Climate, Buildings and Behaviour

Winter Communities Series No. 6

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by Michael A. Persinger
1988

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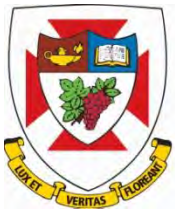

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The psychological health and personal productivity of people are a function of their environment. Although most of that environment is derived from social and family interactions, a substantial portion of it is coupled to the climate and to the buildings within which we work and live. We cannot easily change the climate directly; consequently, its effects are relatively permanent. However, we can change, and we are changing, the characteristics of the buildings which buffer us from the physical environment; they generate their own microclimate. This paper emphasizes the physiological and psychological factors that influence the responses to northern climate. By understanding them in principle, perhaps we can further reduce the negative consequences, and enhance the positive features of northern climate by changing the functional and structural organization of our habitats.[1]

1.0 FIRST ORDER PHYSICAL STIMULI

First then, what factors contribute to the aversive nature of the Canadian winter? Well, you may say that "I enjoy winter" or that "it is a pleasant break from the heat of summer." But, if we look at behaviour, it is clear that winter is aversive. An aversive stimulus is any event that will be freely, operantly, avoided. During the winter we spend a significant portion of time talking about the adversities of the season. After the middle of January, and sometimes before, we only look forward to the first warm breezes of spring. We take vacations, if we can afford them, to distant places, assuming they have copious amounts of sun. But perhaps the simplest evidence is the amount of time we spend outside. The average Canadian spends much less time outside during the winter than during the summer. Since winter lasts for about six months, a substantial portion of our potential behaviour is affected.

There are two obvious contributors to the profound consequences of the Canadian winter. The first involves the significant alteration of the duration and the intensity of sunlight. Duration and intensity of light are well-known controllers of motoric activity. In a variety of non-human animals, the light-controlled alterations in ambulation are mediated primarily by the pineal body, a small organ that is found deep within the human brain. Recent evidence indicates the existence of a clinical subpopulation of depressed patients who can be relieved by restructuring the daily light/dark periods during the winter months.

Architects have frequently emphasized the importance of ambient light intensity as an important factor in aesthetic preference and psychological health. There appears to be certain aspects of the homogeneity and of the intensity of natural light that cannot be compensated for by more localized and, for the most part, dimmer man-made sources. Brightness is a key variable that reflexively evokes changes within the eye and hence short-term changes in ambulation and long-term changes in complicated hormonal responses. A relatively unknown portion of the optic tract allows direct access to the pineal body and to the limbic system portion of the brain that influences mood.

The second powerful contributor to the aversive quality of the Canadian winter is the temperature and the biological necessity to avoid cold, or in some areas to avoid incessant cold rain and cloudiness. Even a few degrees change in temperature has profound effects upon human behaviour. Chronic schedules of episodic exposures to brief cold periods have been suspected to slowly elevate body chemicals, such as those released by the adrenal gland, that are typically evoked by distressing stimuli. Maintained elevations of these chemicals contribute to decreased immunocompetence. As a result, people are more likely to be afflicted by colds, flu, and the consequences of other ambient viral infections. This problem is especially pronounced after about two to three months of the Canadian winter, which indicates that the peak immunofailure months should be between the last of January and the first of April. Not surprisingly, the occurrence of the common cold peaks in February and March. Influenza, with its depression, muscular pain, distressing fever and acute catarrhal inflammation of the nose dominates January and February and does not appear in the summer.[2]

These two variables, light and temperature, are major controllers of the gross physiological changes to the Canadian winter. Although their presence is prominent in the problems of winter or seasonal medicine, their significance is still often underestimated because these large changes take such a long time to occur. They are ramp-like in nature; they are slow, often below the detection threshold. Yet over the course of the season, these changes evoke major alterations in the biochemistry of the body and the psychological status of the person. When the alterations are at their limit, usually during February and March, small, even trivial stimuli can evoke significant instability. Psychological and frank medical ailments often follow.

2.0 PSYCHOLOGICAL FACTORS

There are also psychological factors that influence the response to winter.[3] Sometimes they are even more powerful than the effects of temperature and light; no doubt they interact with them as well. The first major effect is the shift in the ratio of positive stimuli (S+) to negative stimuli (S-). A positive stimulus might be a relaxing walk during a summer evening, while a negative stimulus would be turning the key in your car starter at -30 C and hearing only a click. In coastal climates, negative stimuli may involve incessant rain and wet clothes. During the winter there is an increase in the **relative** number of negative stimuli and, hence, the effects of punishment.

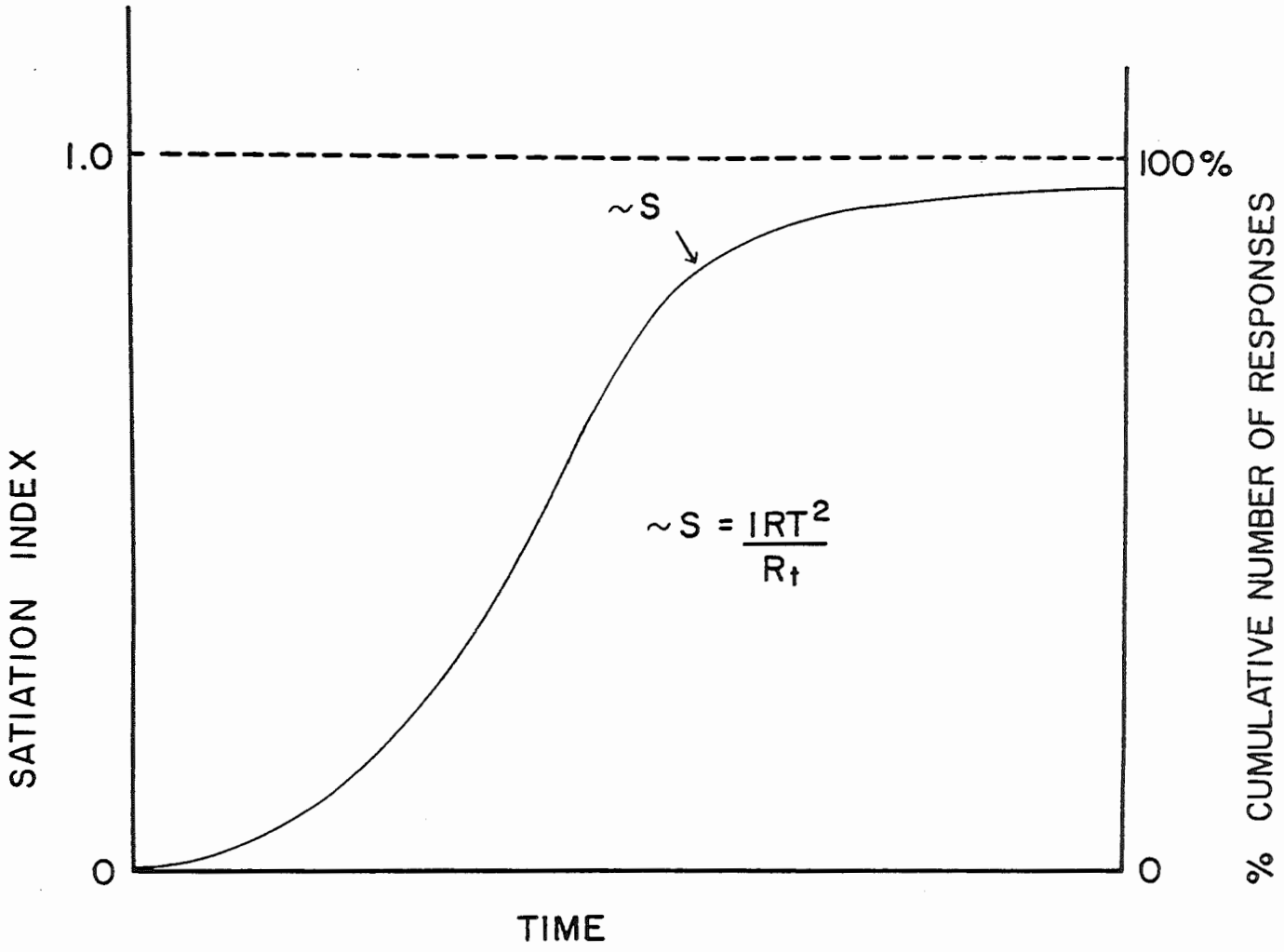
The effects of punishment do not stop with the immediate task involved. Instead punishment generalizes to other behaviours. Although repeated automobile problems may be a central source of frustration, other behaviours are affected as well. After a while most forms of initiative, even simple ones, such as going to movies, visiting friends, or trying a local business venture, become less frequent. These effects not only contribute to the structure of personality, but also to the characteristics of a culture.

There is an increase in the duration of the negative stimuli. Simple responses, like staring the car, walking to the store or crossing the street to another office are associated with aversiveness, which is primarily due to the cold. There are other nuisances, such as longer driving time and enhanced tension due to slippery driving conditions. All of these are subtle, but they add their influence, especially over the six months of the Canadian winter.

Secondly, the very nature of winter stimuli is conservative. There are few stimulus changes. We are exposed to, more or less, the same stimuli day after day, especially after the first snow fall. Whereas summer is associated with a variety of multiple, always changing stimuli, winter contains few alterations. The environment becomes a boring blend of cold grays.

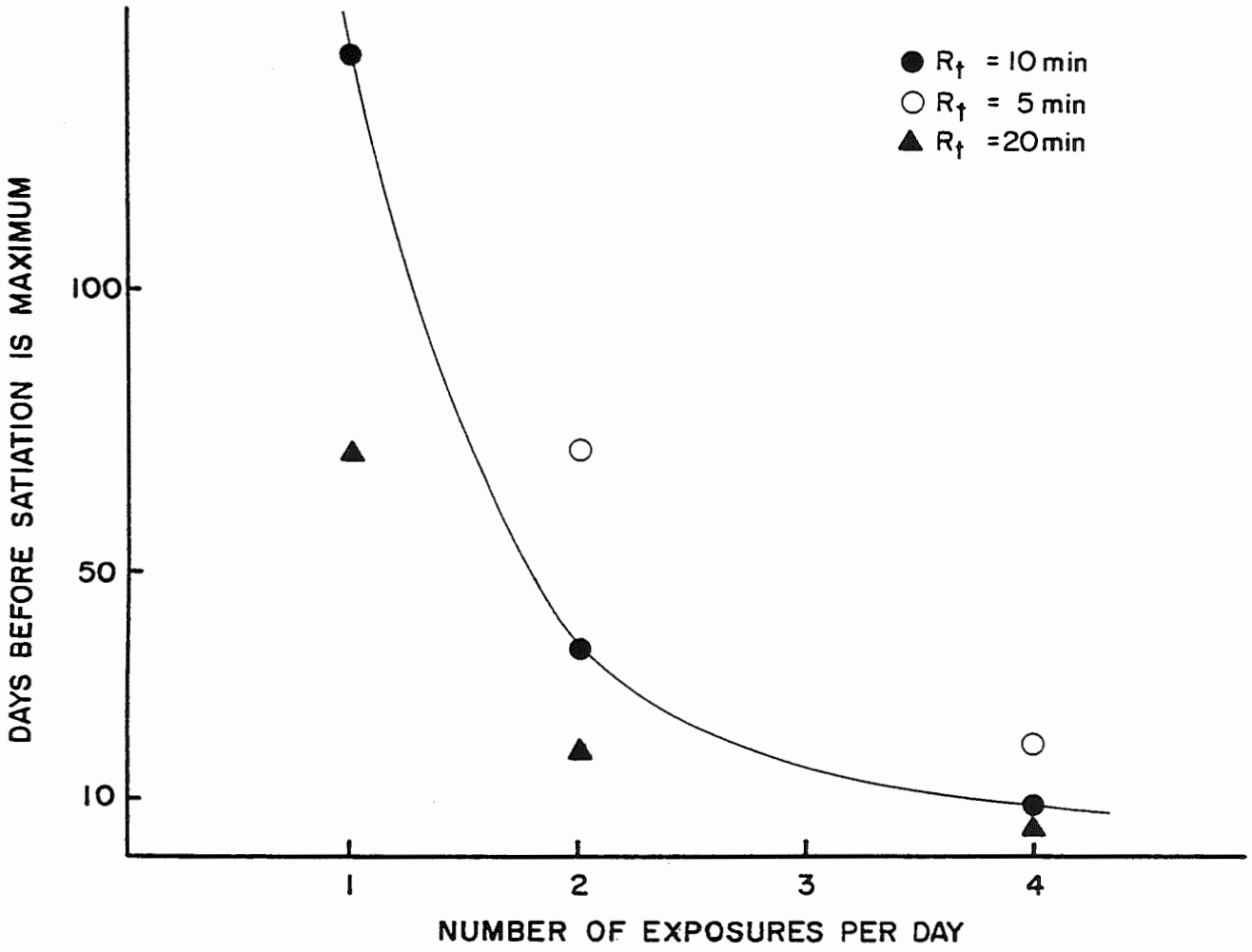
In short, we satiate, or we get tired, of winter stimuli more quickly than summer stimuli. Figure 1 shows that the repeated presentation of a stimulus gradually increases the likelihood of boredom, or satiation. There is sometimes, S, where we satiate to the stimulus involved, as it is in the winter environment.

FIGURE 1



Relative satiation index, or the time before a person habituates to a particular stimulus as a function of time. The index can also be expressed in terms of the percent of the total number of responses. The time, S, or the inflexion point for the beginning of maximum satiation can be calculated by dividing the square of the IRT (interresponse time) by the duration of the response (R_t).

FIGURE 2



Predicted days before looking at snow cover or experiencing a particular cold temperature approaches S, or the beginning of maximum satiation, as a function of the number of exposures per day. Predicted values for different durations of the response (5, 10 or 20 minutes) are indicated. The R_t is not necessarily the amount of time exposed to the cold but the amount of time before habituation to that episode occurs.

This time S can be predicted simply by the equation $IRT^2/R_t.^4$ It is scale invariant, which means it can be used with minutes, hours, days and even years. The relationship simply indicates that if you divide the square of the time between exposures by the duration of the exposure, a first order estimate of when people satiate can be obtained. It is quite useful for predicting when people tire of commodities or novel goods.

The equation is helpful for predicting when students tire of classes. For example, if a class duration, the R_t, lasts for one hour, and the class meets on the average of once every two and one-half days, the satiation should become most marked after five months. It is a very general equation that can be accurately applied to most human behaviours.

In the winter, the average person goes out into the cold, winter conditions twice a day. Physiologically, the adaptation time, that is the duration of the response, is about ten minutes. If we assume that the IRT, the time between exposures, is on the average every twelve hours, then a person exposed to such a condition should **begin** to satiate after approximately thirty-six days.

If the first protracted winter stimuli begin about 1 December, the person should begin to experience the first signs of satiation around the first or second week of January. Of course, diversions such as Christmas or holidays, and individual differences, add their components to the time.

The general psychological effects of **prolonged** satiation are similar between people. Typical symptoms are low-level irritability, the feeling that there must be something more to life, hence the search for new jobs, or at least the thought of looking for another job, usually in another location, and the general dissatisfaction with the quality of life. Often, there is an increase in the level of covert or hidden anxiety.

The third factor that influences the aversive nature of the Canadian winter is the consequence of coerced hypoactivity, due primarily to the physical restraint of avoiding the cold by staying indoors. Such coerced hypoactivity leads to lowered mood and general depression, the so-called "winter-blues." There is an intimate relationship between simple motoric activity, such as ambulation or exercise, and the overall mood of the person. It is becoming increasingly evident that something as simple as exercise, the stimulation of muscles, can produce tonic influences on a person's mood.

Coerced hypoactivity contributes to depression, and depression is an aversive experience. People will engage in almost any behaviour to remove aversive experiences. Alcoholic consumption is a typical avoidance response. It is particularly probable in northern climates because of the side effects of warmth, vasodilation and the misleading experience of indefatigability. Irritable depression can precipitate domestic squabbles. When a large number of people display these symptoms work production conspicuously decreases and social problems increase.

Chronic depression is associated with more morbid escape responses, including thoughts of suicide. Masked depression, a relatively new diagnostic category, is a less severe response to coerced hypoactivity. It is associated with a variety of visceral disturbances such as constipation, frequent sleep disturbances, bursts of hostile thoughts and low-level feelings of paranoia.

The fourth major symptom of the aversiveness of winter climate, again due primarily to its long duration and to its redundancy, is the facilitation of anxiety. Restraint and repeated presentation of the same aversive stimuli contribute to anxiety. Anxiety attacks include feelings of apprehension, sweating, the sensation that the walls are too close and even time distortion. Anxiety can be associated with flu-like symptoms such as the loss of emotional colour, the perception that everything is a lifeless gray and depersonalization--the experience that you are a spectator of your own behaviour. Often it may be dismissed as the flu, which is an apt rationalization for the winter time.

3.0 SUSCEPTIBLE POPULATIONS

Some people are more affected by the winter climate than others. They are high risk populations, not only in relation to their medical health and psychological status, but also in the quality of their subjective life and their productivity. Three major, but not necessarily exclusive, groups of people appear very vulnerable to winter climate and to the average building conditions to which they are now exposed: the elderly, the periodically depressed and the psychiatric populations.

The problem is especially frequent among the elderly who are exposed to the same, small environment day after day. Whereas the summer is filled with bird sounds and fragrant smells that require warmth, or even the varied voices of people walking by,

the winter is characterized by a more redundant input. Although such summer stimuli may be trivial to young people, or to people who can walk about freely, they are important boredom breakers to older members of our society. Winter usually robs them of these stimulations.

Recent research has shown an intimate relationship between the chemistry associated with depression and the chemistry associated with heart failure. Depletion of certain brain chemicals that contribute to depression are also correlated with depletion in heart chemicals that contribute to heart failure. Anxiety and general feelings of uselessness exacerbate these changes. It is indeed ironic that the differences between survival or death may be based upon something as simple as the occasional option to move freely in a warm, bright environment.

There are also indirect consequences of the winter climate that add their measure to winter within the building. Drafty housing and radiative heat loss from elderly people often antagonize their subjective dysphoria. The general coldness "chills their bones" and may contribute to depressed moods and morbid thoughts. Interestingly, one of the singular factors that "make winter so depressing" are the sounds of the wind from which they feel they cannot escape.

The second high risk population includes normal, young and middle-aged people who are prone to occasional depression. All of us are slightly depressed from time to time for no apparent reason; approximately three out of ten people will have a major, medically treated, depressive episode sometime during their life. The winter climate and conventional buildings have the capacity to intensify depressive tendencies. The coerced hypoactivity--staying indoors, general negative--cold or wet and environmental exposures and stimulus redundancy--grays, facilitate rumination, less physical activity and sleep and eating problems. Perhaps the most tragic consequence, which is not clearly marked like a "nervous breakdown," is the loss of personal spontaneity, productivity and sense of well-being.

The third and often ignored group is the psychiatric in- and out-patients. Winter is particularly difficult for them and they respond even more severely to the stimuli previously noted. The marked reduction in spontaneous summer social contact, and the removal of natural comforting colours and warmth, are often reported as the precipitators of remissions and breakdowns. In addition, the design of psychiatric hospitals often ignore these crucial factors. Environmental and psychological factors

contribute to recovery, even to conditions as discrete as surgery. In these instances, the presence of trees within the viewing area of patients, as opposed to the bland stimuli of a brick wall, can facilitate recovery.

4.0 WEATHER AND CLIMATE: THE TRIGGER EFFECTS

Superimposed upon these winter climatic stimuli are the short-term variations of weather. It involves environmental changes of two to three day periods. Weather is optimally viewed as a matrix. That is, weather is a combination of several variables that are changing in-phase and out-of-phase from several hours to days. The major contributors to this matrix are humidity, temperature, sunshine hours, electric fields, barometric pressure, geomagnetic fields and the indirect effect of the release of soil gases. Most of them can be attenuated by the construction of houses, while a few penetrate the best man-made structures.

Human beings are sensitive to weather changes. About ten per cent of the normal population is truly weather sensitive. That is, they **clearly** respond physiologically and psychologically to changes in weather. This population does not include amputees and other special groups who have enhanced sensitivity to special components of weather changes, such as the alterations in electric fields.

Weather sensitivity increases with age, as does the number of weather-related ailments, such as headaches, arthritis and peripheral circulation problems. Often the effects of weather are determined by the simultaneous change in two or more variables of the matrix. For example, many years ago Hollander and his colleagues[5] found that arthritic complaints were most obvious when there was a **simultaneous** decrease in the barometric pressure and increase in the relative humidity.

Our research indicates that what people report as mood is influenced by the weather, particularly during the winter. Although each individual responds optimally to some components of the weather matrix compared to others, the effects appear to be consistent and to be lagged in time.[6] Today's mood, for example, is more likely to be influenced by yesterday's weather or the previous day's weather, than by today's weather. These effects can be masked, of course, by a single contemporary catastrophe.

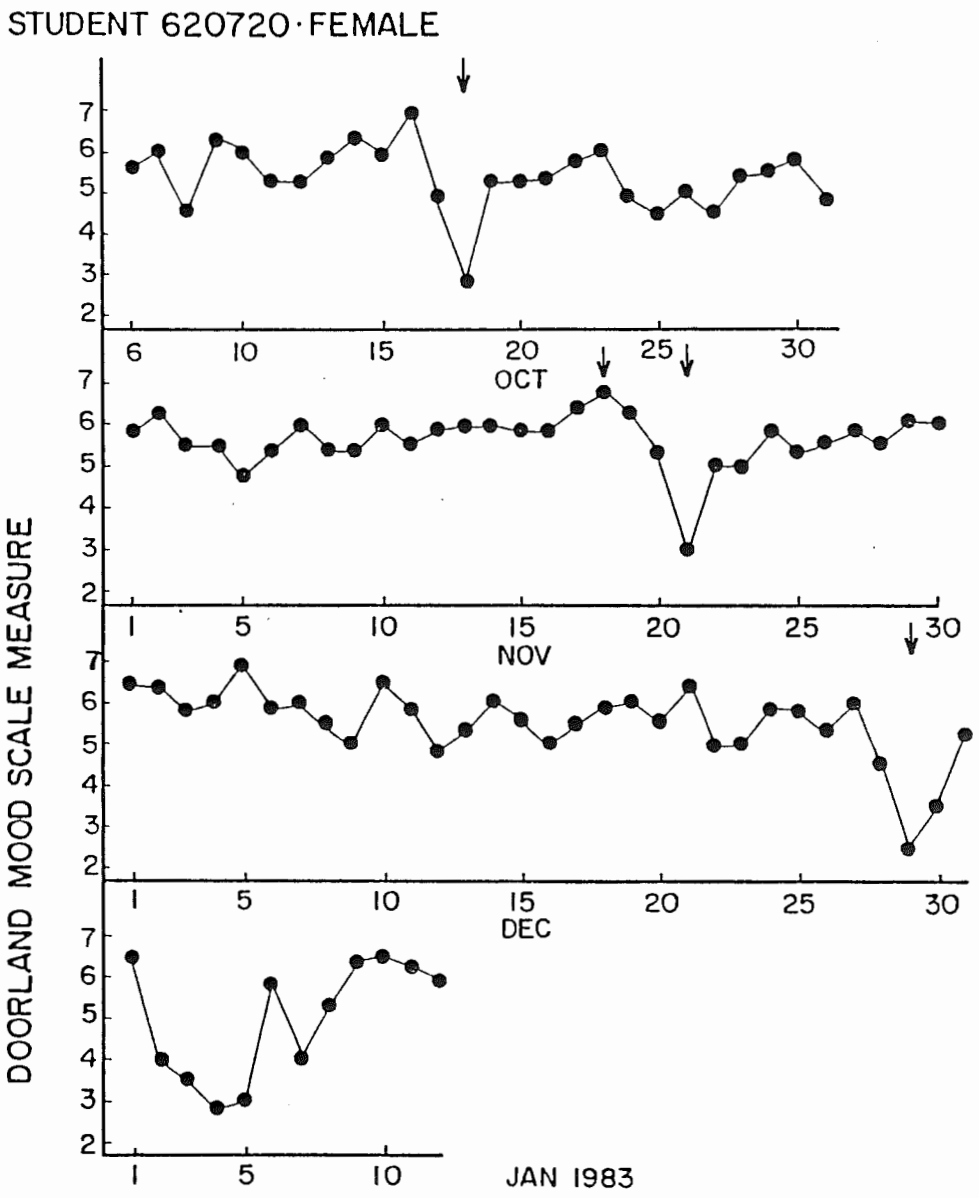
There is no doubt that mood changes from day to day. The following chart, figure 3, shows a recent mood measure of a female student at Laurentian University. This is a typical record selected from a study involving dozens of students.[7] These particular mood measurements are an average for the four daily evaluations. Students were asked to rate their moods in the morning, before lunch, before dinner and before retiring for the night. The chart shows that there are both major and minor fluctuations. The major fluctuations, indicated by the arrows, were associated with social events or with sickness. Some of the depressions typically followed periods of positive anticipation, such as Christmas or parties. The depressions following Christmas and New Year's were associated with migraine headaches.

The minor fluctuations, especially those that contain some indication of periodicity, such as the term from 5 December and 20 December, were related to weather changes. We determined the contribution of weather to mood by looking at the daily weather matrix using a technique called lagged multiple regression. Although people's results vary, over the years the amount of mood variance that can be accommodated by the weather averages about thirty per cent. In other words, about thirty per cent of the changes in measures that people consider representative of their mood is somehow tied to the weather matrix.

The effects of weather on mood are also influenced by season. We have found that the control that weather has upon mood is markedly enhanced during the winter! For example, Figure 4 illustrates the observed mood reports (closed circles) and the predicted mood reports (open circles), according to an equation based on the optimal components of the weather matrix. The equation itself explains about fifty per cent of the person's mood measurements.

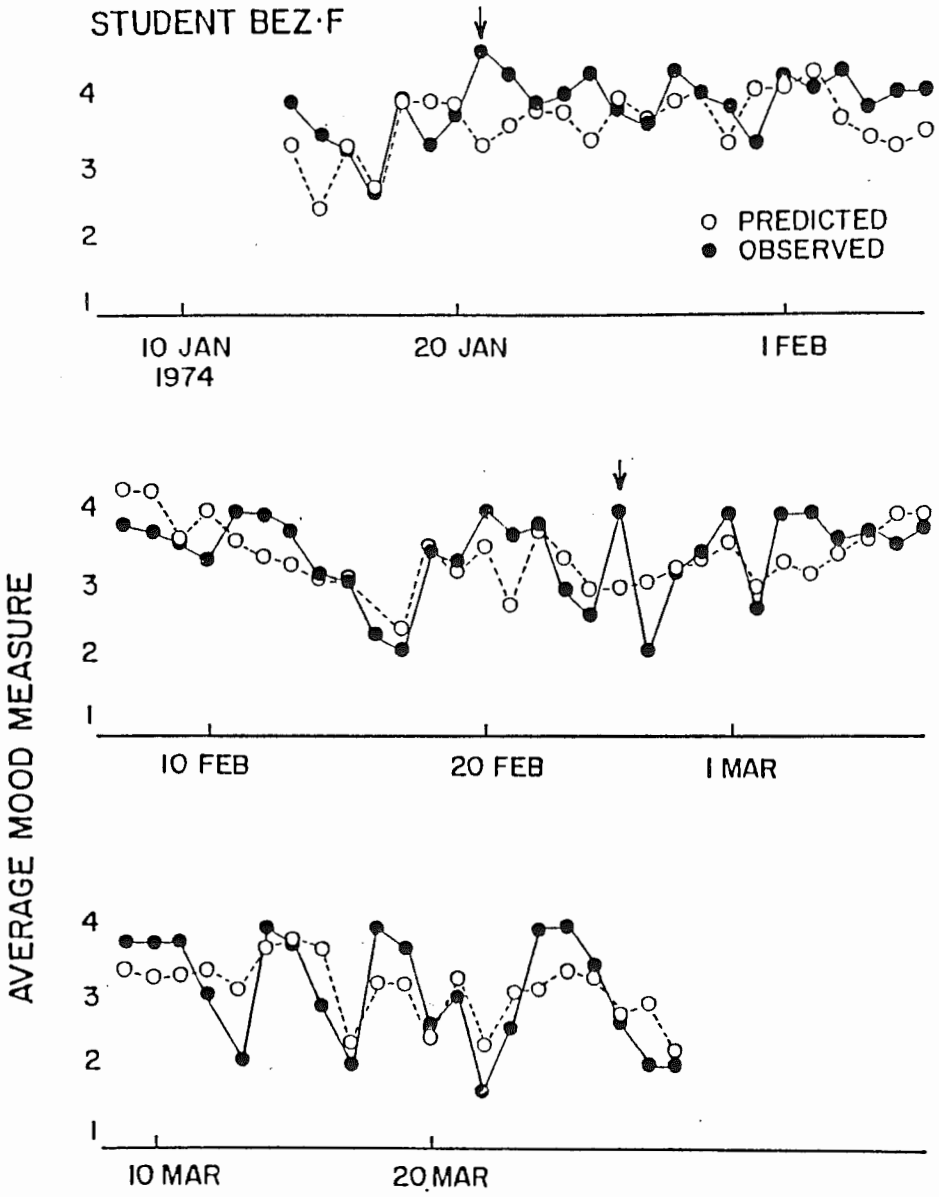
Interestingly, as the winter progresses, the effects of weather upon the person's mood measurements become stronger. Comparatively trivial single stimuli, such as an increase in the number of sunshine hours after two to three cloudy days, is sufficient to control a large portion of the mood variation. In short, as winter advances, mood appears to be influenced by the nuances of winter **weather**. This is not a startling observation. In fact, it has been observed in many other animal species. Stated formally, if the stimuli that control the variability of behaviour are altered, then it comes under the control of other subtle and sometimes unexpected phenomena.

Figure 3



The average mood measurements for a female Laurentian University student between October 1982 and January 1983. Low scores are associated with low self-evaluations of mood, such as depression, while higher values are associated with euphoric feelings. The arrow on 18 October coincided with a death in the family, the high on 18 November was associated with an important party while the low on 21 November was connected to an illness. Low periods after 25 December were identified with migraine headaches.

Figure 4



Predicted (open circles) and observed (closed circles) mood measurements (on a scale different from Figure 3) for a female university student. These data were collected from the first weather-mood study during the winter and early spring of 1974. Seven optimal variables in the weather matrix could accommodate about fifty per cent of the variance in this subject's mood variation. The large singular daily excursions, such as on the 22 January winter carnival and the 25 February party, are associated with social events. More long-term periodicities are clearly linked to the weather matrix.

5.0 WINTER CLIMATE AND HUMAN HABITATS: PAST, PRESENT AND FUTURE

5.1 PAST

Considering the psychological and physiological aspects of winter climate, it is easy to understand how traditional buildings and town/city organizations have intensified the effects of winter. The houses were small, cold, isolated and often poorly lit. The consequences of winter were at their greatest because of harsh climate, thin population, poor transportation and mediocre communications. We can only speculate on the loss of personal and national productivity or upon the traditions that they may have begun.

Diaries and other primary data sources indicate that the time spent outside during the winter was limited to pursuing only necessary tasks. Housewives in particular, rarely emerged during the winter months. The major source of stimulation was the immediate, which was also the extended, family. Although winter exposure was minimal and, for the most part, aversive, the population did emerge from their houses for social events. These events, by a kind of contrast enhancement, became exaggerated rewards. Consequently, great emphasis, perhaps too much, was placed on these intensified pockets of pleasure within the winter scene. They included hockey games and winter carnivals.

5.2 Present

By the 1960s a number of technological innovations changed the allocations of behaviourial time. Roads were maintained and cars became more reliable. Overall, there was much less coerced hypoactivity. This is particularly evident in the massive effort to promote activity programs, especially for the elderly. Programs such as pottery-making or social interaction have begun to break the monotony of the geriatric winter time.

Perhaps one of the most important factors that can reverse the psychological consequences of winter climate is the electronic media. Television allows colourful and varied stimulation. The introduction of VCRs and multiple television channels are alternatives to the conditioned helplessness of the winter. They encourage initiative and promote a sense of personal control.

The recondite problem of the present is the greater isolation of the elderly from social contact, the consequences of a changing family structure. Although the general

standards of buildings for the elderly have become better, with such amenities as reliable heating, there is still social isolation. The problem is enhanced for those who are physically incapacitated. One of their greatest worries appears to involve distances to drug and food stores.

5.3 FUTURE

The design of future habitats for the winter climate should address the problems that have been discussed. Specifically, there should be primary emphasis on buildings that reduce the traditional coerced hypoactivity. While this is essential for all of us, it is particularly important for the elderly and the physically handicapped. By the first decades of the turn of the century the mass of the North American population will lie within this age bracket.

Secondly, building designs should allow for easier and freer access to areas of reward. They include the fundamental services such as foods and medicines, as well as nature areas, such as parks and treed knolls. As people begin to lose their mobility, options to continue to make choices and to maintain control over the environment, become a critical factor for their psychological well-being and productivity.

Thirdly, the designs should be compatible with the capacity to maintain novelty. Despite the additional colour and stimulation of the future winter city, the capacity for the human being to habituate must still be addressed. Considering the quick satiation that people have, even to initially appealing stimuli, some aspect of the buildings should have the plasticity to be changed in shape or characteristic, in order to minimize boredom.

However, planners should be forewarned. Changes in building design will result in some fundamental changes in human interaction. There will be a more complicated dependence upon social skills because more time will be spent in shared social space. Hence, the subtleties of social interaction will be important. People, even those who live in the smaller communities, will be forced to learn different kinds of social skills. The problems that this shift in social emphasis will unmask must still be determined.

6.0 WHAT WE MUST LEARN

People living in the north have been exposed to traditional housing and functional organizations for centuries; the changes we now see in our cities and towns are really a very recent phenomenon. As we gradually close and change our cities some fundamental questions remain to be answered:

(1) *How powerful are personality factors in the response to the structure and function of habitats?* Behaviourial scientists are becoming increasingly convinced that social and environmental conditions which foster maximum satisfaction in one person may be adverse, or even incapacitating, to another. The critical factor does not appear to be the physiological peculiarities, but rather the personality of the person. This paper implicitly emphasizes greater enclosure and simulated summering of the immediate living environment, whereby the access to winter is a free operant--a matter of choice. However, there may be some people who do not respond well in this setting.

(2) Given that there are important personality differences that determine preference for question 1, *what are the fundamental structures and functional organizations of habitats that will appeal to most people?* To some planners, personality appears to be a flimsy and unimportant factor. Indeed, it may be less critical when single, extreme environments are involved. However, in complex environments, personality factors become important in predicting the person's feeling of well-being. It, in turn, influences health and productivity. In the past, psychologists have devised vocational interest tests to determine how a persons' interests were shared with people who were successful, maximally productive and happy within a given vocation. Must we develop similar assessments for people in the context of future building designs?

(3) *What new subtle stimuli will control our moods?* The very nature of mood is its periodicity. Traditionally, the climate and the season were the driving stimuli. The removal of this primary factor simply means that other stimuli may control our emotional highs and lows. The extremes may not be as large, but the variation **will** remain. Will other factors influence productivity within closed buildings with modern lighting and air systems? Will they be subtle and unique to our new microclimate? These factors must still be evaluated.

NOTES

1. M.A. Persinger, *A Weather Matrix and Human Behaviour* (New York: Praeger, 1980).

2. S.W. Tromp, *Medical Biometeorology* (New York: Elsevier, 1963).

3. M.A. Persinger, "Winter Blahs and Spring Irritability: The Chronic But Subtle Behaviourial Operation," *Perceptual and Motor Skills,* **57** (1983): 496-498.

4. M.A. Persinger, "A First Order Approximation of Satiation Time: $(IRT)^2/R_t$," *Perceptual and Motor Skills,* **49** (1979): 649-650.

5. M.A. Persinger, *A Weather Matrix and Human Behaviour.*

6. M.A. Persinger, "Mental Processes and Disorders: A Neurobehavioural Perspective in Human Biometeorology," *Experientia,* **43** (1987): 39-48.

7. If financial support continues, we hope to expand this study into the summer and perhaps over a two-year period. This will allow us to determine the long-term effects of prolonged winter climate on mood variation.