CUES FOR SPACE PERCEPTION IN LANDSCAPES

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INTRODUCTION

An important question in the theory of space perception is whether space perception is identical with depth perception or with the estimate of distance. Canter (1974) gives a careful definition: "In so far as it is understood by present-day psychologists, it seems that the perception of space is based, in the main, upon the use of cues that are normally associated with distance in our daily life." (1) These cues are, for instance, the difference in gradients of texture with different distances and the apparent convergence of parallel lines. Later studies concentrate on a search for invariants in the perceptual field, e.g. Shaw and Bransford (1977) and Epstein (1977).
The concepts of 'gradient' and 'invariant' are not new but stem from Gestalt Psychology, 'gradient' from Kohler and von Lauenstein in 1933 and 'invariant' from Koffka in 1935. (2) Both terms have been reintroduced by Gibson (1950 and 1979): "The theory of the extracting of invariants by a visual system takes the place of theories of "constancy" in perception." (3). Gibson also reformulates a gradient as an invariant: "A gradient is first of all an invariant property of an optic array." (4).

The cues for depth perception formed part of a psychophysical theory of perception. This theory is based on physiological optics and the retinal image. In his earlier work Gibson makes a distinction between what belongs to optics and what does not: "The fact is that in a dark room with no other

sources of stimulation the more highly illuminated of two equidistant and otherwise equivalent surfaces tends to look the nearer. This is an empirical fact which has nothing to do with optics. It is not easy to account for. It does not imply that brightness is a clue, indicator, or sign of distance; it only poses a problem." (5)
Later, Gibson solved the problem whether space perception is identical with depth perception by negating depth perception altogether and by reformulating space perception as the perception of surface layout: "The theory asserts that the perception of surface layout is direct. This means that perception does not begin as two-dimensional form perception. Hence, there is no special kind of perception called depth perception, and the third dimension is not lost in the retinal image since it was never in the environment to begin with. It is a loose term." (6)
So now, the importance of the retinal image for the formation of a mental image is given up. All efforts are are now directed toward investigating how information about the outer world is processed and converted into a picture of reality. This information processing approach is not new either. Accoring to Helmholtz the perception of space is based on the perception of signs, "the interpretation of whose meaning is left to the understanding." (7)
The important question is then: What are the 'signs' in space perception? Where Gibson's search for an explanation is based on the concepts of invariants, it may be useful to start from the other side, with "variants". The question then becomes: Which changes in surfaces or surface layout lead to systematic changes in space perception? One could call these variants "cues" and it seems worthwhile to search for a limited set of cues with a systematic influence on space perception. An attempt will be described.

SUPPORTING EVIDENCE

Some "empirical facts", in the sense of Gibson's more highly illuminated surface looking nearer, have been found in architectural psychology.
Martyniuk et al. (1973) demonstrated that the assessment of the size of a room varies with different lighting arrangements. The more highly illuminated the room the larger it seemed.
Imamoglu (1973) demonstrated that the higher the furniture density in a room the smaller its perceived size. There was an inverse relationship between the mean perceived size and furniture density.

Hayward and Franklin (1974) investigated Spreiregen's theory, that the perception of openness-enclosure of space is determined by the ratio of boundary wall height to physical distance from the wall to the observer, against Garlings theory that it is a function of the physical size of the space alone. Their results support Spreiregen's view. This is confirmed again by MacNab et al. (1978).
Sadalla and Oxley (1984) found that rectangular rooms were estimated bigger than square rooms with the same ground surface.

invariant of equal amounts of texture for equal amounts of terrain, a powerful invariant according to Gibson (8), but with different assessments of size. Other arguments are:

Gibson (1950) states: "The perception of depth, distance, or the so-called third dimension, is reducible to the problem of the perception of longitudinal surfaces." I.e. a surface parallel with the line of sight. However, part of the cues for space perception have nothing to do with longitudinal surfaces but with dimensionless cues, such as color or brightness.

Further, Gibson calls "the traditional list of clues by which the mind is believed to infer a world of three dimensions", such as linear perspective or the superposition of contours, "signs or criteria of distance" (9). None of these cues coincide with the cues for space perception found in this experiment.

And Gibson again: "Brightness is sometimes listed as a cue to distance, the presumable assumption being that an object necessarily appears darker as its distance from the eye increases. In the ordinary environment of illuminated surfaces, brightness is not an indicator of distance." (10). However, it does determine space perception, be it in a reverse sense to Gibson: a darker space is perceived as smaller (closer by), not as larger.

Not only brightness but also the presence of loose elements in space differently affects the perception of distance and the perception of space. Carr, Luckiesh, Forgus and Luria et al. all found that in a space filled with loose elements distance is perceived as longer than in an empty space. They call this phenomenon the "filled-unfilled space illusion". Carr states: "A heterogeneous or differentiated distance is judged to be longer than a homogeneous or undifferentiated one. We may expect then that our judgment of the distance of a given object will vary with the degree of differentiation of the ground pattern of which it is a part, or with the number of intervening objects." (11). In the experiment by Imamoglu as well as in this experiment contrary results were found for space perception. This also goes for "the differentiation of the ground pattern", which is the coarseness of texture.

Concerning the integration of information there seems to be a hierarchy in the cues, depending on the absolute size of the space. In the slides g1 and g2, both showing rather large spaces, the effect of a high wall and a coarse texture cancelled each other (no significant difference). In the slides h1 and h2, both showing rather small spaces, the high wall in h2 had a greater effect than the coarse texture in h1. This integration of information is confirmed by Bartlett: "Even our elementary perceptions are inferential constructs." (12).

So, space perception and the perception of distance use different cues, or the same cues in different ways.

NOTES

1. Canter, 1974, p 39.
2. See Allport, 1967.
3. Gibson, 1979, p 311.
4. Idem, p 149.

5. Gibson, 1950, p 137 note.
6. Gibson, 1979, p 148.
7. Cited in James, 1950, II, p 269.
8. Gibson, 1979, p 162.
9. Gibson, 1950, p 137.
10. Idem, p 137 note.
11. Carr, 1935, p 272.
12. Cited in Koestler, 1976, p 77. Koestler adds: But the inferential process functions on unconscious levels.

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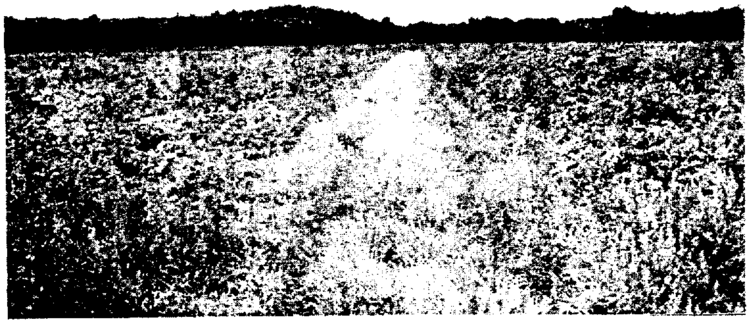
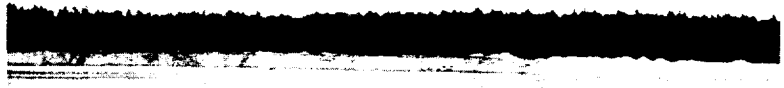
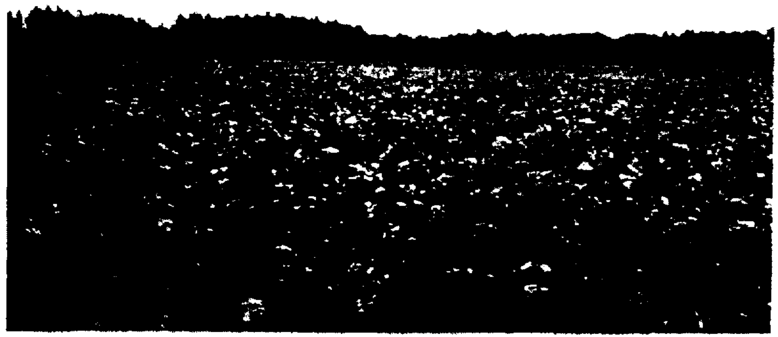


a1. A monotonous boundary wall



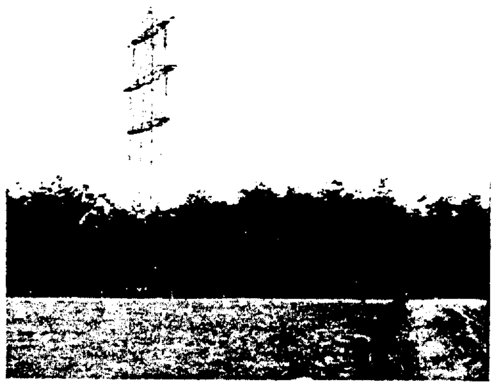
b1. A fine grain of texture

a2. A complex boundary wall



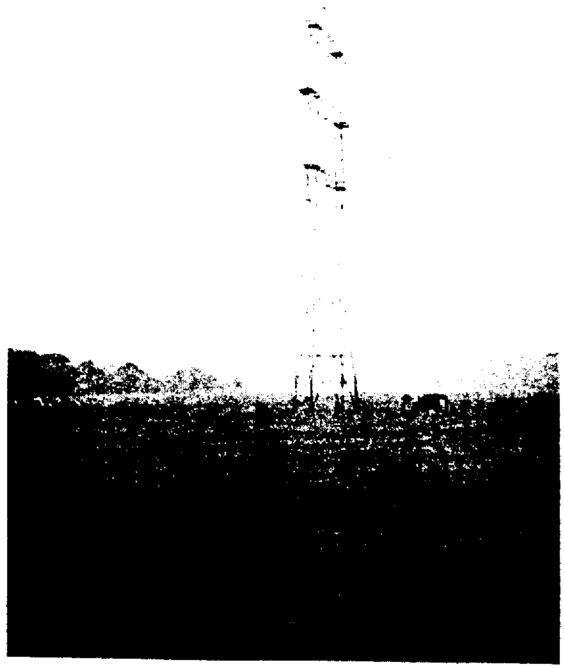
b2. A coarse grain of texture

c1. A landscape



c2. The same landscape with pylon

d1. A landscape



d2. The same landscape behind a pylon

e1. A landscape on a sunny day

e2. The same landscape on a rainy day

f1. A landscape with a fine texture and a monotonous wall

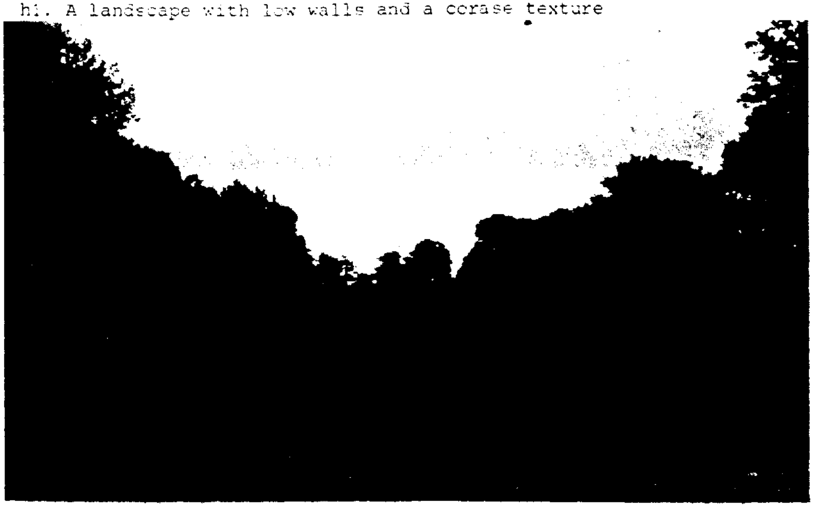
g1. A landscape with a low wall and a coarse texture

f2. A landscape of the same size with a coarse texture and a complex wall

g2. A landscape with a high wall and fine texture

h1. A landscape with low walls and a corase texture

i2. A landscape of the same size with a lower wall but with a pylon



h2. A landscape of the same size with high walls and a fine texture

i1. A landscape with a high wall