1-1-1967

The effect of object texture on the perception of depth.

P. Terrence Oster
University of Windsor

Recommended Citation

Oster, P. Terrence, "The effect of object texture on the perception of depth." (1967). *Electronic Theses and Dissertations*. 6489.
https://scholar.uwindsor.ca/etd/6489

THE EFFECT OF OBJECT TEXTURE ON THE PERCEPTION OF DEPTH

by

P. TERRENCE OSTER
B.A., Assumption University of Windsor, 1965

A Thesis
Submitted to the Faculty of Graduate Studies through the
Department of Psychology in Partial Fulfillment
of the Requirements for the Degree of
Master of Arts at the
University of Windsor

Windsor, Ontario, Canada
1967

ProQuest LLC
789 E. Eisenhower Parkway
PO Box 1346
Ann Arbor, MI 48106-1346

APPROVED BY:

Smith

Richardson

Blackburn

16299

ABSTRACT

This study was an attempt to determine the effect of object texture on the preceived distances of small circular targets.

Twenty Ss were divided into monocular and binocular viewing groups. All Ss were required to estimate the apparent distances of small circular targets, the surfaces of which exhibited a straight line texture pattern which varied through five texture densities and four texture orientations. Orientations were provided by mounting the targets with the grid pattern in a vertical, horizontal and two intermediate positions. All targets remained physically fixed. Density was defined as the number of texture elements subtending one degree of visual angle at a viewing distance of 14.5 feet. The middle texture density of the vertical orientation constituted the standard targets.

Results showed that the finer densities were seen as further away, the effect being that of a psychophysical function. The effect of orientation was more ambiguous, although the vertical orientation did appear closer than the horizontal. No difference was found between the viewing conditions. All variables functioned independently.

PREFACE

This study began as a result of a personal interest in a recently proposed theory of depth perception, in which texture gradients of continuous surfaces in the visual field were held to be the stimuli affecting perceived distance. An observation by the author that objects themselves exhibited their own unique surface characteristics or texture suggested that object texture, without reference to a continuous background, could as well affect perceived distance. An attempt is made to answer this question.

The author wishes to express his grateful appreciation to Dr. A. A. Smith, under whose direction this study was carried out, and without whose advice and patient assistance this work could not have been completed. Gratitude is also owing to Mr. D. H. Richardson and Mr. A. Blackbourn for their interest, and especially for their helpful suggestions. Finally, the author wishes to express his appreciation to the subjects of this study who gave so generously of their time.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The one approach to depth perception which has remained most popular in psychology, traditional and for the most part unchallenged, is the classical theory of cues suggested by Helmholtz in the middle of the last century. Cues are considered to be criteria utilized by an organism in perceiving depth and have been listed with general agreement by most authors as accommodation, convergence, retinal disparity, linear size, familiar size, aerial perspective, light and shade, interposition, filled and empty space, height in the picture plane, linear perspective, brightness, and motion parallax (Forgus, 1966; Gibson, 1950; Ittelson, 1960; Hochberg, 1964; Woodworth & Schlosberg, 1964). These criteria have been in turn categorized as binocular and monocular, implying cues utilized by one or by two eyes, and primary and secondary, implying cues yielding spontaneous perception of depth and cues requiring judgment and past experience for their operation. Although Ittelson (1960) saw these and other dichotomies as implying different but false processes, the latter dichotomy has been most meaningful both in terms of diverse theorizing and historical approach (Boring, 1943).

Primary cues were thought to be those criteria eliciting immediate and automatic perception, namely, accommodation, convergence and retinal disparity. The secondary cues, on the other hand, required judgment and past learning for their efficiency. These latter devices were usually employed to portray depth in pictorial art, and hence have been known for centuries. The discovery or demonstration of the primary cues was of more recent date.

Until the turn of the 17th century the problem of depth perception did not exist, since the dynamics of the eye had not yet been discovered. As a result, those cues used to depict depth in art were taken as the final word in perception. As the function of the eye became known, Aguilonius (1613) verbalizing the mechanism of convergence and Kepler (1604) showing the crystalline to act as a focusing lense, the problem arose. Locke (1690), with his theory of knowledge, put the question. All knowledge comes through the senses, the mind being a tabula raza. He saw, as well as did Berkley (1709), that the eye could not explain all visual knowledge, especially that of the third dimension. Either the mind must in some way supplement the visual sense (inference, judgment, learning) or there is an intuitive understanding of the sense data (innatism or nativism).

Common to all theories, however, was that sensations preceded perception. Only the act of synthesis varied. It is still held today that perception is essentially subjective and not fully determined by the stimulus.

The problem continued. Taking the single eye, no information of the third dimension could be gained, since this dimension comprised the line of sight itself. Ambiguity was present as well since the information of the third dimension could be gained from a picture as well as from the visual world. The answer must be in the use of two eyes. Disparity, shown by Wheatstone (1838) to be a powerful depth cue, was raised as "the" primary cue. It has been shown since, however, that one-eyed infants and those one-eyed from birth are capable of making good spatial discriminations. Binocularity may be a sufficient but not a necessary condition. Perhaps convergence is a cue. Hillebrand, however, in refuting the findings regarding accommodation and convergence in Wundt's famous thread experiment, suggested that, convergence itself depends on the perception of depth. More recently, both convergence and accommodation have been shown to rely on the perception of depth rather than to effect it (Ittelson, 1960; Itellson & Ames, 1950; Woodworth & Schlosberg, 1964).

The primary cues began to be taken as secondary, perception seeming more and more to depend on the so called secondary cues. Not even the most extreme nativist would argue these as pure intuitions of space. Nor could the structuralists' and empiricists' stand remain tenable. Past kinesthetic experience, even though shown to affect depth discrimination, (Hochberg, 1964, p. 48), could be absent and the discrimination of depth still be shown (Walk, Gibson & Tighe, 1957; Gibson & Walk, 1960). There existed, in effect, no comprehensive theory of depth perception in the context of the classical list of cues.

Nativism had assumed that the synthesis leading to perception was intuitive or innate. Empiricism explained stimulus synthesis as learned or inferred from past experience. More recently the Gestaltists have suggested that it is effected by a characteristic achievement of the central nervous system, called (spontaneous) sensory organization. Objects perceived are not a compound of elementary sensations. The whole is what is perceived, and what is perceived is a tri-dimensional world from the outset. Although this three-dimensional percept could not be as well explained as the Gestalt principles of form, edges and surfaces were the stimuli for perception. A correspondence existed between retinal stimulation and one's awareness of things (Gibson, 1950, Ch. II). Forgus, (1966, p. 219) states that there exists an innate potential to respond to various relationships which lead to our perception of space. Which of these factors becomes more functional depends to a large extent on experience and learning. Hochberg (1964, p. 74) contends that:

> Whenever observers agree about what they see, the following must be true. No matter how complicated the stimulus, and no matter how great the effects of past experience (and of other unknown factors) 'there must be some discoverable psychophysical relationship between the objects viewed and the perceptions that result (since if there were nothing in the stimulus pattern to govern the response, there obviously could be no agreement, except by chance, among observers).

Gibson (1950) following much the same reasoning as that of the Gestaltists, proposed a new theory, contrary to that of cue, called ground theory, or the "Cue" of gradient. Gradient to Gibson, is nothing more than an increase or decrease of something along a given axis or dimension. As with the Gestaltists, perception for him was immediate rather than innate. The world was composed of edges and surface, whole organizations, and not objects structured from points of light stimulation. There was a correspondence between the stimulus and the percept. Unlike the Gestaltists, however, he emphasized the importance of surface quality, surface inhomogeneities or microstructures called texture. The concept of visual space was one of a continuous surface or array of adjoining surfaces. The stimulus array on the retina contained the same inhomogeneities or gradients as did that of the visual world, leading to a corresponding impression of depth and distance in the psychological world (Forgus, 1966, p. 209). The retinal image was a stimulus, containing enough variations to account for all the features of the visual world (Gibson, 1950; Flock, 1964d).

There have been a paucity of studies referring to the latter mentioned theory reported in the literature. Those studies that have been reported have used texture as the stimulus and texture elements as the relational variable in terms of stimulus variation. Slanted surface has been the physical spatial dimension manipulated for the most part, and it has been demonstrated that the gradient of texture density is an adequate stimulus for the impression of a continuous distance or slant (Gibson, 1950a; Flock, 1963; Flock & Moscatelli, 1964; Flock, 1964b; Flock, 1964c). Gradients of outline compression, studied alone and with textured surfaces were found as well to be appropriate stimuli for the perception of slant and an accurate perception of objects in a slanted or frontal orientation (Beck & Gibson, 1955; Clark, Smith & Rabe, 1955; 1956a; 1956b). Object identification has been shown to depend on the extent to which photic zones and gradients defining a surface maintain their interrelationships, bearing out the importance of perceived object surface (Nelson & Vasold, 1965). A ground surface itself was demonstrated to relay accurate information regarding the distance of objects in contact with it. Additionally,it was shown that differing ground surfaces did not differentially affect perception.

Although the absolute value of the stimulus may change, the relationships of the gradient (texture element) remain the same. That is, as ground surface receeds, the texture elements decrease in size and increase in density (Dusek, Teichner & Kobrich, 1955; Teichner, Kobrich & Wehrkamp, 1955; Gibson, Bergman & Purdy, 1955). Visual cliff experiments, employing discontinuous texture patterns have shown that depth can be discriminated by the use of texture alone, even by the very young (both animal and man) as soon as they are able to locomote (Walk, Gibson & Tighe, 1957; Gibson & Walk, 1960). Apparently the retinal stimulus variable making possible the perception of a continuous surface must have been a continuous change of some sort in the image of that surface, possibly a change in the densities of the various light intensities reportable as grain or texture. Abrupt changes or discontinuity in a pattern would be seen as a step-at-a-contour, experienced as differences in depth of surface, perceived and accounted for by jumps in texture density.

All these studies have been concerned with the role of texture in the whole field, either as determining slant (as in a ground plane), or with respect to abrupt changes in the overall texture (visual cliff experiments). Objects, however, as they appear in nature, usually have a texture of their own. Does this object texture, or microstructure, affect how one perceives them in depth, even when the total field is essentially textureless? This is the question, the answer to which this present study is directed.

CHAPTER II

METHOD

Subjects.

The subjects were 20 male students between the ages of 18 and 25 attending the University of Windsor. All Ss were equated for visual acuity and stereopsis on the Bausch and Lomb orthorator. Twenty-twenty vision, corrected, was required.

Apparatus.

The apparatus was physically the same as that used by Stelmack (1965) in a previous study of the effect of colour variables on depth perception and by Bonner (1966) in her study of the role of prior receptor reinforcement. The essential features are as shown in Fig. 1. Dimensions of the viewing box were 4' x 4' x 8' long, with S's viewing position 16' from the back surface. The interior was illuminated by incandescent bulbs, concealed from S, where the only view of the interior was a 20" x 40" rec-

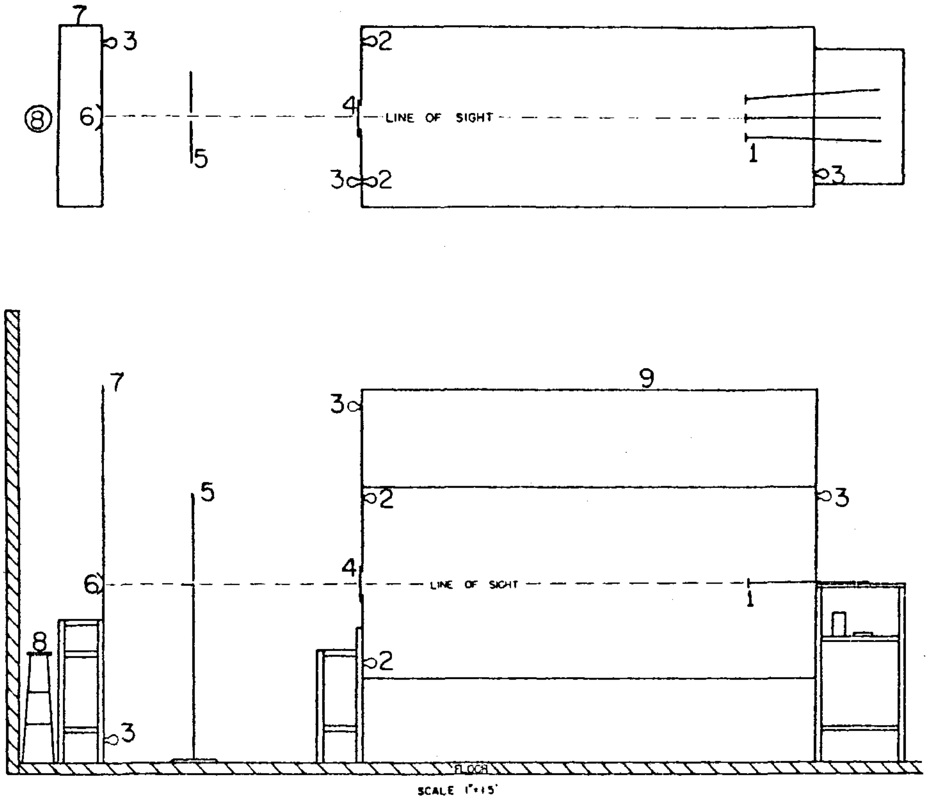


Fig. 1. Top and side view of apparatus.

1. Stimulus targets.
2. Interior lamps.
3. Exterior lamps.
4. Shutter.
5. Reduction screen.
6. Viewing hood.
7. Observer screen.
8. Bench.
9. Pulley.

tangular portion of the far end, this back wall being covered with black velvet to provide a featureless background. Against this background the stimulus objects appeared, mounted on the ends of three wooden dowels (invisible to S) which projected 18" from the background. These (particularly the centre target) constituted the objects whose distances were to be estimated by S. All targets remained physically fixed.

To eliminate as far as possible any non-textural variable, the targets were circular. Any shape other than the symmetrical circle would have yielded a possibly significant binocular form disparity when S used both eyes.

Choice of texture pattern was more difficult and remained to a certain extent arbitrary. For ease in determining the quantitative element, however, the pattern was such that changes in pattern could be clearly described and measured. A pattern of alternating black and white lines of equal width, as used in certain devices for measuring visual acuity, fulfilled this criterion. It also made possible an additional independent, yet measurable, difference in pattern, namely, that of the orientation of the lines.

The patterns were constructed by photographing, from 20 different distances, beginning with 5 feet and continuing through each successive foot to 25 feet, a 22" x 28" sheet of bristol board upon which a black and white grid had been constructed. Construction involved dividing the short axis of the sheet into lines .5 inches in width, and then filling each alternate space with strips of .5 inch, flat black (minimally reflecting) artists tape. From the 20 resulting prints, circles of 1.5 inches in diameter were cut, of which 5 were selected as stimuli. The prints chosen were those representing the grid photographed at 5, 7, 9, 11 and 13 feet. These were selected since they were evenly spaced within a range defined, at one end, by the presence of the grid at a distance of 14.5 feet begin just clearly detectable, and on the other, by at least four elements (2 black lines and 2 white lines) being visibly present.

These five targets thus formed five equal steps along a dimension of texture density, in which density was defined as the number of texture elements subtending one degree of visual angle at the viewing distance of 14.5 feet. At this distance a 1.5 inch circular disc subtends 30 minutes of arc. By this definition, the five densities employed, in terms of elements per degree of visual angle, were 26, 34, 42, 50 and 58.

Line or texture orientation was easily provided by mounting a guide on the stimulus discs and dowel with axes vertical, horizontal and at each of the two 45^{o} intermediate positions.

It will be noted that this technique, apart from errors in the photographing process, eliminated target brightness as a variable.

Procedure.

All Ss were first tested for visual acuity and stereopsis. Of the 20 Ss used in this study, 10 took the monocular condition, 10 the binocular condition. Each S was required to make, by way of magnitude estimation (Andreas, 1964, p. 130), 100 judgments as to the perceived distance of the variable stimulus (the middle disc) relative to a standard (the outside discs), 20 patterns (4 texture orientations x 5 texture densities) each being presented five times. The 20 pattern matrix is given in Appendix A. It will be noted that the standard stimulus was the middle texture density of the vertical texture orientation, and remained so throughout the experiment for all Ss. The standard was assigned the value 100, values then given the variable stimuli depending on S in terms of their perceived distances. The 20 patterns presented were randomly ordered through the 100 presentations 10 times, each S receiving a different order. This decreased the possibility of an order effect intervening, that is, practice and fatigue. Each S was asked to respond within the time that the stimulus array was exposed to view, this duration being 5 seconds. The experimental procedure was identical for both the monocular and binocular conditions. However, for the monocular condition, one of the viewing holes was occluded with a corresponding flat black square of cardboard, the eye blocked out left to the discretion of the S.

Each S was brought into the experimental room and asked to be seated at the viewing stand with his head in the viewing mask. Room lights were turned off, the aperture shutter raised and the interior apparatus lights turned on. Exposed to view were the two standards and a neutral gray stimulus. At this point S was read the instructions (see Appendix B). This procedure was designed to have a two-fold effect, namely, that of allowing S to become adapted to the lighting conditions and that of familiarizing S with the apparatus and experimental procedure.

CHAPTER III

Results.

The five estimates of perceived distance given by each subject to each of the combinations of the stimulus variables were first averaged. The mean estimates are given in Appendix C.

An analysis of variance was then done on these mean values. The results are shown in Table 1.

Only Density and Orientation were shown to significantly affect the judgment of perceived distance. Since these factors were found to function independently of each other and from the Viewing Condition, separate graphs were prepared for each. These are presented in Figures 2 and 3.

The shape of the function in Fig. 2 appeared to be that of a curve rather than a straight line. A trend analysis was therefore carried out. This appears in Table 2.

Results of the trend analysis together with an inspection of Fig. 2 show that the best line of fit to represent the effect of texture density on perceived distance is a negatively accelerating curve.

Table 1.

Analysis of Variance for Mean Judged Distances by 20 Observers for 5 Texture Densities, 4 Texture Orientations and 2 viewing conditions.

Source	Sums of Squares	df	Mean Squares	F
Between Subjects				
Viewing Condition (V) monocular & binocular	131.217	1	131.217	
Error (V)	9274.587	18	515.254	
Within Subjects				
Texture Orientation (O)	815.042	3	271.680	3.005*
O x V	59.267	3	19.755	
Error (O)	4882.109	54	90.408	
Texture Density (D)	32507.657	4	8126.914	15.088*
D x V	304.074	4	76.018	
Error (D)	38780.177	72	538.613	
O x D	229.170	12	19.097	
V x O x D	212.596	12	17.716	
Error (O x D)	14864.434	216	68.816	

* = 0.05

Table 2.

Trend Analysis to Determine the Best Line of Fit to Represent the Effect of Texture Density on Perceived Distance.

Trend	Mean Squares	F
Linear	31202.53	57.90*
Quadratic	4244.77	7.88*
Cubic	.24	
Quartic	60.84	

F .95(1,72) = 3.98*

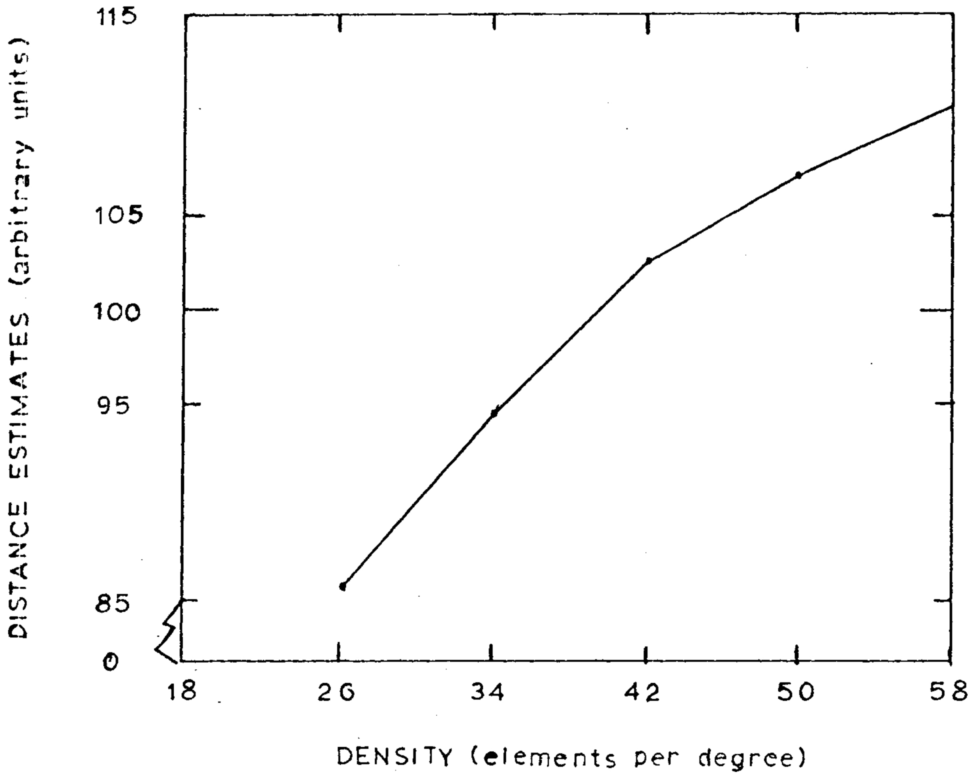


Fig. 2. The effect of texture density on perceived distance.

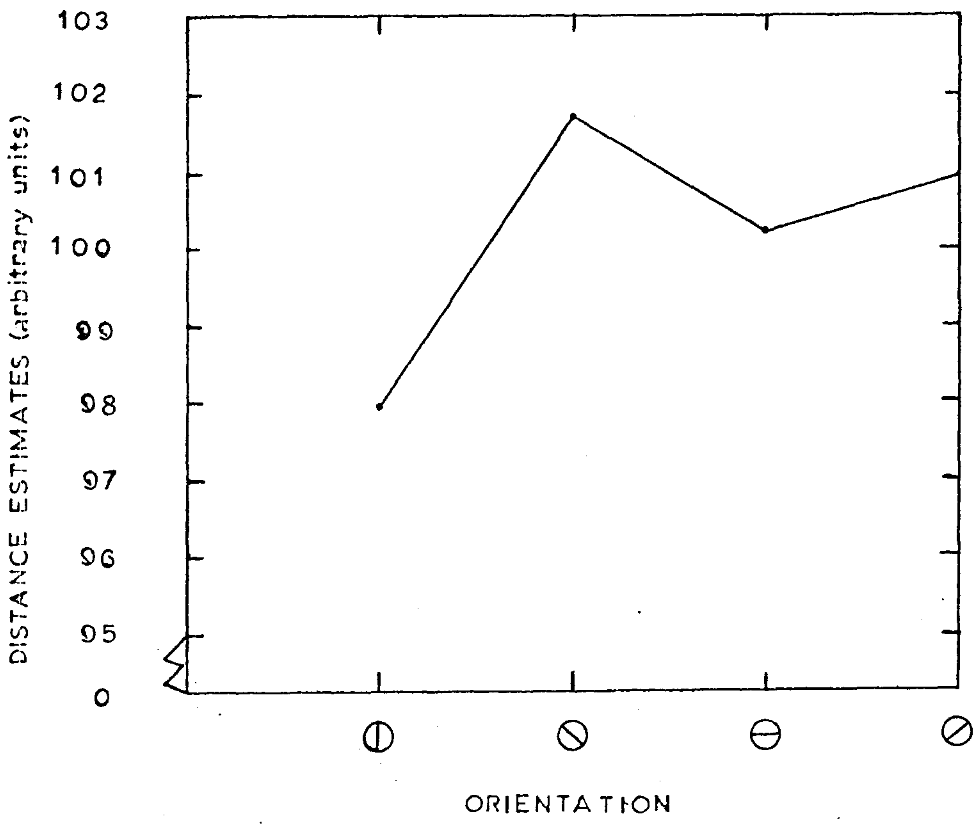


Fig. 3. The effect of texture orientation on perceived distance.

The difference in orientation, on the other hand, is in no particular order or on any absolutely defineable continuum. Therefore a means difference test was carried out in order to determine how the orientations varied among themselves. The Newman-Keuls method was employed. An analysis showed only the vertical and the left orientation to differ significantly (Points 1 & 2, Fig. 3).

Differences between the monocular and binocular viewing conditions did not appear to affect the results in any significant fashion.

CHAPTER IV

DISCUSSION

Both texture density and orientation have been shown to affect judgment of perceived distance under the conditions of this present experiment. They appear, however, to act independently. It therefore seems appropriate to examine them separately.

Influence of Orientation

Orientation was introduced as a variable due mainly to the convenience of the straight line grid. It was reasoned that, since the main lines in the visual field are horizontal and vertical, orientations other than these might produce different perceptions. Pattern orientation is here shown to affect perceived distance. However, there seemed to be no definite pattern in the results obtained. It is felt that explanation, at best, is tenuous.

Why the vertical orientation should be judged to be nearer than the standards, when the orientation of the standards were also vertical, is difficult to determine. It could possibly be explained by the horopter, the locus of all points in space that give nondisparate images at a given degree of convergence (Woodworth & Schlosberg, 1964, p. 460). An object that is fixated at any given distance throws its image on corresponding foveal points of the two eyes, and thus appears single. Objects in front of this point or beyond it give double images since they fall on noncorresponding retinal points, and are seen as nearer or farther than the object fixated. All points at the same distance from the eyes, but off to either side of the point fixated do not, however, necessarily produce a single image. The shape of the horopter actually varies with fixation distance. The nearer the point of fixation, the more the locus of points seen as single approaches a circle passing through the fixated point, bending towards the observer. The further the point of fixation, the more the locus approaches a circle bending away from the observer.

In the present study, the stimulus seems to be on a locus bending away from the viewer, and therefore, in order for the stimuli and standards to appear equal in distance, the stimulus target would have to be placed at a position behind the standards, or the entire stimulus array would have to be moved slightly forward.

The horizontal pattern appearing further away than the vertical can be discussed in terms of a horizontal-vertical illusion. Studies cited by Underwood (1966, Chap. 3) have shown that horizontal lines appear shorter than vertical lines, and that lines tilted to the left appear longer than lines tilted to the right. Lines tilted left appear even longer than the vertical, and those tilted right appear as just shorter than the vertical but longer than the horizontal. In the present study, the vertical orientation comprised the standard stimuli, and therefore were present at all times when the various other orientations were presented in the comparison stimuli. If the horizontal lines appeared to be shorter than the vertical, the horizontal pattern would appear to be further away. This is the case found in this study. On the other hand, the tilted patterns both effected a perception of further distance than did the vertical or horizontal pattern, the lines tilted left appearing the furthest away. These latter results are absolutely contrary to those expected were the horizontal-vertical illusion used to explain the phenomena.

Influence of Texture Density

Texture density has as well been clearly shown to affect perceived distance. As the straight-line texture pattern proceeds from coarse to fine, the resulting distance perceived is judged on a corresponding continuum from nearer to farther. The effect, however, was found to be non-linear.

There are two well known kinds of non-linear relationships found between stimulus variables and perceptual responses: the logarithmic function proposed by Fechner, and the power function championed by Stevens. It seemed reasonable, then, to ask if either of these would fit the present data.

As a rough check on this possibility, the data were plotted in two ways: first, as perceived distance against the logarithm of texture density (a log function), and again as the logarithm of perceived distance against the logarithm of texture density (a power function). These plots are shown in Figure 4.

The plots illustrated in Figure 4 show that the points approximate a straight line in both instances. The presence of a negatively accelerating function is thus borne out. Which type of function is more closely approximated, however, is difficult to determine.

Another significant finding resulting from the present study is the lack of difference in effect between the two viewing conditions upon perceived distance. This has rather important implications in the context of a gradient theory such as that proposed by Gibson (1950), since it suggests that texture, as defined within the presently accepted theory of perception as a secondary cue, has a rather impelling effect on perceived distance.

Although the stimulus discs remained physically fixed in space, and therefore did not change in size or

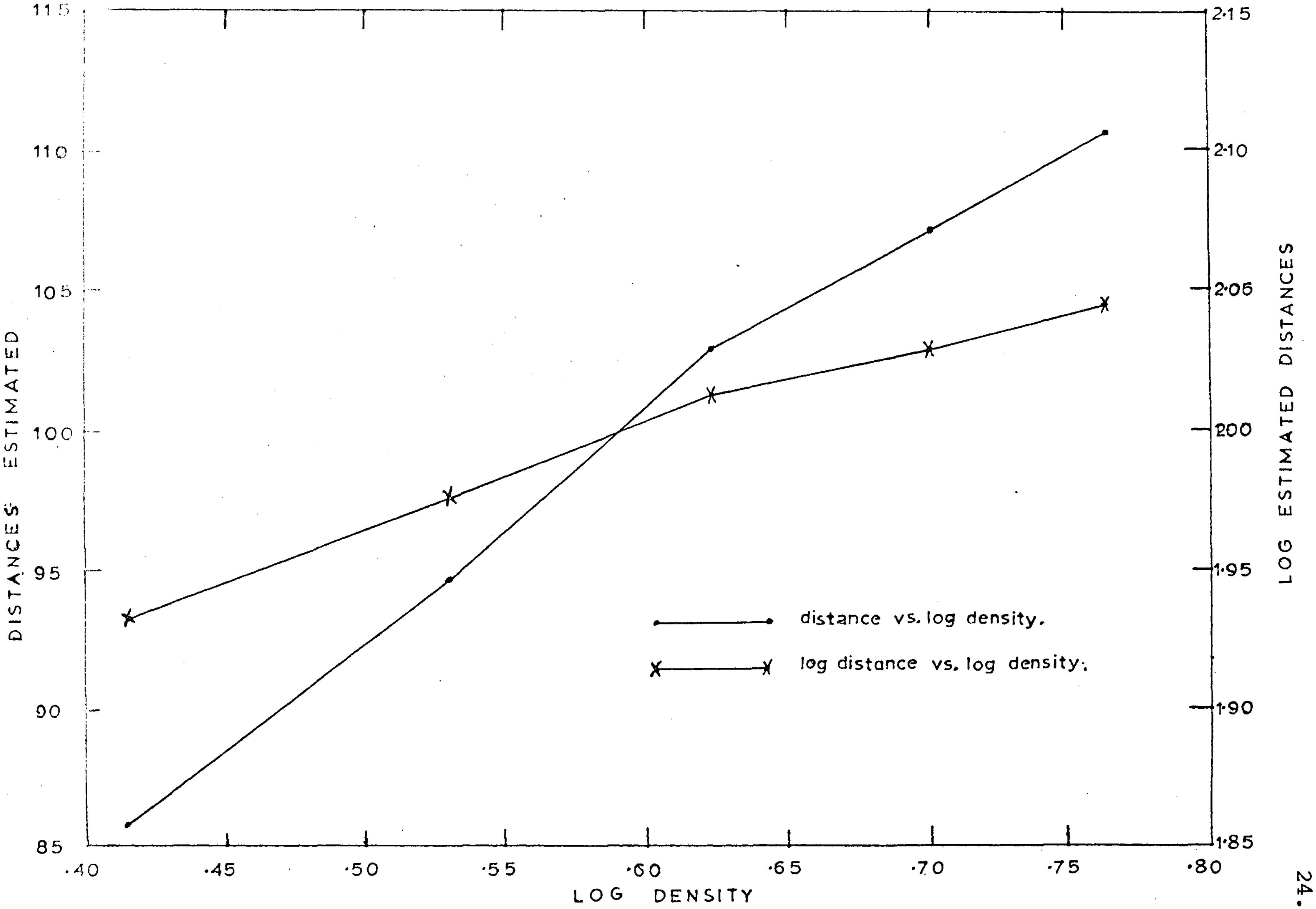


Fig. 4. Distance estimates plotted linearly and logarithmically as a function of the log-stimulus values.

distance, perceived distance varied as a function of the texture densities, even though a size cue was present. Retinal disparity was also present in the binocular condition, and yet the perceived distances varied in the same manner as was the case in the monocular condition. The lack of difference obtained under the two conditions indicates that binocular disparity, held as a rather strong depth cue, was either nullified or extremely weakened.

This would seem to bear out the findings of previous studies (Ittelson, 1960; Ittelson & Ames, 1950) wherein the so called primary cues of accommodation and convergence were shown to rely on a previous perception of distance gained from secondary stimuli or cues, relying on these cues in order to function, rather than themselves effecting a perception of depth. Binocularity has also been fooled in this regard. It has as well been shown that depth can be discriminated without binocularity, as in the case of one-eyed infants and those one-eyed from birth (Hochberg, 1964).

Textured surfaces, such as the straight-line grid used in the present study, make for differential light intensities reaching the retina, and the relationship of these various light intensities in turn make for a perception of objects variously oriented and displaced in space. Tests for visual acuity, for example, rely on the perception of a texture element, acuity being defined in terms of the smallest or thinnest element able to be perceived at a given distance, or the gap in an element that can be perceived at a given distance. Both are quantified in terms of the visual angle subtended on the retina. It is the light reflected from an element which allows it to be distinguished from the background, and the differential light intensities that allow for a perception of various textured surfaces and a distinguishing between them and other objects so textured.

Moreover, for binocular disparity to function as a cue, light rays reaching the eye must present a stimulus that is perceived as disparate. This would require patterns of light rays emenating from at least one object surface. If the visual field were entirely homogeneous, there would be, in effect, no perception. Therefore, the visual field can be defined only by virtue of that which fills it. Gross objects filling the field would be seen as macro-texture. The particular surface quality of objects would have a characteristic grain, and this would be seen as micro-texture.

The most basic unit of perception would seem to be the heterogeneity of light rays as stimuli, called gradients. Perception of depth, then, would be effected in terms of a relationship, the relationship that exists between objects in the field, or macro-texture, and the relationship that exists among the texture elements within object-surfaces (grain) and within continuous ground and background surfaces. As with grass in a field, the rough surface of a rock or the bricks of a building, most objects exhibit a surface characteristic or grain.

Studies requiring judgments of distance over different ground surfaces or terrains have shown that judgment does not vary with change in terrain (Teichner, Kobrich & Wehrkamp, 1955; Gibson, Bergman & Purdy, 1955). The value of the stimulus varies, but the relationships of the gradients (texture elements) do not. A correspondence has been found to exist between these relationships and the distances perceived. Although the relationships may be learned, it is an entirely different type of learning than that suggested by way of past kinesthetic experience or association. The perception is automatic, although not necessarily innate.

This has been found to be the case in the present study. The only stimuli present were straight-line grids of varying densities. A relationship was found to exist between the texture densities and their perceived distances. What can be attributed to learning is not known. However, the judgment of distance was more or less spontaneous, and since textured standards were employed, the judgments were relative. This is the case in terrestial space, where objects are seen both in relation to each other and in relation to a receding ground surface. A more absolute judgment could be effected by employing neutral gray standards or by presenting the stimuli consecutively but in isolation, without standards being present.

The precise relationship found between texture density and perceived distance, however, although appearing to approximate either of the two known psychophysical functions could not, with certitude, be described as either one. It is suggested that a further study, increasing both the number and range of stimuli, be carried out. This would offer more data with which to attempt a more exact definition of the function actually present.

Due to the effect of pattern orientation on perceived distance, it is felt that some factor in the overall pattern of the stimulus array is functioning, an illusion, probably in the category of a horizontal-vertical illusion. An attempt could be made to explain the phenomena by systematically altering the viewing distance in order to find a point, if it exists, at which the phenomena decreases. Further measures could as well be taken, such as those suggested to determine the effect of textured stimuli presented singly or with neutral gray standards on absolute judgments of distance.

The present findings do suggest, however, that a secondary cue such as texture could be of more primary significance in a theory of depth perception than the now considered primary cues of accommodation, convergence, and retinal disparity. Perceived distance would seem to be affected more by the relationship of the differential light intensities emenating from the elements of these secondary cues than by the physiological mechanisms to which they appear to give rise.

CHAPTER V

SUMMARY

This study was an attempt to determine the effect of object texture on the apparent distance of small textured circular targets.

The stimuli were photographs on an alternating black and white line grid pattern, taken from five equally spaced distances. The grid was constructed on a sheet of white bristol board, the surface being divided into .5 inch lines, each alternate line being filled with a .5 inch strip of black non-reflecting artists' tape. Pattern orientation was introduced as a variable by rotating the resulting prints affixed to the discs through the vertical, horizontal and intermediate 45 degree positions. Each disc was 1.5 inches in diameter. Twenty texture patterns were therefore provided (5 texture densities x 4 texture orientations). Texture density was defined as the number of texture elements subtending 1 degree of visual angle at a viewing distance of 14.5 feet.

Twenty Ss, tested initially for stereopsis and visual acuity, were divided into monocular and bonocular viewing groups. Their task was to judge the apparent distances of the comparison stimuli (the middle disc) in relation to two standard targets (the outside discs). The standards were comprised of the middle texture density in the vertical orientation. All targets remained physically fixed. For each presentation the stimulus array was exposed to view for five seconds.

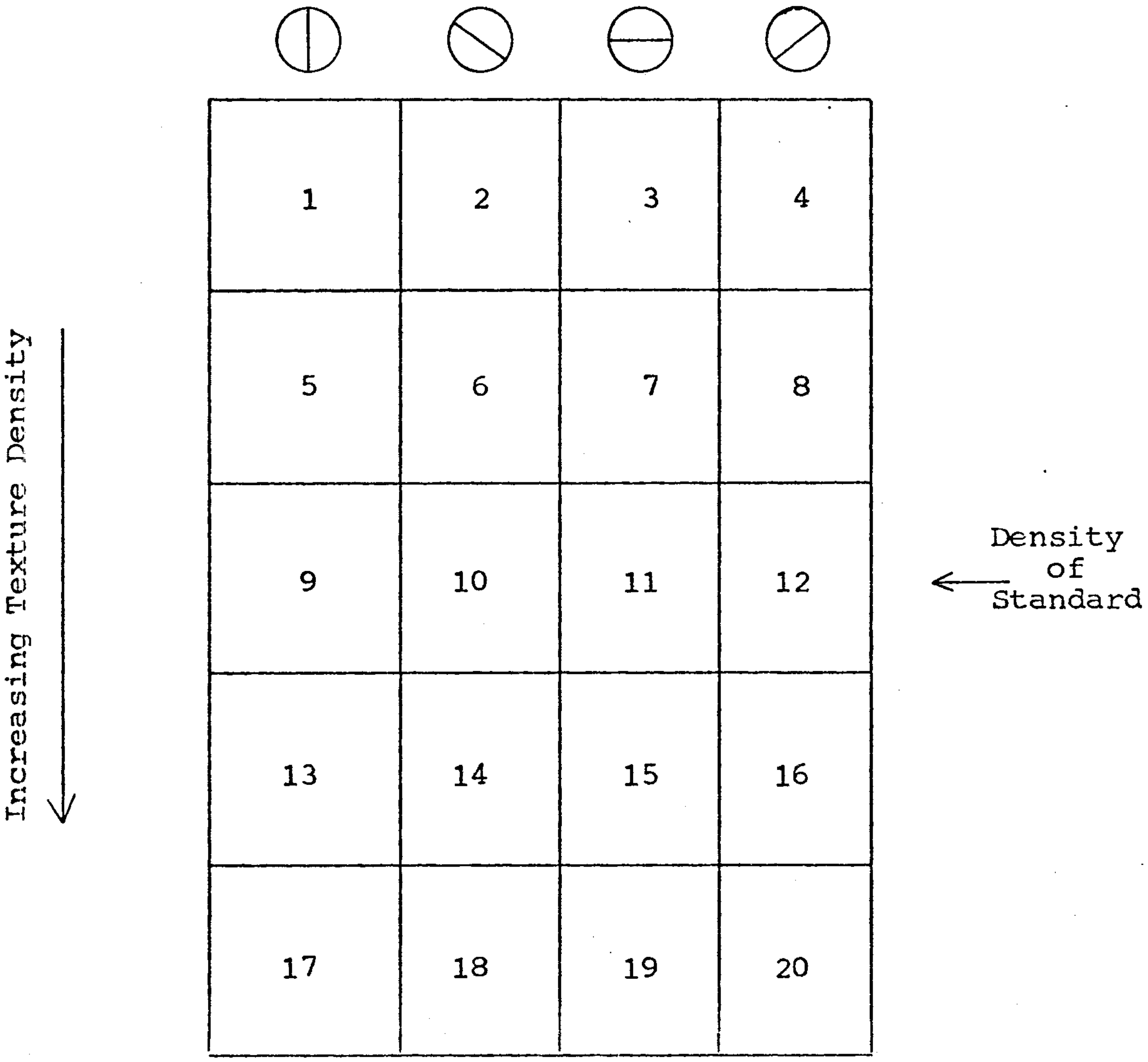
The results showed quite clearly that both texture density and texture orientation affected perceived distance. As the texture grid became finer the distance perceived was correspondingly further away. The effect of texture orientation was more ambiguous, although generally, the vertical orientation appeared closer than did the horizontal. Viewing conditions did not differ significantly in their effect. Suggestions were made for further research to clarify the precise functions of both texture density and orientation.

The results suggest that differential light intensities emenating from textured surfaces may be of more primary significance in a theory of depth perception than the commonly held primary cues of accommodation, convergence, and retinal disparity.

Appendix A.

Pattern Matrix.

Texture Orientation.



⦶	⦸	⊖	⊘
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20

Appendix B.

Instructions.

You will notice that when the shutter is opened there appear in front of you three discs. Both outside discs are the same distance from you and will remain so throughout the entire experiment. This distance is assigned the value 100. The middle disc, however, may vary in distance. Each time the shutter is raised you are to tell me how near or how far the middle disc is from you by assigning to it a value that is proportional to the value 100 of the two outside discs. If the middle disc appears further away than the outside discs, assign a value to it greater than 100 which represents the distance away from you which it appears. If the middle disc appears nearer to you than outside discs, assign to it a value less than 100 which corresponds to how near you see it. The shutter will remain open for only 5 seconds and you must give me your answer in that period of time. During the experiment these particular discs will not be used. You are being shown these now simply to give you an idea of what to expect when the experiment begins. Please do not remove your head from the viewing mask until I indicate that the experiment has ended. Remember, the outside discs will always be the same distance from you, having the value 100. Only the middle disc may vary. You must answer in the 5 seconds that the shutter is open. Do you have any questions?

Appendix C.

Mean estimates of the perceived distances of 5 texture densities and 4 texture orientations, under monocular and binocular viewing conditions, 20 Ss.

SUBJECTS		Orientation	Vertical					45° Left				
		Density	D_1	D_2	D_3	D_4	D_5	D_1	D_2	D_3	D_4	D_5
Binocular Condition	1		70.0	84.0	97.0	111.0	121.0	72.5	87.0	102.0	113.0	128.5
	2		80.5	89.0	100.5	105.0	106.0	88.0	99.0	109.5	105.5	110.0
	3		52.0	69.0	95.0	123.0	149.0	57.0	85.0	124.0	159.0	177.0
	4		86.0	98.0	95.0	101.0	105.0	94.0	94.0	104.0	108.0	108.0
	5		99.0	102.0	99.8	99.0	101.0	99.8	98.8	104.4	101.4	99.6
	6		98.0	98.8	99.0	100.6	102.2	98.2	101.6	101.8	102.2	102.8
	7		99.0	98.0	100.0	98.0	98.0	98.0	98.0	99.0	99.0	100.0
	8		84.0	91.4	100.0	107.0	113.0	84.4	93.8	99.0	109.6	113.0
	9		97.6	99.2	99.4	97.8	100.0	98.2	99.8	100.2	99.8	100.0
	10		97.4	99.6	99.0	102.2	101.2	94.0	96.8	103.6	99.0	101.4
Monocular Condition	11		98.6	97.0	100.6	101.4	95.2	99.6	92.0	96.8	96.6	101.8
	12		86.0	93.4	99.6	109.2	112.0	90.4	96.4	100.2	112.0	116.0
	13		87.0	89.0	100.6	102.6	104.2	92.0	94.0	97.0	100.6	105.2
	14		92.0	104.0	107.0	100.0	106.0	98.0	99.0	103.0	104.0	102.0
	15		35.0	88.0	105.0	73.0	133.0	55.0	87.0	105.0	93.0	103.0
	16		86.8	93.8	99.6	103.6	106.2	88.2	96.4	103.0	105.6	108.6
	17		84.0	94.0	98.0	104.0	108.0	100.0	112.0	120.0	138.0	134.0
	18		70.0	86.0	109.0	115.0	114.0	60.0	90.0	105.0	117.0	119.0
	19		89.0	94.0	101.0	104.0	101.0	94.0	97.0	108.0	108.0	112.0
	20		83.0	94.0	102.0	103.8	111.0	87.0	93.0	96.6	107.0	109.0

Appendix C. (cont.)

SUBJECTS		Orientation:	Horizontal					45° Right				
		Density:	D_1	D_2	D_3	D_4	D_5	D_1	D_2	D_3	D_4	D_5
Binocular Condition	1		72.0	88.0	99.0	111.0	125.0	72.0	87.0	105.0	114.0	120.0
	2		82.0	87.5	97.0	103.5	101.5	82.0	93.0	104.0	103.5	105.0
	3		56.0	71.0	113.0	136.0	155.0	61.0	96.0	139.0	158.0	168.0
	4		90.0	99.0	102.0	103.0	105.0	87.0	97.0	103.0	101.0	105.0
	5		99.8	99.6	97.8	101.8	96.4	99.2	99.6	102.2	98.0	96.6
	6		98.6	100.8	103.0	101.2	102.4	99.2	102.6	102.6	103.8	101.4
	7		100.0	100.0	100.0	100.0	100.0	101.0	102.0	100.0	99.0	97.0
	8		91.0	97.8	99.0	111.0	116.0	84.0	87.4	102.0	107.0	114.0
	9		97.6	98.4	101.4	101.2	97.2	98.2	95.8	101.0	98.8	99.0
	10		97.6	98.6	103.6	103.8	103.6	103.6	100.6	100.0	104.0	105.2
Monocular Condition	11		96.8	98.6	98.8	100.0	100.8	92.0	99.6	95.8	99.6	92.8
	12		89.0	97.2	108.8	112.0	112.4	86.0	96.6	99.2	115.0	116.0
	13		81.0	91.0	97.0	103.4	102.6	88.0	102.6	109.0	104.6	102.6
	14		98.0	99.0	99.0	105.0	103.0	96.0	105.0	104.0	107.0	105.0
	15		55.0	88.0	107.0	122.0	124.0	25.0	45.0	115.0	105.0	109.0
	16		88.2	92.2	97.0	102.4	105.0	90.8	98.2	104.4	107.6	110.6
	17		95.0	104.0	124.0	126.0	122.0	92.0	108.0	118.0	132.0	130.0
	18		65.0	87.0	102.0	102.0	118.0	70.0	102.0	95.0	115.0	119.0
	19		97.0	99.0	105.0	107.0	110.0	95.0	101.0	102.0	105.0	107.0
	20		83.0	90.0	98.0	99.6	105.0	83.0	89.0	93.8	103.0	111.0

BIBLIOGRAPHY

Andreas, Burton G. *Experimental Psychology*. New York: John Wiley & Sons Inc., 1964.

Beck, J. & Gibson, J. J. The relation of apparent shape to apparent slant in the perception of objects. *J. exp. Psychol.*, 1955, *50*, 125-133.

Bonner, Mary. The effects of shock punishment associations on the apparent distance of coloured stimuli. (*Unpublished M.A. Thesis*, University of Windsor, 1966.)

Boring, E. G. *Sensation and Perception in the History of Experimental Psychology*. New York: Appleton-Century-Crofts Inc., 1942.

Clark, W. C., Smith, A. H. & Rabe, A. Retinal gradient of outline as a stimulus for slant. *Canadian J. Psychol.*, 1955, *9*, 247-253.

Clark, W. C., Smith, A. H. & Rabe, A. The interaction of surface texture, outline gradient and ground in the perception of slant. *Canadian J. Psychol.*, 1956a, *10*, 1-8.

Clark, W. C., Smith, A. H. & Rabe, A. Retinal gradients of outline distortion and binocular disparity as stimuli for slant. *Canadian J. Psychol.*, 1956b, *10*, 77-81.

Dusek, E. R., Teichner, W. H. & Kobrich, J. L. The effects of the angular relationships between the observer and the base-surround on relative depth-discrimination. *Amer. J. Psychol.*, 1955, *63*, 438-443.

Flock, H. R. Selective registration of information in visual judgment of surface slant. *Perc. motor Skills*, 1963, *17*, 537-538.

Flock, H. R. A possible basis for monocular slant perception. *Psych. Rev.*, 1964, *71*, 380-391.

Flock, H. R. Some conditions sufficient for accurate monocular perceptions of moving surface slants. *J. Exp. Psychol.*, 1964c, *67*, 560-572.

Flock, H. R. Three theoretical views of slant perception. *Psychol. Bull.*, 1964d, *62*, 110-121.

Flock, H. R. & Moscatelli, A. Variables of surface texture and accuracy of space perception. *Perc. motor Skills*, 1964, *19*, 327-334.

Forgus, R. H. *Perception*. New York: McGraw-Hill Inc., 1966.

Gibson, E. J., Bergman, R. & Purdy, J. The effect of prior training with a scale of distance on absolute and relative judgments of distance over ground. *J. exp. Psychol.*, 1955, *50*, 97-105.

Gibson, E. J. & Walk, R. W. The visual cliff. *Scientific American*, 1960, *202*, 64-71.

Gibson, J. J. *The Perception of the Visual World*. Boston: Houghton Mifflin, 1950.

Gibson, J. J. The perception of visual surfaces. *Amer. J. Psychol.*, 1950a, *63*, 367-384.

Gibson, J. J. What is form? *Psychol. Rev.*, 1951, *58*, 403-412.

Hochberg, J. E. *Perception*. Prentice-Hall Inc., New Jersey: 1964.

Ittelson, W. H. *Visual Space Perception*. New York: Springer Publishing Co., Inc., 1960.

Ittelson, W. H. & Ames, A. Jr. Accommodation, convergence and their relation to apparent distance. *J. Psychol.*, 1950, *30*, 43-62.

Nelson, T. M. & Vasold, P. C. Dependence of object identification upon edge and surface. *Perc. motor Skills*, 1965, *20*, 537-546.

Stelmack, Robert M. The effect of hue and saturation on apparent distance judgment. (*Unpublished M.A. Thesis*, University of Windsor, 1965.)

Teichner, W. H., Kobrich, J. L. & Wehrkamp, R. F. The effects of terrain and observation distance on relative depth discrimination. *Amer. J. Psych.*, 1955, *68*, 193-208.

Underwood, B. J. *Experimental Psychology*. (2nd ed.) New York: Appleton-Century-Crofts, 1966.

Walk, R. D., Gibson, E. J. & Tighe, T. J. Behavior of light and dark reared rats on a visual cliff. Science, 1957, 126, 80-81.

Winer, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill Inc., 1962, pp. 319 f.f.

Woodworth, R. S. & Schlosberg, H. Experimental Psychology. New York: Holt, Rinehart and Winston, Inc., 1964.

VITA AUCTORIS

1940	Born in Toronto, Ontario, to Joseph Walter and Amy Oster.
1946-59	Educated at Corpus Christi School and St. Michael's College High School, Toronto, Canada.
1965	Graduated with the degree of B.A., Assumption University of Windsor, Windsor, Ontario. Registered as full-time graduate student at the University of Windsor.