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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – I – Perceiving Interior Spaces – SDE 1106

I. Introduction

(Perceiving Interior Spaces)

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We shape our buildings, thereafter they shape us.

—Winston Churchill (1943)

Winston Churchill's well-known wartime remark succinctly captures the fact that the connection between people and the places in which they dwell is a two-way relationship. It is a point that is surely understood, at least implicitly, by interiors theorists, researchers, and practitioners. But what does the field of psychology have to say about the two halves of this reciprocal bond? Here we review the main theories and findings from the field of environmental psychology that can inform our understanding of the links between people and places.

PART I: HOW PEOPLE SELECT AND AFFECT

INTERIOR ENVIRONMENTS

Interactionist theorists in psychology have long recognized that individuals select and create their social environments (e.g., friendships, social activities) to match and reinforce their dispositions, preferences, attitudes, and self-views.1 David Buss used the terms "selection," "evocation," and "manipulation"2 to delineate three broad modes of interacting with one's environment. Th e modes were originally developed in the context of social interactions, but they can easily be applied to physical environments to understand the ways in which humans affect interiors. People select existing spaces with interior features that they believe will allow them to express their personalities and preferences and will allow them to engage in their desired activities: an extravert may purchase a house with a large kitchen to facilitate entertaining, where the introvert prefers the property with a library. People evoke environmental features by engaging in activities that leave material traces in their wake—examples include a messy desk or a diverse collection of books on the shelves. And, perhaps of greatest relevance to interiors scholars, individuals manipulate their existing spaces, sometimes with the assistance of a professional; thus, a person may choose décor that reflects a cultural identity, use products to affect the ambient conditions, or alter the arrangement of furniture to facilitate desired activities.

The above three modes of interaction can achieve various psychological goals. But what are psychological motivations driving individuals to select, evoke, and manipulate their environments?

Psychological Motivations for Affecting Spaces

Broadly, people alter their spaces for three reasons:3 they want to broadcast information about themselves, they want to aff ect how they think and feel, and they inadvertently aff ect their spaces in the course of their everyday behaviors.

Identity Claims

One of the ways in which people personalize their interiors is by adorning them with "identity claims"—deliberate symbolic statements about how they would like to be regarded.4 Posters, awards, photos, trinkets, and other mementos are often displayed in the service of making such statements. One's intended audience must understand the intended message, so identity claims tend to rely on objects with shared meanings. Th e specifi c content of identity claims may vary according to the identity of the anticipated "other," with diff erent audiences evoking diff erent self-presentational motives—items that impress your friends may not have the same eff ect on your coworkers.

Thought and Feeling Regulators

Interior environments are the contexts for a wide range of activities, ranging from relaxing and reminiscing to working and playing. The effectiveness with which these activities can be accomplished may be affected by the physical and ambient qualities of the space. As we shall see in Part II of this chapter, the features of an interior environment can have an impact on the individuals who occupy those spaces. It can be hard to relax with a lot of noise around, and it is difficult to concentrate when surrounded by distractions. Th e environmental features conducive to one activity (e.g., socializing) are not always the same as the environments conducive to another (e.g., relaxing).

Th us, many features of interior environments owe their presence to their ability to affect the feelings and thoughts of the occupant. Elements used to regulate emotions and thoughts could include photos of family, keepsakes, the color of the walls, and the music in the stereo.

Behavioral Residue

Many behaviour performed in interior environments leave some kind of discernible residue in their wake. For example, the act of tidying up one's office could result in an organized filing system. Th e term behaviour *residue* refers to the physical traces left in the environment by behavioural acts. Sometimes it is the lack of an act that leaves a residue.

For example, the dishes in the sink are the residue of the fact that you did not clean up after eating. Th ere are four important features of behavioural residue. First, behavioural residue accumulates over time so it tends to reflect repeated behaviours rather than one-off acts. Second, in addition to the residue of behaviours already performed, interior environments may also contain clues to anticipated behaviours; for example, a new deck of cards and a set of poker chips suggest an occupant is planning a game of poker. Third, in addition to containing remnants of activities performed within a space, interior environments also contain residue of behaviour performed beyond the immediate surroundings.

Fourth, different behaviours can result in similar environmental manifestations—a messy room could indicate sloth, or it could indicate a person who is overwhelmed with other responsibilities. Note that three motivations—identity claims, thought and feeling regulators, and behavioural residue—are not mutually exclusive. For example, the snowboard in the corner of a room may indeed reflect exterior behaviours, but the occupant's decision to display the snowboard (rather than stow it in a closet) may also reflect a desire to make identity claims or could serve as a reminder of happy times.

The Expression of Psychological Attributes in Interior Environments

Most past research on manifestations of individual diff erences in physical environments has focused on bedrooms/dorm rooms and offi ces. For example, one study examined the ways in which adolescents decorated their bedrooms, focusing on the diff erences between the items found in boys' and girls' rooms.12 Another study documented the features and artifacts found in living spaces and offi ces occupied by liberals and conservatives; 13 the study showed, for example, that conservative occupants tended to display more sports-related décor and liberals tended to have a greater variety of books in their

spaces.

Lindsay T. Graham, Carson J. Sandy, and Samuel D. Gosling14 reviewed the research documenting connections between individuals and features of physical spaces, such as bedrooms or offi ces. Th e review indicated that many diff erent individual diff erences can be expressed in physical spaces. Several studies framed their analyses in terms of the widely used Big-Five model of personality.15 Th e evidence suggests that all fi ve dimensions can be manifested in living spaces, but openness and conscientiousness appear to leave the biggest imprint.16 High-openness individuals tend to occupy spaces that are classifi ed as "distinctive" and contain a high diversity of content items (e.g., books, magazines) and indicators of interest in various places and cultures (e.g., maps, souvenirs).

Th e spaces occupied by conscientious occupants tend to be clean, organized, neat, and uncluttered. Openness and conscientiousness were the traits most clearly manifested in physical spaces, but others did get expressed. For example, extroverts engaged in more personalization and had offi ces that were classifi ed as more inviting than offi ces occupied by introverts. One way the invitingness can be expressed is in terms of a relatively open chair and desk arrangement.

In addition to the big fi ve, a varied assortment of other traits have been examined, including status, need for interpersonal relationships, and locus of control. In one study, the likelihood of dropping out of college was predicted from the degree of personalization within a room;18 specifi cally, individuals who personalized their rooms had lower dropout rates than did individuals who personalized them less. When the dropouts did personalize their spaces, their décor tended to be related to family and the loved ones. A similar study conducted some years later at the same university showed the opposite eff ect—dropouts used decoration more than nondropouts.19 Th e discrepancies in fi ndings were attributed to the small sample size and composition (only males were assessed) in the earlier William Hansen and Irwin Altman study. However, both studies found that dropouts were inclined to decorate their spaces with photos of family and friends. One interpretation of these fi ndings is that the dorm-room décor consisted of identity claims, expressing commitment to the new college life in the nondropouts (who decorated with college-related emblems) and thought and feeling regulators designed to

counter feelings of loneliness and isolation and reluctance to commit to college life in the dropouts (who decorated with reminders of home).

One study of workspaces20 examined the connections between how a space was personalized and status. Occupants recorded the items in their workspace and gave details regarding their job, such as position and tenure within the company and how many hours per week they worked. Status in the organization was a strong predictor of the amount of personalization in an offi ce space. But these individual diff erence variables were only part of the story.21 Testifying to the complexity of the connections between occupants and their spaces, the research also revealed that other factors such as the type of workspace (e.g., a private, enclosed space vs. an open cubical) and the company's personalization policies infl uenced the types and amount of personalization of the workspaces.

Several studies identifi ed substantial diff erences in the ways in which males and females personalized their bedrooms and offi ce spaces. In general, women tend to decorate their spaces more than men do. In terms of specifi c items, compared with men, women tend to have more stuff ed animals, candles, lotions, trinkets, and photos of close others such as family and friends. Men tend to have more sports equipment, CDs, stereos, and achievement-related items. Th ese trends have been identifi ed in several populations, including young children,22 adolescents,23 and college-age adults.24

In short, research over the past few decades has documented the ways in which individuals aff ect their interior spaces. But how are these spaces perceived and how do features of these spaces aff ect the occupants? We address these questions next.

Environmental Perception and how Interior Environments affect people:

Social scientists and designers often work together to understand how individuals interact with their environments.25 Doing so ensures that spaces in which we spend large amounts of time are functional and enjoyable. Research by environmental psychologists illuminates how particular features of indoor settings infl uence the attitudes and behaviors of building occupants and visitors.

Th is section of the chapter fi rst introduces three important ideas about environmental perception: probabilistic functionalism, aff ordances, and collative properties. Th en it off ers examples of environmental factors that aff ect satisfaction, health, and performance in residential and workplace buildings. Th ese approaches to environmental perception and research fi ndings can be applied to spaces in the real world, where comfort and productivity are important design outcomes.

Environmental Perception

As an interior designer or as a client, how might one look at a room? Th e simple answer might be, in terms of possible colors, décor, and layout. However, environmental psychologists suggest three other ways that might be fruitful: probabilistic functionalism, aff ordances, and collative properties.

Probabilistic Functionalism

Th is infl uential approach is based on the work of Egon Brunswik,26 who proposed that the way people perceive and interpret settings are best described by what he called the "lens model" (Fig. 49). In this model, information about a setting originally manifests itself as objective, distal cues (e.g., the actual height of a ceiling, the actual dimensions of the room), which are selectively perceived through proximal cues (e.g., that the ceiling is "low" and that the room is "boxy"), and lead to the perceiver's fi nal evaluative conclusion, such as, "I can't work in this space." According to Brunswik, perceivers select a

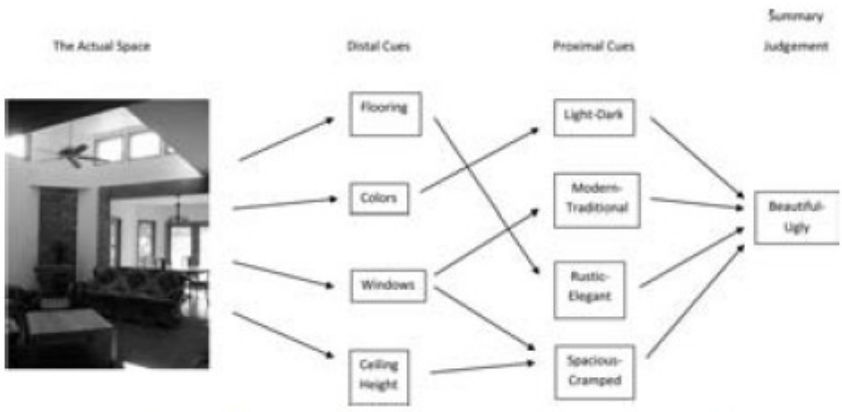

FIGURE 49 A lens model for an interior. The distal and proximal cues are examples that represent many other possibilities, and a variety of summary judgments might be considered as well. Courtesy of Robert Gifford.

subset of the many available cues in a space and reach their conclusions based on that idiosyncratic selection. Diff erent perceivers will select and weight diff erent cues. Th e successful perceiver selects the most important cues in order to function eff ectively in a setting. Th is is why Brunswik's theory is functionalist in nature.

Th erefore, probabilistic functionalism conceives of environmental perception as an active attempt to extract a useful image of a place from a large number of potentially useful environmental cues, particularly in a setting that is new to a person. For example, people who visit a highly stimulating place, such as any downtown for the fi rst time, or a large corporate workspace on the fi rst day of a job, may not be able to sort out the important cues from those that are less important. In this situation, Brunswik predicts that people will actively seek out useful cues that the perceiver thinks will lead to a safe and successful existence in the new setting.

Th e probabilistic aspect of Brunswik's theory is that each cue may or may not be a perfectly valid indicator of the true nature of a setting. Rather, each cue has a particular probability of being accurate. Everyone has experienced perceptual errors and illusions in an environment. A new employee might perceive an offi ce as good based on its large window and lovely fl ooring. However, over time in working in the offi ce, the employee might pick up on other cues, such as peeling paint or a furniture arrangement that does not facilitate work performance. With experience, the perception that the offi ce is good may shift in a negative direction. Some environmental cues are more or less accurate indicators than others.

Because of this variability in the validity or usefulness of individual cues, Brunswik integrated the idea of ecological validity into his theory. Th is refers to the degree of "truth" of the probabilistic relations between an objective environment and the distal cues that one selects for attention. Ecological validity represents the odds that a cue (or the cues as a group) will lead a perceiver to an eff ective or accurate perception of an actual space. Some cues may contribute to a highly accurate assessment of an environment, but others may not be immediately perceivable or may lead to false or undesirable impressions. For example, the widespread assumption that darker wall colors make

a room look smaller has been supported empirically.27

Brunswik further proposes that diff erent cues are given diff erent weights by perceivers, in the process called "cue utilization." Th e perceiver's conclusion about a space is presumed to be the result of this weighting process. Overall, when cue utilization closely matches ecological validity, the perceiver's understanding of an environment will accurately refl ect the objective environment. Th is is what often happens, but not always. Inaccurate cue utilization can occur and have serious effects. For example, if a thirsty hiker comes upon the clear water in the stream, the hiker may well decide that clear and moving water means the water is safe, but if those invisible pathogens or pollutants are present, the thirsty hiker may become ill from drinking the water.

Over time, people learn to pay attention to cues that validly represent a safe and functional path through work and life. Th is is what Brunswik called achievement. Although the examples given illustrate possible errors, most of our everyday perception works to keep us safe —but we had to learn. Th e child has to learn that the cherry color of that circular metal element on the stove is not safe. Th us, achievement varies: it is an indicator of the perceiver's accuracy in assessing the objective environment. Problems can also arise in situations with which a person is unfamiliar, especially those with environmental patterns that have a loose resemblance to those the person is used to. Th ese problems can range from the unimportant, such as getting momentarily lost on the way to someone's offi ce, to the fatal, such as misjudging the cues associated with a sharp curve on a highway.

Affordances

James J. Gibson28 proposed that the environment (such as interiors) can be conceptualized as being made up of substances (e.g., steel, wood, glass) and surfaces (e.g., fl oors, ceilings, walls). In Gibson's framework, arrangements of substances and surfaces are called layouts, which provide aff ordances to perceivers. Aff ordances are functions of an environment that are instantly detectable by a perceiver as useful for a particular purpose. One classic aff ordance is that a fl at horizontal expanse in front of a person aff ords walking. Another might be that a solid, horizontal surface situated about 18 in. (45 cm)

off the ground aff ords sitting. Th is idea diff ers from Brunswik's in that Gibson believed that the environment provides perceivers with an immediate, direct functional assessment of some element, rather than the assessment being processed through a set of cues that are weighted and interpreted.

Gibson's approach has helped to highlight the role of the environment in human perception. One such infl uence has been on design education programs, which often teach that color, shape, and form are the essential elements. Gibson insisted that everyday perception does not rely on these elements and that designers should not be taught to focus so strongly on form and shape; the emphasis should be on substances and surfaces.29 Th is is because, he argued, building users do not pay attention to form and shape per se, but to aff ordances, which are defi ned by substances and surfaces.

Collative Properties

Daniel Berlyne's30 approach proposes that environments contain collative properties, which border on the distinction between cognition and perception. Collative properties are attributes of a setting that cause perceivers to compare environmental details and, generally, to stimulate interest in a setting, such as a particular interior. Some examples of a space's collative properties are novelty (i.e., perceived newness), incongruity (i.e., the sense that something is out of place or does not fi t), complexity (i.e., its number of lines or shapes), and surprisingness (i.e., unexpected features).

Berlyne proposed that collative properties enhance (or do not enhance) one's aesthetic experience and desire to explore an environment through hedonic tone (i.e., the amount of beauty or pleasure experienced in a setting). Berlyne's work has motivated designers to create spaces in accordance to certain collative properties. For example, when some designers decided that modern urban forms were too simple in their lines (i.e., lacked complexity), they pioneered more curvy and articulated designs with the hypothesis that this made them more complex and thus greater in hedonic tone.31

Th is relation between complexity and preference does not apply to built environments in a linear way; rather, moderately complex settings generally elicit greater preference than either very simple or very complex settings. Berlyne's approach has helped

social scientists and designers to further understand properties of settings that reliably elicit certain perceptions. Some researchers have added to the list of collative properties. One such added collative property is fi ttingness or how well a design suits a particular setting.32

Th e theoretical approaches of Brunswik, Gibson, and Berlyne have shaped contemporary thought concerning environmental perception and its relation to design. Next, some examples of how interiors infl uence behavior and well-being will be described to highlight how social science applies its theories to learn from the users and visitors of environments designed for people.

Environmental Influences at Home and Work

Every building interior could be investigated in an eff ort to understand how its design attributes aff ect individuals, and environmental psychologists have studied restaurants, prisons, schools, submarines, the international space station, polar outposts, and retails stores, among other spaces. However, this chapter will focus on two interiors in which people spend large amounts of time, residences and workplaces. Clarifying how these places promote positive behavior and wellness is important in order to avoid designs that harm these outcomes.

At Home

Th e physical attributes of residences obviously infl uence how people feel toward, and act within, them. Of course, diff erent housing types and designs satisfy diff erent people for diff erent reasons, depending on their past experience, preferences, culture, stage of life, values, and so on. One goal of residential environmental psychologists is to understand which type of housing works best for whom, and why.

Housing quality clearly is one attribute that aff ects how people feel about their residence. Not surprisingly, individuals report greater satisfaction with their home when the physical quality of the building is greater.33 But why is this so? One answer is that when other factors are controlled for, higher-quality residences spur greater place attachment in residents. Another is that poorer housing quality is associated with more behavior

problems in children, regardless of income.

Another major design element that infl uences residential feelings and behavior is housing form. For example, in a study of new residents in which participants were asked how they felt about their new homes, over half of those who moved into a single-family dwelling stated they were “defi nitely satisfi ed,” but less than 25 percent of those who moved into an apartment said this.

Although one often hears that condominiums are increasing in popularity, most people in North America still largely prefer a single-family dwelling if they can aff ord one. Purchasing a single-family home can symbolize wealth or achievement in adulthood. Despite being more environmentally preferable (smaller carbon footprint) and usually being less expensive, apartments and condos have been associated in some studies with poorer health and wellness, partly because of high indoor density.36

However, apartments and condos obviously are not always a negative infl uence. Siting them to take advantage of natural views, if possible, can help. Elderly residents of apartments are more satisfi ed if their unit overlooks a natural setting or if there is a natural setting available near the apartment building.37 Children with visual access to nature do better in school.

Besides housing quality and form, as all interior designers know or suspect, the design of a dwelling’s interior also infl uences attitudes toward a residence. For example, individuals generally prefer higher-than-standard ceilings that are fl at or have a 4:12 slope ratio and walls that meet at ninety degrees or more.39 When shown fl oor-plan drawings, American university students preferred fl oor plans that showed the living room in the upper-right-hand corner of the drawing.As one might guess, this result is not true of everyone; for example, this preference was weaker for Israeli students.41 Much more research is necessary to form evidence-based conclusions about perceptions and preferences of room arrangements.

In contrast, colors for interiors have often been studied but not always well. Many studies have utilized small paint chips or other color samples within no particular context.Results from these studies may not generalize to full-scale interiors. One recent idea suggestion is that color preferences are based on their likelihood to succeed in evolutionarily important tasks. For example, in one study women showed a

stronger preference for red than men did, which was attributed to the division of labor in hunter-gatherer societies in which it was the women's job to fi nd ripe red fruit against a background of green leaves.43 Another approach suggests that emotions play a role: people like colors associated with things they like (e.g., blue because of water and blue skies) and dislike colors associated with things they dislike (e.g., brown for excrement).44 Yet these studies, too, used small chips or diagrams, isolated from real environments.

In one notable exception to the usual methods, Japanese researchers showed participants slides of (full) living rooms painted in diff erent colors. Th ey found that preference did not particularly depend on hue but more on saturation and brightness.45 Hue was not strongly related to preference but rather to perceived warmth. Saturation was most closely related to preference: the more saturated the wall color, the better and more comfortable the room was reported to be.

In sum, how people perceive the environmental attributes of their homes, and how those perceptions aff ect them, is complex. Th e examples above are merely that, examples of the many studies of this topic. Much more can be found in Robert Giff ord's textbook on environmental psychology,46 as well as in other sources. Physical infl uences are part of the larger picture, along with social aspects, culture, socioeconomic status, and individual diff erences, that makes research on residential satisfaction challenging and compelling.

At Work

Environmental psychologists have extensively studied work settings and often focus on the interaction between physical elements and employee productivity and well-being. An optimal design for a specifi c workplace can lead to higher employee satisfaction and lower absenteeism, and save organizations money. In fact, productivity can increase by 10 to 50 percent when better workplace designs are put in place.47 Th is section highlights the eff ects of lighting and noise as examples of social science research on the physical workplace, but it certainly does not exhaust them.

Lighting

Illumination consists of four main dimensions: source, fi xture, amount, and arrangement. Light sources in a work setting are often a combination of natural or daylighting (e.g., sunlight) and artifi cial (e.g., fl uorescent). Typical fi xtures include ceiling and desk lamps. Th e amount of light is called illuminance. Lighting arrangement refers to the angle and distribution with which light strikes a work surface (e.g., uniform or nonuniform).

Unfortunately, lighting design often overlooks human preferences and needs in favor of the need for effi ciency. Th is is the main reason why fl uorescent tubes are the dominant light source in most offi ces and industrial workplaces. Despite their relative effi ciency, employees generally do not like them. In response, many organizations have made lighting quality a priority in their decisions about offi ce renovations. Wherever possible, giving employees the kind of light they prefer, and control over it, is a good idea.49

Some research shows that employee performance improves with more light.50 Of course, optimal light levels depend on the job—someone who performs detailed work will likely require more task lighting than someone chairing a meeting in a conference room. Work surfaces are also important. Shiny surfaces can cause glare when light levels are high, especially when the light source is undiff used (e.g., a bare lightbulb). Angle also must be considered; some tasks require bright but diff used lighting (e.g., surgery), but others require sharply angled lighting to make use of shadows. For example, a textile worker searching for fl aws in manufactured cloth needs angled lighting to detect them. In general, lighting ideally should be tailored to the task and to the individual employee. Th is strategy would likely result in more task lighting being utilized at work, yielding an energy savings based on the reduction of energy needed to illuminate large spaces at excessive.51

Not surprisingly, many employees report that sunlight is desirable.52 Although daylighting, as it is also called, in the workplace can cause complaints about glare and heat, most people prefer to be located near a window. Nevertheless, greater sunlight penetration at work is associated with higher job satisfaction,53 and, of course, windows off er views of the outdoors, which also contribute to satisfaction and buff er the negative impacts of job-related stress.54

However, a balance is necessary: too much sunlight penetration is not relaxing for employees,55 and available evidence does not show that proximity to a window increases performance,56 even though it appears to reduce boredom.57

Noise

In a work setting, noise (which may be defi ned as "unwanted sound") might come from construction equipment, offi ce machinery, phones, background music, communications between coworkers, or all of these sources at once! Noise is not only about the volume of sound but also its source, predictability, content, and controllability (the motorcyclist enjoys the sound made by the motorcycle, but nearby employees may not).

Noise is a common complaint among employees. One study found that 99 percent of offi ce workers thought that noise levels caused primarily by telephones and conversations signifi cantly impaired their concentration.58

Noise impairs work performance, especially when the sounds occur at unpredictable intervals and are not controllable.59 Employees who work in very noisy environments often are more aggressive, distrustful, and irritable than those working in environments with less noise.60 Clearly, interior designers should aim to create settings in which sounds are pleasant; if noise must be part of the setting, ways should be found to give employees control over it.

Not all workplace sound is harmful or distracting. One employee might consider a certain sound to be pleasant while another may fi nd it annoying and distracting. Preferences for and against diff erent musical genres (or even music versus not music) are one example of how individual diff erences play a role. Some research fi nds that listening to music while working can enhance employees' satisfaction and mood state61 and productivity.62 However, listening to music also can sometimes harm performance and many people report that they do not enjoy listening to music while working.63

Designing a workplace soundscape requires consideration of all employees' characteristics if one is to create an overall plan that best encompasses noise, employee satisfaction, and productivity. As one example, noise slows reaction times and harms the memory of older individuals more than that of younger individuals.64 As another,

the performance of noise-sensitive workers naturally decreases in noisy workplaces. Some people are able to screen unwanted sounds and stimuli better than others. Extraverts are better screeners than introverts.65 Finally, highly creative employees perform better than less-creative employees with moderate levels of noise or arousal.66

Noise levels in the workplace can also be important for employee health. One study showed that employees who are often exposed to unpredictable noise at work have a 60 percent greater chance of developing cardiovascular disease than other employees.67 Even low-level noise can increase employees' stress reactions and decrease their motivation to solve problems and improve upon their work.68 Sound and noise are part of all work settings. Th erefore, designers must not overlook the potential impact of the interior's soundscape, given that the natural tendency is to focus on the visible aspects of a design.

Overall, not only do people infl uence and alter their interiors, those interiors also infl uence behavior and well-being. Th is begins with how they experience their interiors, and we must emphasize that diff erent people experience the same interior diff erently. At home, at work, and in all the other settings in which we spend time, many aspects of the physical setting aff ect those who use them. Th ese connections are very complex, but they are not random, and they are well understood in some ways and need further study in other cases.

PART III: CONCLUSION

Interior design is important because it aff ects the mood and behavior of those who occupy, use, or visit a space. Th e work summarized in this chapter underlines the strength of the multifaceted connections between individuals and the interiors in which they dwell. In the fi rst section, we described the mechanisms by which individuals infl uence the interior spaces in which they live and work; we focused on the motivations driving individuals to arrange interiors in the service of communicating their values, goals, and identities to others (i.e., identity claims), to infl uence their cognitive and emotional states (i.e., thought and feeling regulators), and to engage in their everyday activities, which may leave material traces (i.e., behavioral residue) in their spaces. In the second section, we presented three central ideas about environmental perception (probabilistic functionalism, aff ordances, and collative properties). Th en, drawing on decades' worth

of research in the fi eld of environmental psychology, we showed how features of spaces can have an impact on the short- and long-term behavior and psychological states of a space's occupants and those who visit it in terms of satisfaction, health, and performance. Lighting, windows, color, layout, art, furniture, plants, artifacts, and the arrangement of these elements all can infl uence the interactions and moods of the space's inhabitants, as well as the impressions of the occupants that are developed by visitors. Th e processes discussed in this chapter are at work in all the residential, workplace, and commercial settings in which modern humans spend the vast majority of their time. Together the studies reviewed here demonstrate how a full account of interiors will require an understanding of people, how they aff ect interior spaces, and how they are in turn aff ected by spaces. As such, environmental psychology will continue to provide crucial insights into the multidisciplinary study of interiors.

Source -

- *The Selection, Creation, and Perception of Interior Spaces: An Environmental Psychology Approach* - *SAMUEL D. GOSLING, ROBERT GIFFORD,AND LINDSAY MCCUNN*

  The Handbook of Interior Architecture & Design

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UNIT – I I – Color and its Effects in Interior Environments – SDE 1106

Introduction

Colours provoke emotional feelings and they are part of everything, from nature and rainbows to man-made creations. Colours have a physiological, psychological and social impact on a person's health, wellbeing and status in the world; from the positive stimulating effects of warm colours, to the mental relaxation and soothing effects of cool colours.

Colours set the mood and tone of the environment by impacting on one's senses and affecting one's perception of the symbolic meaning which is being portrayed. It is a means of communicating one's feelings and self-expression, and it is well known for its biological attraction.

A number of studies have elaborated on the relationship between the human body and colours. Light is energy, and colour is considered to be the interaction of energy and matter. There is a specific wavelength, frequency, and energy for each colour. Einstein maintained that the human body works in harmony with the electromagnetic/energy system of the universe.

"Everything in life is vibration" (Albert Einstien)

The Physiology of Colour

The autonomic nervous system (ANS) functions **involuntarily** as it controls the nervous system as well as regulating the muscles of the heart and smooth muscles.

Smooth muscles are responsible for contracting the hollow organs, such as the bladder, gastrointestinal tract and the blood vessels.

The ANS is considered to play an integral part in **homeostasis** due to the regulation of blood pressure, contraction of hollow organs, gastrointestinal responses to food, focusing of the eyes, as well as temperature and sweating. Colours generate electrical impulses and magnetic currents, or fields of energy that activate the biochemical and hormonal processes

in the human body. A recent discovery identified that the retino-hypothalamic tract leads directly from the retina to the hypothalamus, which links colours to the ANS.
The ANS regulates the sympathetic and the parasympathetic systems, both of which have opposite functions, namely, red is energetic; blue is sedating, and green mediates between both the sympathetic and parasympathetic nervous systems.

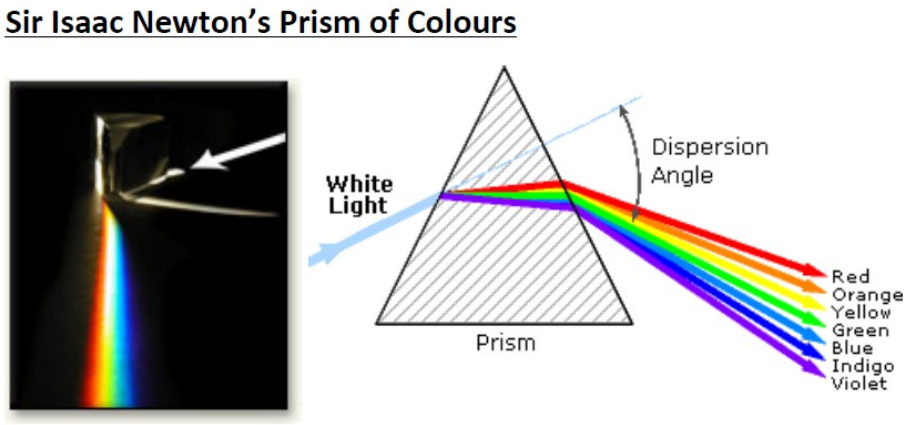
Red simulates the posterior hypothalamus and therefore the **sympathetic** nervous system. Red and yellow provoke anger. All colours in the red spectrum – from red/orange to yellow, have a **stimulating** effect.

The **sympathetic nervous system** causes **dilation** of the blood vessels which **increases** blood flow, heart rate and blood pressure. This results in a surge of energy in times of emergencies, as in the "**fight-or-flight"** response, preparing the body for strenuous physical activity. The body thus receives **well-oxygenated blood** which is rich in nutrients for the tissues that need it, especially the skeletal muscles. The heart rate and blood pressure is increased, as well as oxygen circulation to the vital organs. Liver glycogen is converted into glucose and peristalsis of the gastrointestinal tract (digestion and salivation) is temporarily inhibited.
It also stimulates blood clotting when wounded to minimise the loss of blood. Pupil size and peripheral vision is improved. The symptoms and illnesses associated with sympathetic nervous system dominance are those of fight/flight, and include: hypertension, hypercholesterolemia, fast arrhythmias, heart disease, type 1 diabetes, anxiety, panic attacks, hyper vigilance, and poor sleep.6
Colours which stimulate the circulation, such as red, orange and yellow, will exert qualities of heat. **Heat** expands and relaxes muscles, loosens tension and soothes pain. However heat may aggravate inflammation.

Blue stimulates the anterior hypothalamus, which contains the main regulating part of the **parasympathetic** nervous system. This means that all colours in the bluish spectrum, from blue/green to blue and violet, normally have a **sedating,** digestion-activating, sleepinducing

effect. The **parasympathetic nervous system** causes **contraction** of the blood vessels which **deceases** blood flow, resulting in a decrease of the heart rate and blood pressure. It also causes **relaxation** of the muscles which help to conserve energy during rest. It also regulates the basic functions of the body such as **digestion and urination.** Stimulation of the **parasympathetic** nervous system can be summarized as the **rest and digest** response, as this returns the body functions back to normal: blood pressure lowers, heart rate slows down, gastrointestinal peristalsis is turned on again and the liver starts producing new glycogen. The salivary glands, gastric and intestinal motility are stimulated which facilitates swallowing, ingestion and absorption of food and nutrients. The chemical breakdown of food in the intestine is promoted by enzymes of the exocrine glands of the pancreas. The storage of nutrient molecules within the tissues is enabled by the release of insulin from the pancreatic islets. The parasympathetic nervous system enables the contraction of the urinary bladder which results in urination. It also controls contraction of the pupils of the eyes so that the lens can adapt for near vision.

Colours which suppress the circulation, such as violet and blue will exert qualities of coldness. **Cold** contracts and ice reduces inflammation, so it's good for arthritis or muscle strains from an inflammatory nature. However cold may cause cramping.



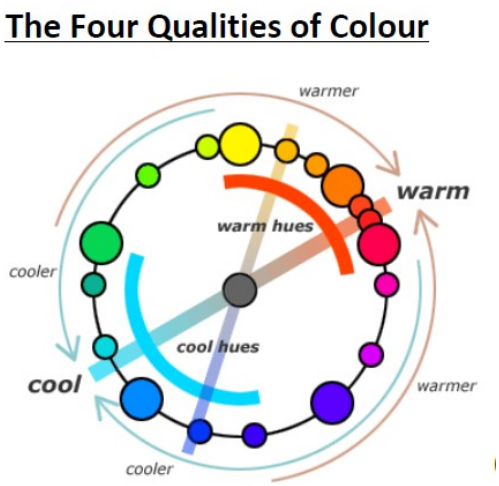
(Left): Newton and the Colour Spectrum. (Right): Visible and Ultraviolet Spectroscopy.[8]

Sir Isaac Newton's Prism of Colours

(Left): Newton and the Colour Spectrum. (Right): Visible and Ultraviolet Spectroscopy.Sir Isaac Newton proved that, by setting up a prism near his window, it projected a spectrum of colours. The

diagram above on the left shows that light enters the prism from the top right, and is refracted by the glass.7 The diagram above on the right shows that violet is bent more than the yellow and red, so the colours separate. He concluded that white light is made up of seven different coloured rays.

Sir Isaac Newton proved that, by setting up a prism near his window, it projected a spectrum of colours. The diagram above on the left shows that light enters the prism from the top right, and is refracted by the glass.7 The diagram above on the right shows that violet is bent more than the yellow and red, so the colours separate. He concluded that white light is made up of seven different coloured rays.8



This diagram depicts warm hues (from yellow to red

violet) and the cool hues (from green to purple). The colour red is a warmer colour than

magenta, because red is closer to orange; but both are warm colours in comparison to violet.9

1. **Hue** is generally defined as a ***source colour,*** one of the twelve basic colours on the colour wheel. Knowing the root hue allows one to mix the colour that he or she sees, using a basic palette.

2. **Value** is the ***lightness*** or ***darkness*** of the colour relative to white, black, and grey.

3. **Intensity** is the ***brightness*** or ***dullness*** of a colour, often determined by the amount of white or complement has been mixed with it. It is measured relative to the brightest colour wheel hue that is closest to the colour. Often the words **chroma** and **saturation** are used interchangeably with intensity.

4. **Temperature**, ***"warm"*** colours of red, yellow and orange, or ***"cool"*** colours of blue and violet.

Primary, Secondary and Tertiary Colours

Primary Colors

Secondary Colors

Tertiary Colors (11)

Primary Colours are the building blocks for all other hues, and cannot be created by mixing any other pigments. They are ***blue, yellow,*** and ***red.***

Secondary Colours are each created from mixing two of the primary colours. They are ***orange, green,*** and ***violet.*** Like the primary colours, they are equidistant from one another on the colour wheel.

Tertiary Colours are formed by mixing a primary and secondary colour. They are ***yellowgreen, yellow-orange, red-orange, red-violet, blue-violet*** and ***blue-green***.11

Newton claimed that certain colours would ***clash*** together if they were in ***direct opposition***

to each other, such as ***red and purple,*** or ***yellow and green.*** In Tibb opposing qualities cannot exist together either, as nothing can be positive and negative, hot and cold, moist and dry at the same time. The relationship of heat, moistness, coldness and dryness has a direct bearing on the health status of an individual. ***Heat*** is generally more ***favourable than cold*** for maintaining the proper ***balance*** and general health of the body.12 Health will only be maintained as long as the overall quality of the humours is in harmony with the overall quality of the individual's temperament.

The Visual Pathway

5

Colour is a property of a surface or substance resulting from absorption of certain of the incident light rays, and reflection of others, falling within the range of wavelengths adequate to excite the retinal receptors….between infrared and ultraviolet.13

Colour vision begins with photoreceptors in the eyes which convert light information into electrical signals in the brain. Rods are receptive to the amounts of light, and cones are sensitive to colours. Each colour has different wavelengths, which we see as reflected wavelengths of light from cones and rods in the eyes.

The optic nerve travels from the retina, past the pituitary gland via the temporal lobe to the occipital lobe of the brain, where this part of the visual system is in touch with the conscious part of our brain of the environment.

The colour of the iris is determined by the amount of melanin it contains; the darker the eyes, the more melanin and the more light is absorbed, as light waves pass through the eye, and the less light is available to reflect within the eye. The pathway of light to the brain is highlighted as follows:

• Light is refracted by the cornea and enters the chamber of the eye through the pupil.

• The iris dilates in bright light and constricts in dim light.

• Light passes through the lens and the image is inverted on the retina.

• Light is absorbed by photoreceptors, which forms into patterns of electrical signals, which are transmitted via the optic nerve to the visual cortex of the brain.

• Light passes from the retinal nerve ganglion to the hypothalamus. The functions of the body are regulated by the hypothalamus and the pituitary of the brain.

• The optic nerve fibres transmit nerve impulses from the brain to the spinal cord, from where the impulses travel to the pineal gland. The ***pineal gland*** is also known as the ***'light meter'*** of the body, which interprets information that one sees.14

Optical Illusions

A colour contrast is an illusory tinge of complementary hue or brightness induced by a vivid hue or luminance on the area surrounding it in the visual field.13 The wavelengths of light travel at different speeds through different mediums. Light waves travel slower in water than in the air, and bend when they move from the air to the water. For example, a stick will appear to look broken in a glass of water, and a finger will appear to look larger. Different colours are created from the reflection and absorption of light.15 It is more difficult to tell apart varying shades of the same colour, as there are not so many words which assigns to these different shades.

6

An afterimage is a type of optical illusion in which an image continues to appear briefly even after exposure to the actual image has ended, which can either be positive or negative afterimages. For example:

• Positive afterimage

If one stares at a very brightly lit image or scene for about 30 seconds, one will experience a positive afterimage for a few seconds, after closing one's eyes, as the image will still be seen as the original one in the same colours and brightness.

• Negative afterimage

The colours that one sees are inverted from the original image. For example, if one stares for about 30 seconds at a red image, one will see a green afterimage.16

The Temperature of Colour

Colour temperature has been described most simply as a method of describing the colour characteristics of light, usually either warm (yellowish) or cool (bluish), and measuring it in degrees of Kelvin (°K).17 The temperature of red colour is about 1800k, the yellowish white – similar to the midday colour when the sun is shining is 6000 k. The blue colour temperature

amounts to 10000k.

The ***kelvin scale*** is an absolute temperature scale in which the unit of measurement, the kelvin, is equivalent to the degree Celsius; the ice point therefore being at 273, 15 kelvins and the boiling point of water being 373, 15 kelvins.13

The temperature of colour is its perceived warmth or coolness. ***Cool*** colours (with a bluer base) tend to ***recede,*** while ***warm*** colour temperatures (in the red and orange families) are perceived as ***advancing***.19

This is why red is used to signal danger, stop signs and the Red Cross sign; whereas mountains fading in the distance appear to be in shades of blue.

"Blue mountains are distant from us, and so cool colours seem to recede". J.W. von Goethe

Tibb, however, places emphasis on the quality of the colours and its relation with the temperaments, as well as its corresponding effects on the body by the autonomic nervous system. Each food and drink has a degree of heat or coldness, which either promotes or slows down metabolism. The heating foods are necessary for the body to achieve and maintain a complete metabolic digestion of foods.20

Jung utilised the principles of yang and yin in the symbolic power of colour and its significance in the expression of emotions through painting. The colours of ***yang*** are ***warm,***

colours, such as red, orange, yellow and magenta. The colours of ***yin*** are ***cool, colours,*** such as blue, violet, turquoise and green. Babbitt related ***yang*** colours as being ***magnetic***, whereas ***yin*** colours are ***electric***. Both yang and yin exert opposite and complementary qualities; either enhancing or diminishing, warming or cooling, and active or passive, respectively.22 Jung believed that colour enabled people to explore the deep, unconscious part of the psyche and to integrate it with the conscious part in order to achieve 'wholeness'.

"Temperature is an attribute of colour or characteristic of a pigment." Artists refer to temperature by the degree of warmth or coolness measured when one colour stands in relationship to another colour, creating a measure of contrast.21 Temperature is also a measure of the average kinetic energy due to thermal equilibrium with other systems.13

When the temperature of colours is increased, colours move from the long metric wave to

the short metric wave, namely from red colour to the yellow colour then to the blue colour then to the violet then the ultraviolet colour and finally the black colour. Finally, when the temperature increases much more, colours turn dark or deep till they become black.
Avicenna believed that cancer is a tumour which arises from 'burning' of the black bile humour, due to the increase of heat which has become pathological. He also described that a tumour swelling is a manifestation of the 'boiling' of the black bile at its junction with the organ, and that the crablike tracks of the cancerous tumour tends toward blackness, green and heat. Frostbite initially appears dark red in colour on the hands and face after exposure to sub-zero temperatures, advancing to black in the advanced stages.20
Gerard's research in the 1970's revealed that exposure to warm colours increased respiratory movements, frequency of eye blinks, cortical activation and palmar conductance (arousal of the ANS). Warm colours consistently showed a more pronounced pattern of stimulation. Cool colours showed opposite effects by acting as a relaxant and tranquilizer for anxious individuals, lowering blood pressure, providing relief from tension, alleviating of muscle spasms and reducing eye blink frequency.1

Why does the colour red appear to be warmer than blue?

When we get ***warm*** more blood is circulating at the surface of the skin which gives it a ***rosy*** colour. When we get ***cold*** the body tries to conserve heat by diverting blood away from the surface of the skin in order to supply more blood to the vital organs, giving the skin a ***bluish*** appearance.
Our perception of colour may also be related to our everyday experience of how we view hot and cold colours. The flames of a fire appear to be yellow and orange, as the burning process beaks up bonds in the molecules of carbon and hydrogen which emit yellow light, which is hot and dry. If there are more particles of soot, it will act like blackbody particles, emitting the colour of red. It is not as easy to see objects which have been exposed to very

high temperatures; therefore the colour blue is not seen as often.23 The molecular properties of water make it bluish-green in colour, which is cold and moist.
Oxygen supply influences the colour of the flame. A low-oxygen fire contains lots of uncombusted fuel particles and will give off a yellow glow. A high-oxygen fire burns blue. So

candle flames are blue at the bottom because that's where they take up fresh air, and yellow at the top because the rising fumes from below partly suffocate the upper part of the flame.24

Blue flames are not always hotter than yellow flames, because the colour of light emitted by the flame depends on which atoms and molecules are in the flame. Each atom or molecule has certain special frequencies (colours) at which it absorbs and emits light. Sometimes that's more important than the temperature of the flame in setting the colour.25

Manifestations of Colour Changes

Various chemical compounds can be used to alter the colour in a flame, as is used in fireworks, for example: red colours is obtained by using lithium and strontium; orange with calcium, yellow with sodium; green with barium and copper and halides; blue with copper; violet/purple with potassium, and white/silver with aluminium, magnesium and titanium.


Left: Yellow flame from sodium chloride. Middle: Green flame from Borax. Right: Violet flame from Potassium chloride.[26]

Icebergs are formed from the glacial ice that has built up from snow falling on the Antarctic continent over millennia. This ice consists of pure fresh water. As seawater is drawn deep under the ice shelves by the oceanic currents, it becomes extremely cold. Under certain conditions it can freeze to the base of the ice shelf. Because this ice is formed from seawater, it differs from the freshwater ice of the ice shelf. Often, the frozen seawater contains organic matter and minerals, causing it to have a different colour and texture. Thus icebergs broken off from the ice shelves may show layers of the pure **blue-white glacial ice** and **greener ice** formed from frozen seawater. As the bergs become fragmented and sculpted by the wind and waves, the different coloured layers can develop striking patterns.27

The Transformation of Light Waves

The molecular structure and pigmentation of each object enables the light rays to be mixed, absorbed and reflected in various speeds and intensities. Objects which ***absorb*** more light

rays and thus reflect less light back to the eyes, appear to be ***darker*** and deeper in colour, whereas lighter objects ***reflect*** more light, appear to be ***lighter*** and more intense in colour. A ***transparent*** object will ***transmit*** light.15 If, for example, one holds a white piece of paper on one side of a glass filled with red liquid, the light will transmit a red colour of the liquid

onto the paper. An object is coloured because of the light it reflects, and all the other colours are absorbed into that specific object.28

The foetus in the womb is able to distinguish between light and dark. At birth infants can see shapes, but they can only see black, white and grey. After a few weeks of life they are able to see the first primary colour of red, and by the age of 3 months they are able to see the full spectrum of colours.

The Psychology of Colour

Individual colour preferences have a huge impact on the body, mind and soul, as well as on the economy in general, due to particular associations which people attach to the meanings of colours. Colours have deeply rooted emotional responses which influence decisions which people make, from the cars they drive to the clothes they wear.

Warm colours include red, orange and yellow, which evoke emotions, ranging from feelings of warmth and comfort, happiness and vibrancy, to feelings of anger and hostility. Blue, green and purple colours are known as cool colours, which are often described as calming and soothing, but can also evoke feelings of sadness or indifference.29

Colours reflect different emotions, moods, attitudes, personalities, characteristics and messages. Colours may inspire, energise and create a sense of calmness, happiness, sadness, uneasiness, or anger. It can be attention seeking, provoke passion, alert one in the event of danger; it can denote loyalty, compassion, confidence and a team player; it can denote power, efficiency, elegance and style; or it can portray a sense of cheerfulness, playfulness and excitability.

Certain colours alter mood states and can change patterns of behaviour, for example: ***bright*** colours ***reflect more*** light, as in the colour of ***yellow*** which may ***over-stimulate*** the mind, causing strain and ***irritability.*** However the right shade of yellow painted on the walls can positively stimulate the mind in a classroom setting. Conversely ***dark*** colours ***absorb*** more

light, as in the colours of black, purple, violet and blue, have a ***sedating,*** digestion-activating, sleep-inducing effect.

Goethe understood the relationship between colour and emotions, as did Luschner, the latter, who believed that colour preferences revealed a person's basic personality traits. He indicated that a person who had a preference for the colour of ***red*** has an ***assertive*** personality type, who is ***outgoing*** and with a ***strong will,*** as in the Sanguinous/Bilious temperament. Conversely, a person who dislikes red indicates that he is shy and possibly withdrawn from society, which may be linked to the Melancholic/Phlegmatic temperament.

The colour clothing that one wears also reflects one's emotions, and at the same time it portrays to other people how one would like to be perceived, such as confident, loyal, passionate or a team player. Very often people come to work wearing the same colours. This may be a reflexion of the sharing of emotions, personal information and work issues,

which subconsciously are translated into patterns of psychological interpretation of the emotions elicited by the milieu of the work environment.

According to Sheila Dicks, a professional style coach, "the colours you wear in a professional setting are about so much more than mere fashion or style. Colours send subconscious messages, and can affect your mood, as well as the mood of the workers around you."30

"Mood dressers are people who are in-tune with their emotions and dress accordingly".31

The Influence of Hormones on Mood

Photoelectric energy influences the functioning of the pituitary gland which controls the hormonal system and hence coping mechanisms, emotional and stress relations.32

The ***pineal gland*** in the brain produces the hormones of serotonin and melatonin. ***Serotonin*** is a neurotransmitter in the brain, which has been linked with mental disturbances such as schizophrenia and hallucinations. It is a ***stimulant*** which is produced during daylight (yellow of the sympathetic nervous system and the Bilious temperament). ***Melatonin*** has a chemical pathway which enables an organism to respond to light and synchronize bodily functioning with diurnal and seasonal variations. It is linked with ***sleep*** (blue of the parasympathetic nervous system and the Phlegmatic temperament), and it increases when it is dark, but it also has a depressive effect1 (too much blue causes depression). Where daylight and

artificial lighting in the interior of buildings are inadequate, the natural suppression of melatonin production during the day fails and may be accompanied by feelings of depression.32

Studies on sleep disorders, depression, seasonal affective disorder and post-traumatic stress disorder suggested that signs, symptoms, and biologic markers associated to these psychiatric disorders are due to marked alterations in melatonin and serotonin levels.33

Neurophysiology of Colour

Modern neuropsychology maintains that memories are colour-coded and that distinct frequencies of colour can reactivate synapses in the brain which were previously blocked. Repressed memories of a physical or emotional trauma are held in the hippocampus and amygdala of the limbic system of the brain. These memories can be accessed and treated with the correct colour wavelength, with, for example wearing colour glasses with the recommended colour, and other treatment options.

Colours can have two distinct and often opposite effects. Because of the color-coding of emotions, treatment with colour can either trigger the expected colour with a physiological reaction, or enable the release of a related colour coded emotion or problem. For example: blue light will usually have a sedative effect, but if a person was molested by his mother when he was a toddler, and she was wearing a blue bra at the time, blue may cause sympathetic arousal (distress) in this person until the trauma is healed.

11

The complexion constantly changes according to the fluctuation of the emotions and the difference in the state of health, for example: blushing or extreme anger may turn the face reddish in colour; cyanosis has a bluish colour, and jaundice has a yellow complexion.

In Tibb ***warmth*** is associated with blood, fire, life force energy, growth, movement, joy, as well as an outgoing, enthusiastic and optimistic temperament. A glowing complexion from a fever is also associated with warmth. From an ***emotional*** perspective, ***warm*** colours of ***red and yellow*** are ***extrovert,*** inviting, happy and cosy, and ***stimulate*** the body, such as the Sanguinous and Bilious temperaments. Warm colours are best used in conditions which require energising, such as in depression and lethargy, but not in conditions such as ADHD or hypomania, which would further exacerbate energy levels.

In Tibb ***coldness*** has characteristics which are completely opposite to warmth, namely those of phlegm and black bile, with a compassionate and perfectionistic temperament. Coldness is also associated with death. The ***cooler*** colours of ***blue, violet*** and ***green*** are ***introvert***, such as the Phlegmatic and Melancholic temperaments, which would be more suitable for disorders of hyperactivity and anxiety.

The Colour of Emotions

From a ***physiological*** perspective ***warm*** colours ***enhance*** human metabolism, increase respiration rate, raise blood pressure and increase circulation; whereas ***cooler*** colours have antiseptic and anti-inflammatory qualities, and which ***slows down*** metabolism, and induces sleep.

From a Tibb perspective, ***joy*** and happiness, as well as ***anger*** and aggression, have qualities of ***heat,*** which is linked with the ***Bilious*** Temperament and the colour of ***yellow***, which is associated with a fiery temperament. ***Sadness*** is opposite to joy, and has qualities of ***cold,*** which is inked to the ***Melancholic*** Temperament and the colour ***purple/violet***, which is associated with the serious and pessimistic temperament. ***Fear*** *is the opposite of anger, and* has ***cold*** qualities, which is linked with the ***Phlegmatic*** Temperament and the colour ***blue,*** and which is associated with its calm, controlled and even temperament.

The mind and emotions are the most powerful energies on earth, and people associate certain colours and language with emotions.

• “I’ve got the blues,” or ‘down in the blues’ (blue slows us down and makes already slow people depressed. as in the Phlegmatic temperament).

• “I am in a black mood” (as in Melancholic temperament)

• “I am green with envy” (envy is a liver emotion and the correct colour is yellow/green.

• “Red-Hot love” (red brings out emotion in people - including sexual passion).4 ‘In the pink of health’; ‘looking at the world through rose-coloured spectacles’; ‘red carpet treatment’; ‘and ‘business is in the red’.34

Conclusion

Colour has a physiological, psychological and social impact on a person’s health, wellbeing

and status in the world; from the positive stimulating effects of warm colours to the mental relaxation and soothing effects of cool colours. Colours set the mood, state of mind and tone for any environment, situation or healing therapies. Colour influences our emotions, our actions and how we respond to various people, situations and ideas. Reds and yellows stimulate the senses and produce feelings and thoughts of warmth and comfort, whereas blues and violets/purples are associated with coldness.

Every colour has its own specific wavelength and frequency, from stimulating and energetic qualities, to calming and more subdued ones. This generates specific biochemical and hormonal responses, which influence the physiology and autonomic nervous system. Certain colours alter mood states and can change patterns of behaviour. The use of colour therapy can be applied to the body to alter its functioning.

Source -

tibb
A Science of Medicine
The Art of Care

The Physiology and

Psychology of Colour

Dr Linda Mayer and Prof Rashid Bhikha

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UNIT – I I I – Light in Interiors – SDE 1106

Introduction

Light and its effects considered as a complex issue, since the effects happens during the time i.e. space users reside in the spaces for a long time and exposed to different radiated energies of color and regular radiation of the colors make longer effects on sprit of space users and it has longer durability. In current world situation, in which psychological and spiritual problems arise in different layers of society, most of the problems are the result of the environmental effects, and this is the environment, causing intellectual deviation of people, home and city considered as environment in which city is composed of mass of homes. Conditioning relax and pleasant environment provided at homes and individuals in the home live together peacefully, the city and society approach relaxation, however, color and light considered as factors cause relaxation and/or stress, which bear strong and deep effect due to endurance. One shall provide a relax and happy environment through correcting interior decoration and using the light and natural colors as well as their effects. In this study, we move toward an environment in which at first color and lighting composed of organic/natural components, colors and lights directed toward natural colors, second, lighting and color of public places shall increase social communications and we prioritize using colors leading spiritual and psychological relaxation. Meanwhile, we shall remind appropriate use of artificial lights, since most of people are not aware of artificial light`s side-effect, neither know their disadvantageous aspects. All researchers know that whatever exists in nature is useful and considering man-made things, although there are useful aspect, its considered as an artificial one and its use bears side-effect, since its an artificial and non-natural thing, and all non-natural things bear environmental side-effect, including spiritual and psychological one, etc. One shall consider side-effects of artificial spectrum and lights in current life of human being, and use them with caution.

Light is the stimulus that influences most the human perception, but also the psychophysical wellbeing of the individual in everyday life. This paper analyzes the light from a psychological point of view, investigating the relationships between light-based emotions and behaviours, and the psychophysical responses to lit environment by the perceivers in different experiential contexts.

Light becomes, therefore, "Cognitive Map" and "Emotional Driver", but also a "Gestaltic Device" for the perceiver, in order to understand and interpret the external reality. Even the dark and lighting deprivation were considered, not only as environmental conditioning on the mood (Fusco, 2005a), but also through the psychological analysis of specific light manipulation techniques, such as "Sendep" and "Ganzfeld Effect". Finally, some guidelines were shown to improve health and wellness of the individual exposed to the light in a given environment (healthy lighting), getting to define an "Ecological" approach to light and lighting perception in human life, that would also involve some light-based techniques, such as Light Design and Light Art.

Keywords

Psychology of Light, Light Perception, Light Design, Ligh Art, Lighting Psychology

1. Introduction

From a psychological point of view, talking about the light is like plunging into the depths of the psyche, but also dealing with the limits and possibilities of the perceptive skills, natural equipment of the human psychophysical apparatus, influencing our health and wellness throughout the life.

Light was analyzed not only by a perceptive point of view, but also as a driver of cognitive, emotional and behavioural responses by the perceiver in different experiential contexts of everyday life. It showed that light is a Cognitive Map able to guide and direct the individual in the exploration and discovery of the surrounding environment, providing the interpretative keys of an increasingly complex reality. Even the dark (i.e. the opposite of light) was analyzed, describing the effects of specific sensory deprivation or light manipulation techniques on the neuro-perceptual sphere of the perceiver, that may be used for breaking the individual's will, by changing the reality perception (such as in a war scenario), but also to increase the aesthetic enjoyment of the viewer, as in the case of Light Art installations. From our perspective, the study of psychological effects of light and lighting on the individual should lead to an overall "ecological" approach to light perception.

2. Light as a Cognitive Map and Emotional Driver

Beyond the classical behavioural model of *stimulus-response*, the neuro-perceptive reaction mechanisms, andthe environmental adaptation by the perceiver, light may stimulate our perceptual apparatus through type andrange of exposure to a lighting source and its colours, inducing specific emotional states or behaviour in the human:this specific type of stimulus is able to excite, move, impress, communicate, heal and generate wellness,creating a sense of harmony and syntony with the surrounding environment, like a home interior, a store corner,an office space, or an exhibition wing of a museum (Birren, 1969a, 1969b; Flynn et al., 1973).

The strategic layout and modulation of lighting by *light designers* may influence the perceiver's mood, creatinga sense of calm and rest in a sacred environment (as a temple or a church), or add mystery and suspense to a theatre performance on the stage, driving the eye's direction and the meaning attribution inside a specific space-time context (Flynn, 1973): light is therefore an environmental "cognitive map" and a psychophysical *driver* of human perception. The induction of specific cognitive and emotional responses by an individual exposed to a light setting inside a domestic, architectural, urban, commercial, working, or exhibition space (e.g. a museum or art gallery), but also into the natural environment (Kaplan & Kaplan, 1989), largely determined by

human neuronal asset and psychophysical equipment, is one of the most evident effects of the light, although sometimes *light designers*, because of their focus on the functional or aesthetic values related to their lighting projects, are not fully aware.

Within a home or working space, light is able to induce—according to its intensity, saturation and modulation —specific emotional states, but also activate specific cognitive skills inside the perceiver (Flynn, 1977): dynamism, relaxation, privacy, visual clarity, excitation, productivity, efficiency, but also stress, sleepiness, sadness, agitation, restlessness, anxiety. The individual response by a subject exposed to the light is variable inside the range between the extremes of a light source, that can be bright/dim, uniform/non-uniform, central/perimeter, warm/cool: in short, it is possible to induce a change of the psychophysiological responses by the perceiver through the alteration/modulation of the nature and typology of light stimuli within a continuum of variations, allowing also the measurement of subjective impressions in lighting conditions (Flynn et al., 1979; Boyce, 2003).

Furthermore, the synesthetic possibilities of human perception, and the range of emotional responses by each individual exposed to the light, grow if—besides the impact generated by a light source—we also add a sound stream, such as a piece of music. Moreover, colored light may evoke a tactile sensation in the perceiver (according to the range of chromatic hue), manifesting itself in the form of perceived temperature, implementing modalities of synesthetic perception in the human: in this way, the individual may be able to "feel" the light (Berry, 1961).

3. Light as a Gestaltic Device

On the basis of a psycho-cognitive approach, the *environmental cognition*, that is the basic need of human being to give meaning to the surrounding environment, through the activation of mental processes about matching andassimilation of stimuli coming from the external reality towards familiar and already known patterns that fallwithin the subject's experiential sphere, allows to recognize the light as one of the primary factors of the processof mental reconstruction, interpretative decoding, symbolic decryption and semantic reappropriation of the environmental

space by the perceiver: light is, therefore, a device (natural or artificial) that supports the brain work of reconstruction and classification of reality by the viewer, setting the syntax rules of visual perception (Galetta, 2014). This process of *Gestaltic* reconstruction about the surrounding environment through the light, which involves simultaneously both the sensorineural sphere and the individual unconscious, is intended to bridge the cognitive gap relating to a reality unknown by the subject, giving humans the correct interpretative keys about the outer environmental space and the necessary answers to their security basic need, enabling them to overcome the instinctive and primitive defense mechanisms against the *unknown*, that may determine fear (instinct to escape) or aggressiveness (instinct to attack): so, light helps to give meaning to the environment and drive the process of interpretation of reality (but also adaptation to that), performed by a subject in a state of cognitive uncertainty in order to controlling the external environment. But, at the same time, human being is also attracted by a sense of mystery and complexity, that arises from the discovery of a new and unknown environment, being inclined to prefer "unconventional" solutions, in which light, with its many shades and gradations, leads the individual through the process of exploration towards the *unknown*: paradoxically, light seems to hide, rather than reveal the mystery, but just for this it attracts, involves, stimulates and fascinates us so much. While coherence reassures, complexity fascinates us; but either way, light always drives our visual apparatus through the semantic path of environmental information decoding, whether that comes from a domestic or

working environment, an architectural or urban space, a store corner, a building interior, or an exhibition space of a museum or art gallery: light, and its perception by human, shapes the world (Lam, 1992). According to the model of mental processing provided by each individual, based in part on his/her own neuro- perceptual structures, partly on the subjective personality and unconscious drives, light stimuli (i.e. sensory input) will be able to induce specific emotions, behaviours and mood (Fusco, 2005b, 2012; Fusco et al., 2011; Tomassoni, 2014), as well as influence bodily and mental health, but also the level of aesthetic appreciation by the perceiver towards a given environment, especially if the same viewer (and not the light designer) controls the light source, that becomes a source of aesthetic pleasure or environmental enjoyment by the subject. Due to the capacity of light—whether natural or artificial, colored or fluorescent, evanescent or material—to induce specific perceptive alterations within the sensory sphere of the human, the holistic, all-encompassing, and immersive dimension of individual involvement is, therefore, the key to the effectiveness of any lit environment. Light source, the energy that emanates from it, and the light-generated biopsychic effects, just become the focus of all perceptual mechanisms and interpretative processes implemented by each perceiver: light has not only the role to make *visible* an object for a viewer, but also to contextualize it within the environmental space. For example, the location of an object within the environment, according to the angle of incidence of one or more light sources, as well as the capacity of the object in absorbing and reflecting the light (*luminous radiance* or *reflectance*), are capable of driving human perception and emotions, as well as influencing the bodily and mental wellness (Collins, 1993). As already noted by Arnheim (1954), by a perceptual point of view, human eye is not able to distinguish between the reflection power of an object and its real light emanation: eyes receives only the final result by a *gestaltic* impression, that is the intensity of light perceived within the visual field by the human: this is the reason why a light-reflecting object seems to emanate a light of its own, as if this was an property inherent the object in itself. Therefore, what influences the psychophysical viewer's apparatus is the overall effect of the environment exposed to a light source, together with the object positioning within a space context: Light Design takes advantage of that cumulative effect, related to the sum of all the above factors (object + light + environment) to induce specific emotions, behaviours and psychophysical feedbacks by the perceiver, influencing his/her health and wellness. The so-called *Light Art*, for example, uses various types light sources (such as Neon, LED, fluorescent lighting, and so on), namely objects emanating a specific luminous energy inherent to the same lighting devices, but such energy (and its chromatic spectrum) is mixed to the items present on the set, appropriately positioned in the environmental space to be able to absorb and reflect light energy in a precise exhibition strategy, in order to produce an overall perceptual effect in the perceiver, exciting different emotions and behaviours during the individual experience of aesthetic appreciation. In the case of realistic painting, light perceived within the depicted scene is not a light energy inherent to the canvas in itself, but an analogical representation of the light handed back by the artist through an artful use of colours, that are able to simulate light refracted by represented objects and the surrounding environment, as they reflect the light of the exhibition space (or environment) in which the artwork is positioned: house, public space, museum, art gallery, shop corner, factory, city and urban space.

4. Light vs. Dark: Sendep and Ganzfeld Effect

Even the *dark*, namely absence of light, contributes to organize and set out the surrounding environment, marking emptiness and fullness, presence and absence, given that it is the *right light*

to make visible an object. At the same time, overlaps and intersections generated by different light intensities, are able to create shadows and depth, modulating feelings and emotions in the perceiver, who can *read* an object by different dark shades. At the end, all the items will converge in a well-organized project, in a visual intelligible (and *gestaltic*) order, in which light scans reading, perception and interpretation times by the perceiver. Moreover, it must consider the influence of light on the human being's biorhythms: in fact, human life is marked by the alternation of night/day, dark/light, sleep/wake and work/rest rhythms (or *circadian rhythms*). According to light intensity, refractive index and wavelength of the electromagnetic radiation emitted by a light source, light determines the colour perception of the objects inside a lit environment, influencing the mood and behaviour of people exposed (Veitch & Newsham, 1998; Boyce et al., 2000).

The "Sendep" (i.e. *sen*sory *dep*rivation) or perceptual isolation, especially about light, has negative effects on the human being from a neuropsychiatric perspective: in fact, it has been widely used in the military field as a torture method, (such as the *brainwashing*), on war prisoners, as happened during Korean and Vietnam wars (Solomon et al., 1961). A related phenomenon is the so-called *Ganzfeld Effect* (or perceptual deprivation), that occurs when a constant and uniform light stimulus is used, instead of remove it: this leads to effects similar to sensory deprivation: for instance, by submitting an individual to a uniform lighting (or flashes of light) for a long time (Wackermann, Pütz, & Allefeld, 2008). It is no coincidence that the American artist James Turrell, in the artwork series entitled "Ganzfeld", uses the properties of the fluorescent light to reproduce a feeling of estrangement and absence of depth field. The "Ganzfelds" are defined by Turrell as *sensing spaces*, namely homogeneous perceptive spaces and visual fields that provide the viewer the disorienting experience of "fullness of emptiness" or horizon's absence, enhancing the perception of real space and permitting the views of so-called *skyspaces*. Through his art research about the control-based use of light, James Turrell (together with his colleague Robert Irwin, and the perception psychologist Edward Wortz) explores the human perception processes in controlled environments, in a state of alteration of perception, performing experiments about the total perceptual fields (Ganzfeld) and sensory deprivation, as a part of Art and Technology Program, established by the Los Angeles County Museum of Art (in collaboration with scientists and engineers at Lockheed Aircraft, IBM and Garrett Aerospace Corporation).

5. Lighting and Environment: Towards an "Ecological" Approach to Light Perception

Research about the relationships between lighting levels and colours by one side, bio-physiological and neuropsychological phenomena by the other, have shown that light influences biochemical and hormonal processes, body temperature, mood, psychological well-being and electrical brain activity, influencing the neuro transmitters (Mahnke & Mahnke, 1987): that is the reason why in the waiting rooms of public spaces (surgeries, hospitals, churches, airports, and so on) low lighting is used, accompanied by warm colours or pastel shades, in order to induce relaxation and evoke a sense of protection and hospitality (for example, light green or blue); while, in a production or competitive environment (such as the working space of an office, or a boxing or fighting ring), marked by the dynamism of production rates, high lighting accompanied by colder chromatic temperatures is able to stimulate a greater work efficiency and productivity, but also aggressiveness and competition (Tiller, 1990; Badia et al., 1991; Ginthner, 2002). A great contribution to research about the *Psychology of Light* (or *Lighting Psychology*) was given by the *eyetracking* studies,

namely the engineering research on the eye movements involved in vision and decoding of visual stimuli coming from the environment, which help to organize the overall perception of reality by the perceivers at various complexity levels. These studies are also contributing to the improvement of Cybernetic Systems, Artificial Intelligence, Virtual Reality and Video Games, where light perception is simulated in a similar way to that experienced in the reality by humans. In the perspective of a computational approach to aesthetics, light may be considered as the inferential engine of the aesthetic quality of an object exposed to a light source: in fact, the functional specialization of cerebral cortex has showed that the bioelectric signals transmitted to the brain by the photoreceptors, namely neurons specialized in scanning the light photons, determine the aesthetic quality of the reality perceived by humans, demonstrating the correlation between perceptual processes and visual brain (Zeki, 1999, 2008). *Light Art* and Light Design are creating the perfect fusion of scientific technology, art research and aesthetic perception: this is obvious if we consider the flexibility and versatility of Neon light, that allows to create, through the deep connection between space and light, and the perceptual mechanisms of the perceiver, new and unexpected aesthetic paths (Sabra, 1981). The environmental experience by human is intimately connected with the light space, given that the space itself (in a visual sense) is a *space-light*, and viewers perceive spatial relationships only when light is intercepted and reflected by an object settled in a space-light context (Kepes, 1944): with the space *neonization*, a new form. of artistic expression was born, as just demonstrated with famous artworks by James Turrell, Dan Flavin, and the artists of the Californian art movement of *Light and Space* (Butterfield, 1996). The aesthetic perception by the viewer, led by psychobiological mechanisms specialized in the course of evolution (Martindale, Locher, & Petrov, 2007), has faced for the first time an "artificial vision" of the environmental space, that—just through the light—has become *modified spatial perception*, according to a precise aesthetic strategy planned by light designers (Flynn, 1988; Kaplan et al., 1998). In the *Light Art* artworks, as well as Light Design in general, light and lighting take up the function to illuminate the environmental (which is perceptual and experiential space),highlighting and marking objects, revealing spatial or symbolic paths, focus or divert the viewer's attention infront of a specific artwork's detail, letting out the symbolic strategy and meaning trajectories planned by the artistor light designer. In fact, through research performed by using light sources of different spectrum (from naturalto artificial light), it was established a significant correlation between lighting levels and light colours, psychophysiologicalreactions and emotional responses by the perceivers: generally, a higher intensity of light stimulationcorresponds to a higher level of concentration/attention, associated with a greater emotional responseby the subject. For example, the exposure to a flashing or pulsating light (rather than a steady light) inducesfaster emotional responses by the perceiver: in fact, flashing light is associated with the danger, activating aninnate state of alert in the human, enabling him/her to react quickly and in a most extreme way,influencingjudgment abilities, problem solving and decision making skills. Through the lighting modulation (and its colourspectrum), it is possible to stimulate different emotions in human being, such as physical attraction or aggressiveness:the activation of specific neurotransmitters and the production, at biochemical level, of specific hormonesin the presence of determined colour light source, shows the psychobiological bases of light perceptionby human, that may change according to the subject's sex or age (Burg, 1967), but also the supposed effectivenessof some alternative medicine techniques (such as chromotherapy) on the psychological wellbeing of the individual.Lighting conditions, as well as the intensity and colour of the light source, influence indeed the human biologicalcycles and, by a chronopsychological point of view, the circadian rhythm, by increasing or decreasingthe level of specific hormonal secretions (such as *melatonin*,

namely the marker-hormone of circadian rhythms,produced by the pineal gland), that are responsible for certain neurophysiological states. Critical, in this sense,was the discovery of a specific photoreceptor cell in the human retina, the *melanopsin*, responsible (during thephototransduction process) for synchronizing the biological clock in the human: through the use of higher orlower lighting levels, it is possible to inhibit the production of *melatonin*, inducing a higher concentration; infact, melatonin levels increase during the night, when light is low, stimulating the sleep onset (McIntyre et al.,1989); on the contrary, over-lighting or close light flashes provoke dazzle, that by reducing the perceiver's visibilityand visual performance, bring out discomfort, stress, sense of danger, and disorientation in the individual,that if sustained over time may lead to neuropsychiatric disorders: human is a photosensitive being (Bruce &Green, 1990; Daurat et al., 1993).

Conclusion

By using the outcomes of these investigations, Light Design and Light Art might propose—from the point of view of human health—an integrated, strategic and "healthy" use of the light sources, in order to improve thepsychophysiological wellness of the individual (*healthy lighting*), the holistic-perceptive experience relating to aspecific architectural environment (e.g. the exhibition space in a museum or art gallery, but also the home interior,or the working space in an office), and, moreover, concerning the aesthetic appreciation of a space, object or artwork and their *affordance*: since the photobiological lighting effects are related to the characteristics oflight energy incident on human retina, a different modulation of the light stimulus and its chromatic range hasnot only the role of making pleasant, comfortable or simply significant a given environment for a perceiver, butalso improving the health and wellness of the individual, according to a specific *ecological* approach to visual perception.

Source -

- *Psychology of Light: How Light Influences the Health and Psyche*

  Article *in* Psychology · August 2015 - 3 authors, including: Giuseppe Galetta - Università degli studi di Cassino e del Lazio Meridionale

UNIT – IV – Psychology & Design Process in Interior Design – SDE 1106

Information from all the sensory modalities influences how someone experiences a product. The sound of a product may tell a person something about its quality, the colour may influence the product's expression, its odor may be perceived as pleasant or unpleasant, and so on. More and more people understand how products that address each of the modalities can appeal to users through all their senses. As an example, in 2004 Magnum introduced a limited edition series of ice cream: Magnum 5 senses. Each of these five different ice creams was dedicated to one of the senses. The Magnum Sound, for example, was filled with pieces of caramelised sugar that produced a sound while the ice cream was eaten. Figure 1.1 shows the packages of the Magnum five senses ice creams on which each of the senses was visualized.

Another, completely opposite approach, is designing a product in a way that incongruent information is provided to different senses. Designers can use this approach to surprise consumers, to make exploring the product more challenging, and to let them discover something new. Whether they want to communicate a consistent message through all sensory channels or prefer to design for surprise, designers who intentionally try to create specific experiences for their audiences are more likely to achieve the intended effects when they think about and address each of the sensory modalities through their design. For example, a designer could decide to design a lemon juicer that communicates elegance through all the senses or he or she could decide to offer an incongruous aspect in one of the senses. The studies presented in this thesis will demonstrate that designers can benefit from designing for multiple modalities.

1.2 Sensory incongruity

The different modalities bring different types of information that is compared, combined, integrated and processed to finally form a coherent view of the object that is perceived. Although people perceive different types of sensory information through the different modalities, the information they perceive is somehow related. People (think they) know how certain things feel without actually touching them and they (think they) know how other things smell without actually smelling them.

This knowledge about sensory characteristics of objects may be due to perceptual learning. Information about the objects that surround us and that we experience continuously, is stored in cognitive schemas. Research suggests that these schemas contain multisensory information (Neisser, 1976). Thus, while they experience objects in the world, people learn to relate and integrate different types of sensory information. It has also been argued that there are innate neural connections between brain areas of the different modalities (Marks, 1978). Maurer and Maurer (1988) discussed evidence for such innate wiring and state that newborn babies do not appear to discriminate between inputs from different sensory modalities. Maurer and Maurer suggested that a lot of this sensory confusion is lost with maturation in most people. For some, however, the confusion remains into maturity. For these people, called syneasthetes, the interrelation of the senses is very obvious. They see, for example, colors for sounds or numbers. Syneasthetic perception occurs when stimulation of one modality leads to automatic, involuntary experiences in a second modality (Cytowic, 1989). Although only a small number of adults 16 Introduction

demonstrate synaesthesia, many people may still have residual connections between input from different sensory modalities (Zellner and Kautz, 1990). Merleau-Ponty (1962) has argued that synaesthetic perception is not a phenomenon that occurs for some people only. In a way, he says, people all experience the interrelations between the senses, whether it be through learned association or through some form of syneasthesia. For example, the form of objects stands in a certain relation to their specific nature, and appeals to all other senses as well as sight. The form of a fold in a cotton cloth shows us the resilience or dryness of the fibre, as well as the coldness or warmth of the material.

Someone who perceives a product does not necessarily use all senses at the same time. Therefore, perceiving a product through one sense modality first can create an expectation on what will be perceived through other sense modalities. If, upon perception through a second sense, this expectation is disconfirmed, the information from the two senses is incongruent. In this way, 12 forms of sensory incongruity can occur that are defined by two parameters, (1) the 4 senses that are used to perceive the product (vision, audition, touch and smell) and (2) the order in which they are used (see Figure 1.3). Because our research does not involve food products, we will not include the sense of taste in our overview.

Some senses are more likely to be used first than others. The senses can be divided into two groups: the distance senses, which are audition, vision and olfaction, and the proximity senses, which are taste and touch. People are capable of seeing, hearing and smelling objects from a distance, but to touch

Figure 1.3 Matrix of sensory incongruity: Visual – Olfactory, Visual – Auditory and Visual – Tactual incongruity are most relevant for product design.

or taste something people have to be in physical contact with the object. The perception of temperature forms an exception here, people can *feel* a heat or cold source from a distance. However, it is more likely that a person will perceive an object through vision, audition or olfaction first. Furthermore, people have reported that a product's appearance is often relatively more important than a product's sound or scent (Schifferstein, 2006) and among the three distance senses, vision will provide the most detailed information about a product within the shortest time frame (Jones & O'Neil, 1985; Schifferstein & Cleiren, 2005). In addition, people often do not perceive scents consciously or it may take them a while before they perceive a scent. Perceiving the sound of an object first is most likely to occur when the object is hidden or too far away to see. Therefore, the forms of sensory incongruity that start with a visual impression seem to be the most relevant for product design. These forms of sensory incongruity were studied in this thesis.

1.3 Surprise

Based on theoretical research on surprise, designer Silvia Grimaldi (2006) presented a technique for the creation of surprising objects. Amongst others, she created surprising products based on the incongruity between what an object looks like and how it feels. The first step in Grimaldi's design process involves studying what is expected of objects. Secondly, the designer has to find opposites of the expected characteristics and incorporate these into the new design. The vases in Figure 1.4 created by Madieke Fleuren form an example. These vases look like they are made of leather patches that are stitched together, however, they are made of porcelain that mimics the characteristics of the soft, supple material. Someone touching such a vase will probably be surprised by the discrepancy between what he thought he would feel and the actual experience. This may evoke curiosity about how the vase is made, which could result in further exploration of the product.

Figure 1.4 Leather vases designed by Madieke Fleuren.

Figure 1.5 shows the process of experiencing surprise through sensory incongruity. In short, a surprise-eliciting event follows four steps: first, an event is experienced as exceeding some threshold value of unexpectedness; second, a surprise experience occurs; third, ongoing activities and information processing are interrupted and attention is focussed on the unexpected event; finally, the unexpected event is analysed and evaluated and, if deemed necessary, stored knowledge is updated and a more effortful, conscious, and deliberate analysis of the unexpected event is initiated (Meyer, Niepel, Rudolph, & Schutzwohl, 1991; Meyer, Reisenzein, & Schutzwohl, 1997; Stayman, Alden, & Smith, 1992).
We distinguish between a number of processes and actions in the 'surprise episode'. The 'feeling of surprise' refers to the subjective feeling of surprise. A surprising event can be evaluated as pleasant or unpleasant (generally) or as annoying, irritating, joyful, etc (more specifically). 'Interruption of ongoing activities' comprises a sudden stop of all activity, both mental and physical, and a focusing on the surprising event. The 'facial expression' of surprise is defined by three components: widening of the eyes, raising the eyebrows, and opening of the mouth (Darwin, 1873; Ekman & Friesen, 1975). 'Spontaneous vocalizations' are vocalizations that reflect the unexpected nature of the surprising event and that are made almost unconsciously, e.g., "Oh!". The 'Evaluation of surprise' is a subjective evaluation of what the surprising event means to the person who is experiencing it. 'Exploratory behavior' refers to actions that are used to gain information about the unexpected event and to lower the heightened arousal level (Berlyne, 1966).
While the first four of these processes together form the manifestations of a surprise reaction, the last two reflect cognitive and behavioral reactions to
F wards the surprise experience. The double-headed arrows within the surprise episode in Figure 1.5 indicate that these processes and actions may alternate or may occur simultaneously (Lewis, 2005; Scherer, 1982; Smith & Ellsworth, 1985). The outcome of the surprise episode is likely to affect the overall evaluation of a surprising event.

Emotion theorists have put forward different views on surprise. Some of the researchers adopting a categorical approach to emotions regarded surprise as one of the 'basic emotions' (Ekman and Friesen, 1971; Izard, 1977; Plutchik, 1980). They distinguished surprise from other emotions based on its unique manifestations (e.g., facial expression, and feeling of surprise). Russell (1980) organized emotions on two dimensions, arousal and pleasantness. He classified surprise as an emotional state high in activation and neutral in valence, i.e. neither unpleasant nor pleasant.
Another group of theorists have used appraisal theories to explain the differences and similarities between emotions. They see emotions as the result of an individual's evaluation and interpretation (appraisal) of events in the environment (Smith and Ellsworth, 1985; Scherer, 1987; Roseman and Evdokas, 2004). Lazarus and Smith (1988) see true appraisal as the assessment of the implications of events for an individual's goal commitments. Most appraisal models suggest that combinations of several different appraisal types eventually cause an emotion. Surprise has been associated with appraisals of unexpectedness, pleasantness, novelty, motive consistency, and complexity (Smith and Ellsworth, 1985; Roseman et al., 1996; Reisenzein, 1999).
For our purposes, appraisal theory is valuable because it explains how emotions can be elicited. For surprise elicited by products, Desmet (2002) defined different appraisal patterns for pleasant surprise and unpleasant surprise. Both appraisal patterns consist of the combination of an appraisal of novelty (in terms of suddenness and unexpectedness) combined with one of three other appraisal types ('motive (in)compliance', '(un)appealingness', and '(il)legitimacy') and that determine whether the surprise will be experienced as pleasant or unpleasant. The patterns of appraisals Desmet defines to distinguish pleasant surprise from unpleasant surprise are similar to the patterns he defines for the product emotions amusement and disappointment respectively.
The combinations of multiple appraisals Desmet defined for pleasant and unpleasant surprise and the overlap with the appraisals he defined for amuse20 Introduction

ment and disappointment are in line with theories in which surprise is seen as the first stage in a sequence of appraisals. The evaluation of the environment is a dynamic and continuous process. Events evaluated as relevant to a person are evaluated further. In this way, emotions result from appraisal structures rather than from single appraisals (Silvia, 2005a). Several researchers (Scherer, 1987; Meyer et al., 1997) have argued that when a sequence of appraisals starts with appraising an event as unexpected, it will result in surprise. Subsequently, the surprising event is further evaluated and a 'second' emotion is elicited. Silvia (2005b) suggests that interest can follow surprise in such a sequence of appraisals, when an appraisal of novelty is followed by an appraisal of coping potential. In Roseman's model (Roseman et al., 1996) of the appraisal determinants of emotions, surprise is the only emotion that results from a single appraisal (unexpectedness), whereas all other emotions result from combinations of appraisals. Scherer (1987, pp15) stated that surprise is often only the precursor to other emotions.
Some authors have suggested that surprise is not an emotion. For instance, Ortony et al. (1988) suggested that surprise is not an emotion because it lacks hedonic value. However, because of its distinct manifestations (e.g., the feeling of surprise and the facial expression of surprise) others view surprise as an emotion. Of course, the answer to the question lies in the definition of emotion, an extensive discussion (see Kleinginna and Kleinginna, 1981) that we did not include here, because it does not seem particularly relevant to designers. Hudson 2002, Rashid 2003) showed that 1-6 % of these designs incorporate some form of visual – tactual incongruity. Therefore, we decided to focus our discussion of surprise in product design on this type of products.

Visual - tactual incongruities and surprise
Visual – tactual incongruities occur when people perceive incongruent information through vision and touch. Some object properties can be experienced through both vision and touch. People can, for example, both see and feel a texture or a shape. However, the information the two modalities provide is not always the same. Sometimes, you feel something different from what you (thought you) saw. If you feel something unexpected, you will be surprised.
We studied 101 products with visual – tactual incongruities (63 found in the IDYs and 38 found at design fairs, on the Internet, and in shops) and distinguished two types of surprising products that have different mechanisms underlying the surprise reaction. We defined these two types of surprising products as 'Visible Novelty' (VN) and 'Hidden Novelty' (HN). The distinction between the two surprise types is based on the initial sensory expectations the user forms.
Expectations can be based on different sources of information. Oliver and Winer (1987) mention three sources for expectations as conceptualised by Tolman (1932): 'memories of actual experiences, perceptions of current stimuli, and inferences drawn from related experiences such as trial of other objects. With respect to expectations about how a product will feel, taste, smell or sound this implies that a person's visual impression of a product, his/her previous experiences with that product, or experiences with similar products can be the basis for the expectation.
Figure 2.2 Logo of Kia with pay-off: 'The power to surprise'. Advertisement of Swatch with claim 'Always surprising'.26 Surprise in product design

An expectation involves uncertainty (Oliver & Winer 1987), which depends on the source of the expectation. When the expectation is based on a memory of an actual experience, the level of uncertainty is likely to be lower than when it is based on inferences drawn from related experiences. In the latter case, the perceiver cannot be sure that the current experience is fully comparable to the related experiences and will thus be more uncertain about what to expect.
The sources for expectations and their uncertainty differ between the two surprise types. The VN surprise type consists of products that seem unfamiliar to the perceiver. Consequently, the perceiver is not able to form an expectation based on previous experiences with the product. The perceiver forms an expectation about how the product will feel based on resemblances with other products in, for example, shape or material. A high degree of uncertainty will accompany this expectation. A surprise is experienced whenever the uncertain expectation is disconfirmed. A VN product can, for example, be made out of a new material that the perceiver vaguely associates with a material he/she knows. An expectation could then be based on experiences with the known material, but the new material can have very different tactual properties.
The HN surprise type includes products that seem familiar to the perceiver, but have unexpected tactual properties. In this case, the expectation about how the product feels is based on previous experiences with a similar product. The perceiver is quite certain about his/her expectation. A surprise is elicited, because the apparent familiarity is evidently proven wrong by touching the product, disconfirming the expectation: the visual perception is misleading or the product has hidden characteristics that prohibit the perceiver from forming a correct expectation. An example of a HN product is a plastic bowl that looks like a crystal bowl. Upon seeing this product, the perceiver thinks that the product will be heavy. When the product is touched and lifted, however, the perceiver is surprised about the much lower weight of the bowl.

2.3 Design strategies

Designers seem to create products in the HN and VN type by making use of several different design strategies. We identified six different design strategies (DS): 'new material with unknown characteristics', 'new material that looks like familiar material', 'new appearance for known product or material, 'combination with transparent material', 'hidden material characteristics', and 'visual illusion'.

In all six strategies, a combination of two opposites is used: something new is used ('Newness') and a reference to something familiar is made ('Familiarity'). The combination of new and familiar elements is likely to result in surprise. The familiar element of the product forms the basis for an expectation about other elements. Subsequently, the new element will disconfirm this expectation. New and/or familiar elements can be used in the visual domain in the appearance of the product (e.g., in shape, material, or type of product), and/or in the tactual domain in the material properties of the product (e.g., in weight, flexibility, or balance).
The newness of a product is likely to be relative. According to Berlyne (1971), it is highly unlikely that someone encounters an absolutely novel stimulus, a stimulus unlike anything that individual has met before. Probably, what someone perceives as new, will consist of previously experienced elements in a different combination, or will resemble familiar stimuli. This is what Berlyne describes as relative novelty. Hekkert et al. (2003) found that people prefer products with an optimal combination of typicality and novelty. Their findings are consistent with the design principle called MAYA (most advanced, yet acceptable) by designer Raymond Loewy (1951). Analogously, people will prefer products that have a combination of both familiar (i.e., typical) and new (i.e., novel) elements.
The next sections discuss how these two elements are present in each design strategy. In addition, we present examples of products that could have been designed following that strategy. The design strategies can result in the two different types of surprising products discussed. Four strategies can lead to a product in the VN type. One of these strategies can also lead to a product in the HN type

and the two other strategies can only lead to a product in the HN type. Figure 2.3 illustrates the relationship between the six design strategies, newness and familiarity, and the two types of surprising products. 28 Surprise in product design

Figure 2.3 Relationships between design strategies, their underlying dimensions and resulting types of surprising products.

Design Strategies 1 and 2: New materials

New materials are likely to have new and unknown characteristics that can lead to new visual and/or tactual experiences. According to Ezio Manzini (1989) more and more surprising products have gradually occurred on the market due to a 'loss of recognition' since the introduction of plastics. Many new plastic materials possess unknown material characteristics. Upon seeing these materials, people experience uncertainty about their feel characteristics because they do not know them. Upon touching the materials they might be surprised by their feel. For example, the much lighter weight of many plastics combined with their strength relative to previously known materials like steel and wood surprised many people when plastics were first introduced.

The development of smart(er) materials also offer wide opportunities for designers to explore new sensory experiences (Verbücken 2003). An example of the use of a smart material is a water kettle made out of a thermochromic material that changes colour when its temperature rises. Through this material, the kettle 'warns' the user when it is hot. Several companies and institutes, such as Material Connexxion, Materia and Innovathèque assist designers in their search for new and innovative materials.

When observing a new material, a perceiver will form a feel expectation based on resemblances with familiar materials. When the new material looks exactly like a known material, these expectations can be certain. If not, they will be uncertain. These two cases yield very different design approaches .

As another example, some time ago, I received an invitation to the opening of a new showroom of my Alfa Romeo dealer (see Figure 1.2). It invites me to come and let my senses be stimulated. Subsequently, the invitation tells me how each of my senses will be addressed: I can see, hear, smell and feel the cars in the showroom and I can taste the drinks that will be served (and that synchronize in color with the familiar Alfa-red). These are just two of the many examples in product design and marketing (see also Lindstrom, 2005) that illustrate the growing attention for the senses.

However, sensory impressions obtained through hearing, seeing, touching, smelling and tasting do not always contribute to a desired end-experience in an integrated way. Janlert and Stolterman (1997) emphasized that all the senses add to the 'character of things.' On the basis of the perceived physical characteristics, such as color, size, or shape, people can infer expressive or personality characteristics of products, for example, the toughness or the femininity of a product (Govers, Hekkert, & Schoormans, 2004). Designers can manipulate a product's expression to influence the experience of a product (van Rompay, Hekkert, Saakes, & Russo, 2005). For example, a slim-shaped stainless steel lemon juicer may be experienced as luxurious and elegant while standing on the kitchen sink, but its loud and harsh sound may diminish the experience of luxury when it is used. In such cases, it will be hard to integrate the information from different senses into a coherent product experience. Instead, the information from one of the senses may clash with other sensory inputs and thereby have a major (undesirable) effect on the product experience. Hence, designing sensory experiences can be aimed at communicating a consistent message to all sensory channels, making this message a stronger one.

Figure 1.2 Invitation for the opening of a new Alfa Romeo showroom. The text on the left part of the figure (front) reads 'Stimulate your senses' , the text headings on the right part of the figure (inside) read: 'See', 'Taste', 'Hear', 'Smell' and 'Feel'.