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A HYPOTHETICAL MODEL OF ENVIRONMENTAL PERCEPTION

Ambient Vision and Layout of Surfaces in the Environment

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1. INTRODUCTION

This paper reexamines a hypothetical model of environmental perception underlying my research development since 1978 when I started to study visual perception of texture in an environmental context. While studying the perception of texture in the environment, it became clear that perception of discrete elemental features (objects) and continuous environmental features (textures) are quite different: texture, which is perceived without focal attention, creates a context in which attended objects stand out, and contributes to enhance the subtle ambience or feelings of the environment (Ohno, 1980; Ohno & Komuro, 1984).

Beyond the study on texture, my research interest has extended to our unconscious process of perception for continuous environmental features in general (Ohno, 1985). Unlike most psychological research, the research emphasis lies not in the psychological process itself but in the source of information in the physical environment, more particularly in the method to describe relevant physical features which are potentially sensible.

Although discussions in this paper deal with visual perception, the dichotomy here is a part of the comprehensive model of multi-modal perception in the environment, in which our senses are distinguished between two basic modes: subject centered (autocentric) and object centered (allocentric). The former concerns people's feeling and pleasure whereas the latter is concerned with objectification and understanding, and involves attention and directionality (Rapoport, 1977). This differentiation among

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between the two channels of visual analysis, Julesz and Bergen (1983) regarded ambient vision as a preattentive visual system. Based on findings of experiments on texture discrimination, they suggested the existence of a separate preattentive visual system that cannot process complex forms, yet can, almost instantaneously and without conscious effort or scrutiny, detect differences in a few local conspicuous features regardless of where they occur. Preattentive vision, therefore, was believed to serve as an early warning system by pointing out those loci that should be attended to. With this interplay of two visual systems, we can pick up wanted information from a wide area of the environment with limited attentional effort.

When we treat perception as an information processing system, the two visions can be characterized by the difference of strategies for controlling the flow of information. Focal vision eliminates unwanted information by selective attention while enhancing the elements attended to. Ambient vision deals with broader areas, with scattered or unconscious attention, and provides quick global impressions.

Although the above discussions were extracted from experiments under special laboratory situations, a hypothetical model of environmental perception can be formulated based upon the dual mode of vision. The dichotomy of the two visions is schematically represented in Fig. 2, in which focal vision is characterized by an active visual line fixated on an object, while ambient vision is characterized by numerous radiant visual lines converging on the station point, which I call "visual radiation."

2.2. A Source of Ambient Information: Continuous Environmental Surfaces

In order to make the preceding discussion feasible for environmental design, we have to know the relevance of the physical features in the environment to focal and ambient information. We cannot simply determine that a certain element always provides focal information, since that depends on human action and mental state, namely arousal, motivation and/or expectation. We can however estimate the relation by considering common behavior in a certain places. Considering usual situations, we can tell what kind of physical features tend to provide focal or ambient information.

We can assume that the continuous surfaces which surround us are usually processed by ambient vision, while discrete objects scattered in the visual field are processed by focal vision.

The author's attention to surfaces in the environment has stemmed from Gibson's discussions (Gibson, 1966) on the environment as a source of stimulation in which he showed a new approach as contrasted with traditional object-oriented one. The essential difference between the two approaches seem to be derived from different conceptions of the basic units which convey stimulus information in the visual field, in other words, the differences in ways to abstract the visual field. Landwehr (1984) clearly

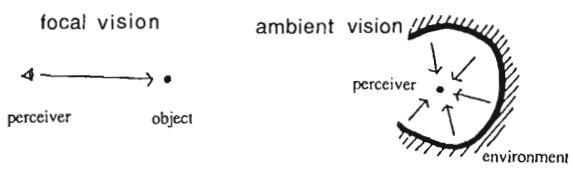

Figure 2. A schematic representation of the two visions.

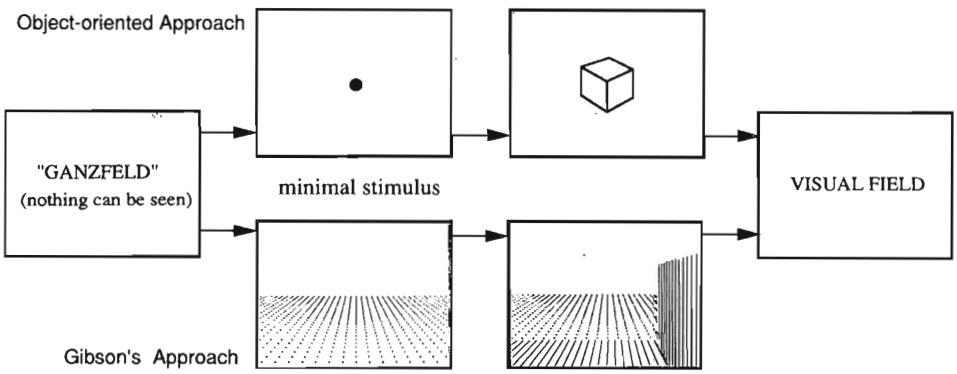

Figure 3. Two approaches for filling up visual field.

demonstrated this difference as shown in Fig. 3, in which the homogeneous "Ganzfeld" where nothing is seen is supposed to be filled up in two different ways. Traditional theory begins with a minimal point and then extends to lines, figures, and abstract solids. Gibson's theory on the other hand begins with a textured horizontal plane as a minimal stimulus information, which may be associated with the plane of the earth's surface, and extends various layouts of textured surfaces, or "ambient optic arrays" (Gibson, 1979).

Both of these different approaches can be accepted if we consider that each of the two approaches puts emphasis on one side or the other of the two aspects of the visual system. The object-oriented approach may explain more about perception of individual elements by focal vision, whereas Gibson's theory may explain more about perception of larger fields by ambient vision. As a hypothetical model, the differences of the two visions discussed in the previous section and the relevant source of information are summarized in Table 1.

Table 1. A Hypothetical Model of Environmental Perception: A Dichotomy of the Two Visions

	Focal vision	Ambient vision
Perceiver's attitude	Focal attention/conscious/active	Scattered attention/unconscious/passive
Visual pathway	Visual cortex	Superior colliculus*
Nature of information processing	Time consuming process	Instant process
	Detailed information per area of visual field	Limited information per area of visual field
	Perceptual selection	Perceptual integration
Outcome/function	Recognition of objects	Body posture/locomotion
		Attention evocation/orientation
	Understanding	Global impression/feeling
Source of information	Discrete elemental features (objects)	Continuous environmental features (surfaces)

*The superior colliculus has recently been found as a second projection area in the brain.

3. DEVELOPMENT OF A METHOD FOR MEASURING AMBIENT VISUAL INFORMATION

Ambient visual information has rarely been taken into account as a environmental variable by researchers and designers since it is not easy to manipulate and describe the continuous surfaces surrounding people by conventional methods. Thus it is worth having an alternative tool to describe ambient visual information of the environment. A computer program was, therefore, developed to provide a visual representation and statistical analysis of the ambient visual information. In order to develop a computer program, the preceding discussion about the nature of ambient vision has to be extended to postulate hypotheses which serve as design criteria of the computer program.

The basic units which convey ambient visual information were postulated to be areas of visible surfaces divided up by differences in meaning for basic human behavior, or differences in their "affordance". They are, for instance, surfaces of pavement, water, grass, trees, building, and sky. Pavement affords walking but water surface cannot, and trees afford going through or under but building wall cannot. The way of dividing environmental surfaces is similar to Thiel's (1997) concept of "basic pattern areas" in his "notation" and is virtually made following his ideas, but it does not distinguish surfaces of the same affordance regardless of their texture or color.

Ambient vision deals with broad areas, with scattered attention and provides a quick global impression. This "instant" process which integrates information from broad areas implies that ambient vision performs a simple statistical analysis. The program was, therefore, designed to assess visual information from all directions around the perceiver and conduct some statistical calculation for integration although accuracy of details was not required.

The program, in practice, assesses surrounding scenes by numerous scanning lines radiated from a station point in all directions with equal density, and records the array of visible surfaces of various components and the distance between the surfaces and the station point. The concept of spatial volume, a mean length of visual lines, is similar to Benedict's (1979) two-dimensional "Isovists", although in this present case three-dimensional volume are measured. Having this data, it then calculates various measures which are expected to describe various psychological impacts of "visual radiation" from the surfaces surrounding the perceiver.

4. SOME EMPIRICAL STUDIES

The followings are brief reviews of some empirical studies which examine quantitative relations between measured ambient visual information obtained by the program and a variety of human responses.

4.1. Sensory Information and Behavior in the Japanese Gardens

This study (Ohno, Hata, & Kondo, 1997) examined the hypotheses that people's behavior commonly changes at certain places in the Japanese garden, and can be explained by the sensory information in the environment. It has been often mentioned that Japanese gardens have been designed so as to control visitors experience, partic-

ularly the vistas, as they move along the garden paths. If we can learn from these sophisticated skills of landscape design, we could naturally direct people's attention to something we want to be viewed.

In a typical circuit-style garden in Kobe City, each of the twenty-one participants was asked to stroll at will along the main circuit path. The participant's behavior was recorded on videotape by a TV camera from a position about 5 meters behind them. From the videotape each participant's motion (viewing directions) and walking pace were observed and recorded at every 0.5 meter consecutive points along the path. In order to analyze participants' behavior with objective data, the changes of sensory input latent in the environment as people moved along the path were measured by a set of personal computer programs (Ohno & Kondo, 1994).

By comparing the results of the experiment and the measurement, it was found that participants commonly change their viewing direction where ambient vision detects a sudden change in surrounding scenes. It occurred when a participant was moving from enclosed space to open space, and passing over water on a bridge. An asymmetrical distribution of participant's viewing direction suggested that people tend to extend their attention to open areas where vistas are larger. Although influences by other senses (hearing, kinesthetic) are acknowledged, the measurement of ambient visual information in the environment was found to predict these behaviors.

4.2. Evaluation of Landscape of Housing Neighborhood and Ambient Visual Information

An impression or feeling of landscapes was attempted to explain by ambient visual information measured by the program (Ohno, 1991). Nine simulated housing neighborhoods which were systematically different in density of vegetation were created and scale models (1/250) of the sites were made. A sequence of scenes along a typical path in each of the housing sites was presented to forty-three participants by a series of slides taken by an endoscope at ten consecutive points each ten meters apart. The participants were asked to rate the impressions of each simulated landscape using a rating sheet which contained ten bipolar adjective pairs. The program was applied to eight consecutive points along the path, and profiles of the numerical measures, namely visible area of components and the spatial volume, were obtained. From these data, averages of each measure and the coefficient of sequential variation were calculated.

The relation between the subjective judgment of "natural—artificial" and the visible area of greenery, suggests that greenery softens the negative impression of "artificial," but the positive impression of "natural" would not be enhanced by an increase of greenery beyond 15 percent. As for the sequential variation, changes in visible spatial volume was found to relate with the impressions of "unique—featureless" and "pleasant—boring." This study, in which subjects rated sequential landscapes of different housing neighborhoods, revealed that the global impressions or feelings of a place can be well explained by some of the measures obtained by the program.

4.3. Site Planning of Multifamily Housing Considering Residents' Mutual Visual Interactions

In order to develop a tool for the site planning of multifamily housing as related to the residents' psychological responses, the program was modified to measure the

amount of visual interaction, or the probability of being seen, at a given point in a proposed environment (Ohno & Takeyama, 1994). While negative aspect in the visual interactions causes a problem of visual invasion of privacy, there is also the positive aspect of "natural surveillance", related to feelings of safety (Newman, 1972). The basic hypothesis for this study is that the residents' perceptions and attitudes concerning privacy and security from crime are a function of the amount of "visual radiation" from the surrounding buildings. The amount of "visual radiation" at a given station point is postulated to depend on the visible area of surrounding surfaces which potentially have residents' eyes, namely the surrounding buildings' facade with windows.

An empirical study was conducted using a questionnaire which asked the respondents (1) to rate how much they cared about neighbors' visual invasion of privacy on a 6 point scale, and (2) to mark the area on the housing site map where they do not let children play and they avoid themselves for safety reasons. It was revealed that the residents' sense of privacy was related to the measures of "visual radiation" to each individual apartment from surrounding buildings and paths, and the outdoor spaces in the housing site where residents feel unsafe could be predicted by lack of residents' eyes measured by "visual radiation" from surrounding buildings.

5. CONCLUSION

The three empirical studies generally support the validity of the measurement of ambient visual information latent in the disposition of environmental surfaces in the visual field, and they clarified some numerical relations between the measures obtained by the program and human responses at various levels. In this paper I put more emphasis on direct, ongoing perception rather than on cognitive aspects of perception. Since the latter aspects, more related with focal information, are receiving considerable attention by conventional environment-behavior studies, I stress the former aspects which tend to be ignored. The study of ambient perception may, I believe, make up for the deficiency of traditional object-oriented approach and contribute to a more complete theory of environmental perception.

Finally, I would like to draw attention to ambient information unconsciously received by nonvisual senses. Considering the changes in our built environments which tend to cause increasing dependence on artificial elemental features, we should stress the importance of the ambient features of natural and traditional environments which enrich our sensory experience.

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