 Moderately improves your mood or energy level
3 Markedly improves your mood or energy level
4 Don't know

A. Cold weather	-3	-2	-1	0	1	2	3		4
B. Hot weather	-3	-2	-1	0	1	2	3		4
C. Humid weather	-3	-2	-1	0	1	2	3		4
D. Sunny days	-3	-2	-1	0	1	2	3		4
E. Dry days	-3	-2	-1	0	1	2	3	OR	4
F. Grey cloudy days	-3	-2	-1	0	1	2	3		4
G. Long days	-3	-2	-1	0	1	2	3		4
H. High pollen count	-3	-2	-1	0	1	2	3		4
I. Foggy days	-3	-2	-1	0	1	2	3		4
J. Short days	-3	-2	-1	0	1	2	3		4

4. By how much does your weight fluctuate during the course of the year?

1.	0 - 3 lbs	(0 - 1 kgs)	
2.	4 - 7 lbs	(2 - 3 kgs)	
3.	8 - 11 lbs	(4 - 5 kgs)	*(please circle one)*
4.	12 - 15 lbs	(6 - 7 kgs)	
5.	16 - 20 lbs	(8 - 9 kgs)	
6.	Over 20 lbs	(Over 9 kgs)	

5. Approximately how many hours of each 24-hour day do you sleep during each season? (including naps).

	(Hours slept per day)	**Over 18 hours**
WINTER (1 June - 31 Aug)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	X
SPRING (1 Sept - 30 Nov)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	X
SUMMER (1 Dec - 28 Feb)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	X
AUTUMN (1 March - 31 May)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	X

(please circle one)

6. Do you notice a change in food preference during the different seasons? YesNo
(If 'Yes' Please specify what form the changes take)

____

7. If you experience changes with the seasons, do you feel that they are a problem for you? Yes No

If 'Yes', is this problem: 1. Mild 2. Moderate 3. Marked 4. Severe 5.Disabling

8. Have you lived out of town for more than 1 week at a time in the last 3 months? Yes No

9. Have you had a psychiatric illness or mood problem during the last 6 months? Yes No

10. Have any of your blood relatives (including grandparents, uncles and aunts, cousins etc, but not your spouse) ever had a psychiatric illness or mood problem, including in the last 6 months? Yes No Don't know

11. How many years have you lived in this district? ____________

12. What is your marital status? Single Married/De Facto Divorced/Separated Widowed

13. How fit do you consider yourself to be? not at all fit 1 2 3 4 5 6 7 very fit
(please circle one)

14. Today's date is: ____________________

15. Would you like a copy of the results of this study? Yes No

APPENDIX H

Demographic Data for the Total Sample (n=176)

Sex, (%)	
Male	66 (38)
Female	110 (63)
Age, (%)	
Under 20	8 (4)
20-29	21 (12)
30-39	40 (23)
40-49	39 (22)
50-59	25 (14)
60+	43 (24)
Mean (±SD) age	46.1 (16.6)
Ethnic Group, (%)	
European	157 (92)
Other	13 (8)
Marital Status, (%)	
Single	26 (15)
Married	110 (64)
Divorced	23 (13)
Widowed	14 (8)
Highest Qualification, (%)	
Up to 3 years High School	57 (35)
3 or more years High School	30 (18)
Tertiary Education	74 (45)
Trade Certificate	3 (2)
Elley-Irving Income Level*, (%)	
Level 1	13 (7)
Level 2	14 (8)
Level 3	32 (19)
Level 4	15 (9)
Level 5	6 (4)
Level 6	49 (28)
Retired	44 (25)

* Elley and Irving (1985). Level 1 is the highest income bracket.

APPENDIX I

Means, SDs, and Paired *t*-Tests for Weather Variables by Season (n=176)

	Winter		Summer				
	Mean	**SD**	**Mean**	**SD**	***t***	***df***	***p***
Day Length	10.9	0.1	12.6	0.5	-43.75	165	.000 *
Sunshine	5.2	0.6	9.0	0.9	-43.03	145	.000 *
Rainfall	1.1	1.1	0.5	0.6	5.95	165	.000 *
Min Temp.	4.3	0.7	13.8	2.1	-52.08	165	.000 *
Max Temp.	13.2	0.6	25.1	1.5	-93.15	165	.000 *
Barometric	1021.9	3.6	1017.4	2.9	12.03	165	.000 *
Wind Speed	20.5	3.8	21.1	2.4	-1.85	165	.066
Humidity	78.2	2.3	19.9	2.2	221.64	165	.000 *

* $p<.001$

Variable Means, SD's, and Independent Samples *t*-Tests for Weather Variables Grouped by Region

	Palmerston North (n=95)		Hastings (n=80)				
Winter	**Mean**	**SD**	**Mean**	**SD**	***t***	***df***	***p***
Day Length	11.01	0.09	10.97	0.11	2.92	173.00	.004 **
Sunshine	5.23	0.71	5.20	0.63	0.36	173.00	.717
Rainfall	0.26	0.42	2.21	0.62	-23.75	133.45	.000 ***
Min Temp.	4.55	0.63	3.95	0.57	6.71	172.37	.000 ***
Max Temp.	13.09	0.34	13.43	0.76	-3.69	104.59	.000 ***
Barometric	1022.10	3.50	1021.74	3.58	0.66	167.37	.513
Wind Speed	23.53	1.28	16.94	2.63	20.43	110.03	.000 ***
Humidity	77.78	1.73	78.50	2.90	-1.95	124.05	.053
Summer							
Day Length	12.99	0.26	12.16	0.23	21.51	165.00	.000 ***
Sunshine	9.07	1.14	8.90	0.51	1.17	94.16	.245
Rainfall	0.60	0.74	0.47	0.37	1.39	165.00	.167
Min Temp.	13.17	1.99	14.48	2.11	-4.11	165.00	.000 **
Max Temp.	25.40	1.66	24.82	1.32	2.46	165.00	.015 *
Barometric	1017.84	2.77	1016.85	2.96	2.22	165.00	.028 *
Wind Speed	22.11	1.29	19.81	2.75	6.73	104.37	.000 ***
Humidity	21.21	1.25	18.39	2.01	11.05	165.00	.000 ***

* $p<.05$
** $p<.01$
*** $p<.001$

APPENDIX J

Results of an 'All-in' Multiple Regression Analysis of Interaction Effects Between Dependent Variables and Weather Variables

Variable	*B*	Beta	*p*
Winter BDI (n=173)			
Sex	-1.777	-.155	.0440
Zone	-7.394	-.665	.0957
Day Length	-3.039	-.056	.8101
Sunshine	1.347	.163	.2791
Minimum Temperature	-.141	-.017	.9319
Maximum Temperature	-.762	-.082	.7242
Rainfall	2.406	.478	.2624
Humidity	.327	.139	.3532
Wind Speed	1.709	1.184	.0322
Barometric Pressure	.898	.577	.2439
Adjusted Squared Multiple R: 0.023 F-ratio: 1.507		$p<.1409$	
Winter Exercise (n=173)			
Sex	-1.833	-.016	.8296
Zone	-109.607	-1.017	.0121
Day Length	-234.285	-.446	.0590
Sunshine	6.284	.079	.6022
Minimum Temperature	25.196	.316	.1199
Maximum Temperature	-37.556	-.417	.0752
Rainfall	2.551	.052	.9027
Humidity	-5.860	-.258	.0877
Wind Speed	12.327	.885	.1133
Barometric Pressure	4.095	.272	.5866
Adjusted Squared Multiple R: 0.024 F-ratio: 1.423		$p<.1744$	
Summer Exercise (n=145)			
Sex	18.368	.156	.0758
Zone	-6.876	-.061	.9015
Day Length	9.269	.081	.8701
Sunshine	-4.205	-.065	.6525
Minimum Temperature	-3.021	-.122	.7324
Maximum Temperature	-4.523	-.128	.6393
Rainfall	-8.742	-.093	.5141
Humidity	-8.057	-.320	.3274
Wind Speed	3.134	.134	.6126
Barometric Pressure	3.273	.166	.4079
Adjusted Squared Multiple R: -.021 F-ratio: .700		$p<.7229$	

Variable	*B*	Beta	*p*
BDI Difference (n=144)			
Sex	-1.795	-.166	.0606
Zone	-4.525	-.438	.5289
Winter Variables			
Day Length	-4.377	-.089	.7459
Sunshine	.536	.067	.6920
Maximum Temperature	.114	.014	.9599
Minimum Temperature	-.589	-.077	.7385
Rainfall	3.152	.682	.1723
Humidity	.113	.053	.7651
Wind Speed	1.228	.927	.1526
Barometric Pressure	.683	.481	.4238
Summer Variables			
Day Length	1.882	.179	.7194
Sunshine	1.214	.205	.1564
Maximum Temperature	-.480	-.148	.6149
Minimum Temperature	-.485	-.214	.5746
Rainfall	.662	.077	.6001
Humidity	-.024	-.010	.9754
Wind Speed	.099	.046	.8646
Barometric Pressure	.351	.193	.3546
Adjusted Squared Multiple *R*: 0.02*F*-ratio: 1.187		*p*<.2820	
HSCL-21 Difference (n=146)			
Sex	-2.803	-.177	.0520
Zone	8.578	.551	.4301
Winter Variables			
Sunshine	1.213	.100	.5509
Barometric Pressure	-.225	-.105	.8615
Humidity	-.330	-.104	.5614
Minimum Temperature	-2.407	-.207	.3679
Day Length	10.509	.141	.6070
Maximum Temperature	-1.425	-.116	.6793
Rainfall	2.398	.345	.4895
Wind Speed	.172	.087	.8937
Summer Variables			
Day Length	-4.141	-.262	.6012
Sunshine	1.954	.218	.1303
Maximum Temperature	.255	.052	.8567
Minimum Temperature	-1.315	-.383	.3084
Rainfall	.074	.006	.9689
Humidity	-.537	-.154	.6490
Wind Speed	-.412	-.127	.6380
Barometric Pressure	.234	.086	.6808
Adjusted Squared Multiple *R*: 0.01*F*-ratio: 1.094		*p*<.3660	

Variable	*B*	Beta	*p*
Exercise Difference (n=173)			
Sex	14.060	.120	.1899
Zone	112.582	1.003	.1667
Winter Variables			
Day Length	-67.435	-.126	.6583
Sunshine	3.878	.045	.7984
Minimum Temperature	7.262	.088	.7150
Maximum Temperature	52.908	.602	.0403
Rainfall	23.694	.474	.3618
Humidity	2.504	.110	.5544
Wind Speed	-1.428	-.099	.8832
Barometric Pressure	10.529	.686	.2766
Summer Variables			
Day Length	-52.543	-.461	.3721
Sunshine	1.578	.025	.8698
Maximum Temperature	5.035	.143	.6318
Minimum Temperature	-4.741	-.193	.6215
Rainfall	-7.475	-.081	.5958
Humidity	-3.392	-.136	.7002
Wind Speed	-3.045	-.130	.6393
Barometric Pressure	.766	.039	.8568
Adjusted Squared Multiple *R*: -.046 *F*-ratio: .656		$p<.8476$	

APPENDIX K

Results of an 'All-in' Multiple Regression Analysis of Interaction Effects Between Dependent Variables and Weather Variables with GSS

	Winter BDI (n=172)		Winter HSCL-21 (n=173)		Summer HSCL-21 (n=145)	
	Beta	***p***	**Beta**	***p***	**Beta**	***p***
Step 1						
GSS	.270	.0008	.275	.0005	.367	.0000
Gender	-.083	.2835	-.156	.0389	-.020	.7869
Day Length	.205	.3140	.061	.7603	.115	.4731
Sunshine	.184	.2123	.197	.1680	.134	.2668
Min. Temp.	-.041	.8349	-.134	.4877	.485	.0704
Max. Temp.	.068	.7277	-.226	.2520	-.304	.1838
Rainfall	.436	.2926	.354	.3845	.168	.1146
Humidity	.257	.0833	-.135	.3492	.071	.7910
Wind Speed	.414	.2805	.271	.4727	-.205	.2743
Barometric	.309	.5112	-.115	.8056	-.260	.0680
	Adjusted R^2 = 0.074		Adjusted R^2 = 0.114		Adjusted R^2 = 0.251	
	F = 2.36*		F = 3.223**		F = 5.863****	
Step 2						
	Sun x GSS -4.718	.0000	Sun x GSS -3.086	.0041	Humid x GSS -3.802	.0281
	Rain x GSS -1.209	.0285	Min. x GSS -1.884	.0120		
	Min. x GSS -1.975	.0077				
	Max. x GSS 7.647	.0617				
	Adjusted R^2 = 0.246		Adjusted R^2 = 0.199		Adjusted R^2 =0.310	
	F =4.492***		F = 3.672****		F = 5.076****	
	R^2 Change = 0.189		R^2 Change = 0.108		R^2 Change = 0.083	
	F Change = 7.145***		F Change = 3.853**		F Change = 2.926*	

* p<.05 ** p<.01 *** p<.001 **** p<.0001