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Abstract

The paper concerns the effects of windows on work and well-being. Literature from a variety of disciplines was reviewed although most recent research was found in the area of environmental psychology. The most consistent finding in the literature is that people prefer natural rather than built or urban views from windows. Windows with views of nature were found to enhance work and well-being in a number of ways including increasing job satisfaction, interest value of the job, perceptions of self-productivity, perceptions of physical working conditions, life satisfaction, and decreasing intention to quit and the recovery time of surgical patients. However, the access to a view did not improve the performance of students or actual productivity of office workers. The positive psychological and health effects of natural views were explained in the context of recent psychological theories. The direction and potential for future research is discussed.

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1.0 Introduction

The importance of windows on work and well-being has long been assumed in conventional wisdom and more recently supported in the scientific literature. The fact that windows appear to be ubiquitous in most places designed for human occupancy indicates, at the very least, a preference by people to see outside. Indeed, this preference has been explained as a product of evolution that favoured humans who looked to nature for food and safety (e.g., Ulrich et al. 1991). Others have conceptualized our preference to look outside in terms of restoring depleted attention processes (e.g., R. Kaplan & S. Kaplan, 1989) while still others point to the importance of daylight in hormone production and regulation (e.g., Küller & Lindsten, 1992).

Although the lack of windows will surely elicit complaints from office workers, home buyers, recovering surgical patients and vacationers in hotel rooms, other spaces like department stores and theatres that lack windows yield no similar dissatisfaction (e.g., Collins, 1975). Therefore, the preference for windows is often related to the function of the space and even the task of the individual occupant. If these variables are not congruent, people will alter their space to fit their needs. For example, people will often decorate a windowless office with posters of outdoor scenes (e.g., Heerwagen & Orians, 1986) but actually cover up existing windows in computer rooms (Butler & Biner, 1989). Thus, understanding the complexity of human-window interactions is important in maximizing the fit between places to work and live and the people who must occupy them.

The purpose of this paper is to review the literature concerning the effects of windows on work and well-being. First, earlier research from a variety of disciplines will be discussed. This will be followed by a review of more recent research primarily from the environmental psychology literature. Finally, a general discussion of the consistencies in the research including theoretical perspectives will be presented.

2.0 Early Research on the Effects of Windows

The first major review of how people react to windows was undertaken in response to the energy conservation trends in building designs in the early 1970s (Collins, 1975). Briefly, in view of the advances of in the fields of artificial lighting and mechanical ventilation, it was thought that a substantial reduction in the size of windows, or their complete elimination would be necessary to reduce excessive energy consumption.

Collins (1975) however, found that windows provided many more functions for people than just sources of light and air. In her review of 88 window-related studies conducted in a variety of settings (including schools, factories, offices, and hospitals), she found that windows provided a view to the outside, knowledge of the weather and time of day, relief from feelings of claustrophobia, monotony or boredom, a change of focus, lent character or beauty to a room and "furnished an indication of status or wealth" (p. 2). In general, Collins' (1975) review focused on two broad areas; the reactions of people to windowless places, and the benefits and psychological functions of windows. It included articles, books, proceedings from conferences and technical reports from 1959 to 1975. She found most research work on windows conducted in the areas of education, lighting, architecture, engineering, medicine and city planning. She found only one article in an environmental psychology journal (*Environment and Behavior*) and listed no other psychology journal references.

2.1 Reactions to Windowless Places

Collins (1975) identified only one review that included the reactions of people to windowless residential buildings (Hollister, 1968). In a study of windowless building types for the Greater London Council, Hollister (1968) found that even the limited use of windows in bathrooms in residential buildings resulted in very unfavourable reactions from occupants. He concluded that public opinion would prevent the use of windowless environments for habitable rooms in residential buildings. Collins (1975) opined that the paucity of research in this area was due to the fact that architects and builders understood the potential negative reaction to windowless homes and rarely attempted to build them.

In contrast, the effects of windowless schools received much more research attention. Collins (1975) found several studies supporting windowless schools on the basis of practical and economic advantages (e.g., Langdon & Loudon, 1970; Arnold 1961). Several of these studies argued that the large windows found in most schools in Britain and the United States resulted in serious problems of overheating and glare on warm and sunny days. Moreover, the use of daylight from side windows as the primary source of illumination also resulted in an inflexible style of classroom arrangement reducing the potential usable classroom space.

The disadvantages of windowless schools were seen to be primarily psychological. Nimnicht (1966) found that parents had very negative responses to windowless classrooms for their children. Burts (1961) argued that the experience of looking out the window can be, of itself, an educational experience, providing the child with change, variety and awareness of the external world.

Although windows seemed to be preferred by parents and students, the effects of windowless classrooms on scholastic performance did not appear to be negative. In one study of fifth graders, Demos (1965) compared achievement tests, grade point averages, personality tests, and school health records of students in one windowed classroom to students in a windowless classroom. No significant differences were found between classrooms on any of these dimensions over the two-year course of the study. Similarly, in a larger study of four separate grades over a three-year period (Larson, 1965) found that the removal of windows did not significantly alter scholastic performance. Interestingly, attitudes about windows were different for students and teachers. Larson (1965) reported that almost all (90%) kindergarteners and about half of third graders expressed a desire for windows. In contrast, teachers tended to prefer windowless classrooms because they found students were less distracted by outside happenings and they found the extra wall space useful.

Although Collins (1975) found no research establishing positive effects of windows on scholastic performance, she argued that the general preference for windows by students and parents and the absence of any long-term studies should signal caution when windowless designs are considered.

Unlike the windowless classroom, Collins (1975) found that windowless factories had received little research attention to that time. In fact, she found only anecdotal evidence from Britain (Pritchard, 1964) suggesting that workers were relatively content in the windowless environment. Pritchard (1964) attributed the lack of worker complaints about the absence of windows to the influence of the piece rate work schedule. The author suggested that workers were so focused on completing as many pieces as possible that it mattered little what the physical work environment was like.

Several studies revealed “a widespread opinion that people do not like to work in windowless offices” (Collins, 1975; p.25). In one study of 139 office workers in the United States, for example (Ruys, 1970), 90% of respondents in windowless spaces expressed dissatisfaction with the lack of windows. Almost 50% of these workers thought that the lack of windows affected them or their work adversely. The main reasons given by respondents for disliking their windowless offices were; no daylight, poor ventilation, lack of information about the weather, lack of a view, feelings of isolation and feelings of depression and tension.

In another study of windowless (underground) office workers, Sommer (1974) found that people tended to compensate for a lack of windows by hanging landscape pictures and posters. Wild animals, seascapes, forest scenes and travel posters were preferred over cityscape or non-natural views as surrogate windows. Similar to the workers in Ruys’ (1970) study, workers in this study complained about poor ventilation, lack of stimulation and feeling down. Collins (1975) suggested that the more negative attitudes of office workers toward a lack of windows as compared to factory workers might be due the size of the respective work areas. That is, factory workers are rarely confined to small workspaces as is the case with most office workers. The ability to move about more freely in a more open space may lessen the impact of the windowless factory for workers.

Hospital wards are much like small offices in that they are usually restricted, cramped spaces and windows are usually preferred by occupants (Collins, 1975). In one study for example, Wilson (1972) found that more than twice as many patients in windowless intensive care unit developed post-operative delirium (40% vs. 18%) compared to a similar group of patients in a unit with windows. Post-operative delirium is a multi-determined syndrome to which age, sex, alcoholism, drug abuse, preoperative anxiety, sleep deprivation and perceptual distortion resulting from anaesthesia all contribute (Wilson, 1972). Fifty subjects were studied in each unit (windowed and non-windowed) of the same hospital who received surgical care and general anaesthesia. The patients were similar in age, physical condition prior to surgery, and patient-to-nurse ratio. There was also a greater incidence of post-surgical depression among those patients in the windowless unit who did not develop post-operative delirium. The author suggested that windows might provide some sort of necessary psychological escape from the grim realities of surgery and without them, the additional stress is sufficient to tip the balance toward a brief psychotic episode for a large percentage of patients.

Unlike schools, offices and hospitals, there are some environments in which the absence of windows is so common as to be unremarkable. Collins (1975) noted that theatres, cinemas, restaurants, bowling alleys, night-clubs, department stores and museums are frequently designed as windowless buildings. Hollister (1968) for example suggested the reason for the acceptance of windowless department stores is the result of the large size of the interior space, the constant activity of a busy store and the wide range of auditory, visual and tactile experiences available. Moreover, people tend to move from area to area rather than remaining stationary for long periods of time. Thus, the main quality of the interior environment is dynamic as compared to smaller single function spaces such as offices.

Considering the research on windowless spaces to that time, Collins (1975) pointed out that the reaction to the absence of windows appeared to form a continuum with the most adverse reaction to the intensive care unit at one end and the least to such public facilities as department stores at the other. Reactions to offices, factories and schools appeared to fall in the middle. At one extreme of the continuum, the absence of windows can further the development of a brief psychotic episode. Yet at the other, their absence may not even be noticed. Thus, some windowless situations were, in general, found to be much less tolerable than others.

2.2 Benefits and Psychological Functions of Windows

Although it was clear that, generally speaking, people prefer windows to not having windows, Collins (1975) went further to try to determine the underlying psychological reasons for this preference. Unlike the research on windowless spaces, research in this area tended to focus on specific aspects of windows such as size, sunshine or view.

Several studies identified the desire of workers to have a view of outside. Wells (1965) for example, surveyed office workers to determine if they could accurately estimate the proportion of daylight in a primarily artificially lit office. Almost 90% of respondents felt that it was desirable to be able to look outside even when there was plenty of artificial light available and 69% believed that daylight provided better quality illumination for work.

Markus (1967) assessed the view preferences for 400 office workers who occupied nine floors of a 12 story building in Britain. Almost all the rooms were large open-plan offices so that all participants had some access to a window. The quality of the view varied depending on what direction workers were facing (trees and distant hills; old bombed out sites and parking lots; non-distinctive views). Not surprisingly, participants rated the view of trees and hills much higher than the others. Overall, respondents reported preferring views of the landscape (88%) over nearby buildings (8%) and a view of the sky (4%). Markus (1967) also found that participants' distance from the window affected satisfaction with the view. The greater the distance, the less satisfied the participant was and the more he or she desired to sit nearer a window.

Using an approach similar to that of Markus (1967), Cooper, Wiltshire & Hardy (1973) administered a survey to the occupants of eleven office buildings. Although the authors were primarily concerned with the reactions to special types of window glass, they also assessed opinions about the entire office environment including view. They found that the greater the variety of distant objects that could be seen, the more adequate and pleasant the view was judged. View contents, height above the ground and age of the respondent also affected the judgments of the adequacy and pleasantness of the view.

S. Kaplan and Wendt (1972) evaluated the effect of complexity on preferences for outside scenes. These researchers found that when office workers rated 56 colour slides for both complexity and preference, nature scenes were preferred to urban scenes. Participants appeared to prefer scenes that were judged complex, but complex nature scenes were preferred to complex urban scenes.

In summary, this early research identified three general characteristics of a desirable view: high complexity or information content; greater expanse of view; and nature rather than urban scenes. Although none of the studies reviewed here evaluated the appeal of a moving, changing scene, Collins (1975) suggested that movement might also be an important quality of a desirable view.

In terms of window size, Collins (1975) found two studies that specifically investigated the minimum acceptable window size. In one study Ne'eman and Hopkinson (1970) used two scale models of office environments, one full-scale and one one-tenth scale, in three different locations with 319 participants. Participants could easily arrange the shape, size and location of an office window in each model. Use of the one-tenth scale model revealed that participants could define a minimum acceptable window size in all cases except when the view outside was uniformly bright and featureless. The use of the full-scale model revealed that view, distance from the window, window height and visual angle all affected the participants' judgments of acceptable size. One of the most important parameters proved to be the type of view. These researchers found that participants preferred wider windows (equivalent to 3.1 m) for views of near objects than they did for distant objects (equivalent to 2.4 m). They suggested that these preferences were related to the relative size of the thing being viewed, that is, closer items would appear larger and require a wider opening to be wholly seen. Unlike window width, they did not find consistent preferences with respect to window height. In this case they inferred that height is less critical than width in determining preferences. They suggested that increased height did not provide as much visual information as did increased width and this may account for the observed differences.

Ne'eman and Hopkinson (1970) also determined that acceptable window width was directly proportional to a participant's distance from the window (i.e., the further one sat away from the window the wider one preferred the window). Using mean values of preferences from all positions in the office, the authors calculated that in order to obtain a window size that would satisfy at least 85% of the participants, the window would have to occupy 35% of the window wall.

A similar scale-model approach was taken by Keighley (1973) who investigated the effects of reduced window area in offices. He used a one-twelfth scale model to simulate a large, open office in size, lighting and furnishings. In the window wall of this model there was an aperture whose dimensions could be varied. Through this window eight different colour transparencies were projected to simulate different views. The author had 30 participants view the model as if it were in their office. They were then asked to adjust the shape and location of the window to the most desirable dimensions for the eight different views. The results indicated that participants were most influenced by the external view in their choice of the preferred shape and location of the window. Similar to the findings of Ne'eman and Hopkinson (1970), participants in this study preferred a wide lateral scan so they selected wider rather that taller windows. In addition Keighley (1973) found that windows occupying 10% or less of the window wall were regarded as extremely unsatisfactory. Satisfaction was greater for a window occupying 20% or more of the wall and larger (more than 20% of the wall) windows were evaluated as most satisfactory.

Based on these two studies it is evident that there are window sizes that are too small to be acceptable (<20% of the wall). Taken together, the results indicate that windows should occupy at least 20% to 30% of the window wall, and, consistent with the previous research on view, what can be seen from the window is of great importance in determining a person's satisfaction with a window.

Collins (1975) found a number of studies that dealt with daylight and sunshine from windows as sources of illumination. She found that the literature on sunshine focused on its psychological effects compared to the work on daylight, which tended to look at the amount and quality of illumination provided.

Overall, when research participants have been asked directly about their desire for daylight, they have generally expressed a strong preference for daylight over artificial light in their offices. For example, Wells (1965) found that 69% of participants in his study desired daylight; Markus (1967) noted that 95% of participants preferred daylight to work by; and, Manning (1965) discovered that 65% of participants in his study wanted daylight. Most of these participants expressed the belief that daylight was superior to artificial illumination (Collins, 1975).

The study of the desire for sunlight has revealed more ambiguous results. Ne'eman and Longmore (1973) for example, administered a survey to the occupants of four different building types: schools, houses, offices and hospitals. They found that preferences for sunlight varied with the type of environment. The vast majority of residential dwellers (90%), hospital patients (91%), and office workers (73%) wanted some sunshine in their environment. By contrast, 62% of hospital staff and 52% of school staff considered sunshine to be a nuisance. The authors suggest that differences in preferences might have been related to the individual's ability to use shading to control excessive thermal gain and glare and the specific activities of the individual. In addition, Collins (1975) opined that the desire for sunlight might be confounded by latitude (i.e., people in northern latitudes have a stronger desire for sunlight than for people in more southern areas). She cited a number of studies from South Africa and Israel suggesting that people in these countries (located at comparable latitudes north and south of the equator) tend to avoid sunshine in their buildings because of its excessive heat.

In summary, of all the benefits and psychological functions provided by windows the provision of a view appears to be most valued by building occupants. The desirability of a view is related to the amount of information available and the qualitative aspects of scene; natural or built. In addition to a view, the importance of daylight and sunshine for the psychological well-being of building occupants should not be underestimated. That said, the function and activity of the space seem more related to perceptions of sunshine than for daylight or view.

2.3 Summary of Early Research

Collins' (1975) work was the first substantive review to that time of the window literature. In fact, there has been no other similar review since that time as comprehensive or as often cited. In her work, Collins (1975) pointed to several shortcomings in the literature that, as we will see, have not been completely overcome in the intervening three decades. For example, although the conclusion that windowless rooms are not particularly desirable appears legitimate, this opinion was not based upon a large number of investigations. Further investigations would be needed to determine if dislike of a windowless space is in fact determined by the kind of task, the amount of personal interaction, the size of space, and the variety of activity. While the research into windowless spaces seemed to suffer from a lack of specificity, research into the reaction to windows seemed to "suffer(s) from a lack of synthesis" (Collins, 1975; p. 78). Although much research focused on various aspects of windows such as view, daylight and sunshine, no studies addressed the overall impact of a window on occupants. Moreover, almost all of the research into the various functions of windows had been conducted in Britain and Northern Europe rather than the United States or Canada, leaving open the possibility that cultural and climatic variations might cause substantial differences in the desirability of such aspects as sunshine and daylight. Thus, the investigations into reaction to windows suggested some of the benefits, but did not provide any final answers about why windows are desirable.

3.0 More Recent Research on the Effects of Windows

Since the work of Collins (1975), interest and research on the effects of windows has continued. However, the present review of research on the effects of windows since 1975 revealed a definite shift in where this research was being published. In contrast to Collins (1975) who found most research to that time in non-psychology areas (e.g., education, lighting, architecture, engineering, medicine, city planning), research since that time has appeared more often in the areas of environmental psychology (e.g., *Environment and Behavior*), social psychology (e.g., *Journal of Social Psychology*), and applied psychology (e.g., *Journal of Applied Psychology*). To a lesser extent, research has appeared in landscape journals (e.g., *Landscape and Urban Planning*) and architecture journals (e.g., *Building Science*). In fact, of the nearly 30 related articles identified during the period 1975-2001, the majority (20) appeared in psychology journals and books.

Since 1975, the effects of an outside view on job satisfaction, life satisfaction and overall health have been studied in a number of different environments including schools (Küller & Lindsten, 1992), hospitals (Ulrich, 1984; Verderber, 1986), and the workplace (e.g., Butler & Biner, 1989; Finnegan & Solomon, 1981; S. Kaplan, 1987; R. Kaplan, 1993; R. Kaplan, S. Kaplan & Ryan, 1998; Leather et al. 1998).

3.1 Window Preferences

Butler and Biner (1989) argued the preference for windows was more likely related to the function of the particular space rather than simply a universal human desire to see outside. They based this assertion on published and unpublished research findings that found some teachers preferred classrooms without windows (e.g., Larson, 1965). To test this idea they hypothesized that window preferences would vary across spaces and, secondly, that in some spaces small or no windows would be preferred.

The subjects were 59 undergraduate students at an American university. No biographic information was provided. The authors constructed a questionnaire consisting of 14 spaces common to this group of students including: large lecture hall, small classroom, public bathroom, dorm room, office, bathroom at home, and library. For each of these spaces, several types of windows were listed that varied in terms of size (small, medium, large), transparency (clear, translucent), number of walls (one and more than one) and no windows. Also included was a list of 14 influence factors such as view of outside to see people and surroundings, sunlight for illumination, mood of individuals in the room, and performance of tasks in the room. For each space, participants were asked to indicate the “best” window option. They were then asked to indicate all of the “bad” window options, that is, those they would find unacceptable in the space. Finally, they were asked to indicate the factors they used in making their window judgments.

The authors found that window preferences varied substantially across spaces. The mean percentage was calculated for each window type across spaces and the normal approximation of the binomial was used to approximate a 95% confidence interval for each percentage. Of the possible 182 window preference combinations, 32 fell outside their respective confidence intervals. Interestingly, large windows (of any type) were the modal response for only three spaces: family room, dorm room, and library. No windows was the modal response for three spaces: lecture hall, public bathroom, and computer workroom and small windows were the modal response for two spaces: garage and bathroom at home.

A similar procedure was used to analyze the factors influencing window preferences. The authors found that of the possible 252 percentages possible (18 factors X 14 spaces), 98 fell outside the 95% confidence intervals. Overall, 11 of the factors were significantly greater than the mean percentage in at least one space. In order from the most likely, they were sunlight, view of outside for temporal information, mood, view of outside to see others, task performance, privacy, ventilation, room appearance, social interaction, glare, and safety/security. The authors also list the significant factors for each space (seven residential and seven non-residential spaces). For the kitchen for example (residential space), five window-related factors were mentioned with frequencies above the 95% confidence interval: sunlight, view of outside for temporal information, view of outside to see others, task performance, and ventilation. Similarly, five major reasons were reported for the office (non-residential space): view of outside for temporal information, task performance, mood, sunlight and view of outside to see others.

The relation between factors and window preferences was evaluated using multiple regression. A stepwise regression analysis revealed that the strongest single predictor of window size preferences was view of outside for temporal information (R^2=.86, p<.01; no other values given). When added to the regression equation, ventilation was the second most important predictor (i.e., the factor that significantly strengthened the prediction equation) (R^2=.95, p<.01; no other values given). The beta weight for view was positive indicating that the more frequently view was chosen, the larger the window preferred. The beta weight for ventilation, on the other hand, was negative, indicating that the more frequently ventilation was cited, the smaller the window preferred. No other factors reliably improved the regression equation.

Based on these results the authors concluded that the state of affairs regarding window preferences was far more complex than previously thought. In particular, one important determinant of size preference that should be taken into account is setting. Thus, the authors recommend researchers and practitioners should exercise caution in generalizing the results from window preference research in a particular setting to other settings.

Although this study was important in pointing out that setting plays an important role in window preferences for many people, the multiple regression approach used here should be interpreted with some caution. For example, the regression analysis was performed on means of settings. That is, a weight was assigned to each window option such that “no windows” was assigned a 0, “small window in one wall” was assigned a 1, and so on. These weights were multiplied by the percentage of subjects choosing each option. Finally, a weighted average was calculated by summing the products for each space. These values were then regressed on the predictors; the frequencies with which each factor was indicated for each space. This procedure resulted in view being the strongest predictor for discriminating among spaces. However, from the analysis of individual spaces, it was clear that view was not always the best predictor (e.g., privacy was the most dominating factor in window preference for bathrooms).

Using similar logic to Butler and Biner (1989), Stone (1998) argued that the presence of windows may not enhance, and may even inhibit, performance depending on the type of task. She described unpublished research that found retention from viewing a videotape was higher and errors were lower under some conditions when there was no window. It is possible, she thought, that the visual stimuli a window presents may not be appropriate for, or may even draw one’s attention from some kinds of tasks. Other tasks, however, may benefit from environmental stimuli by cueing the performer or reducing the performer’s boredom. According to Stone (1998), appropriate, task-related cues would be more important than the presence of windows per se in improving performance. Thus, Stone (1998) hypothesized that supportive cues (i.e., task relevant posters) would increase performance for monotonous and creative tasks (tasks that may result in boredom) but would decrease performance for a computational task (requiring focused attention). Moreover, windowed or non-windowed rooms would not differ with respect to participant performance on any task.

Participants were 35 male and 85 female undergraduate students. The majority of participants (53%) had no office work experience, 23.3% had one year of experience, 19.2% had two to three years experience and 3.3% had four to five years experience. Participants were randomly assigned to each experimental condition (windowed or windowless, poster or no poster, and filing, computational or creative task). In the windowed room, the window began 117.5 cm from the floor and continued to the ceiling (178 cm), was 96 cm wide and was behind and to the left of the respondent. If the student was assigned a poster, it was centred in front of the participant with the bottom of the poster 21.5 cm above the desk.

The filing task consisted of filing a total of 400 index cards in alphabetical order. The computational task consisted of completing 329 basic arithmetic questions. The creative task required students to create 30 answers to 20 different items (e.g., list 30 things that are soft). Each task had a time limit of 40 minutes.

Task-relevant posters were created for each task. The alphabet was printed on three lines for the filing task. Eight simple math problems and their answers were printed on the computational poster and four photographs (waterfall, cityscape, lake, sunset) were placed on the creative poster. A 23-item, 5-point Likert-type questionnaire was created to assess the students’ perceptions of privacy, the room task demand, mood, confidence with the task and work experience. A principal components analysis with varimax rotation was conducted to confirm the items reflected the intended constructs. A total of eight items were dropped because they did not meet the loading criterion (not reported). The final factor structure consisted of task demand (six items, alpha=.88), mood (three items, alpha=. 73), room perception (two items, alpha=.61), and two item measured privacy and fatigue (alpha=.30). Although the last factor did not appear to fit conceptually and had a low alpha value, the author retained it for interpretation.

Performance was measured by the total number of items completed and number of errors for each task. Total task completed was significantly affected by task type, $F(2,108)=3.32$, $p<.05$ (no effect size provided). Contrasts revealed filing task participants completed more of their task than creative task participants. Math task participants were not significantly different from the other two groups with respect to total items completed. Task type also affected the number of errors, $F(2, 108)=84.16$, $p<.001$ (no effect size provided). Contrasts identified significantly more errors for the math task compared to either the filing and creative tasks which did not differ from each other. The tasks also differed on participant task demand ratings with filing receiving the lowest score, followed by math and the highest ratings for the creative task. Thus, the tasks represented different levels of demand.

With respect to the hypothesis that performance would not differ between windowed or non-windowed rooms, the author found that total completed ($F(11, 108)=.003$, ns) and number of errors ($F(11, 108)=.44$, ns) did not differ significantly between these two conditions. Moreover, there were no interactive effects of windows and type task on the total completed or number of errors. Although the presence of a window did not affect performance, participants reported to be more motivated when in a windowed room as compared to a non-windowed room for the computational task.

It was also hypothesized that the presence of posters would affect performance. There were no effects of posters on the total completed, but the Poster X Task type interaction ($F(2,108)=4.04$, $p<.05$) indicated that errors were significantly reduced for the math task when a poster was present as opposed to when the poster was not present. Posters had no effect on the number of errors for the filing or creative tasks. Thus, the data do not support this hypothesis.

In summary, Stone (1998) found that neither windowed nor windowless rooms affected performance. However participants did perceive the room to be more motivating with than without windows on the computational task. The author argued that this might be due to the fact that the window was located behind and to the left of the participant and relaxation increases when sun penetration comes from the side of the individual (e.g., Boubekri, Hull, & Boyer, 1991). This effect would be most salient in tasks that require focused attention. Unfortunately, sun penetration was not measured in this study so there is no way to determine if this was the case. Neither was there any information with respect to time of day, window orientation or the type of view (built versus natural) that could be seen from the windowed condition. Moreover, given the short period of time participants were in the room (maximum of 40 minutes) it is questionable whether this study provides a realistic example of how workers and windows interact.

3.2 Window Views in Hospitals

Similar to the work of Wilson (1972), Ulrich (1984) found that access to a view through a window influenced the recovery of surgical patients. The author obtained records of patients assigned to rooms on two floors of one wing of a hospital between 1972 and 1981. Single windows in each room of the same wing were identical in size (1.83 m high and 1.22 m wide) and looked out on either a small stand of deciduous trees or a brown brick wall. The size and placement of the windows allowed for an unobstructed view for the patient lying on the bed. Patients were matched (N=23 tree view; N=23 wall view) on type of surgery (all participants had undergone the same type of gall bladder surgery), time of year of the surgery (to ensure foliage during recovery time), age, sex, smoker/non-smoker and weight.

Five types of information were extracted from patient files for examination: number of days of hospitalization; number and strength of analgesics each day; number and strength of doses for anxiety (tranquilizers and barbiturates) each day; minor complications such as headache and nausea; and, all nurses' notes relating to a patient's condition or course of recovery.

Patients with window views of trees spent less time ($M=7.96$ days) in the hospital that those with views of the brick wall ($M=8.70$ days; $t(17)=35$, $p=0.025$). Nurses made more negative notes (e.g., "upset and crying" or "needs much encouragement") for patients with views of the brick wall than for patients with the view of the trees ($t(21)=15$, $p<0.001$). Tree-view and wall-view patients also differed in terms of analgesic intake. For the period of primary interest, days 2 through 5 when pain was expected to be greatest, tree-view patients took fewer numbers of doses than brick view patients (Hotelling test $t^2=13.52$; $F=4.30$, $p<0.01$). No differences were found between groups on anti-anxiety drugs, however the authors suggest that the higher level of analgesics taken by the wall-view group may have reduced their use of anti-anxiety drugs. In terms of post-surgery complications, tree-view patients had fewer complications than the wall-view group but the difference was not statistically significant. The authors recommended that, based on these results, hospital design and siting decisions should take into account the quality of patient window views.

In a study of window preferences for hospital staff (N=125) and patients (N=125), Verderber (1986) hypothesized that patients would be critical of "insufficiently windowed spaces" (p. 452) because they were restricted in their movement for extended periods of time with few opportunities for respite. In contrast, staff would be less critical of similar spaces because they were able to self-select their "degree of windowness" (p. 452), and were more able to come and go. The physical medicine and rehabilitation (PMR) unit of a hospital was selected to test these hypotheses because patients were typically in-house for more than three months at a time. Of the 125 inpatients participating in the study, approximately 50% were male and they had a mean age of 62 years. Inpatients had a variety serious physical problems and most (58%) were wheelchair bound. For the staff, 62% were women. No other biographic information was provided.

The author developed a photoquestionnaire that included 64 colour 4 x 5 photos illustrating other PMR units that ranged in the size, number and view content of windows in each. The photos were followed by 89 items which asked about preferences, self-ratings of one's general satisfaction with windows in one's unit, and the extent to which patients and staff engaged in positive or social behaviours such as talking with others, interest in the weather, and reading. The photos were mounted, four per page, in a 8.5 x 11 inch binder. Each photo was rated along a five-point scale from lowest preference (1) to highest preference (5). Other items that rated satisfaction with one's own windows and behaviours were also rated on a five-point scale. On average, respondents required 30 minutes to complete the photoquestionnaire.

Verderber (1986) used multidimensional scaling to discern an underlying conceptual structure. Staff and patient ratings were grouped together to attain greater strength in the analysis. For each dimension, the criterion for item retention was a loading of .4 or greater. Photos yielded an eight-factor solution (13 items were dropped) accounting for 69% of the total variance. Non-photo items yielded 13 content dimensions (18 items were dropped) accounting for 65% of the variance. For each dimension, Student's *t*-tests were performed to compare staff with patients.

For photos, the most desired views from therapy rooms were of trees and lawns, the surrounding neighbourhood, people outside, and near and distant vistas (views of cityscape, mean-3.74), and particularly those that afford information about activity outside (views of street life, mean=3.61). Rooms with large windows that offered a direct view of a concrete building 25 feet away (architectural windowlessness, mean 2.02) and windows that offered monotonous views of sky or a parking lot (psychological windowlessness, mean=2.00) were least liked by respondents. Others dimension included appropriate sill height, sunlight, disorienting views and nature content. In general, sufficiently informative views of the external environment were preferred. By contrast, insufficiently windowed spaces were characterized by sills high from the floor, distant from the viewer, and views obscured by nearly walls, screens, furnishings, and so on.

Consistent with the original hypothesis, patients tended to rate most dimensions more negatively than did staff; however, they differed significantly ($p<.05$; other statistics not provided) only on half of them: cityscape, street life, nature content and psychological windowlessness. The author concluded that occupants with different perceptual and physical abilities differ in terms of the importance they place on the informational needs satisfied by windows and views.

3.3 Windows in Schools Revisited

Although the findings of previous research (e.g., Demos, 1965; Larson, 1965) indicated little influence of windows on academic performance, more recent work suggests that windows affect the health and behaviour of school children. Based on recent information regarding the effects of light on stress and growth hormones, Küller and Lindsten (1992) hypothesized that classroom behaviour, body growth and sick leave would be different for children in windowless versus windowed classrooms.

Briefly, the authors cited research demonstrating the synthesis of melatonin in the pineal gland mediates the effect of ocular light and that the rate of melatonin synthesis is controlled by environmental illumination. Moreover, melatonin has been implicated in the functional activities of organs including the brain, pituitary, thyroid, adrenal and smooth muscles. Melatonin induces sleep, inhibits ovulation, modifies the secretion of other stress hormones like cortisol and has been related to psychiatric disorders such as Seasonal Affective Disorder (SAD). As different levels of stress are known to promote different behaviours, the authors hypothesized that variations in cortisol would be accompanied by changes in classroom behaviour.

Citing other medical research indicating that light perception many have an influence on the metabolism of growth hormones and overall general health, Küller and Lindsten (1992) hypothesized further that children in widowed classrooms would show more growth and have fewer sick (absent) days than children in windowless classrooms.

The participants were 90, eight and nine year olds in two schools in Sweden. The duration of the study was one year. The children were situated in four classrooms differing in respect to the access to natural daylight and fluorescent light. One classroom (A) had ordinary windows on the northern wall, another (B) had natural light through a large skylight in the middle of the ceiling, two others (C) and (D) had only fluorescent lights (warm-white type and daylight type respectively) and no natural daylight. Dependent measures included behaviour observations (four times during the year), the analysis of morning urine for the stress hormone cortisol (four times during the year), a growth measure (beginning and end of the year) and number of sick days (end of the year). For the behaviour observations, trained observers used a pre-tested 18 item common classroom behaviour checklist (inter-rater reliability=.83). For each observation period of 30 minutes, each child was observed 20 times. Factor analysis revealed two areas of behaviour accounting for 48% of the variance; ability to concentrate (e.g., "works independently") and sociability (e.g., talks with schoolmate).

The design was a 2 x 2 x 4 repeated measures design; daylight versus no daylight (2); warm-white tubes versus daylight tubes (2); and, periods of the school year (4). The first two variables and their interaction were tested between subjects and the last variable was tested within subjects.

In terms of results, cortisol levels in students revealed no differences between males and females but did suggest a seasonal variation across all conditions where higher levels occurred in summer months (September and May) and the lowest levels in December (F (3,240)=3.16, p=.025). Children in two classrooms with natural light and the daylight type fluorescent showed significantly higher levels of cortisol production that did children in the warm-white type fluorescent condition without windows (F (1,80)=13.62, p=.0004). These results indicated that the absence of daylight might have delayed the annual variation in the production of cortisol by as much as two months for children in the warm-white type fluorescent classroom.

There was an inverse relationship across classrooms throughout the year (n=16) between the annual variations in cortisol and the ability to concentrate; that is, when cortisol levels were highest, ability to concentrate was lowest (rho=-.64, n=16, p<.01). However, ability to concentrate improved in all classrooms during the autumn term and developed more smoothly in the classroom with conventional windows compared to the other rooms (F (3,240)=2.90, p=.035). Overall then, the ability to concentrate increased during the first part of the school year but was also sensitive to type of lighting.

Changes in social behaviour seemed to follow changes in cortisol levels. The correlation between variations in cortisol and changes in social behaviour across classrooms throughout the year (n=16) was strong and positive (rho=.71, n=16, *p*<.01). On average, sociability was higher in classrooms A (ordinary windows) and D (daylight fluorescent light) than in the other two (*F* (1,80)=30.24, *p*<.001).

There were no differences across classrooms with respect to body growth over the year. However, there was an overall negative correlation between cortisol and body growth (r=-.30, n=74, *p*=.009). That is, children with high levels of morning cortisol did not grow as much as the other children. This relation became strongest in the winter months. Similarly, there were no significant differences between classrooms with respect to sick days. Only in December was there an overall relation between cortisol and sick days (r=-.23, n=75, *p*=.03). Children with lower levels of cortisol had more sick days during this period.

Although the hypothesized relations between growth and sick days between classrooms were not found, these results may have been influenced by the quasi-experimental design of the study. That is, participants were members of intact groups (classrooms) rather than being assigned randomly to experimental conditions. Thus, other uncontrolled for variables such as pre-study health, nutrition, and non-school activities may have accounted for some of the variance. Alternatively, a nested design with more classrooms could have been used to partial out classroom effects.

In summary, the results of this study suggested that work in classrooms without daylight might have upset the basic hormone pattern, and this in turn influenced the ability to concentrate or co-operate. High levels of cortisol were associated with an inclination towards social behaviour and moderate to low levels of cortisol seemed to promote individual concentration. Growth and sick days also seemed be affected by overall seasonal changes in cortisol levels. As cortisol acts as a mobilizer of the body's defences, the authors opined that it was reasonable that sick leave became highest for those children with the lowest levels of cortisol. It was found that the children in the classroom lacking both natural and artificial daylight demonstrated a marked delay in the normal seasonal rise of cortisol. Finally, in northern countries the critical period seems to be late autumn, winter and early spring.

4.0 Windows at Work

4.1 Windowed versus Windowless Offices

Although previous work had identified worker perceptions that windowless offices affected their work adversely (e.g., Ruys, 1970), Finnegan and Solomon (1981) found little systematic research to that time on the effect of windowless work environments on job satisfaction. They hypothesized that workers in a windowless environment would have more unfavourable attitudes toward their jobs than would those with windows. The authors developed a 33 item questionnaire taken from existing sources (e.g., Job Satisfaction Index; Brayfield & Rothe, 1951) and open ended interviews with health-care workers. Each item was rated on a five-point, agree-disagree scale. The 33 items were seen as belonging to six "logical" factors: job satisfaction, interest value, time sense, space, anxiety, and physical working conditions. In a small pilot test of the instrument (N=10), Pearson correlation coefficients were computed between the individual item scores and the factor totals. Fourteen items that did not have a significantly significant item-factor correlation (*p*<.05) were dropped from the questionnaire.

The revised 19-item questionnaire was completed by 110 female and 13 male participants. All participants were either health care workers or office workers; 81 worked in windowed settings, 32 in windowless settings. No other information about the settings, windows or what could be seen from the windows was provided.

The attitudes of the windowed and windowless participants were compared on each of the six mean factor scores and total scores using t tests for independent samples. The samples did not differ significantly in their responses to questions on time sense; anxiety; or sense of space. However, the windowless employees were significantly less positive (*p*<.05) that the windowed employees on job satisfaction (i.e., liking the job), interest value of the job (i.e., finding the job stimulating), and physical working conditions (i.e., visual appearance, lighting, temperature).

This study is important in that it was one of the first in psychology to draw attention to the influence of windows on job satisfaction. Unfortunately, no information about the type of window (large, small, clear glass, etc.), what was seen from the window (built or natural views) or what degree of access workers had to the window was provided. Similarly, no information about how the participants were broken down according to job duties, location and window/non-window status was provided. That is, if all windowless people came from one or a few settings with similar job duties then not having windows may not be the most salient issue with respect to their dissatisfaction. Rather, it could be that some other aspect of their job (e.g., lower pay) was more related to the observed differences than not having windows.

The effects of windows on several aspects of environmental satisfaction at work was also studied by Boubekri and Haghighat (1993). After reviewing the workstation layout of several deep-floor-plan office buildings (a number of workstations along the perimeter of the building next to windows and a number of other workstations in the core area), these researchers hypothesized that those workers occupying workstations next to windows would be more satisfied with attributes of the work environment overall. Specifically, using data collected in a post-occupancy evaluation (POE) of an office building, they examined the effects of nearness to windows on office worker perceptions of workplace attributes such as lighting, air quality, temperature, privacy and amount of space.

Participants were 102 office workers (34% males and 66% females). Of those asked, 73% agreed to participate. Almost half (49%) of participants occupied workstations in the core (windowless) area and the remainder (51%) worked directly adjacent to windows. Most (58%) had been assigned to their workstation for at least one year.

Detailed, objective measures of workstation attributes were taken over several days. These included indoor air quality parameters (carbon dioxide, formaldehyde, volatile organic compounds, particles, and ventilation rates); artificial and daylight measures made with a colour and cosine-corrected illuminance meter; and, thermal comfort parameters including dry-bulb and operative temperature, relative humidity, and air velocity. All measurements were found to meet industry and government (Illuminating Engineering Society of North America - IESNA; American Society of Heating, Refrigerating and Air-Conditioning Engineers - ASHRAE) recommended values.

The authors developed a questionnaire which asked respondents to provide some biographic information (age, sex, tenure in workstation), rate their overall satisfaction with their workstation (seven-point scale, satisfactory (7) to not satisfactory (1)) and then rate seven attributes (lighting, views, indoor air quality, furniture, privacy for conversation, spaciousness of workstation, glare). These attributes were rated on a seven-point scale (very good (7) to very bad (1)). Finally, respondents were asked to rank these attributes from most important (1) to least important (7). The authors did not provide any reference or psychometric information about these items and rating scales although similar scales have appeared elsewhere (e.g. Stokols & Scharf, 1990).

The authors used a Wilcoxon signed ranks test to determine the relative importance of ranked attributes. For those with windows, the three most important attributes were indoor air quality, lighting, and privacy. For those without windows, the three most important attributes were indoor air quality, view and lighting. The authors report that the most significant difference between groups with respect to the ranking of attributes was the ability to have a view out (no test information or values given). The windowed group perceived this attribute to be among the least important whereas the windowless group rated view as the second most important attribute. No other significant differences were found between groups although the authors do not report how they determined this.

With respect to satisfaction, the authors derived mean scores (between 1=not satisfied and 7=satisfactory) of the importance of attributes and correlated (Kendall's rank-correlation test) the workers' satisfaction with them. In general, satisfaction with each attribute appeared to be higher in the windowed group. Both groups were dissatisfied with the quality of indoor air (windows, M=2.96; no windows, M=3.12) although objective measures indicate satisfactory air quality. The windowed group was more satisfied with lighting, view and privacy (M=5.80, 5.78, 4.32) compared to the windowless group (M=3.18, 3.28, 2.24).

A similar procedure was used to correlate the rankings with the overall satisfaction item. The authors concluded that for the windowed group, indoor air quality, privacy and lighting were strong predictors of general satisfaction. The same attributes were important in the windowless group but, in addition, view was also a factor in determining environmental satisfaction.

Overall, the windowed and windowless groups differed only in terms of how they perceived two office attributes, namely view and lighting. Moreover, these two attributes affected overall satisfaction in the group deprived of windows. Indoor air quality and privacy were the two factors that affected both groups with respect to general satisfaction. The authors pointed to other research in which workers attached less importance to an attribute (such as windows) if they possessed it. For example, Ne'eman, Sweitzer, and Vine (1984) found a negative correlation between satisfaction and the perception of the importance of that particular attribute; that is, those who are least satisfied with the attribute perceive it to be important and those who are most satisfied would tend to take it for granted and would perceive it as less important.

Unfortunately, there was no between-group analyses of general satisfaction in this study. Other problems such as biographic differences between groups that were not controlled for and questionnaire issues make the results of this study more difficult to interpret. For example, item scaling (1 to 7) changes in last item to 1 being good and 7 being bad from the reverse in previous items (1 being bad and 7 being good) might have caused confusion for the respondents.

In a more recent study of windowless office spaces, Sato and Unui (1994) reported that windowless offices effected task performance, eye movement, and resting behaviour. In one experiment for example, 15 engineering students (no biographic information provided) experienced 11 different experimental conditions with varying arrangements of illuminance (low=200 lx; medium=500 lx; and high=1000 lx), paintings (50cm x 70cm ocean scene) potted plants (1.5 m to 2.0 m tall), simulated views (video of forest scenery in Europe) and windows (a real view of a nearby forest and sky). Windowless conditions were simulated by covering the windows with panels. Participants performed a threading bead task for each of the 11, three-minute sessions, each followed by a two-minute rest period. An eye camera was fitted to each participant to monitor eye movement. Participants completed a 23-item semantic differential rating scale questionnaire (no reference or psychometric information provided) at the end of the last rest period to rate their impressions of the various conditions. Each item (e.g., "gay-gloomy", "lively-lonely", "spacious-small") was rated on seven-point rating scale. All sessions were monitored by videotape for later behaviour analyses.

The authors conducted a factor analysis (no other information provided) of the questionnaire data and presented a five-factor solution. The two main factors were "spaciousness" and "friendliness". They describe "spaciousness" as "a feeling of satisfaction of being connected to the outside" (p. 29) and "friendliness" as "the factor thought to pervade interior space" (p. 29). Factor scores for "spaciousness" were highest for experimental conditions that incorporated windows and factor scores for "friendliness" were highest for conditions that incorporated potted plants and paintings.

Task performance (average number of beads threaded in three minutes) varied according to condition. A number of t tests were conducted between mean scores on a standard condition (not described, however it appears to have been barren of all windows, plants, paintings etc.) and the remaining 10 conditions. Although somewhat difficult to interpret, it appears that task performance was greater in windowed conditions that in windowless conditions. Moreover, task performance in the windowless conditions improved with the use of decorative elements such as potted plants and paintings.

Eye movement was measured during the rest periods. In the standard condition, eye movements were scattered around the room, moving slowly from point to point. When potted plants were added, eye movements were concentrated on these objects and "friendliness" scores went up (no values given). In the windowed conditions, eye fixation points were scattered inside the room and outside the window, rapidly moving back and forth between them. Under windowed conditions, ratings of "spaciousness" were "extremely high" (p. 32; no values given).

By analyzing videotapes of participant behaviour, the authors categorized behaviour patterns during rest periods. Nine categories of behaviour were identified (e.g., resting elbows on objects, resting chin in hand, folding arms; individual playing; standing or walking, shaking head or arms; touching experimental equipment; yawning, stretching, sighing, etc.). The average time spent in each behaviour pattern varied widely with most time spent in resting elbows on objects etc. and touching the experimental equipment. The authors report significant differences (no values given) between behaviour patterns and experimental conditions. For example, yawning etc. were most frequent in the standard (barren) condition and standing and individual playing were most frequent in windowed conditions. The authors concluded that the visual environment in windowless office spaces had a negative effect on behaviour including task performance and that these negative effects can be compensated for by adding interior decorations to the visual environment of the room.

The problems with this study were largely methodological. Small sample size, no counterbalancing for possible carry-over effects, a simplistic performance measure and a lack of statistical analysis and reporting make this study difficult to interpret and generalize to real office environments. Moreover, improvements to actual performance resulting from the simple introduction of windows have not been found in other window research. (e.g., Collins, 1975, Stone, 1998).

4.2 Built Versus Natural Views

The preference of people for natural over built or urban views is one of the earliest and most consistent findings in the window literature (e.g., Markus, 1967; Cooper, Wiltshire & Hardy 1973; S. Kaplan & Wendt, 1972; R. Kaplan & S. Kaplan, 1989; S. Kaplan, 1995; Purcell, Lamb, Mainardi-Peron, & Falchero, 1994; Ulrich, 1983; Ulrich, et al. 1991). In fact, the influential 19th century American landscape architect Frederick Law Olmstead wrote about stresses associated with cities and job demands, and argued that viewing nature is effective in producing restoration or recovery from such stresses (Olmstead, 1865, cited in Ulrich, et al. 1991).

Ulrich (1983) proposed a psychoevolutionary framework to explain the influence of a view of nature on health and well-being. In this perspective, preference is considered to be an important affect, but is understood as only one of a broad range of emotions (e.g., fear, interest, anger, sadness) that are central to the psychological component of stress and restoration. This is in contrast to the more cognitively oriented perspective of R. Kaplan and S. Kaplan (1989) which will be discussed in a later section. Ulrich (1983) postulated that immediate, unconsciously triggered and initiated emotional responses, as opposed to cognitively mediated responses, played a central role in the initial level of responding to nature, and had major influences on attention, subsequent conscious processing, physiological responding and behaviour. He argued that the initial level of response to natural elements was preconscious and this multimodal process of responding was adaptive in the sense that it is appropriate to the situation and motivates approach-avoidance behaviours that foster ongoing well-being or survival. Depending on the characteristics of a natural setting and the individual's preceding affective, cognitive, and physiological state, adaptive responses could range from stress and avoidance behaviour to restoration and approach behaviour.

Ulrich (1983) provided an example of an early human encountering a venomous snake as a situation where adaptive responding would entail stressful influences. In this example, the quick-onset emotional reaction comprising fear, dislike, and attention would initiate adaptive physiological mobilization and very quickly motivate avoidance behaviour on the basis of only a minimum of cognitive activity. However, the costs of this adaptive process of responding would be evident in energy consuming physiological arousal and negatively-toned emotional states. If the threat situation were resolved, and the individual then encountered a natural setting favourable to ongoing well-being or survival (e.g., a setting with water), Ulrich's (1983) theory suggests the adaptive need is to restore energy (or "restoration") to sustain subsequent behaviours such as gathering food, water, enhancing safety and so on. According to Ulrich (1983), " An adaptive constellation of restorative responses would involve, for instance, attention/interest accompanied by liking, reduced levels of negatively-toned feelings such as fear, and reductions in physiological arousal from high levels to more moderate ranges" (p. 93).

Therefore, Ulrich's (1983) theory suggests that restorative influences of unthreatening natural scenes following a stressor should be evident in a shift towards a more positively-toned emotional state and decreased levels of physiological arousal. Moreover, this theory would predict that that such restoration should occur fairly quickly depending on the intensity of the stress response. In addition, humans should react with automatic "involuntary" attention to potentially dangerous stimuli as part of the process of motivating avoidance or other adaptive behaviour that would favour long-term survival.

In summary, Ulrich's (1983) psychoevolutionary theory suggests that acquiring a capacity for restorative responding to certain unthreatening natural contents and configurations had important advantages for humans during evolution. These included rapid attenuation of stress responses following threatening encounters, and fostering recharge of physical energy. In fact, Ulrich (1983), argued that modern humans are biologically prepared to quickly and readily acquire restorative responses with respect to unthreatening natural settings, but have no such preparedness for most urban or built contents and configurations.

Although quick or automatic "involuntary" responses in humans to threats and subsequent restoration would favour long-term survival, this does not necessarily mean cognition plays no role in the process. Indeed, a major criticism of this theory is its limited view of cognition (e.g., S. Kaplan, 1995). Kaplan stated that Ulrich's (1983) theory sees cognition as "conscious, language-based, and dependent upon reason…" (p. 173), a process much too slow to play a role in restoration. By contrast, Kaplan (1995) and others (e.g., Margolis, 1987) consider perception to be a cognitive, and very rapid, process. Another example of rapid cognition is the implicit prediction that people continuously make about what will happen next in the environment (e.g., Macphail, 1987). This process is generally unconscious and typically surfaces only when is it falsified by subsequent events. Thus, the role of cognition appears to be unnecessarily minimized in Ulrich's (1983) theory.

In a test of several components of Ulrich's (1983) psychoevolutionary theory, Ulrich et al. (1991) found that recovery from a stressful event was faster and more complete when subjects were exposed to natural rather than urban environments. These authors reported that stress mitigation was the most important verbally expressed perceived benefit for participants in over 100 studies of recreation experiences in wilderness and urban nature areas. Using Ulrich's (1983) psychoevolutionary conceptualization of stress, they hypothesized that exposures to unthreatening natural environments would foster greater recuperation from stress than contacts with various urban settings. Specifically, it was anticipated that following a stressor, restorative influences of unthreatening natural scenes would be evident in a shift towards a more positively-toned emotional state, by declines in physiological arousal, and that these changes would be accompanied by comparatively high levels of attention or interest.

Participants were 120 undergraduate students (60 males and 60 females) at an American university. While seated in a comfortable chair and attached to physical measurement equipment, each participant viewed two 10-minute videotapes. The first videotape was the stressor (a black and white film about industrial accidents used as a stressor in previous studies), the second was the recovery condition (one of six different everyday outdoor settings; two natural-water, vegetation, and, four urban-heavy traffic, light traffic, mall with few people, mall with many people). Each videotape contained appropriate visual (e.g., nature vegetation scene = trees, vegetation, light breeze, no people or animals) and sound (e.g., birds, light breeze, dB range 42-64) content based on previous outdoor research. Using random assignment, 20 participants were exposed to each recovery environment.

Physiological dependent measures were those known to measure stress responses and included electrocardiogram (EKG), pulse transit time (PTT), spontaneous skin conductance responding (SCR), and frontalis muscle tension (EMG). Subjects were also asked to rate their feeling before and after the stressor, and after the recovery videotape using a brief state affect questionnaire that assesses feelings on five factors: Fear, Positive Affects, Anger/Aggression, Attentiveness/Interest, and Sadness (Zuckerman, 1977). The participants were asked to rate on a five-point scale the degree to which each item described the way they feel "now" (e.g., "I feel angry or defiant", and "I feel elated or pleased").

Mixed model analyses of variance (ANOVA) were used to analyze the data. In addition, correlation analyses were used to assess the relation among the physiological measures and between the questionnaire data and the physiological measures. The first ANOVA on the physiological data revealed no significant differences between groups for either the baseline or stressor periods. Reactions to the stressor resulted in pronounced increases in skin conductance, muscle tension and significantly shorter pulse transit time ($p<.001$ for all measures, no other values given). Self-ratings were consistent with the physiological data for stressor exposure. Post-stressor scores were higher for the Fear factor ($p<.01$) and Anger/Aggression factor ($p<.01$), and levels of Positive affect were much lower ($p<.01$). Scores for the Sadness factor rose significantly ($p<.01$) and reported levels of Attentiveness/Interest were lower following the stress that during baseline ($p<.01$). However, there were few significant correlations between the physiological data and the self-ratings, which might have been due to the fact that these measures were taken at different times. The self-ratings were obtained before and after the stressor, whereas the physiological data were recorded while the participants viewed the video-tape.

In terms of recovery from the stressor, the results indicated that recovery was much faster and more complete when participants were exposed to the natural settings as opposed to either the pedestrian mall or traffic environments. A series of ANOVAs performed for each of three, 3-minute recovery periods revealed that significantly greater recovery in terms of SCR had already occurred in during the first recovery interval ($p<.01$ for all periods; no other values given). The differences in PTT and EMG were significant during the recovery interval of 5-7 minutes ($p<.05$ for both measures; no other values given) and persisted during the following 8-10 minute interval ($p<.05$ for PTT; $p<.01$ for EMG; no other values given). Therefore, greater stress reduction for nature was evident in all three measures, at the latest, during 5-7 minutes of exposure to the settings. There were no significant differences between the two categories of urban environments with respect to recovery influences expressed in either SCR or EMG.

Heart rate following onset of the nature tapes (rather than urban tapes; $p<.01$) decelerated, despite the pronounced deceleration that had already occurred during the stressor. This suggests that during the initial minutes of recovery, responses to the nature but not the urban settings were strongly influenced by the parasympathetic nervous system.

Comparisons of the post-stressor self-ratings with the data obtained after the recovery video-tapes indicated that the natural, pedestrian mall, and traffic exposures had markedly different effects on affective states. Participants exposed to the natural settings, in contrast to the urban environments, had lower scores for he Anger/Aggression factor ($p=<.001$), reported lower Fear ($p=<.05$), and reported far higher levels of Positive affects ($p<.001$). In fact, recovery with the natural exposures was so pronounced in terms of Fear, Anger/Aggression, and Positive affects that "somewhat more positively-toned that those reported during the baseline period" (p.220).

In summary, the findings from both physiological and self-report measures in this study converged to indicate that different everyday outdoor environments have quite different influences on stress recovery. The results support the idea that recuperation from stressors will be faster and more complete when individuals are exposed to natural rather than various urban environments. The authors explained these findings in the context of Psychoevolutionary Theory. Briefly,

> rewards associated with natural settings during human evolution have been sufficiently critical to favor individuals who quickly and easily learned, and persistently retained, two related types of adaptive positive responding to nature: restoration following stress or taxing activities; and, in the absence of stress, positive emotional/attentional, approach responses to nature contents and configurations, especially those that favored well-being or survival because of such advantages as high food potential and low risk. (p. 226).

In contrast to Ulrich (1983) and Ulrich et al., (1991), R. Kaplan and S. Kaplan (1989) proposed the Attention Restoration Theory (ART) arguing that recovery from directed attention fatigue (restoration of effectiveness) could be accomplished by using modes of attending that required no effort. For these authors, James' (1892) concept of involuntary attention partially explained the preference of many people for natural rather than urban views. Natural environments, they argued, are restorative because the involuntary attention (or fascination) they engender requires no effort on the part of the perceiver. In this way, natural scenes are advantageous to human health because they provide an opportunity for recovery from mental fatigue.

In addition to involuntary attention, R. Kaplan and S. Kaplan (1989; S. Kaplan, 1995) considered three other components integral to the analysis of what makes an environment restorative; being away, the view must have extent, and compatibility between the environment and one's purposes. A sense of being away frees one from mental activity that requires directed attention to keep going. A change in the direction of one's gaze, or even an old environment viewed in a new way can provide the necessary conceptual shift. In terms of extent, the view must be rich enough and coherent enough so that it constitutes a whole other environment, "…a restorative environment must be of sufficient scope to engage the mind." (S. Kaplan, 1995; p. 173). Finally, for a view to be restorative the setting should fit, or be compatible with, what the individual is doing. For example, easy access to a window view would be compatible for an office worker but perhaps not for a factory worker or operating room nurse.

The major difference between ART and Psychoevolutionary Theory is the method of appraisal each uses to explain the preference for natural scenes. R. Kaplan and S. Kaplan (1989) relied on a cognitively oriented "voluntary" appraisal process whereas Ulrich (e.g., 1983) argued that the restorative response was "involuntary" and contingent upon the autonomic nervous system for activation. S. Kaplan's (1995) integration of these theories is presented in a later section.

In a recent study to develop a rating scale measure of restorative components of environment, Laumann, Gärling and Stormark (2001) confirmed much of R. Kaplan's and S. Kaplan's (1989) ART. These researchers hypothesized that restorative components between nature and city environments would be different and these restorative components would predict preferences for the environments. Moreover, a four-factor model based on ART (being away, fascination, extent, and compatibility) was predicted.

In two separate studies the authors asked participants to rate from memory city and natural environments to determine restorative differences (study 1); or, rate videos of different natural and city environments (study 2). In study 1, 238 undergraduate students (93 men and 145 women) in Norway were asked to complete a two-page questionnaire. On each page there were 38 items on a seven-point rating scale (0 = not at all to 3 = neither little nor much to 6 = completely) drawn from the R. Kaplan and S. Kaplan (1998) descriptions of restorative environments. Examples of items used were "I am away from my obligations" (being away factor), "there are many objects that attract my attention" (fascination factor) and "all the elements constitute a larger whole" (extent factor). The participants were asked to imagine that they were present in a nature environment (a familiar high mountain area) and rate this environment using the items on the first page. Then, they were asked to imagine being present in an urban setting (downtown Oslo, the capital of Norway) and use the rating scales on the second page. If participants indicated they had not visited either of these areas their questionnaires were discarded.

In terms of results for study 1, a PCA was conducted for each environment (nature and city). For the nature environment the PCA revealed a five-factor solution accounting for 65.9% of variance. This solution was similar to R. Kaplan's and S. Kaplan's (1989) conceptualization; however, the first construct, Being Away was split into two factors, novelty and escape. A second PCA on the urban setting revealed an almost identical structure with the same five factors with only two items loading on different factors than in the nature PCA. Moreover, a canonical correlation of .99 indicated a close similarity of the factor structures. The urban PCA accounted for 67.2% of the variance. Cronbach's alpha for all factors in both solutions ranged from .76 to .86. Thus, it seems that the same restorative components described both natural and city environments.

However, mean scores for all five indexes were significantly higher ($p<.05$) for the nature setting that for the urban setting, indicating the measure may satisfactorily differentiate between more restorative (nature) and less restorative (city) environments. Finally, sets of multiple regressions indicated that indexes of novelty, escape, extent, fascination and compatibility predicted preferences for both the nature (F (5,230)=32.47, $p<.01$, $R^2=.41$) and city environments (F (5,230)=40.45, $p<.01$, $R^2=.47$). Fascination and Compatibility were the most important predictors for both environments.

In Study 2 another 177 university students (52 men and 105 women) followed the same procedures as in Study 1. However, in this study participants were asked to watch five videos (forest, park, sea area, city and mountain) and after each one use the rating scales developed in study 1. An additional item to measure relaxation was included "how relaxed would you feel in this environment?. Separate PCAs were conducted for all environments revealing a similar five-factor solution for each ranging from 69.6% of the variance for the city environment to 78.9% of the variance for the mountain environment. Canonical correlations between the factor matrices for the different places were .98 or .99 (p<.001) indicating that the factor structures for the different environments were very similar. Cronbach's alpha values ranged from .82 to .94. Multiple regression showed that relaxation predicted preference differently according to setting with sea area being the highest (F (1,155)=239.95, p<.001, R^2 =.61) and city being the lowest (F (1,155)=45.58, p<.001, R^2 =.22).

The findings from this study provide strong support for R. Kaplan and S. Kaplan's (1989) conceptualization of the restorative qualities of environments. A stable factor structure was found that is useful in describing and rating the qualities of urban as well as natural environments and, consistent with previous research, the restorative and relaxing qualities of nature settings seem more salient to people than do the qualities of urban settings. Although the results of this study are impressive, a common problem with developing scales in one language and culture is that they may not always work the same in other cultures. For example, Purcell et al. (1994) found that Australian and Italian university students judged transition from city to country scenes (some city and some nature elements) differently. Italian participants consistently rated these scenes as natural whereas Australian participants tended to rate these scenes as built. As the literature points toward a preference for natural versus built settings, these cultural differences may confound research results if not controlled for.

In another study based on the ART of R. Kaplan and S. Kaplan (1989), Wells (2000) hypothesized that children living in places with more restorative resources (natural scenes) were likely to benefit with respect to cognitive functioning or attentional capacity. In a longitudinal study of 17 children in low-income urban families, Wells (2000) measured cognitive functioning first while participants were living in "poor" housing that typically had fewer natural or restorative resources and then again after the families were relocated to better housing.

The participants were 11 African American (five boys and six girls) and six white children from predominately female-headed single-parent homes (76%). All families were participants in a self-help housing program through which their families helped to construct and then purchase a new home. At the beginning of the study, the majority of families lived in public housing.

Wells (2000) used a 10 item restorative sub-scale drawn from a housing quality scale as the dependent variable (Evans, Wells, Chan, & Saltzman, 2000). The sub-scale (four and five point scales) measured the amount of nature in the window view from the living room (e.g., "what is the view?" 0=none, 2=less than half natural, 3=more than half natural), kitchen, and mother's bedroom, as well as questions about material in the yard. Reliability coefficients for the 10 item restorative sub-scale were unsatisfactory however. Bases on larger samples from the same data set, Cronbach alpha values for the sub-scale were: pre-move, N=38, alpha=.43; post-move, N=30, alpha=.46.

To measure cognitive functioning or ability to focus attention, the Attention Deficit Disorders Evaluation Scale (ADDES; McCarney, 1995) was used. This scale consists of 46 questions to be answered by a parent regarding the frequency of some behaviours of the child (e.g., "starts but does not complete homework"). These items are rated on a five-point scale (0=does not engage in the behaviour, to 4=engages in the behaviour one to several times per hour). Normative data were collected by McCarney (1995) based on the evaluation of 2,414 young people, 3 to 20 years of age. Reported test-retest reliability of the scale ranged from .88 to .93. Interrater reliabilities were also in the satisfactory range, .80 to .84. Internal reliability values (Cronbach alpha) for each of two sub-scales (inattention and hyperactivity-impulsivity) exceeded .95. The scale also yields an ADDES percentile score which is age based to reduce confounding due to age.

Families were visited in the early summer for the pre-move data collection. Two researchers visited the home; one to conduct the ADDES with the child's mother and the other to complete the housing quality scale. The families were visited again after they had lived in their new homes for at least four months. The procedure was identical for the second visit including the use of the same researchers to collect the data. Like the initial visits, all second visits took place during the summer months.

Results confirmed that the new home environments had more nature resources than the original houses (pre-move=2.19, post-move=2.46; t (16)=3.22, p<.01). In addition, the author conducted a series of hierarchical regression analyses to examine the relation between the naturalness of the home environment and the children's directed attention capacity (DAC; percentile score from the ADDES). Using the post-move DAC as the dependent variable, the pre-move DAC score was entered on step 1 to control for its effects and accounted for 50% of the variance in the dependent variable (F (1,15)=15.08, p<.01, R^2 =.501). The change in naturalness from pre-move to post-move was then entered on step 2. Naturalness of the home explained an additional 19% of the variance in post-move attention capacity (F (1,14)=9.22, p<.01, R^2 =.198). A similar analysis was conducted to determine whether or not housing quality would explain any of the variance in DAC scores. No additional explanatory power was found (F(1,14)=1.06, p=.321, R^2 =.035).

Thus, the effects of natural elements within the home environment appeared to have a profound effect on children's cognitive functioning. Indeed, accounting for almost 20% of the variance with such a modest sample size (N=17) is an impressive finding. However, the weak psychometric properties of the naturalness sub-scale of the housing quality survey make the results more difficult to interpret. Moreover, other changes in the children's lives such as attending a new school or a new teacher did not appeared to be controlled for and may have accounted for some of the observed change in post-move DAC scores.

Earlier work had suggested people generally preferred nature scenes from offices. For example, based on the empirical support to that time for the positive effect of windows, Heerwagen and Orians (1986) were interested in how people in windowless offices compensate for the lack of windows in their environment. They thought that people might compensate by the use of office décor. Specifically, they hypothesized that visual décor in windowless offices would be dominated by materials with a nature content. Moreover, and similar to Sommer (1974), these authors hypothesized that occupants of windowless offices would put up more visual materials than did occupants of windowed offices to compensate for stimulus deprivation.

The authors surveyed 75 windowed (N=37) and windowless (N=38) office spaces from buildings on the University of Washington campus over a six month period. Permission was obtained from occupants for a researcher to take a survey of the wall décor. In each office, a researcher noted window availability, view content of windows, number of desks in the space, presence of barriers within the office and desk orientation to the window. The researcher would also note each individual item of décor and classify it as either "landscape" (views dominated by the natural environment), "cityscape" (views of urban places), "nonlandscape natural" (natural elements such as flowers, animals shrubs or other items not placed in a larger context), or "other" (abstract paintings, collages, crafts, etc.). For each individual landscape, cityscape, or nonlandscape natural item, a more detailed content analysis was conducted (e.g., type of water present, amount of sky, type of vegetation, etc.).

Using chi-square contingency tables, the authors tested the hypothesis that windowless occupants would use more visual materials. The median number of items per office was 2.44. The windowless sample had 28 offices in which occupants used more than the median number and 10 offices with fewer than the median. The window sample had 24 office spaces that had fewer than the median number and 13 spaces with more than the median number of items (chi-square=9.86, 1 df, p<.005). To determine if fewer items of décor were due to having less space because of the window, the authors tested the median number of items per wall (.88 for the full sample). They found that the two groups differed significantly; 24 of the windowed spaces had fewer than the median compared to 14 windowless spaces (chi-square=4.82, 1 df, p<.025).

To test the hypothesis that windowless offices would be dominated by materials with a nature content, the authors compared the distribution of landscapes and cityscapes using contingency tables. They found that occupants of windowless offices used almost six times more landscapes than cityscapes, whereas those in windowed offices used only about twice the number of landscapes (chi-square=5.54, 1 df, p<.01). By combining the landscape category with the non-landscape category (nature dominant theme) and combining cityscape and other categories (non-nature theme) the authors tested for which group had more nature content overall. They found that the occupants of the windowless office spaces used three times more nature-oriented visual materials that did people in windowed offices (chi-square=4.48, 1 df, p<.025).

Based on their findings, Heerwagen and Orians (1986) concluded that people want to see the natural world even if the contact is a surrogate one provided by posters and paintings. Moreover, they suggested that visual contact with the natural world might prove to be more crucial to the psychological comfort of office occupants than had been previously suspected. Finally, they concluded that the behavioural observations used in their study were a useful method to study people's responses to windowless environments and were consistent with the findings of attitudinal survey studies found throughout much of the literature.

Interestingly, Biner, Butler, Lovegrove, and Burns (1993) found a more complex relationship when they examined how people compensate for a lack a windows in the workplace. These researchers extended Heerwagen and Orians' (1986) compensation hypothesis to include actual objects (rather that pictures or posters) found in nature such as living plants, flowers and ferns. They expected windowless offices to have more (living) plants than offices with windows. In the first and second of three experiments these researchers developed a set of items and features that could serve as window substitutes. In the third experiment, they examined the use of these items in actual office spaces and the degree to which compensation is a factor in their use.

In Experiment 1, 57 male and female undergraduate students (no biographic information provided) were asked to rate on an 11 point scale (0= "not a window in any sense" to 10= "fulfills the same purposes as a normal window") the extent to which each of 37 office features offered an occupant some of the benefits of windows. These features (each written on a small index card) had been drawn from a survey of over 50 offices and a review of architectural magazines and journals and included different kinds of common equipment (e.g., computer, telephone), other apertures (e.g., clear skylight, inside window), living things (e.g., plants and trees, aquarium) and furniture (e.g., bookcase, coat rack). In addition to rating the objects, participants were asked to sort the items into piles that represented items that were perceived to be similar.

A PCA (no other information provided) on the data revealed a six-factor (other apertures, paintings and art, living things, panels, furniture, office equipment) solution accounting for 76% of the total variance. Relatively large means were obtained in four of the factors: other apertures, M=6.33, paintings/art, M=4.88, living things, M=5.04, and panels, M=3.84. Very low means were obtained for items in the furniture, M=.37 and office equipment, M=.77 categories.

In Experiment 2, the external validity of Experiment 1 results (conducted with university students) was tested with full-time office workers. In a procedure similar to Experiment 1, 47 female full-time office secretaries and administrative assistants (no other biographic information provided) completed the 37 item, office feature questionnaire. However, these participants were not required to do the card sorting exercise as in Experiment 1. Rating of items were analyzed using a 2 x 37 ANOVA with group (secretaries vs. students) and items as independent variables. Differences in the ratings for the items were significant (F (36,3672)=121.92, p<.0001) and accounted for a large proportion of the variance (eta^2 =47%). There was also a very small group difference (F (1,102)=12.40, p<.001, eta^2 =1%) and even a smaller interaction between the group items (F (36,3672)=3.40, p<.001, eta^2=1%). As the proportion of variance accounted for by group differences was very small, the authors suggested this indicated that the two groups used the rating scale numbers slightly differently. The relative ordering of the items was identical for each group and the Pearson correlation comparing student ratings to secretary ratings was very large (r(35)=.96, p<.001).

The results of Experiment 2 provided evidence for the external validity of the results of Experiment 1. Moreover, the researchers reported more confidence in their original hypothesis that several office features, in addition to paintings and pictures were perceived as affording some of the benefits of windows. The next step (Experiment 3) was to re-evaluate the Heerwagen and Orians (1986) hypothesis that employees in windowless office environments actively compensate for lack of windows compared to employees in windowed offices.

In Experiment 3, Biner et al (1993) surveyed 173 office spaces in 17 public and private sector businesses and institutions. Of the 173 offices, 96 were private offices, 44 were shared with one or two others and 32 were open office spaces with low-height, workspace divider panels. A total of 79 offices did not have windows and 94 offices did have windows. Unfortunately, no record of the type of view from the window was recorded. The sample was confined to workstations of secretaries and administrative assistants (126 women and 47 men) to control for job duties. Using about 10 minutes per office, researchers measured the number and size of windows, size of available wall space and the size and number of all of the items in the four top factors (other apertures, paintings and art, living things, and panels).

Biner et al. (1993) found no significant differences between groups with respect to the number or size of pictures or living things. In fact, most F values were less than 1. The other two factors (other apertures and panels) were not found in any of the spaces surveyed. All statistical tests had substantial power (average probability of a Type 2 error was less than .10). Thus, significant differences between groups, if they existed, should have been detected. The authors concluded that these results were "inconsistent, in all respects, with the hypothesis that window substitutes such as paintings are used in employee office spaces to compensate for a lack of windows." (p. 219). The authors explained these findings in the context of individualizing personal space. That is, they suggested that personal taste in terms of office decoration was more important than the desire to compensate for the lack of windows.

The major problem with this study, and in contrast to that of Heerwagen and Orians (1986), is that it assumes that windows, in and of themselves, are the variable of interest. It does not take into account what could be seen from the window. Other research conducted in hospitals (e.g. Ulrich, 1984) and other settings (e.g., R. Kaplan, 1993) indicates that a window view of another building has no effect on individual well-being and is similar to having no window at all. Unfortunately, no record of what could be seen from windows was kept for this study. As all offices were reported to be in businesses located in an urban area (Muncie, Indiana), one might assume that the majority of views from windows were of built, not natural settings. Therefore, office workers next to windows in this setting might have decorated their office with nature scenes and pictures as if they had no view at all. This could account for why there were no decoration differences between the window and no-window groups. Moreover, the authors did not discuss the possibility that organizational limits on personalization might have been different among the 17 organizations surveyed.

Indeed, R. Kaplan (1993) found that what could be seen from the window is more important that just having a window. She found that a view with only "built" elements did not foster any psychological benefits although a view with even a few elements of nature made large differences in worker ratings of satisfaction with their job, life and overall health.

R. Kaplan (1993) reported the results of two studies designed to determine the effect of "view from the window" on a variety of measures including perceived health (nine items), job (eight items) and life satisfaction (five items), frustration (one item) and attitudes toward work tasks (seven items). Most items were completed using a five-point rating scale. Participants were also asked about various restorative opportunities and job setting characteristics. Psychometric properties of the various scales were not included in the paper. In the first study 168 employees from one large corporation and two public agencies participated. The majority of the participants were desk workers, with 55 having no view to the outside or views that included no natural elements from their workstation. There were also 48 participants whose jobs were mostly outdoors in natural settings (e.g., park and maintenance workers). As participation in the study was voluntary and questionnaires were administered through the respective worksites, the authors could not determine accurate response rates per setting.

Results of the first study, indicated that participants whose work was mostly outdoors had clearly different responses from those with desk jobs. These outdoor workers indicated that their job was significantly less demanding, and they felt less pressured, and less frustrated. However, it could not be determined if these differences were directly attributable to being in the natural environment or if they were a function of other job characteristics.

With respect to participants who had similar (desk) jobs but different access to nature in their view, those with a view reported significantly fewer physical ailments and greater job satisfaction compared to those workers without a view. Although t test values were reported as significant ($p<.05$), effect sizes were not calculated and no other descriptive statistics were provided. The relatively large sample size for some comparisons (~100) coupled with rather modest t values suggest the effect size was fairly small.

In the second study, 615 (92% women) office workers participated in the study. Again, the accurate response rates could not be calculated. In addition to the outcome measures used in the first study, participants were asked about the difficulty of seeing outside an their likelihood of doing so. In addition, a checklist was provided of potential features that could be seen out of the window. These were categorized as "built" (street, parking lot, other buildings) or "natural" (trees/bushes, grass, flowers). There were also items that asked about satisfaction with the view (three items), satisfaction with the opportunity to look out (not reported) and the restorative quality of the view (not reported). R. Kaplan (1993) reported that the ratings of satisfaction with the view and the opportunity to look out were strongly related to the opportunity of doing so. However, what could be seen out of the window made a difference in how participants responded to items.

For example, there was no difference in satisfaction with the view between respondents who could see more or fewer built elements. Nor did seeing other buildings, streets or parking lots contribute to the restorativeness of the view. However, R. Kaplan (1993) reported that the availability of nature in the view strongly affected these satisfaction and restorative ratings. For example, for those workers that had no opportunity to see nature the mean satisfaction with view score was 2.2 compared to those with a view that included just two of the listed natural items who had a mean score of 3.40 ($F(3,525)=29.07$, $p<0.001$).

Moreover, the availability of a view with natural elements influenced positively respondent's perceptions of privacy, which in turn, was an important predictor of work and life satisfaction. In addition, those with a view of nature felt less frustrated ($F(2,598)=5.27$, $p<0.001$) and more patient ($F(2,605)=7.69$, $p<0.001$), found their job more challenging ($F(2,607)=20.12$, $p<0.001$), expressed greater enthusiasm for it ($F(2,605)=12.82$, $p<0.001$), and reported higher life satisfaction ($F(5,605)=6.86$, $p<0.001$) as well as overall health ($F(2.605)=3.74$, $p<0.05$). The data did not yield similarly positive outcomes for indoor plants as a potential source of satisfaction. Based on the results of these studies, R. Kaplan (1993) recommended building designers incorporate natural elements into views as much as possible.

It could be however that respondents with a view had different jobs than those without a view. R. Kaplan (1993) reported that although all participants had relatively sedentary jobs, the respondents "…represented a wide spectrum in terms of job classification and pay grade" (p. 197). No analysis was performed to determine if people with certain jobs tended to have windows. If this were the case, it could be that job type was more important than a view of nature with respect to how respondents rated aspects of their work like enthusiasm for the job or how challenging their jobs were.

R. Kaplan, S. Kaplan and Ryan (1998) recommend that the optimum view should include more rather than fewer natural elements (e.g., trees, water, vegetation), have both coherence (distinct grouping of elements) and focus (some contrasting element that captures the viewer's attention), and should change when seen from different vantage points.

Support for the idea that a view of natural elements has positive effects for workers was also found by Leather et al. (1998). In a very systematic and broad examination of the effects of windows and workers, this study investigated both the direct effects of windows (higher job satisfaction, improved well-being and lesser intention to quit) in the workplace and the possibility that they might moderate, or buffer, the negative effects of occupational stress on job satisfaction, well-being and intention to quit. That is, they predicted an interaction between windows (including general illumination level, light penetration and characteristics of the view from the workstation) and job stress.

Leather et al. (1998) operationalized stress in terms of Karasek and Theorell's (1990) model of job strain wherein strain results from the interaction of high job demands and low decision latitude. If windows did provide some moderation of the adverse effects of occupational stress they argued, then this impact should be found across a range of negative outcomes commonly found to be associated with occupational stress, such as reduced job satisfaction, impaired well being and increased psychological withdrawal.

A questionnaire was constructed of six scales drawn from the literature. Job strain was measured using a 13 item scale drawn largely from Karasek (1979). The scale consists of two sub-scales that measure job demand (six items), and decision latitude (seven items). Job satisfaction was measured using Warr, Cook, and Wall's (1979) 15-item scale, with each item using a seven-point response format. Intention to quit was measured using the three –item scale developed by Cammann, Fichman, Jenkins, & Klech (1981). Finally, well-being was measured using Cox, Thirlaway, Gotts, and Cox's (1983) General Well Being Questionnaire consisting of two factors; Worn out and Uptight/tense. Internal consistency values (coefficient alpha) were satisfactory for all scales (job demand, .76; decision latitude, .91; job satisfaction, .92; intention to quit, .94; worn out, .86; and uptight, .90).

General level of illumination was measured using a light meter from five locations within each workstation. Sunlight penetration was measured by respondents' self-assessments of the amount of floor area that could be covered in direct sunlight when the sun was at its maximum penetration for that work area. The size of the area was recorded as a percentage of the floor area. Respondents were also requested to make self-assessments of the extent to which any view through a window from their workstation comprised rural elements (trees, vegetation, plants, and foliage) and to record this assessment as a simple percentage of the total view.

The questionnaire was completed by 100 employees (66 males and 34 females) who were working in a large wine-producing organization in a Mediterranean region of southern Europe. No one who was asked refused to participate. No information was provided about how the questionnaire was translated or if the translation was validated. The authors reported that the sample was representative of the ages (range 25-62 years) and occupational tasks (65% brewing, 35% professional, administrative, clerical) within the organization and worked in a variety of settings including private offices, workshops and laboratories.

The relationship of control variables (number of months in workstation, gender and job status) and predictor variables (illumination, sunlight, and view) with outcome measures (strain, job demand, decision latitude, job satisfaction, intention to quit, worn out and uptight) were first examined by means of Pearson product-moment correlations. Job strain was found to be negatively correlated to job satisfaction (-.54, p<.001) whereas sunlight penetration (.25, p<.01) and view (.27, p<.01) were positively related to job satisfaction. Job strain was also related to intention to quit (.21, p<.05), worn out (.30, p<.01) and uptight (.36<.001). By contrast, sunlight and view were negatively related to intention to quit (-.32, p<.001; -.20, p<.05), worn out (-.28, p<.01; -.18, p<.1) and uptight (-.36, p<.001; -.27, p<.001). General level of illumination manifested no significant relation to any of the outcome variables studied and was dropped from further analyses. Gender was found to be related to most outcome variables such that women experienced lower sunlight penetration, greater job strain, lower job satisfaction, a greater intention to quit, and a greater number of symptoms of being uptight and tense. Although not related to any of the predictor variables, months in the workstation was associated with lower job satisfaction (-.29, p<.01) and poorer well-being (worn out; .42, p<.001 and uptight; .39, p<.001). Blue-collar workers had fewer natural elements in any available view and reported both lower job satisfaction and poorer well-being than did white collar workers.

A series of hierarchical regression analyses were used to test the direct and indirect (moderating) effects of sunlight penetration and view on job satisfaction, intention to quit and well-being. Gender, months at workstation and occupational status were entered on the first step and job strain, sunlight penetration and view were all entered on the second step. Each of the possible two-way interactions (job strain x sunlight, job strain x view and sunlight x view) were entered on the third step. Finally, the three-way interaction (job strain x sunlight x view) was entered on the fourth step.

For job satisfaction, control variables (step 1) accounted for 36% of the variance and significant main effects for job strain (t=-5.58, p<.001) and sunlight (t=2.02, p<.05) were identified (step 2; R^2 Change=.19). No significant main effect for view was found. None of the hypothesized two-way interactions (step 3) or the three-way interaction (step 4) were significant.

For intention to quit, control variables did not account for a significant proportion of variance. Main effects for sunlight (t=-2.46, p<.05) and view (t=-1.74,p<.1) were found although the effect for view was weak (step 2; R^2 Change=.13). Step 3 revealed a marginal effect for the interaction between job strain and view (t=-1.82, p<.1; R^2 Change=.04). The nature of the relation was such that having a greater rural view helped to buffer the negative effect of job strain on intention to quit. There was no significant three-way interaction.

For well-being – worn out, all three control variables were significant and accounted for 27% of the variance in worn out scores. At step 2 job strain (t=2.23, p<.05) and sunlight penetration (t=-2.23, p<.05) made a significant additional prediction but view did not (R^2 Change=.09). None of the two-way or three-way interactions were significant.

For well-being – uptight, all three control variables were significant again accounting for 28% of the variance. At step 2 both job strain (t=2.90, p<.01), sunlight (t=-3.13, p<.01) and view (t=-1.71, p<.1) all contributed to additional prediction (R^2 Change=.16). A significant interaction between job strain and view was found at step 3 (R^2 Change=.04). The negative effect of job strain on uptight scores was moderately less severe when a greater rural view was available. There was no significant 3-way interaction.

In summary, the area of sunlight penetration was found to be directly and positively related to job satisfaction and general well-being and negatively related to the intention to quit. Moreover, rural view was directly, but only marginally, negatively related to intention to quit and the uptight factor of general well-being. Sunlight did not buffer any adverse effects of job strain, however, rural view did act as a buffer of strain on both the uptight factor of well-being and intention to quit. These results seem to indicate that sunlight might operate via a more immediate route of influence than is the case for rural view. View, on the other hand, might act more on appraisal processes and environmental coping resources in the amelioration of the negative impact of job strain.

The findings of this study suggest that it is not the general level of illumination for which windows are important, but rather the size of sunlight areas to which they give rise and the proportion of natural elements in the available view. According to the authors, it is through these dual influencing mechanisms that windows have direct and indirect effects on the work attitudes, behavioural intentions and well-being of occupants.

4.3 Windows as Individual Control

Wyon (2000) argued that indoor environmental control (e.g., light, temperature, air quality) is the result of group preferences and that often substantial numbers of workers find their environment uncomfortable. He suggested that the solution to this problem was to provide some means of individually adjusting each occupant's microclimate. By using such devices as free-standing air cleaners, task lighting systems and operable windows with adjustable solar shading, control of one's microclimate can delegated to the individual. The effect of allowing the individual to control the microclimate is thought to be beneficial to both the individual and the organization.

For example, Wyon (2000) cited a case study where the rate at which insurance claims were processed in a large company increased by 2.8% and overall productivity increased by 5.4% when these personal controls were operative compared to when they were not operating. Moreover, dissatisfaction with the thermal environment decreased from 50% of workers before personal controls were introduced to 8.1% when personal controls were operative.

Similarly, Doggart (2000) cited several case studies in which office workers preferred openable windows to newly designed air-conditioned systems. In one case, when staff were asked what features they would prefer in their new office building, 80% said they wanted openable windows, far higher than any other item. In another case in which a university in the Netherlands was upgrading several buildings, a trial was made with retrofitting air-conditioning on one floor, as an alternative to improved windows and thermal mass to another. In a subsequent survey of occupants, most said they preferred the naturally ventilated floor. Doggart (2000) reported that due to the growing understanding of the importance of windows, Dutch Health Codes now require that no one should sit more than 6 m away from window for any extended period.

Clements-Croome and Kaluarachchi (2000) also found that a lack of personal control was a major complaint for office workers. In two separate studies of officer worker satisfaction with the indoor environment (N=100; N=120) in England, the authors found that workers perceived they had very little personal control in adjusting temperature, lighting and ventilation according to individual needs. Using a self-report questionnaire, the authors asked respondents to describe their office environment, job status, health, productivity, job satisfaction and how much personal control they feel they have on a seven-point scale. Respondents were also asked how much their office environment affected their productivity at work (from decrease of 40% or more to increase by 40% or more).

Overall, the authors found that respondents who reported more personal control over temperature, ventilation and lighting also reported greater self-rated productivity. Moreover, a complaint expressed by most occupants was that they had no access to a window and that they were “deprived of a view to the outside which resulted in depressing conditions” (p. 156). The majority of occupants stated that a view to a green area would be ideal, but they would settle just to have an outside view. These findings are consistent with Wyon’s (2000) and Doggart’s (2000) research and suggest that access to a view of outside is not only important for its restorative quality but also for enhancing one’s control of the environment.

5.0 Summary and Discussion

The overall thrust of the research findings reviewed here is that people prefer windowed rather than non-windowed places and windows, particularly windows with views of nature, are important in psychological and physical well-being. Although many of the studies have some limitations with respect to conceptual or methodological issues, the overall weight and consistency of the literature supports this general conclusion. Moreover, the thrust of the literature is consistent with the conventional wisdom that people value a view of nature and feel deprived if confined to a windowless space.

In general, research on the effects of windows and views since 1975 has been guided by the recent development of relevant psychological theories such as Attention Restoration Theory (ART; e.g., R. Kaplan & S. Kaplan, 1989) and Psychoevolutionary Theory (e.g., Ulrich et al. 1991). This trend is consistent with the research publication shift from non-psychology areas toward, primarily, environmental psychology.

In terms of research methods, early and recent research on the effects of windows on work and well-being has tended to focus on a few specific variables (e.g., sunlight, view) rather than the overall impact of windows on people. One notable exception was the work of Leather, et al. (1998). The number of variables under study and their interaction was impressive and a sets an excellent standard for related work in the area. Specifically, future research should focus on the moderating effects of a view of nature on job and environmental satisfaction, intention to quit, strain and productivity in number of different work settings.

Similarly, most studies of windows and views continue to rely on participant self-report (e.g., Butler & Biner, 1989; Clements-Croome & Kaluarachi, 2000; Doggart, 2000; Finnegan & Solomon, 1981; R. Kaplan, 1993; Laumann, et al. 2001; Leather, et al. 1998; Verdeber, 1986). However, behavioural and physiological observations are becoming more common especially in health related research (e.g., Küller & Lindsten, 1992; Ulrich, 1984; Ulrich, 1991). Behavioural observations have also been used in university (e.g. Stone, 1998; Heerwagen & Orians, 1986) and business settings (e.g., Wyon, 2000).

The most consistent finding in earlier and more recent research is the preference for natural over built views (Heerwagen & Orians, 1986; R. Kaplan & S. Kaplan, 1989; R. Kaplan, 1993; R. Kaplan et al., 1998; Laumann et al. 2001; Ulrich, 1991). R. Kaplan and S. Kaplan's (1989) ART explained this preference in terms of attentional processes that lead people to seek and benefit from restorative experiences. This restoration of effectiveness could be attained by experiencing a view that required no effort, engendered a sense of being away, had extent and was compatible with what the person was doing. In contrast, Ulrich, et al. (1991) explained this preference for a natural view in terms of an evolutionary stress-related process that rewarded humans who quickly and easily learned how to restore themselves after stressful activities and sought nature as a source for food and safety. The main difference between the theories appears to be the role of cognition in the restoration process. Ulrich, et al. (1991) appear to avoid allowing cognition to play a role in the stress process as compared to R. Kaplan and S. Kaplan (1989) and S. Kaplan (1995) who argue information processing can occur rapidly and without consciousness.

It is clear that theory building with respect to why people prefer natural rather than built views is not complete. Indeed, S. Kaplan (1995) offered an integration of these two main perspectives. Recall the fundamental difference between ART (R. Kaplan & S. Kaplan, 1989) and Psychoevolutionary Theory (Ulrich, et al. 1991) was the role each gave to cognition processes, most notably directed attention. S. Kaplan (1995) focused on the sources of stress in his integration and argued that stress resulted from resource inadequacy. Resource inadequacy is determined via appraisal (for direct threats of harm), via intuition or pre-attentive processes (for perceptual patterns of harm) or occurs through gradual depletion. Although resources may be external to the individual the psychological resources are the major limiting factor for the individual. Specifically, S. Kaplan (1995) argued that an overall, pervasive resource would be necessary to meet the complexity of human challenges. Moreover, this resource would be subject to depletion and subsequent inadequacy if not restored. Not surprisingly, S. Kaplan (1995) points to directed attention as meeting these requirements because of the central role of selectivity in human information processing. Thus, S. Kaplan (1995) argued that the integration of attention restoration and stress-related models was possible by focusing on directed attention as a major resource for coping with challenges. The problem with this integration is that stress and attention are often confounded (e.g., Bohnen, et al. 1990) and this will likely cause problems for research flowing from this conceptualization.

The more recent research reviewed in this paper pointed to complex relations between humans and their access to a view of outside. People have preferences for the size and number of windows in various places according to the function of the space (Butler & Biner, 1989) and even the task of the individual (Stone, 1998). Consistent with earlier research in school settings where windows did not effect performance (e.g. Larson, 1965), access to a window does not appear to influence productivity in office tasks (Stone, 1998). However, a view of nature does influence workers perceptions of job satisfaction (Finnegan & Solomon, 1981; R. Kaplan, 1993; Leather, et al. 1998), interest value of the job (Finnegan & Solomon, 1981, R. Kaplan, 1993), physical working conditions (Finnegan & Solomon, 1981), life satisfaction, (R. Kaplan, 1993) and intention to quit (Leather, et al. 1998). Having access to a view of nature at work also seemed to act as a buffer of strain (Leather, et al. 1998).

In terms of the effects of window views on health, a number of recent studies continue to point towards a positive relationship. Recovery times and analgesic intake of surgical patients were less for those with a view of nature (Ulrich, 1984) and in-patients were very critical of windowless spaces (Verderber, 1986). Moreover, the recovery from stressful events appeared to faster and more complete when people were exposed to natural rather than urban environments immediately after the stressor

(Ulrich et al., 1991). This latter finding is consistent with buffering effects of a natural view on strain found in office workers (Leather et al., 1998).

Complex physiological processes related to windows have also been identified in healthy children (Küller & Lindsten, 1992). Classrooms without windows were shown to disrupt basic hormone patterns in children and this in turn influenced the ability to concentrate and co-operate. These research issues continue to be particularly salient in northern countries such as Sweden where average daylight hours are shorter (Küller & Lindsten, 1992).

Finally, research has shown that openable windows provide an element of individual control to workers by allowing them to adjust their office microclimate. Workers continue to express a desire for openable windows (Doggart, 2000) and those who reported more personal control over temperature, ventilation and lighting also reported greater self-rated productivity (Clements-Croome & Kaluarachi, 2000). Actual productivity was also seen to increase when these types of personal controls were in place (Wyon, 2000).

The present interest in environmental psychology will likely ensure continued research effort in the area of windows and their effects on work and well-being. Although window size and position issues will continue to be of interest, the recent trends toward explaining the quality of views and their effects on psychological well-being will undoubtedly consume the majority of the research effort. This, coupled with understanding the complex interactions of physical (like view and sunlight) and psychological variables (like attention and stress) will continue to develop current theoretical perspectives.

6.0 References

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