

Seasonal Affective Disorder

A Description of the Syndrome and Preliminary Findings With Light Therapy

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● **Seasonal affective disorder (SAD) is a syndrome characterized by recurrent depressions that occur annually at the same time each year. We describe 29 patients with SAD; most of them had a bipolar affective disorder, especially bipolar II, and their depressions were generally characterized by hypersomnia, overeating, and carbohydrate craving and seemed to respond to changes in climate and latitude. Sleep recordings in nine depressed patients confirmed the presence of hypersomnia and showed increased sleep latency and reduced slow-wave (delta) sleep. Preliminary studies in 11 patients suggest that extending the photoperiod with bright artificial light has an antidepressant effect.**

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In this article, we define seasonal affective disorder (SAD), which is a condition characterized by recurrent depressive episodes that occur annually. Numerous investigators have shown a strong association between the seasons and the incidence of depression,^{1,11} mania,^{2,11-14} and suicides and suicide attempts,^{5,8,15-23} and these associations have been well reviewed.^{19,24} However, little has been written about patients who experience affective episodes in association with the changing seasons year after year. We describe 29 patients who suffered depressions in fall and winter; these depressions remitted by the following spring or summer. We report our preliminary attempts to modify these depressions by manipulating environmental lighting conditions. We have recently reported reversing depression in one patient with SAD by modifying his environmental lighting.^{25,26}

METHODS

A pilot study of the effects of light on winter depression was carried out by one of us (P.S.M.) with a 29-year-old woman who regularly suffered depressions every winter and hypomanias every spring since early adolescence. These cycles were strongly affected by the relative latitude of her residence: The further north she lived, the earlier these depressions began in the fall, the more severe were her symptoms, and the longer these symptoms would persist into the next spring. On two occasions, this patient reported a complete disappearance of these winter symptoms within two days of arrival in Jamaica on vacation. Early-morning light therapy (around 5 AM to sunrise) was used successfully in late August 1980, when her next depressive cycle had just started. This therapy has continued to be beneficial during the fall and winter

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seasons up to the present time. This pilot study, together with the extensive clinical observations of one of us (P.S.M.) and a further pilot study conducted at the National Institute of Mental Health,^{25,26} encouraged us to seek other similar patients in the community. We did this by means of a newspaper article (*Washington Post*, June 12, 1981, section E5) in which the details of the patient mentioned previously were described. In the article, we suggested that changes in the light might be responsible for the mood changes and invited persons with seasonal mood changes to contact us. More than 2,000 persons replied, and they were sent screening questionnaires. We screened suitable persons and included those with (1) a history of major affective disorder, according to the Research Diagnostic Criteria (RDC)²⁷; (2) at least two consecutive years in which depression had developed during the fall or winter and remitted during the following spring or summer; and (3) residence close enough for us to maintain adequate communication.

Twenty-nine patients met these inclusion criteria. Detailed histories were taken from these patients, and structured questionnaires that inquired about their seasonal cycles were administered to them. We admitted a subgroup (n=9) to our inpatient unit during the summer months for EEG sleep studies.²⁸ Standard 1-mg dexamethasone suppression tests (1 mg of dexamethasone),²⁹ and protirelin (thyrotropin-releasing hormone) infusions (500 µg)³⁰ were administered at least one week apart from each other to seven patients. The only criteria taken into account in deciding which patients to admit were willingness to participate and availability of beds. Patients were followed up at regular clinic visits, with the frequency of visits being determined by clinical need and research requirements. During the winter months, all of these studies were repeated. As patients began to feel depressed, the 23-item Hamilton Rating Scale (HRS)³¹ was administered to them regularly, and they completed the Beck Depression Inventory (BDI)³² on a weekly basis. Patients who became moderately depressed for a period of at least two weeks were offered experimental light treatment. This was a clinical judgment, but as it happened, all of these patients had an HRS score of at least 14.

The following light treatment was administered. Two separate kinds of light were used: (1) bright, white full-spectrum fluorescent light (approximately 2,500 lux at 90 cm), and (2) dim yellow fluorescent light (approximately 100 lux at 90 cm). The light originated from eight fluorescent lamps in a rectangular metal case with a plastic diffusing screen. The lights were placed in a room in the patient's home, either standing vertically on the floor or horizontally on a flat surface. Patients were randomly assigned to one or the other lighting condition. The patients were instructed to sit in front of the lights for three hours before dawn and three hours after dusk, though this was not always possible because of work and family demands. Patients were requested not to sleep, but to do some sort of work or recreation about 90 to 180 cm from the lights and to glance at them from time to time. Patients were seen on a weekly basis, and the HRS was administered by psychiatrists (D.A.S., T.A.W., and J.C.G.) who were unaware of the treatment condition.

After two weeks of the first light treatment, a clinical judgment was made as to the patient's response by the treating psychiatrist (N.E.R.). If obvious clinical improvement had occurred (a judgment made on clinical grounds, but always constituting a decrease of at least four points on the HRS, resulting in a score of less than 15), lights were withdrawn for at least a week, at which time the

Feature	Finding
Sex, No. (%)	F, 25 (86); M, 4 (14)
Mean \pm SD age, yr	36.5 \pm 11.2
Mean \pm SD age at onset, yr	26.9 \pm 13.2
Mean \pm SD No. of seasonal cycles	9.5 \pm 7.4
Pattern of annual cycles	
Onset, mo (%)	Sept (7), Oct (21), Nov (29), Dec (29), Jan (14)
Remission, mo (%)	Jan (11), Feb (11), March (54), April (21), May (3)
Mean \pm SD length of depression, mo	3.9 \pm 1.5
Depression changed over time, %	Yes, 47; no, 53
Depression milder near equator, No. (%)	23 (83)
RDC diagnosis, No. (%)	Bipolar II, 22 (76); bipolar I, 5 (17); unipolar, 2 (7)
Previous treatment, No. (%)	
Antidepressants	7 (24)
Lithium carbonate	5 (17)
Thyroid	6 (21)
Hospitalization	3 (10)
ECT	0 (0)
No treatment	9 (31)
Family history, No. (%)†	
Affective disorder	20 (69)
Alcohol abuse	2 (7)
SAD	5 (17)

*Number and percentage of patients are given throughout. SAD indicates seasonal affective disorder; RDC, Research Diagnostic Criteria; and ECT, electroconvulsive therapy.

†First-degree relative.

second type of light treatment was administered. If improvement did not occur, the second type of light treatment was given without delay. Subjects were instructed to note the times when they were in the light. Motor activity was monitored throughout the treatment by means of an ambulatory wrist activity monitor.³³

After both types of treatment had been given, patients were allowed to choose to go back on the type of treatment that they had found more helpful or to discontinue treatment. At all times, the option of conventional antidepressant medications was discussed with them. Extensive eye examinations, including slit-lamp biomicroscopy, dilated funduscopy, dark adaptometry, and stereocolor photography of the retina, were performed before and after light treatment.

RESULTS

Clinical History

Clinical and demographic data are given in Table 1. Data were reported as means \pm SDs. The majority of the patients (86%) in our population were women. The mean age was 36.5 \pm 11.2 years. The mean number of previous cycles was 9.5 \pm 7.4, and the range was from two to 30 cycles. The mean age at onset was 26.9 \pm 13.2 years.

Three patients spontaneously reported a history of seasonal cycles that went back to childhood (ages, 3, 9, and 12 years), but in most cases, the seasonal cycles began after the age of 20 years. Many patients were unable to pinpoint exactly when the cycles began because (1) mood changes frequently were mild at first and became more severe with increasing age, and (2) it took several years to recognize the recurrent annual pattern of the cycle because of the long interval between episodes. Some patients had not been aware of the seasonal or cyclical nature of their problem before reading the newspaper article.

Depression started most frequently between October and December, and symptoms ended most frequently in March. Some patients, however, experienced anticipatory anxiety as early as July or August, months before the onset of a stable state of low mood and energy set in. Depression lasted an average of 3.9 months.

Symptom	No. (%) of Patients
Affect	
Sadness	29 (100)
Anxiety	21 (72)
Irritability	26 (90)
Physical activity decreased	29 (100)
Appetite	
Increased	19 (66)
Decreased	8 (28)
Mixed	1 (3)
No change	1 (3)
Carbohydrate craving	23 (79)
Weight	
Increased	22 (76)
Decreased	5 (17)
Mixed	1 (3)
No change	1 (3)
Sleep	
Earlier onset	23 (79)
Later waking	22 (76)
Increased sleep time	28 (97)
Change in quality (interrupted, not refreshing)	26 (90)
Daytime drowsiness	21 (72)
Decreased libido	20 (69)
Difficulties around menses	17 (71)
Work difficulties	28 (97)
Interpersonal difficulties	29 (100)

Seventy-six percent (22) of patients met a lifetime RDC diagnosis of bipolar II affective disorder, 17% (five) of patients met the RDC for bipolar I affective disorder, and only two patients (7%) met the RDC for unipolar affective disorder. About half (47%) of the patients reported that their cycles had changed over time. Of this group, 61.5% (eight) of the patients said that their depression had become either more severe or longer in duration.

Subjective symptoms are given in Table 2. All subjects reported sadness and decreased physical activity during their depressed periods; 72% (21) experienced anxiety, and 90% (26) experienced irritability. In 66% (19) of the cases, appetite increased during depressions, while in 28% (eight) of the cases, it decreased, and in one case, the picture was mixed. Only one patient reported no change in appetite. Seventy-nine percent (23) of the patients described carbohydrate craving. Some craved sweets and chocolate, whereas others preferred starches. Eating was not experienced as pleasurable; several patients used terms, such as "compulsion," "craving," and "pressure to eat." Some stated that they ate more "to get more energy," "to keep warm," or "to perk me up." Weight generally increased during depression (76% [22] of the cases), usually by 2 to 5 kg. Some patients noted that in the milder stages of depression, they ate more and gained weight; however, as they became more depressed, the reverse occurred.

Most subjects reported sleeping longer (97%) when they were depressed, going to sleep earlier (79%), and waking up later (77%), but not sleeping as soundly (90%). Most patients reported drowsiness during the day (74%) and never felt refreshed and rested. Most patients reported that the late afternoon was a time of especially low energy and mood.

Libido decreased in 69% (20) of the cases. Seventy-one percent (17) of menstruating women reported some difficulties around the time of their periods. This was usually premenstrual depression that occurred even when patients were not seasonally depressed.

Almost all patients (n=28) (97%) reported difficulties at work during their depressions, and all experienced interpersonal difficulties. Despite work difficulties, patients were generally able to keep their jobs through the winter. Their ability to concentrate, feel motivated, and initiate projects was greatly impaired, however, and many took sick leave at these times.

Patients generally withdrew from others and, at times, became irritable and suspicious. A few of the single women reported an inability to keep a boyfriend through the winter, but no difficulty in finding another one during the following spring or summer. Married patients reported difficulty in maintaining their share of

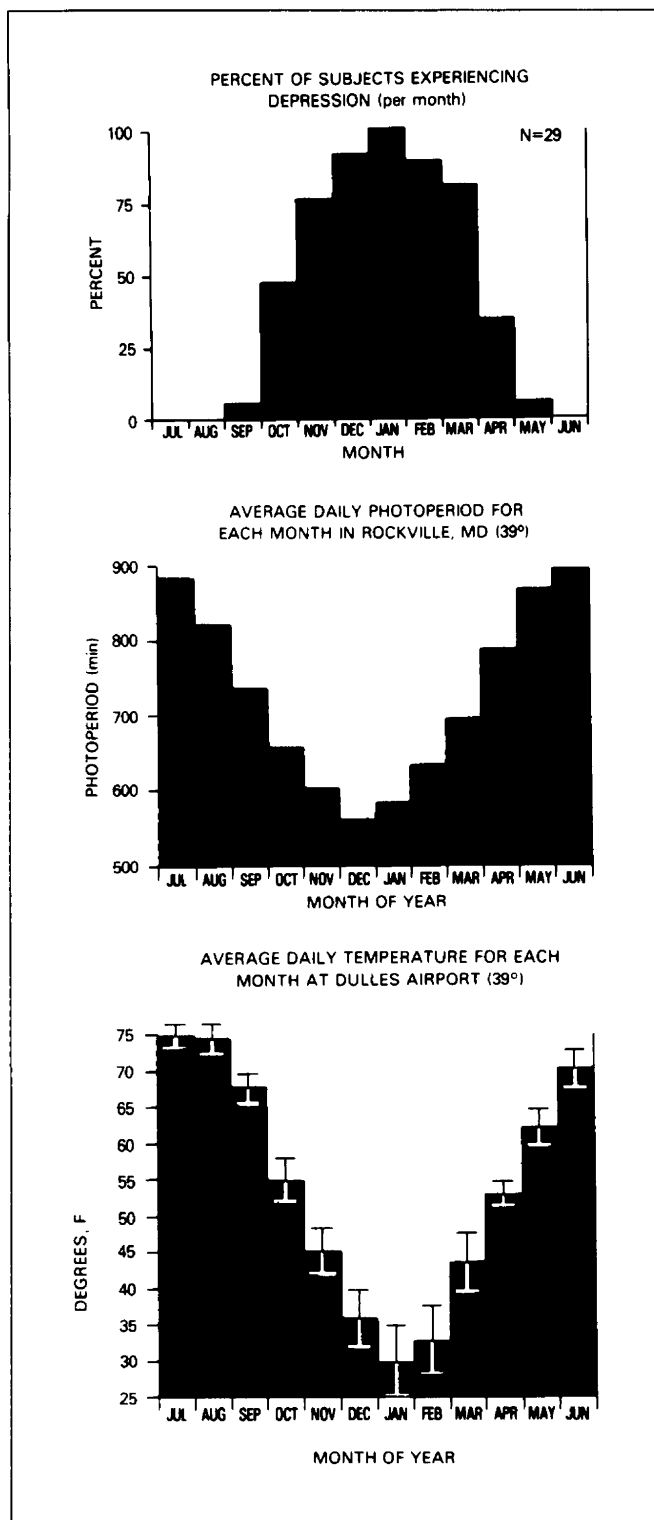


Fig 1.—Percentage of patients depressed per month (based on history) compared with mean photoperiod in Rockville, Md (Smithsonian Radiation Biology Laboratory), and average daily temperature at Dulles Airport, Virginia (National Climatic Center, Asheville, NC). There is high correlation between percentage of patients depressed per month and mean photoperiod for that month ($r = -.87, P < .001$), which increases in one-month lag period between photoperiod and percentage depressed allowed ($r = -.98$). There is also high correlation between percentage of patients depressed in any month and mean daily temperature for that month ($r = -.98, P < .001$). F indicates Fahrenheit at bottom; 39°, degrees of latitude north of equator.

responsibilities in the winter, whereas during spring and summer, they would become energetic and demanding. These mood and energy fluctuations frequently produced tension in the marriage.

Physical symptoms accompanied depressive episodes in several cases: a few patients reported joint pains or stiffness, three patients reported headaches, three patients reported constipation, and one patient reported muscle cramps.

About a third of the population (nine patients or 31%) had received no treatment for their seasonal problems (Table 1). Among the rest of the patients, past treatment included lithium carbonate and/or antidepressants in 12 patients (42%) and thyroid replacement in six patients (21%). Patients reported that they had varying degrees of response to both lithium carbonate and antidepressants, but many chose not to try them again either because of side effects or a preference to try nonpharmacologic approaches. At the time of the study, three patients were taking lithium carbonate, and one was taking phenelzine sulfate. Only three patients had a history of hospitalization (one was for mania, and two were for depression). No patient had received electroconvulsive therapy.

Twenty-three patients had traveled north or south during the winter after the onset of their seasonal depressions. Of these, 19 patients (83%) stated that they had observed a change in mood after such travel. Patients reported mood improvement a few days after arriving in the South (usually Florida or the Caribbean) and a deterioration in mood a few days after returning to the North again. In a few cases, the journey south was followed by hypomania. Three subjects reported a worsening of depression when they traveled north in the winter. One subject reported that when she lived in Morocco and Egypt, her depressions started a full month later and were milder than they had been in the northeastern United States. She had also lived in Chile, where her depressions had occurred between June and September, ie, during the winter months in the southern hemisphere.

Several patients related their seasonal depression to changes in day length or quality of environmental light. While many of these patients may have been influenced by the newspaper article, some had clearly recognized a "light hunger" before reading it. One woman had been nicknamed "Lights" by her husband, because of her habit of turning on all the lights in the house on entering it. Another patient went to Florida to lie on the beach as much as possible during the winter. When this patient was unable to do so, she would dream of sunbathing. Yet another patient termed the illness "the gray sky syndrome," and several patients reported a lowering of mood after three or four overcast days at any time of the year. Although depressions occurred predominantly in the winter, brief depressive episodes associated with either poor weather or stressful life events at other times of the year did occur; however, these episodes were not as sustained, profound, or predictable as the typical winter depressions. A few patients believed that cold weather was at least as important as light in causing their winter depressions.

Patients reported those months during which they generally felt depressed (Fig 1). A clear-cut seasonal distribution is apparent. There is a high correlation between the percentage of patients depressed in any given month and the mean monthly temperature ($r = -.98, P < .001$) and length of the photoperiod ($r = -.87, P < .001$). If a lag of one month is allowed between the photoperiod and the percentage of patients depressed, the correlation is even higher ($r = -.98$).

Family History

The majority (69%) of the patients reported a history of major affective disorder in at least one first-degree relative. There was a family history of SAD in a first-degree relative in only five cases (17%). There was a history of alcohol abuse in a first-degree relative in only two cases (7%). No other significant family history was reported. Data were not available on the total number of first-degree relatives.

Follow-up into Winter

As the winter of 1981 approached, 18 patients gradually became depressed. In general, feelings of being physically slowed down

Table 3.—Clinical Features and Response to Bright White Light Treatment First*

Patient/Sex/Age, yr	Diagnosis	HRS Score					Response		Comment
		BL	WL	W/D	YL	W/D	Bright White Light	Dim Yellow Light	
1/F/30	BP II	25	16	...	22	...	ER	D	Compliance difficulties
2/F/21	BP II	19	14	7	0	7	ER	UR	Compliance difficulties
3/F/36	BP I	17	4	16	15	...	UR	NC	...
4/F/38	BP II	18	3	11	15	...	UR	D	...

*HRS indicates Hamilton Rating Scale; BL, baseline HRS score before light treatment; WL, HRS score during second week of bright white light treatment; W/D, HRS score one week after withdrawal from light; YL, HRS score during second week of dim yellow light; BP II, major affective disorder with history of hypomania; ER, equivocal response (responded, ie, had a decrease of at least four points on the HRS, but did not deteriorate when light was withdrawn); D, deterioration (increase of at least four points on HRS); UR, unequivocal response (responded to light and deteriorated when light was withdrawn); BP I, major affective disorder with history of mania; and NC, no change (less than four-point change on HRS).

Table 4.—Clinical Features and Response to Dim Yellow Light Treatment First*

Patient/Sex/Age, yr	Diagnosis	HRS Score					Response		Comment
		BL	YL	W/D	WL	W/D	Bright White Light	Dim Yellow Light	
5/F/41	BP II	14	16	...	4	3	ER	NC	...
6/F/42	BP II	15	19	...	8	16	UR	D	Receiving phenelzine sulfate (60 mg/day)
7/F/41	BP II	21	18	...	1	8	UR	NC	...
8/M/48	BP II	14	6	11	5	18	UR	UR	...
9/F/52	BP II	22	8	16	5	13	UR	UR	...

*For explanation of abbreviations, see footnote to Table 3. Patients 10 (female, 33 years old) and 11 (female, 20 years old) were not in the crossover study. Patient 10 had a bipolar I affective disorder, a baseline score of 26 before light treatment, a score of 17 during the second week of bright white light treatment, and an equivocal response to bright white light. She became irritable and wanted to discontinue the protocol. Patient 11 had a bipolar II affective disorder, a baseline score of 22 before light treatment, a score of 8 during the second week of bright white light, a score of 16 one week after withdrawal from light, and a score of 9 during a repeated second week of bright white light. She had an unequivocal response to bright white light and became suicidal on withdrawal.

and changes of appetite preceded actual mood changes. The 11 patients (38%) who did not become depressed offered the following reasons for this irregularity in the pattern of their illness: (1) Lithium carbonate prophylaxis was started after the previous winter (three patients). (2) Psychotherapy was started since the previous winter (one patient). (3) Emotional support was derived from participation in the research program (one patient). (4) They stayed outdoors in the sunlight for longer periods of time (one patient). In five cases, no explanation was offered. Of the 18 patients who became depressed, 11 received light treatment. The other seven patients were either judged to be too mildly depressed to show a significant degree of change (two cases) or were unwilling to comply with the treatment protocol (five cases).

Sleep Studies

Results of EEG studies of sleep were available on nine subjects in summer and winter. Eight of these patients were studied after they had become depressed; one patient did not become depressed. In winter, these patients showed an average increase of 17% in total sleep time (both rapid eye movement [REM] sleep and non-REM sleep) ($P < .01$, two-tailed paired t test), an average increase of 23% in sleep latency ($P < .05$), and an average decrease of 46% in slow-wave (delta) sleep ($P < .01$), compared with summer recordings. The change in sleep parameters was as profound in the single patient who did not become depressed as in the eight subjects who did. The REM latency and REM density did not change. There was a trend toward more frequent waking during the winter, but this did not reach statistical significance.

Neuroendocrine Studies

Paired summer-winter dexamethasone suppression tests and TRH infusions in seven subjects showed no summer-winter difference. None of the subjects failed to show normal cortisol suppression or had blunted or exaggerated responses to protirelin infusions in either condition.

Light Treatment

Eleven patients were treated with bright white light, and all experienced some antidepressant effect (Tables 3 and 4, and Fig 2). Baseline HRSs \pm SD before treatment with bright white lights were 18.8 ± 4.3 for the total population ($n = 11$) and 17.7 ± 3.7 for the subgroup of nine patients who went through the entire crossover study. After treatment, these scores dropped to 7.7 ± 5.5 and 6.7 ± 5.1 , respectively, for the two groups ($P < .001$, two-tailed paired t test, Bonferroni intervals,³⁴ in both groups). This change in the HRS score was 11 points or more in seven cases (Tables 3 and 4, patients 3 to 7, 9, and 11). In almost all of the cases, the antidepressant effect was observed between the third and seventh days after the light treatment was started. After the bright lights were removed, relapse occurred to a significant degree ($t = 3.29$, $P < .01$, two-tailed paired t test) usually after three to four days. Only one patient who showed a marked antidepressant response (Table 3, patient 6) did not relapse when bright white lights were removed. Seven patients (Tables 3 and 4, Nos. 2 to 4, 6 to 8, and 11) restarted treatment with white lights at the end of the crossover study at their request. First and second responses to the bright light were similar in all cases. The BDI scores correlated well with HRS scores ($r = .71$, $P < .001$) and showed significant change after bright light treatment ($P < .01$). The BDI scores were, however, a less sensitive measure of change and of clinical state.

In the dim yellow light treatment, patients had a mean baseline HRS score (\pm SD) of 15.1 ± 4.6 and a mean posttreatment score of 13.2 ± 7.1 (not significant, paired t test). Three patients showed unequivocal improvement, ie, response followed by relapse after withdrawal of lights (Tables 3 and 4, patients 2, 8, and 9). However, this response was greater than 11 HRS points in only one patient (Table 4, No. 9), and she chose to return to treatment with dim yellow lights and responded to these again after the crossover study was completed. We have little information on withdrawal from yellow lights, as most patients failed to respond and were crossed over directly to bright white lights. Three patients' conditions deteriorated during the course of dim yellow light treatment, and three patients showed essentially no change. There was a

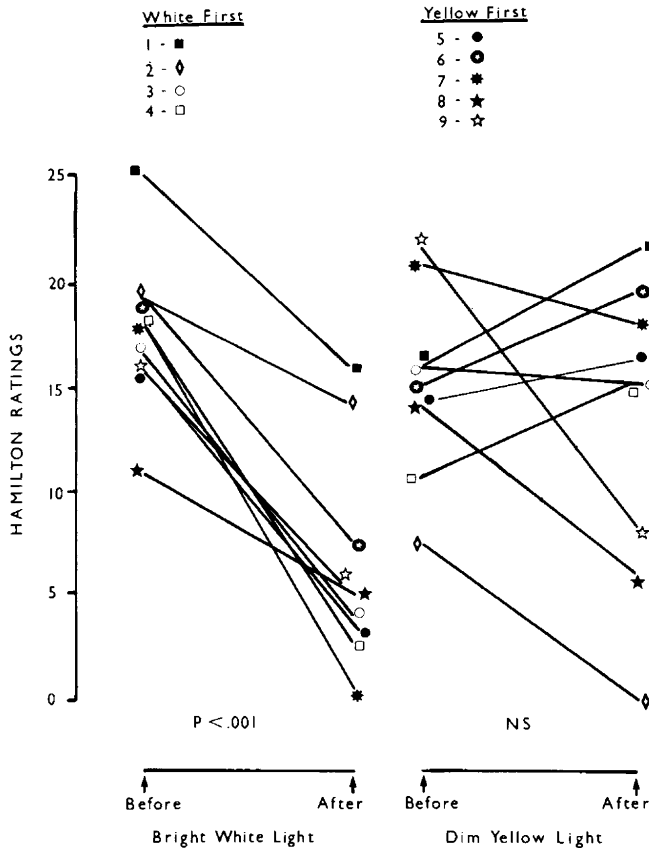


Fig 2.—Effect of light on mood in seasonal depression. Bright white light had significant antidepressant effects ($t = 8.45$, $P < .001$, two-tailed paired t test, Bonferroni intervals³⁴). There was no significant effect with dim yellow light.

statistical difference in the change induced by bright white light *v* dim yellow light ($P < .01$) when a paired t test was performed on the changes in HRS values.

Two patients (Table 4, Nos. 10 and 11) were not crossed over from bright to dim lights. Patient 10 felt irritable and confined with white lights despite an improvement in mood rating. She asked to be removed from the protocol and responded well to treatment with phenelzine. Patient 11 became suicidal on withdrawal of bright white lights. This occurred toward the end of the study, and the investigator (N.E.R.) who was not "blind" to the study thought it was unethical to cross this patient over to yellow lights. Bright lights were restarted, and she responded within three days. Patient 8 (Table 4) was atypical in that he was the only man in the study. Patient 2 (Table 3) left for Florida after the study ended and switched out of her depression within a week of arriving there. Six patients were asked to predict how helpful the different lights would be before the treatments were started. Of these, five patients thought both lights might be helpful. Four patients thought the white lights would be more helpful, one patient thought that yellow lights would be more helpful, and one patient thought that both lights would be equally helpful. The predictions proved to be correct in four cases and incorrect in two cases.

Wrist activity recordings per 15-minute period for the hours of morning treatment (5:30 to 8:30 AM) showed a significantly larger number of low-value counts (less than or equal to eight per 15-minute period) in dim than in bright light conditions (6.2 ± 2.0 low-value periods in dim light compared with 4.9 ± 2.6 in bright light, $P < .03$).

As judged by clinical findings, fundus photographs, and test results, no differences in visual function were observed after light treatment. The only side effects noted were hypomanic irritability and hyperactivity in a few cases with bright lights. These subsided when the light treatment was discontinued.

No systematic follow-up was obtained after the crossover study or on patients who did not receive light treatment, but some clinical data were available. The 11 patients who did not become depressed in the winter remained well, except for one patient who became depressed in the spring and was treated with lithium carbonate, to which he responded. In the seven patients who became depressed in the winter and were not treated with light, their depressions remitted by late spring or summer. One of these patients was treated with phenelzine, to which she responded well. In the spring, patients appeared to be more energetic and active before their mood improved, and some experienced anxiety and irritability during this transition time. After the crossover study was completed, some patients experimented with altering the length of light exposure from day to day. In a few cases, this produced unstable mood control and days of depression that alternated with days of hypomania. A consistent regimen of light treatment was found to be helpful in these cases. Four patients, who were treated with light in the winter and responded, experienced depressions during the following spring and summer. In two cases, this depression was treated with medications (trazodone hydrochloride in one case and phenelzine in the other), and in one case, it was treated with phase advance of the sleep-wake cycle.³⁵ All three patients responded to treatment. The fourth patient recovered spontaneously.

COMMENT

Clinical Picture and Sleep Findings

Hellpach³⁶ first noted the existence of manic-depressive patients whose cyclical mood shifts occurred in association with the seasons. Kraepelin³⁷ agreed with this observation and described such patients as follows:

Repeatedly I saw in these cases moodiness set in in autumn and pass over in spring, 'when the sap shoots in the trees' to excitement, corresponding in a certain sense to the emotional changes which come over even healthy individuals at the changes of the seasons. As a rule [this might represent cases] with a very slight course, hypomania and simple inhibition.

Most of our patients (93%) with SAD fit that description well: 76% had bipolar II affective disorder, and 17% had bipolar I affective disorder. It is noteworthy that so large a proportion met the criteria for bipolar affective disorder, especially since a history of mania or hypomania was not a reason for including a patient nor was its absence a reason for exclusion. Almost a third of our patients had not received any previous treatment, and only three patients had been hospitalized for psychiatric reasons. These characteristics suggest that Kraepelin³⁷ was correct in identifying this variant of the disorder as mild, compared with that seen in hospitalized manic-depressive patients. The relative mildness of the disorder in our patients, however, may reflect a selection bias since our population consisted of self-referred patients who read a newspaper article and were sufficiently motivated to follow up on it. Nevertheless, all patients said the condition interfered with their social relationships, and all but one patient said that the quality of their work was affected. This was largely because of the screening criteria; those patients whose syndromes were mild were excluded. Although this study involved patients with fall and winter depression, we were contacted by patients with other seasonal patterns of affective episodes. Some patients, who complained of summer depressions or depression every spring and fall, have not yet been studied systematically.

The symptoms seen in these patients are characteristic of bipolar depression of a mild to moderate severity. Hyper-somnia, hyperphagia, and weight gain have been described as "atypical" in that they differ from the pattern of insomnia, anorexia, and weight loss typical of major depression with melancholia.³⁸ Davidson and colleagues³⁹ have recently

reviewed the literature on "atypical depression" and described a bipolar variant of this condition that fits the clinical picture of our patients quite well. Hypersomnia, which our patients reported and which we confirmed in several patients by EEG recordings, has been reported to occur in bipolar depression.^{40,41} Reduction in the amount of slow-wave sleep and increased sleep latency have been widely reported in depression.^{42,43} These sleep changes have also been described in patients who experience other types of periodic hypersomnia, including the Kleine-Levin syndrome.⁴⁴ Significant reduction in slow-wave sleep has also been reported to occur in the winter in a group of healthy volunteers, recorded at different times throughout the year in Antarctica.⁴⁵

Hyperphagia and carbohydrate craving have been described in atypical depressive patients.^{39,46} Paykel⁴⁷ studied 208 depressive patients and found that appetite was increased in only 14% of the cases. These patients differed from the anorexic depressive patients by being more predominantly female and more mildly depressed, with "neurotic" rather than "psychotic" illness, but with a greater reduction in sexual interest. These features are shared by patients with SAD and with atypical depression. In general, our observations were in agreement with those of Paykel⁴⁷ who noted that in depressed patients with hyperphagia, this symptom became worse with increasing severity of depression. Paykel⁴⁷ suggested that there might be two distinct groups of depressive patients with appetite changes in opposite directions, but within each group, there was a tendency for greater appetite disturbance as illness became more severe. Similarly, Kupfer and associates⁴¹ have pointed out that there are hypersomnic and hyposomnic depressive patients and that these may constitute two biologically distinct groups. The coexistence of hypersomnia and hyperphagia in atypical depression, such as SAD, and insomnia and anorexia in endogenomorphic depressive patients may serve as a further clue to the pathophysiologic characteristics and clinical differences of these conditions. Several investigators have studied the interactions between diet and sleep and have shown that changes in diet may produce changes in total sleep time, delta sleep, and REM sleep.⁴⁸⁻⁵⁴ It is conceivable that some of the sleep changes observed in our patients during the winter may be secondary to changes in diet and weight.

The female-male ratio (6.3:1) in our population was greater than that reported in other studies of atypical depression in which ratios have ranged between 1.5:1 and 2.3:1.³⁹ The far higher ratio that we observed may indicate that some characteristic of women makes them particularly vulnerable to SAD. On the other hand, it may indicate a selection bias.

The single outstanding clinical feature of patients with SAD is their apparent sensitivity to changes in season and latitude and the approximately annual occurrence of their affective episodes. Eighty-three percent (19) of our patients reported changes in mood after traveling north or south in the winter, always in the direction of amelioration of depression after traveling south and exacerbation after traveling north. The sensitivity of patients with SAD to changes in season and latitude lead us to conclude that some environmental variable or variables are of major importance in causing and sustaining depression in these patients, and conversely, a reversal in direction of these variables is responsible for alleviating these symptoms. Of all the possible climatic variables, day length, daily hours of sunshine, and temperature, all of which are related to one another, seem to be the most promising candidates for

future study. The possible role of psychosocial influences in accounting for the timing of episodes in SAD has not been thoroughly explored. Anniversary reactions to a traumatic experience and psychologic reactions to the holiday season have been held responsible for annually occurring mood changes in certain patients.⁵⁵⁻⁵⁷ It was our clinical impression that patients were more vulnerable to become depressed in fall or winter in reaction to stressful life events, but that the events per se did not play a major role in their depressions. The duration and recurrent pattern of their episodes make this explanation seem unconvincing. However, the way in which environmental factors may exert their effect, either individually or in combination, requires further study.

Changes in neurotransmitter function that normally occur with the seasons may be a risk factor for patients with SAD. Seasonal changes in biochemical variables in blood have been widely investigated.⁵⁸⁻⁶¹ The serotonin system has been studied most extensively in this regard.⁶⁰⁻⁶² Carlsson et al,⁶² in a postmortem study of brains of persons who died at different times of the year from nonpsychiatric, non-neurologic causes, showed a sharp drop in hypothalamic serotonin levels from fall to winter. It has been suggested that abnormalities in serotonin and other neurotransmitter systems may be altered in depression.^{63,64} Patients with affective disorders have been shown to be hypersensitive to the suppressant effects of light on melatonin,⁶⁵ the pineal hormone that mediates various light-dependent seasonal rhythms in animals.⁶⁶ In every species studied, the duration of melatonin secretion is longest in the winter (or when the experimental photoperiod is the shortest) and shortest in the summer (or when the experimental photoperiod is the longest).⁶⁷ It is unclear whether these observations may explain why some patients with affective disorders show an increased vulnerability to the effects of the changing seasons.

Prevalence

Kraepelin⁸⁷ stated that only a small minority of manic-depressive patients, probably not more than 4% to 5%, show regularly occurring seasonal mood cycles. A review of the literature disclosed only two cases in which annually occurring mood changes were documented.^{3,68} In a preliminary study (N.E.R., C. Carpenter, J. Nurnberger, MD, PhD, E. Gershon, MD, D.A.S., and T.A.W., unpublished data, November 1982) of a clinic of patients with bipolar disorders, nine (23%) of 39 patients reported seasonal mood fluctuations of similar magnitude to those reported by our patients with SAD. We have no data that address the question of population prevalence of SAD, but the large number of persons who have responded to requests to participate in our study suggests that the problem has been frequently overlooked. The main reasons are probably (1) a rhythm with a one-year period length is difficult for both the patient and the physician to perceive, and (2) the patient with relatively mild anergic, hyperphagic, and hypersomnic depression typical of SAD may never reach a psychiatrist or his or her condition may be misdiagnosed.

Family History

In the absence of reliable diagnoses and information on the total number of first-degree relatives and their ages, our family history data must be regarded as a rough estimate of familial prevalence. Nevertheless, the finding that 69% of our patients had at least one first-degree relative with a history of affective disorder is similar to the findings of E. Gershon, MD, and J. Nurnberger, MD, PhD, in a bipolar population in which 63% of the patients had

affected first-degree relatives (oral communication, November 1982). It would be interesting to know whether seasonally occurring mood changes are more common among the relatives of patients with SAD than those of other patients with affective disorder, but we do not have the data to address that question at present.

Neuroendocrine Studies

None of the seven patients studied showed abnormal responses to the dexamethasone suppression test or the protirelin infusion test, either in summer or winter. This is compatible with the low incidence of abnormal responses to these tests found by other investigators who have dealt with populations of mildly to moderately depressed outpatients.⁶⁸⁻⁷⁴

Animal Models

Circannual (approximately annual) rhythms in a wide variety of physiologic functions have been found to occur in mammals and other vertebrates.^{66,75-78} To achieve a high survival rate of the young, the external conditions that prevail during birth, lactation, and early development are of great importance.⁶⁶ Circannual rhythms of reproduction are widely prevalent among mammals.⁷⁹ In a sample of 219 children of patients with SAD, we have found 100% variation in the distribution of the month of birth throughout the course of the year, with the maximum number of births occurring in the late spring and summer (D.A.S., N.E.R., R. Hobbs, MSW, and T.A.W., unpublished data, October 1982). This is a tenfold greater variation than that found in the general population (Vital Statistics of the United States, 1940 to 1978, Rockville, Md) and serves as an objective corroboration of the extreme seasonal changes in behavior reported by patients with SAD. It is conceivable that SAD may be a pathologic manifestation of an atavistic seasonal rhythm, a concept first suggested by Lange⁸⁰ and, more recently, by Kripke et al.⁸¹

In many species, circannual rhythms have been shown to be endogenous in origin,^{66,75-78} that is, they continue in the absence of environmental input. Environmental variables influence the timing of these rhythms, and of all these variables, the photoperiod seems to be the most influential.⁷⁷ In experimental investigation, changes in the photoperiod have been shown to alter circannual rhythms.⁷⁷ It is not known whether such endogenous seasonal rhythms exist in humans.

While there are clearly major differences between patients with SAD and hibernating animals (we have not noted dramatic temperature changes in these patients, and they actually sleep less deeply), there are certain similarities, eg, hypersomnia, hyperphagia, change in food preference, and weight gain.⁸² Overeating in hibernators precedes hibernation, during which time animals are generally anorexic.⁸³ In patients with SAD, however, overeating and carbohydrate craving persist through the winter. Such similarities clearly do not imply similar biologic mechanisms.

Light Treatment

The results of our crossover study suggest that extending the photoperiod by means of bright white artificial light has a robust antidepressant effect in SAD. Certain problems have to be considered, however, in the interpretation of the data.

The newspaper article that was used to recruit patients suggested that light might be helpful, although no details about the lights were mentioned. We had theoretical rea-

sons to suspect that bright light might be biologically active and dim light might be inactive in humans. Many photoperiodic effects in animals are mediated via secretion of the hormone melatonin.⁶⁶ In humans, melatonin is suppressed by bright artificial light (2,500 lux) but not by light of less intensity (500 lux).⁸⁴ In addition, we were aware that, in winter, patients were exposed regularly to room light outside daylight hours and, nevertheless, became depressed.

Lights with different physical properties look different, so patients cannot be "blind" as in drug studies. The color yellow was chosen as a control to distract patients from our prediction. We believed this would be a credible control since this color had pleasant connotations for a number of our patients. We were satisfied that all patients were unaware that we predicted that bright light would be active and dim light would be inactive. They applied themselves diligently to both light regimens, and although the majority predicted that bright white light would be more helpful, five of six patients predicted that both lights would be helpful to some degree; in two cases, (Tables 3 and 4, patients 2 and 9) degree of improvement went contrary to prediction. The occurrence of relapse after the lights were removed, and the latency period of three or more days in both response and relapse, make a placebo response seem unlikely, but the possibility that the superior efficacy of bright light was caused by a placebo effect cannot be excluded. As we used light of different spectral qualities in the different conditions, we cannot rule out the possibility that it was spectrum rather than intensity that made the difference, though we have no reason to believe this to be so.

Since patients with SAD complain of hypersomnia, it is not possible in most cases to administer three hours of light before dawn without partially depriving patients of sleep. Sleep deprivation during the second half of the night has been shown to have antidepressant effects.⁸⁵ We did find a significantly higher number of low activity scores in patients under dim light conditions than in bright light, which strongly suggests that more sleep occurred under these conditions. If we assume that all activity counts less than or equal to eight per 15-minute epoch indicate that the patient slept for that period of time (a probable overestimate based on previous data from our unit⁸⁶), then the patients slept for a mean of one epoch per day more under dim than under bright light. While this difference (2% of the total photoperiod) cannot be overlooked, it seems unlikely that it was the reason for the sharply different effects of the two conditions, especially since we found no correlation between the mean number of low activity counts and the degree of improvement observed. Nevertheless, in further studies of light treatment, sleep deprivation should be much more rigorously controlled. Similarly, in studies of sleep deprivation, lighting conditions should be more thoroughly examined. Kripke and associates^{87,88} have presented evidence that depressed subjects exposed to one hour of bright light at 5 AM showed a greater antidepressant response than those subjects exposed to an equivalent amount of dim red light at the same time of day.

Since this was a pilot study, the treating psychiatrist (N.E.R.) who was aware of the lighting conditions made decisions as to whether patients should be given a washout period, based on clinical considerations. In addition, patients sometimes spoke with each other in our clinic waiting room. The outcome of the experiment may have been influenced by these conditions. In a follow-up study, we are attempting to address these questions.

The number of patients in the crossover study was small,

and for this reason alone, our findings should be regarded as preliminary. The statistical analysis, however, corroborated the strong impressions of both patients and "non-blind" clinicians that the bright light treatment was extremely effective in most cases, and the dim light treatment was ineffective, except in one case (Table 4, patient 9).

We should note that the HRS does not fully reflect the severity of depression in SAD. Hypersomnia, overeating, weight gain, and carbohydrate craving, which are commonly found in SAD, are not represented at all on the HRS, and fatigability is given little weight. Other symptoms, such as insomnia and weight loss, which patients with SAD do not generally experience, are heavily weighted. Further studies on patients with SAD should take these symptoms into account.

Assuming that light itself is the active element of the treatment, it is interesting to consider what the mechanism of the response might be. Is it photoperiodic, ie, dependent on light exposure during a critical part of the 24-hour day, as is the case with certain animals,^{66,77} or is it a direct response to light regardless of when during the day a person is exposed? Anatomically, the most likely route along which photoperiodic information might be channeled is the retinohypothalamic tract that terminates in the hypothalamus,⁶⁶ a structure believed to be functionally disturbed in affective disorders.⁸⁹ The relatively short latency to response has its parallels in animal studies. For example, changes in prolactin secretion in response to photoperiodic alterations in rams have been found to occur within three days,⁷⁹ and neuroendocrine changes in birds can occur even earlier.⁹⁰ Clinically, it would be important to determine which patients benefit from light treatment and how best to administer it. The value of this treatment may extend beyond the circumscribed syndrome of SAD.

FINAL REMARKS

Seasonal Affective Disorder is a subgroup of the affective disorders of special interest because of the apparent reactivity of affected persons to changes in some environmental factors, eg, climate, latitude, or environmental light. We suggest that a reasonable working definition of SAD would be as follows: (1) a history of major affective disorder, according to the RDC²⁷; and (2) at least two consecutive years in which the depressions have developed during fall or winter and remitted by the following spring or summer (a history of this pattern changing with changes in latitude or climate would strengthen the diagnosis); (3) absence of any other axis I psychiatric disorder³⁸; and (4) the absence of any clear-cut seasonally changing psychosocial variables that would account for the seasonal variability in mood and behavior, eg, work stresses.

Although the regular seasonality of episodes and extreme reactivity to changes in latitude seem to differentiate SAD from other affective disorders, SAD has yet to be validated as a distinct syndrome in other ways, notably clinical, demographic, family history, laboratory studies, outcome and response to treatment,⁹¹ especially light therapy. Further work in this area is required.

Preliminary evidence suggests that manipulation of environmental light may be clinically useful in SAD and may also prove to be a valuable research tool in investigating this condition. The existence in animals of annual rhythms that resemble certain features of SAD offers hope that animal models of this disorder may improve our understanding of its pathophysiology and our approach to treatment.

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