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TEXTURE PERCEPTION VERSUS OBJECT PERCEPTION IN THE ENVIRONMENT

The nature of texture perception in the environment, as opposed to object perception, is discussed, and a distinction between them is empirically made based on element size and the distribution of elements. A psychophysical experiment using visual stimuli (dot-patterns) revealed that there is an optimal scale range of elements to be seen as "texture". The upper and lower limits of the category varied according to (1) the element shape, (2) the regularity of element arrangement, (3) the brightness contrast between element and background and (4) the size of the stimuli.

INTRODUCTION

Our perception of the environment may depend not only on some dominant elements (discrete symbolic features) but also on the global impressions (continuous environmental features). The former may be perceived through the focal attention with which people selectively pick up wanted information from a limited part of the environment, whereas the latter may be perceived through unconscious scanning of attention over the numerous inarticulated elements in the environment. The above difference may be regarded as that of two basic perceptual modes: focal perception and ambient perception.

The former mode of perception, with which objects are detected and recognized, has been regarded as a dominant tendency (i.e., Gestalt tendency) and has been emphasized by psychologists. Although the original philosophy of Gestalt theory emphasized the holistic character of perceptual experience and recognized the importance of context, subsequent attention from psychologist has been focused primarily on the "figure" (object). The theory of perception derived from the results of these studies thus fails to fully explain the actualities of environmental perception (Ittelson, 1973).

When we treat perception as an information processing system, the above two modes of perception can be characterized by the difference of strategies for controling the flow of information. In the former mode of perception, selective and focal attention eliminates unwanted information while enhancing the elements attended. In the latter mode of perception, people deal with a large number of elements with scattered or unconscious attention and grasp the global impression.

Based on above mentioned criteria, perception of texture belongs to the latter mode of perception, which has been generally neglected by psychologists. In fact, texture perception permits us to digest a very large amount of details quickly. We may assume that when perceiving texture, the visual system automatically and unconsciously performs some basic tests on the optical data and these tests yield an immediate answer about overall characteristics (Pickett, 1970). In environmental perception, texture perception deals with an almost infinit number of elements at once, and informs the human perceiver of the subtle qualities or ambience of the environment to which feelings and resposes may attach. Therefore, the study of texture perception may, we believe, make up for the deficiency of the traditional object oriented approach and contribute to a more complete theory of environmental perception.

THE SIZE-LEVEL HIERARCHY OF THE ENVIRONMENT

The visual field surrounding us contains numerous objects, elements, and spaces differing continuously in size between the smallest and largest sizes theoretically visible. From the undifferentiated mosaic of the visual field, one is compelled to select a figure on which attention

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concentrates and detects a visual object of a certain scale. At the same time, one perceives texture which is composed of smaller elements not perceived independetly. In other words, the elements which comprise texture belong to hierarchically lower levels of size, as opposed to the object to which an observer is paying focal attention.

The selective perception in the hierarchy of size-level is achieved by attention which is greatly influenced by observation distance. In the case of texture perception, seeing a mountain at a distance, for example, we may appreciate texture composed of trees, and looking at a tree nearby, we may appreciate texture composed of leaves. In other words, at a certain distance, there appears to be an optimal size of aggregated elements to be seen as texture.

This notion of the size-level hierarchy may be schematically represented as in Fig.1. In this figure, elements which are usually aggregated in the environment are represented by diagonal lines. Each line shows the relation between the observation distance (horizontal axis) and the size of projected image on the retina (virtical axis). The virtical axis is hypothetically divided into three perceptual categories: an array of independent elements, texture and a smooth plane. Using this figure, we may know how each of the elements changes in appearance according to the observation distance or at a given distance, which elements appear as independent elements, texture or smooth planes. If the boundaries between neighboring categories are defined, it should become a useful tool for environmental designers who wish to manipulate texture in the environment. They can predict with greater precision how environmental elements appear in a given situation and thus avoid ineffective use of texture.

The experiment reported below is a part of a first attempt to define these boundaries in a quantitative way. Although using abstract patterns, the present experiment provided a set of empirical understandings which may be interpreted for actual or simulated environment.

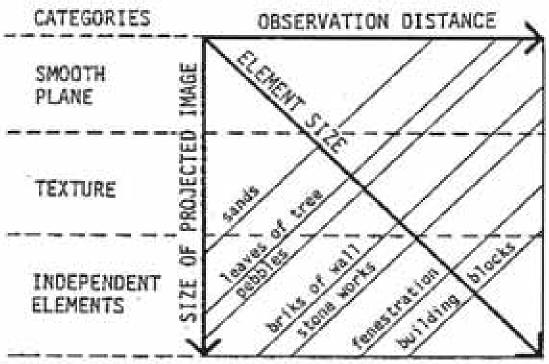


Fig.1 A hypothetical scheme of the size-level hierarch in the environment.

PSYCHOPHYSICAL EXPERIMENT

The question of when we perceive texture (as opposed to perceiving independent elements or smooth planes) for aggregated elements in the environment was operationalised by asking the same question for two dimensional dot-patters. This experiment attempted to define the necessary conditions for us to sense texture visually.

Subjects

Thirty University students of Tokyo Institute of Technology served as subjects. Half of the subjects were from the Department of Architecture. All subjects had normal vision.

Stimuli

Stimuli were sheets of mat surfaced "dot-patterns" arranged in many black or gray geometric figures on a white or gray background. The dot-patterns were systematically varied based on the following two hypotheses and consisted of six types and many subtypes, totaling two hundred forty-four variations (see Fig.2).

The hypotheses were:

(1) The basic requirement for an optical pattern to be seen as texture

is the awareness of the repetitive spatial variation in brightness over an area of a certain broadness. To sense the variation in brightness, the size of dark or bright dots and spacing between neighboring dots must be large enough, and the brightness contrast must be strong enough. The requirement of repetitiveness implies the necessary broadness of the area where sufficient repetitive variation can occur. Element size, interval between elements, brightness contrast and frame size were, therefore, taken as relevant variables.
(2) Neighboring elements were required to unite together to form a sense of texture. The degree of unity between elements was regarded to be influenced by arrangement of elements and element shape as well as those variables already taken.

Procedure

Using the experimental apparatus shown in Fig.4, each observer was presented various dot-patterns and was asked to make three judgements: (1) whether or not the stimulus appears as a smooth plane of homogeneous gray color? (2) whether or not it appears as texture? (3) whether or not it appears as an arry of independent elements? The experiment was divided into six sessions according to the type of stimuli, and in each session, the order of presentation was randamized for each subject.

Results and discussion

Fig.5 shows a part of the experimental results using the standard dot-patterns. In the figure, the proportion of positive responses to three questions were ploted against element size and interval between elements. In both graphs, the judgement of "smooth plane" and "texture" as well as that of "texture" and "independent elements" shows reciprocal relations. The stimuli that yields 50 percent of judgement of "texture" are very close to that of "smooth plane" and also that of "independent elements". Therefore, it may be well to consider three exclusive categories although there are transitional zones. From the fogure, it should be noted that the transition from "smooth plane" to "texture" was sharper

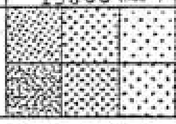
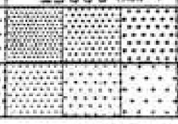
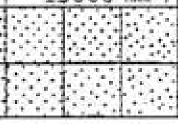
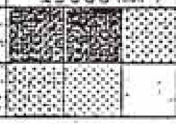
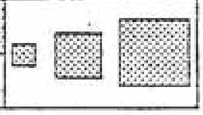
VARIABLES \ TYPES		1: STANDARD DOT-PATTERNS	2: V & C SHAPED PATTERNS	3: TRIANGULARLY ARRANGED PATTERNS	4: IRREGULARLY ARRANGED PATTERNS	5: BRIGHTNESS CONTRAST PATTERNS	6: PATTERNS WITH DIFFERENT FRAME SIZE
ELEMENT SHAPE		●	V , C	●	●	●	●
ARRANGEMENT		square	square	triangular	(randamized)	square	square
GRAY LEVEL		0.00976 − 78.5(%)	5·10·20(%)	5·10·20(%)	5·10·20(%)	20 (%)	10 · 20(%)
BRIGHTNESS	EL.	N 1	N 1	N 1	N 1	N 1.4 − 8.2	N 1
	BG.	N 9	N 9	N 9	N 9	N 2.7 − 8.6	N 9
FRAME SIZE		15600 (mm²)	15600 (mm²)	15600 (mm²)	15600 (mm²)	15600 (mm²)	3910 − 62500 (mm²)
EXAMPLES		see Fig. 3					

Fig.2 Variations of stimuli

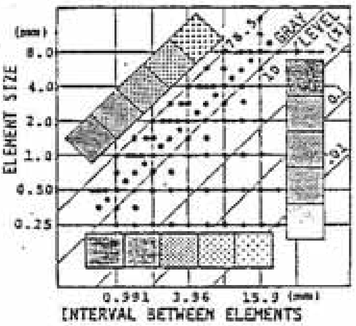
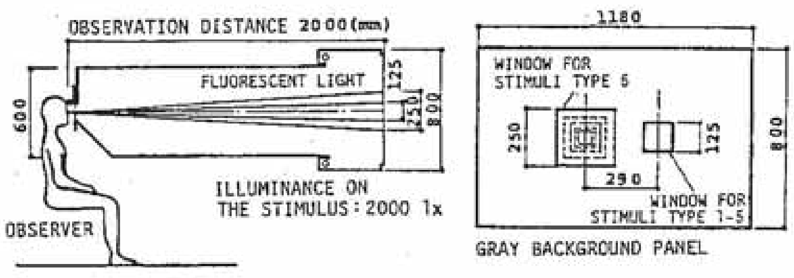


Fig.3 Variations of standard dot-patterns



(section) (inside elevation)

Fig.4 Experimental apparatus

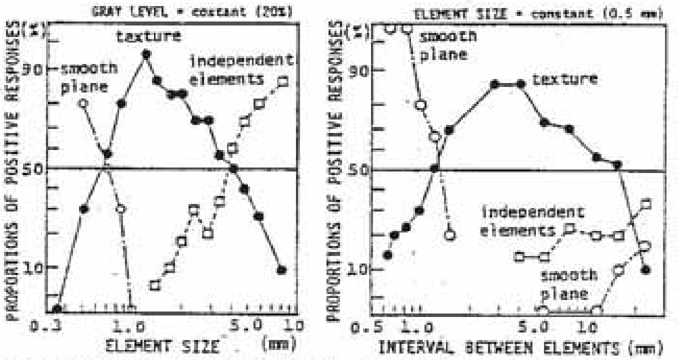


Fig.5 Proportions of positive responses

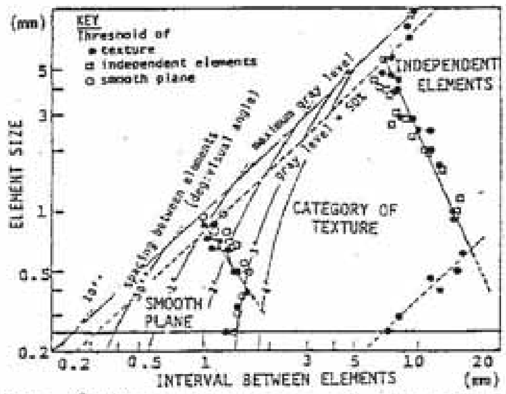


Fig.6 Destribution of thresholds

than the transition from "texture" to "independent elements". This difference suggests that the former boundary entails a physiological or optical limit of human eyes for detection of brightness variation, while the latter entails a psychological limit in which neighboring elements are perceived to unite together.

Threshold values for the perceptual categories were defined by the stimulus that yielded a 50 percent positive response. In Fig.6, a series of the thresholds which are determined by element size and interval forms two boundaries and the scale range of patterns which yield texture perception are clearly defined.

A similar analysis was made for each of the other types of stimuli, and the influence of each variable was examined by the shift of the threshold from the standard dot-pattern. V and C shaped patterns tended to be more easily judged as independent elements than the round dot-pattern of the same size. Each element of irregularly arranged pattern was more easily articulated than the regularly arranged pattern. Similarly, patterns with strong brightness contrast more easily appear to be independent elements. A slight influence of frame size was observed: As a frame is reduced in size, elements become more easily separated perceptually, thus losing their textural appearance. For stimuli near the lower limit of texture category, V and C shaped patterns, irregularly arranged patterns and patterns with strong contrast were similarly more readily identified as "texture".

A number of interpretations of these findings have occured to us, but, they lead us in different directions. For the present, they perhaps best serve as points of departure for the design of future experiment.

CONCLUSION

From the experiment, the notion of an optimal scale range for aggregated elements to be seen as texture was supported, and some relevant variables were clarified. It should be noted, however, that the above results were extracted under special laboratory conditions. Nevertheless, as an initial step toward an alternative approach dealing with ambient perception, the present study may be regarded as a basic guide to futher study.

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