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WHEN BUILDINGS DON'T WORK: THE ROLE OF ARCHITECTURE IN HUMAN HEALTH

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Abstract

We spend upwards of 90% of our lives within buildings, yet we know much more about the effects of ambient environmental conditions on human health than we do about how buildings affect our health. This article employs the heuristic of psychological stress to generate a taxonomy of architectural dimensions that may affect human health. Specific interior design elements illustrating each of these architectural dimensions are provided. There is little existing evidence that specific design features directly impact human health. The aim of this article is to provoke further thinking and research on this possibility.

Introduction

People spend more than 90% of their lives within buildings. Yet we know much more about how ambient environmental conditions affect human health than we know about how the built environment influences health. There is very little direct evidence that characteristics of the built environment can affect human health. The aim of this paper is to provoke additional thinking and research on properties of the built environment that can adversely affect human health. A heuristic that may provide some insight is the concept of stress (Saegert, 1976; Zimring, 1982).

Stress occurs when there is an imbalance of environmental demands and human resources (Evans & Cohen, 1987). This article develops a preliminary taxonomy of design characteristics that have the potential to challenge human adaptive coping resources. We acknowledge that stress is a dynamic process that depends heavily upon individual coping resources. However, until we understand more about how salient properties of typical, everyday interiors challenge human coping capacities, our understanding of environment and human health will remain incomplete.

Below we describe five dimensions of the designed environment that potentially could affect human health by altering stress levels. The proposition that stress significantly contributes to physical health is well established (Cohen *et al*., 1995). Most research on stress and ill health has focused on personal variables (e.g. Type A behavior) or social conditions (e.g. social support) (Kiritz & Moos, 1974; Taylor, Repetti, & Seeman, 1997). With the exception of ambient environmental stressors such as noise, traffic, crowding, and air pollution (Evans, in press; Evans & Cohen, 1987), very little attention has been paid to the potential role of the built environment in human health. In the next section five architectural dimensions are defined and linked to stress. For each dimension, ideas are presented about specific interior design elements that constitute that particular dimension.

Linking Architectural Dimensions to Stress

Stimulation

Stimulation describes the amount of information in a setting or object that impinges upon the human user. Intensity, variety, complexity, mystery and novelty are specific design qualities pertinent to stimulation. Human beings function optimally with moderate levels of stimulation. Lack of stimulation leads to boredom or, if extreme, sensory deprivation. Insufficient stimulation may also deprive

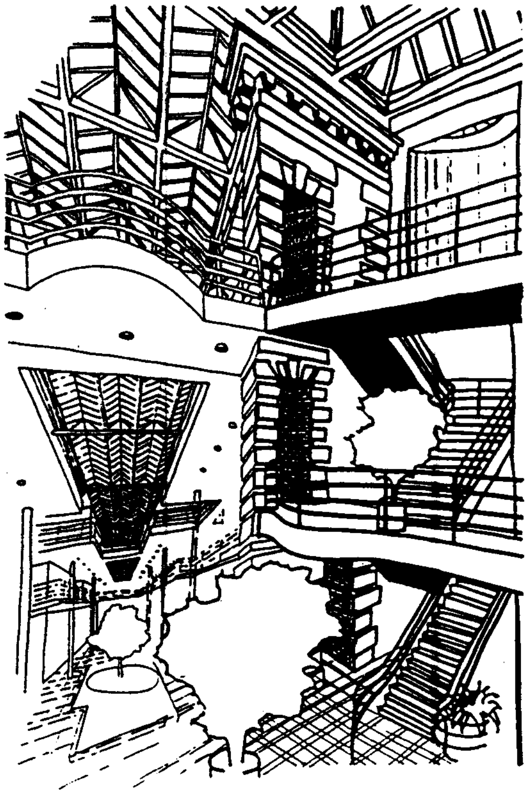

FIGURE 1. High levels of complexity created by variety and intensity lead to an overabundance of stimulation. The sheer diversity of elements and size of the space combine to overload the senses. The space lacks any strong unifying theme or pattern.

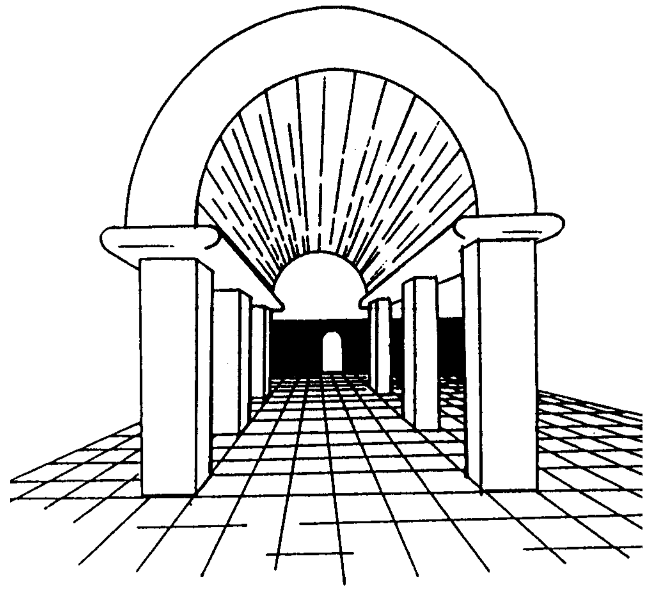

FIGURE 2. Mystery, the promise of further information, invites the user to explore the scene further. Partially occluded spaces and views, embedded spaces, and the suggestion of additional interesting spaces foster mystery.

the human organism of practice in successfully accommodating environmental challenges. Too much stimulation causes distraction and overload which interfere with cognitive processes that demand effort or concentration. Overstimulation makes it difficult to focus attention and interrupts ongoing, planned action patterns (Wohlwill, 1974).

Levels of stimulation are influenced by properties of interior settings such as intensity, complexity, and novelty of stimulus characteristics. Loud noise, bright light, unusual or strong smells, and bright colors, particularly at the red end of the spectrum, all appear to increase stimulation (Berlyne, 1971; Mehrabian & Russell, 1974). Crowding and inappropriately close interpersonal distances increase stimulation (Aiello, 1987; Baum & Paulus, 1987). Extremes of stimulus intensity and very complex or incoherent patterns of stimulation are potentially stress-inducing. A typical example of such an environment is shown in Figure 1.

Exposure to visual and acoustic stimulation is strongly influenced by layout, circulation systems, and the individual's location in space. The shape and orientation of an interior space directly influence stimulation levels. Adjacencies to sources of stimulation and proximity to circulation paths can directly affect stimulation levels. Location in space and room shape can both affect visual exposure—the extent to which others can see a person in a room (Archea, 1977). The visual and acoustic properties of barriers can obviously affect stimulation levels in terms of the degree of shielding they provide.

People like small amounts of change but do not adapt well to large amounts of variation. Thus, familiarity and routine will influence reactions to stimulation levels. Over time we gain coherence with a setting but lose our sense of involvement and interest since the challenges of exploration and discovery diminish (Kaplan & Kaplan, 1982). People need enough complexity and mystery to provide challenging opportunities so that meaningful problem solving can happen. Complexity refers to the degree of variety and diversity in a setting. Mystery indicates the promise of further information with continued exploration. Partial vistas, spaces that are not fully comprehensible without exploration, and building layout configurations that portend but not restrict what is ahead contribute to mystery. Too much complexity or mystery makes interiors confusing and unanalyzable; too little renders prediction trivial (Kaplan & Kaplan, 1982). This is illustrated in Figure 2.

Coherence

Coherence refers to the clarity or comprehensibility of building elements and form. Ambiguity, disorganization, and disorientation are major impediments to coherence. Purposive actions require legible interiors. Coherence enables users to make reasonable deductions about the identity, meaning and location of objects and spaces inside of buildings. Coherence is inversely related to complexity and directly related to the clarity of thematic or underlying patterns of stimulation. Multiple, repetitive features, underlying expression of rules, and thematic continuity, all contribute positively to coherence (Lynch, 1960; Kaplan & Kaplan, 1982).

Stress can occur when changes or disruptions in physical surroundings make prediction difficult. Incoherence can also arise from disorganization where it is difficult to discern the underlying form or pattern of spaces. Incoherence is also caused by mixed or ambiguous cues about prescripted behaviors in a setting (e.g. what behaviors are appropriate). Barriers that are nonsynchronous with behavior setting functional boundaries elevate incoherence plus increase the potential for misfit between organizational objectives and design (Bechtel, 1976). Conflicting information from adjacent design elements or abrupt shifts in size, color, texture, or stimulation levels can heighten stress. Highly ambiguous spaces may cause stress because people cannot make sense out of them—their meaning, function, or even their basic form and composition are hard to discern. This is shown in Figure 3.

Legibility, the ease with which one can comprehend the spatial configuration of an interior space, is a critical component of building coherence. Legibility in interiors is enhanced by regular geometric building shapes (Weisman, 1982), distinctive interior markings (Evans, 1980) and views of the external environment (Garling *et al.*, 1986). Good signage and other navigational aids contribute to building legibility, although their ability to compensate for a disorienting space is limited (Passini, 1984; Zimring & Gross, 1991).

Given extensive research on wayfinding at the urban scale showing this, it is likely that distinctive, interior landmarks located at decision nodes and at major path termini and origins would facilitate coherence in buildings (Appleyard, 1976; Carpman *et al.*, 1986; Evans, 1980). Similarly, circulation patterns aligned with building facades, connected at right angles, and providing visual cues about progression toward goal points, ought to be more legible (Evans, 1980).

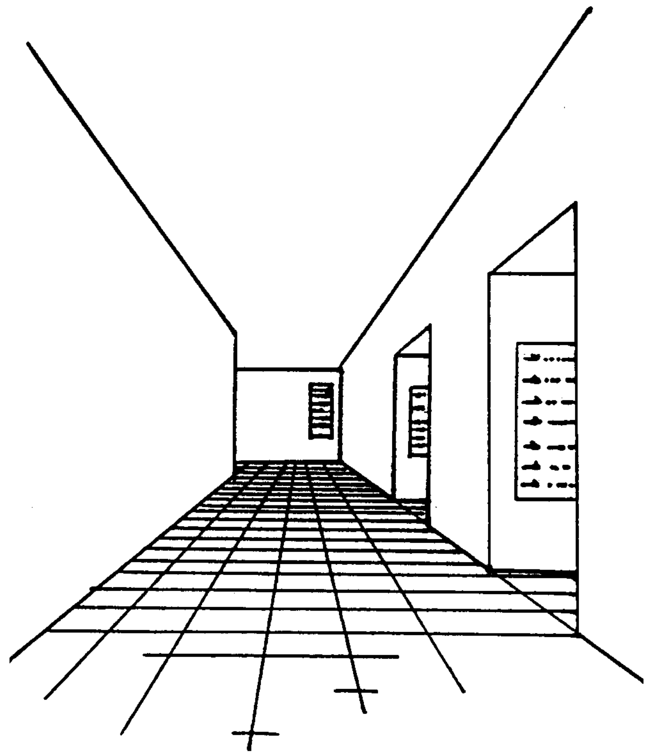

FIGURE 3. This space is incoherent for several reasons: too much information in the signage; the space is homogeneous; it is hard to formulate a mental map of the overall plan or configuration of the space; comprehending one's location in the building is difficult.

Affordances

We utilize interior spaces according to our understanding of the functions that they provide us. We also rely on information systems to provide feedback about building or equipment performance. When we are unable to readily discern the functional properties of a space or incorrectly gauge building or technological function, misaffordances occur (Heft, 1997). An example of misaffordance is shown in Figure 4.

Ambiguities or misinformation about the functional meaning of interior elements can occur for several reasons. Rapid changes in visual access produced by movement across a sharp vertical or horizontal barrier can cause marked disorientation. Corners, entryways, and stairs are sometimes designed so that little is discernable about impending space until one has crossed the barrier. Many accidents in buildings are attributable to this misaffordance (Archea, 1985).

An ill affordance may also occur when ambiguous or conflicting information is present. A typical example of such a misaffordance is a single step

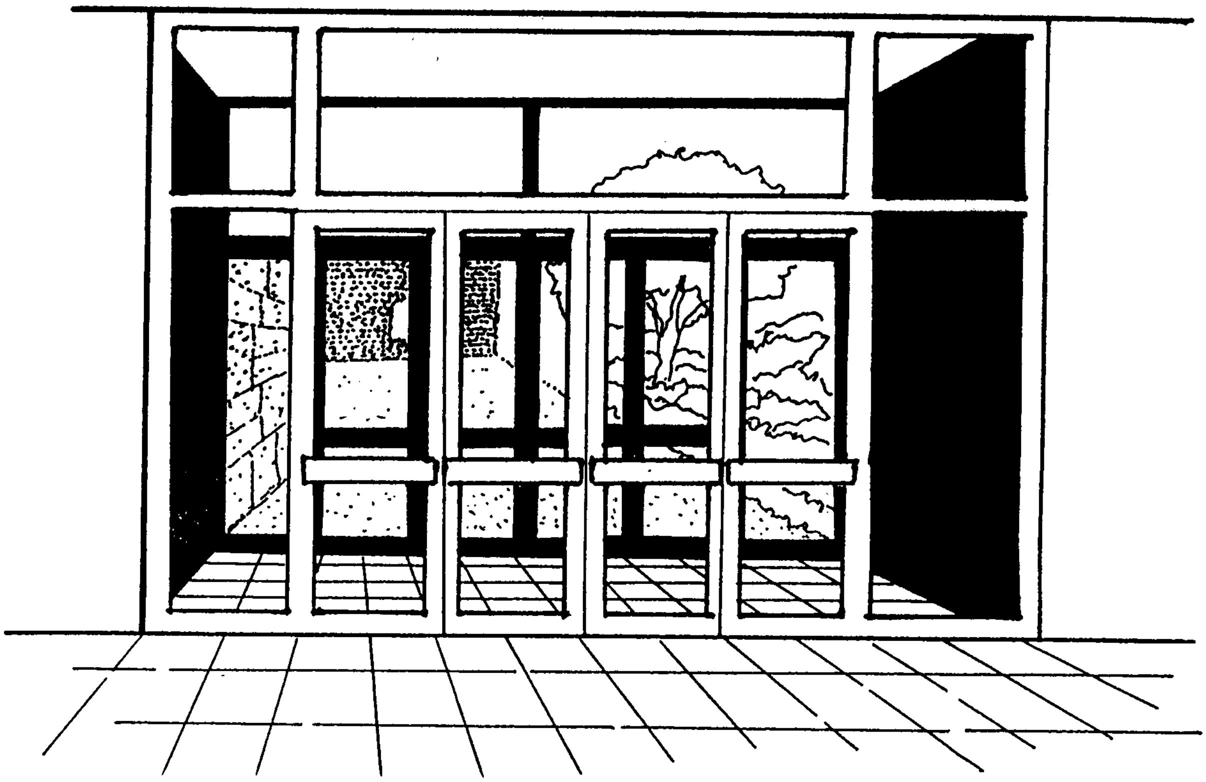

FIGURE 4. These doors illustrate a misaffordance because it is not clear how to utilize the doors. On which side and in what direction should one operate the doors?

down from one identical surface to another. The ledge of the step is indistinguishable from the lower surface, obscuring any cues for a change in depth. Several optical illusions function by pitting competing cues for distance and or size against one another.

Ambiguity can also be caused by vague or missing cues for use or too many competing cues. When a building user cannot see what or how something in the space functions or when confronted with cues about purpose or use which are vague or in conflict, human reactions are likely to encompass frustration, annoyance, and, on occasion, even hostility or helplessness (Norman, 1989). Design features that provide little or no feedback about the consequences of their use can also evoke negative reactions. Confusion about use can also arise when the user and designer's respective mental models do not coincide. For example a 'You Are Here' indicator in a directional system that is not in the same Euclidean orientation as the user is very difficult for most people to utilize (Levine, 1982). Programming one's VCR is perhaps the contemporary archetype for a nearly insurmountable user-designer gap in understanding an intended use.

Control

Control is defined herein as mastery or the ability to either alter the physical environment or regulate exposure to one's surroundings. Physical constraints, flexibility, responsiveness, privacy, spatial syntax, defensible space, and certain symbolic elements are key design concepts salient to control. Physical constraints that reduce choice or behavioral options can produce or exacerbate stress (Glass & Singer, 1972; Evans & Cohen, 1987). Prolonged experiences with uncontrollable environmental conditions have also been associated with learned helplessness (Cohen *et al.*, 1986). Helplessness, in turn, is clearly related to psychological distress and may be associated with physical disease (Peterson *et al.*, 1993). Insufficient spatial resources, inflexible spatial arrangements, and lack of climatic or lighting controls, all threaten individual needs to effectively interact with interior space (Hedge, 1991; Sherrod & Cohen, 1979).

Spatial resources include both density and volume. In addition to amount of available space, visual exposure, structural depth, openness of the perimeter, brightness, and extent of view have all been

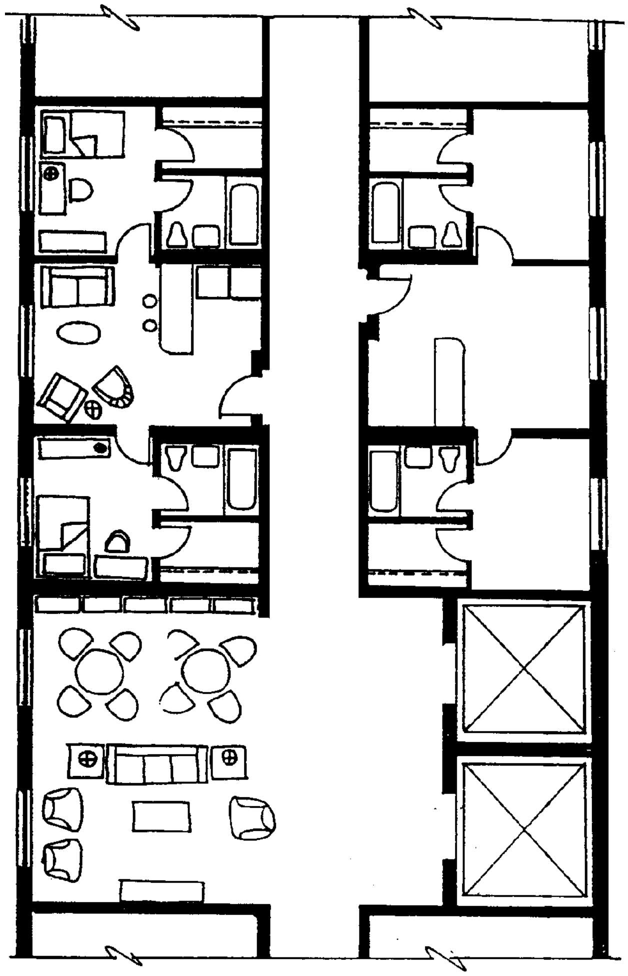

FIGURE 5. Privacy in this dormitory is well supported by a spatial hierarchy. Spaces for solitude or intimacy, small groups, and for larger social gatherings are all accommodated and well defined.

shown to moderate the effects of crowding on human behavior (Evans, 1979). Flexibility can be provided by degree of perimeter openness, moveable partitions, and semi fixed furniture (Sommer, 1969).

Another interior design element influencing control is responsiveness. Responsiveness refers to the clarity and speed of feedback one receives when acting upon a setting or object (Wachs, 1989; Wohlwill & Heft, 1987). Particularly important to responsiveness is differential feedback. Distinct actions in a responsive environment produce unique feedback about the consequences of each act. In addition to differential feedback, responsiveness is also sensitive to the latency between actions and feedback. The longer the delay, the poorer the responsiveness. Unresponsive environments appear to be a major factor in the development of helplessness, particularly among children (Cohen *et al.*, 1986).

Privacy, or the ability to regulate social interaction, is a major contributor to a sense of control in interior settings (Altman, 1975). Perhaps the central design element influencing privacy is spatial hierarchy. The provision of spaces ranging from places that provide solitude and intimacy, through small group meetings, to those that foster contact with the public, constitute the major components of spatial hierarchy within buildings (Alexander, 1972; Greenbie, 1981; Zimring, 1982). Size, location, and degree of stimulus isolation of interiors, influence the effectiveness of buildings to provide privacy. The scheme of the dormitory in Figure 5 is a good example of a design providing privacy.

The extent to which spaces are interconnected via doorways and passages influences social regulation capabilities of spaces. The visual or acoustical permeability of barriers affects social interaction potential (Zeisel, 1981). Depth refers to the number of spaces one must pass through to get from one point in a structure to another (Hillier & Hanson, 1984). Deeper spaces afford more privacy and enhance ability to regulate social interaction. They also affect visual access and visual exposure (Archea, 1977).

The functional distance between spaces also influences social interaction potential (Festinger *et al.*, 1950). The directness of doorway openings and the intersection of circulation paths influence social interchange. Focal points provide socialization and small group interaction opportunities. Well-designed focal points include activity generators, are centrally located, function as neutral territories, and provide prospective visual access (Bechtel, 1976; Becker, 1990), as shown in Figure 6.

Furniture arrangements can directly affect social interaction potential (Sommer, 1969). Sociopetal furniture arrangements encourage interaction by moveable components, provision of comfortable interpersonal distances, ease of eye contact, and physical comfort during conversation. Sociofugal furniture arrangements that are inflexible and that orient people in space so that eye contact is difficult or interpersonal distances that are inappropriately close or far have the opposite effect, discouraging social interaction.

There are also major symbolic elements of control in design. Large size, sterility, uniformity of materials and furnishings, and restrictions on personalization options, all contribute to the institutional quality of buildings. An important quality

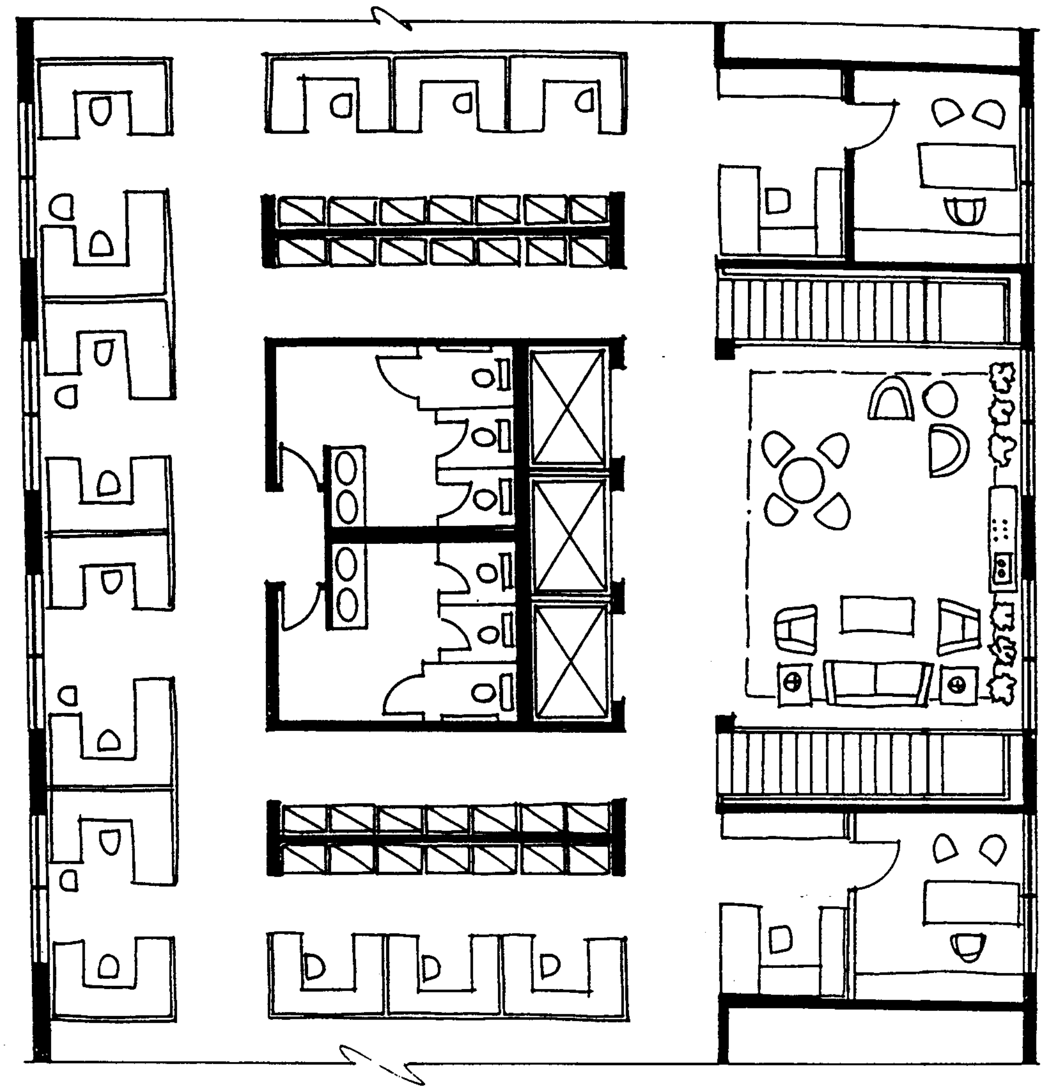

FIGURE 6. Focal points facilitate social interaction. In this office building, the focal point is located centrally, near several major circulation paths, and can be viewed prospectively, prior to making a behavioral commitment to the space. The focal point is neutral territory, has a pro-social furnishing arrangement, and provides coffee and food which attract and hold interest for prospective users.

of institutionalization may be a sense of powerlessness among users (Rivlin & Wolfe, 1985).

Jurisdiction over space is enhanced by actual or symbolic ownership. Good surveillance opportunities, clearly delineated and visibly marked boundaries, semi-public spaces that provide community meeting space, and smaller, subunits of large living complexes can all enhance feelings of territoriality (Newman, 1972; Kaminoff & Proshansky, 1982; Taylor, 1988). Territoriality enables regulated use and occupancy of space. It also enhances the expression of personal or group identity (Brown, 1987; Taylor, 1988).

Although our analysis has focused primarily on interior elements that reduce control, settings can afford more opportunities for control than the individual desires or has the competency to utilize. Lawton (1989), in particular, has emphasized the importance of matching individual competencies with design resources. Among the elderly some individuals with limited capabilities require more restricted environmental opportunities, which the general public would find oppressive.

Restorative

Restorative qualities define the potential of design elements to function therapeutically, reducing cognitive fatigue and other sources of stress.

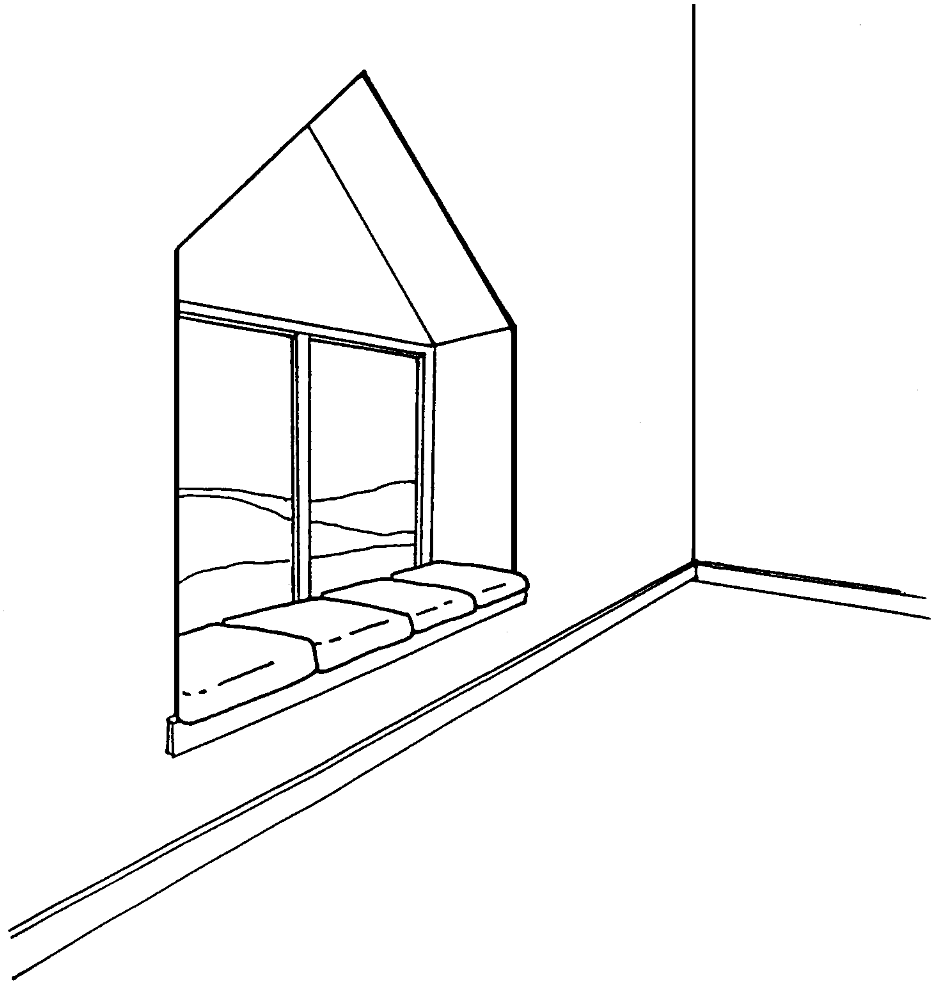

FIGURE 7. Stimulus shelters provide opportunities for solitude and a chance to get away from overstimulating situations or routines of work and daily life. Such spaces may buffer stress by providing a temporary respite; a time out from prolonged or high levels of environmental demands or stressors.

Restorative elements of design represent a theoretically distinct category. Rather than directly producing stress, restorative elements provide resources that can attenuate stress. Thus design can function as a coping resource that can help building occupants alter the balance between environmental demands and personal resources. Restorative design elements include retreat, fascination, and exposure to nature. Certain types of settings such as religious sanctuaries, hospitals and other therapeutic facilities are explicitly designed with restorative intent. Such settings may uplift the human spirit and promote healing.

Design may offer opportunities to combat stress by providing rest, recovery, or contemplation. Reflective activities in particular demand a minimum of distraction and some degree of isolation. Privacy nooks and stimulus shelters (see, for example, Figure 7) may offset some of the stressful impacts of high levels of stimulation. Having a space to retreat to, for example, appears to buffer some of the negative impacts of residential crowding and noise (Wachs & Gruen, 1982).

Focused or voluntary attention can create mental fatigue. Restoration entails the replenishment of cognitive capacity and is fostered by several types of design characteristics. Involuntary attention or fascination facilitates recovery from mental fatigue (Kaplan & Kaplan, 1989). Fascination can be created by design elements such as window views, burning fireplaces, and various displays (e.g. aquarium, moving water) (Coss, 1973). Direct contact with natural elements as well as views of nature provide restoration (Hartig & Evans, 1993; Kaplan & Kaplan, 1989; Ulrich, 1993), as shown in Figure 8.

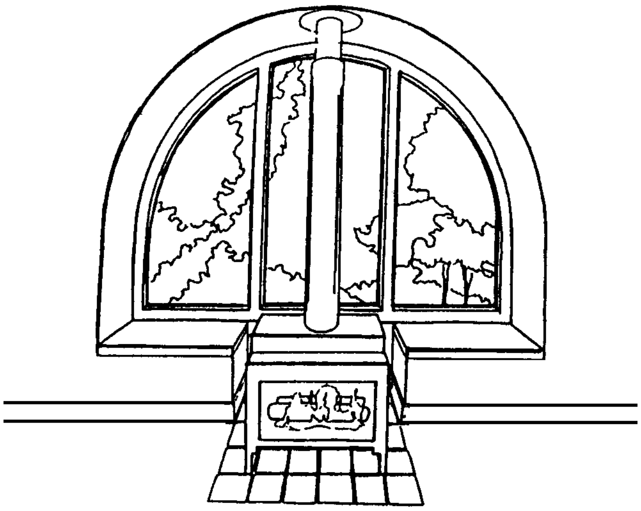

FIGURE 8. Restoration is supported by design elements that draw our attention effortlessly. Mental fatigue is reduced by views of nature as well as other design elements that foster involuntary attention or curiosity. Fascination helps replenish mental reserves depleted by sustained concentration or efforts to pay attention.

Summary and Conclusions

Building design has the potential to cause stress and eventually affect human health. At present we know very little about the potential role of interior design elements in human health. Stress which occurs when environmental demands exceed coping resources may be a useful heuristic to conceptualize design elements potentially relevant to human health.

Stimulation, coherence, affordance, control, and restoration are a preliminary set of environmental dimensions inter-related to stress. Each of these dimensions, in turn, consists of explicit interior design elements (see Table 1). Better understanding of these dimensions coupled with greater knowledge of their underlying physical properties may enable designers to more consciously create healthy environments. Theoretically, scientists have largely ignored the potential role of the designed environment to contribute to human health.

A major weakness of our taxonomy is the lack of empirical evidence linking the design elements we have identified to human health. At present the knowledge base is simply not there. In addition this taxonomy was derived with the heuristic of psychological stress. However, stress is only one of several

TABLE 1
Interior design elements that may influence stress

Stimulation	*Affordances*
intensity	ambiguity
complexity	sudden perceptual changes
mystery	perceptual cue conflict
novelty	feedback
noise	
light	*Control*
odor	crowding
color	boundaries
crowding	climatic & light controls
visual exposure	spatial hierarchy
proximity to circulation	territoriality
adjacencies	symbolism
	flexibility
Coherence	responsiveness
legibility	privacy
organization	depth
thematic structure	interconnectedness
predictability	functional distances
landmark	focal point
signage	sociofugal furniture arrangement
pathway configuration	
distinctiveness	*Restorative*
floorplan complexity	minimal distraction
circulation alignment	stimulus shelter
exterior vistas	fascination
	solitude

underlying processes to explain how or why the built environment might affect human health. Other equally viable pathways warranting consideration include negative emotions such as anxiety or depression (Taylor *et al*., 1997) or health promotion activities such as safety compliance or lifestyle alterations (e.g. exercise, smoking cessation) (Stokols, 1992).

The principal aim of this article has been to provoke further thinking and research on characteristics of the built environment that can influence human health. We currently know much more about the role of ambient environmental quality in human health than we do about the role of the built environment in people's health. This state of affairs is puzzling when we consider how much more we are exposed to interior environments than we are exposed to exterior, ambient environments. In addition to the obvious practical value of articulating a taxonomy of interior design elements relevant to health (Archea & Connell, 1986), how we define and then measure a set of physical properties of the built environment relevant to health, turns out to be a major theoretical challenge (Lawton, in press).

Notes

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