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The effect of background colour and texture on the apparent distance of coloured targets.

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THE EFFECT OF BACKGROUND COLOUR AND TEXTURE
ON THE APPARENT DISTANCE
OF COLOURED TARGETS

by

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ABSTRACT

This study was an attempt to determine the effect of background colour and texture on the apparent distance of small coloured targets.

The stimulus targets were four coloured discs, red, yellow, green, and blue seen against "horizon" backgrounds of the four same colours under plain and textured viewing conditions.

The Ss were divided into plain and textured viewing groups whose task was to judge the apparent distance of the coloured targets in relation to a standard modulus target using the method of magnitude estimation.

The results of the present experiment indicate that colour affected perceived distance. The nearest appearing colour was yellow, followed by red, green, and then blue.

All target colours appeared nearer when viewed against the green and blue backgrounds and appeared further when viewed against the red and yellow backgrounds under both the plain and textured conditions.

There was no significant difference between the plain and textured viewing conditions, although all targets were generally judged as further when viewed against the textured backgrounds and as nearer when viewed against the plain backgrounds.

PREFACE

This study reports a further step in the investigation of the apparent distance of colour and is based in part on the previous research carried out by Robert Stelmack at this university.

The author is grateful to Dr. A. A. Smith who originally proposed the study and whose constant assistance and encouragement was so helpful in its execution. He is also grateful to Dr. Hugh Kirby and Dr. Cameron MacInnis who read the manuscript. Finally, he expresses his thanks to the subjects who gave generously of their time.

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CHAPTER I

INTRODUCTION

Depth cues have been defined as patterns of proximal stimulation that can convey information about the spatial locations of objects (Hochberg, 1964). The traditional approach to the study of depth perception has been the classical theory of cues as outlined by Helmholtz in the middle of the last century. These traditional cues as listed by most authors are interposition, linear perspective, aerial perspective, movement parallax, light and shade, accommodation, convergence, retinal disparity, shape, colour, brightness, and position in the field (Bartley, 1958; Boring, 1943; Gibson, 1950; Ittleson, 1960; Postman and Egan, 1949; Woodworth and Schlosberg, 1954). From an historical and theoretical position, the terms primary and secondary have proved most useful in classifying these cues. The primary cues were considered as convergence, accommodation, and retinal disparity, while the secondary cues were those generally attributed to the artists such as linear persective and interposition (Boring, 1943). For Berkeley (1709) convergence and accommodation of the eyes were the primary cues, basic to the immediate perception of distance, while the secondary cues were judgmental criteria which a person learned by experience to use in his estimate of distance. This fundamental view lasted for two centuries and was essentially the position of Helmholtz, Wundt and Titchener.

In the present century, however, the classical secondary cues are now being regarded as the primary criteria in visual perception with convergence and accommodation regarded as the secondary cues (Boring, 1945).

From Berkeley on, most philosophers, physiologists, and psychologists have assumed that the perception of space could not be accounted for in terms of the information in visual stimulation and had thus tried to discover how the perceiver made up for this inadequacy. The traditional viewpoint was challenged by James J. Gibson who claimed that people do perceive space and thus some kind of information was present in visual stimulation (Hochberg, 1964). He thus posited a theory of texture gradients in which the gradient of density of a surface is an adequate stimulus for the impression of continuous distance (Gibson, 1950).

Koffka (1935) suggested that the different aspects of the visual world, size, shape, colour, orientation and localization, are constituted in a thorough-going mutual inter-dependence. This implies that colour and texture should be investigated as cues in order to determine their influence on perception. Little research has been done on the apparent distance of colour and almost none on the apparent distance of colour as it is affected by coloured backgrounds and texture.

In the history of apparent distance of colour Leonardo Da Vinci included in his account of perspective such effects as increasing haze and blueness with increasing distance. He demonstrated that colours have a different appearance at varied distances (Gregory, 1966).

Other investigators have noticed that various colours in the plane do not appear to be in the same plane when viewed by Ss. Luckiesh (1918) asked nine Ss to equate the apparent distance of red and blue letters by varying the actual distance. He concluded that colours do actually "retire and advance" and that, in general, blue is retiring and red is advancing.

Katz (1935) claimed that this phenomenon had a psychological base. In one experiment he pasted alternately red and blue paper squares onto the heads of nails which were driven into a board with a grey base. At a distance of 80 centimetres and when viewed binocularly the reds stood out approximately one-half to one centimetre nearer than the blues. He also punched holes of one-half centimetre in diameter and about one-half centimetre apart in a piece of white cardboard. The S, 60 centimetres away, looked through the holes, fixating their borders at a piece of red or blue paper. The reds seemed to be nearer than the blues.

Levanthol (1952) studying colour as a variable in perceptual response found that blue is seen as farthest away from the S; red is seen as closest, green next, and then grey. Although the hues were not exactly equated in terms of brightness and chroma he was able to state that the "character" of the colour seemed more important than the amount of light reflected (brightness). Red had a chroma value of ten, while both green and blue had a chroma value of eight. Green was seen as phenomenally brighter than the other colours, but still red was judged as the nearest colour. Green is experienced as closer than blue despite the fact that they both have the same chroma value of eight.

Taylor and Sumner (1945) investigated the quantitative relationship of the actual distance of colours to the individual brightness of the respective colours. Using Hering's coloured papers they found that when the apparent distances of the different four colours are held constant, the bright colours - white, yellow, and green - are actually much farther than they appear to be, while the darker colours - red, blue, and black - are actually very near the position at which they appear to be. At a constant distance light colours appear nearer than the dark colours.

Johns and Sumners (1948) replicated the previous study and obtained similar results. However, they did find that red, although having a lower brightness measure than white, yellow, or green, appeared nearer than these colours.

Over (1962) in a study of stimulus wavelength variation and size-distance judgments found that, in general, when the S was presented with two stimuli subtending the same visual angle and of the same luminance but of different wavelength, the stimulus of the longer wavelength would be judged both larger and closer than the stimulus of the shorter wavelength. Most studies in the literature do report objects of longer wavelength to be perceived as nearer than objects of shorter wavelength (Luckiesh, 1918; Katz, 1935; Johns and Sumner, 1948; Mount, Case, Sanderson and Brenner, 1956).

Stelmack (1965), using four colours from the Munsell Renotation System and controlling saturation and brightness, demonstrated the presence of significant hue and saturation effects in the apparent distance judgments of small coloured targets. Yellow was judged the nearest appearing hue, followed by red, then green and blue. Colours of high saturation (chroma 10) were judged consistently nearer than those of lower saturation (chroma 4). The targets were viewed against a black velvet background.

The problem of apparent distance has also been closely linked to the moon illusion as is evidenced by the studies of Holway and Boring (1943), Taylor and Boring (1942), Boring (1943), Dadourian (1946), Leibowitz and Hartman (1959), Kaufman and Rock (1962), Rock and Kaufman (1963), King and Gruber (1962) and Hamilton (1965).

When the moon hangs low over the horizon it seems much bigger than when it is high in the sky. In photographs its image has essentially the same size no matter where it is photographed. This change is considered psychological rather than optical and is known as the moon illusion (Kaufman and Rock, 1962).

Ptolemy recognized the illusion in the second century and proposed that any object seen through filled space, such as the moon seen across terrain at the horizon, is perceived as being more distant than an object just as far away but seen through empty space, such as the moon at its zenith. He claimed this because the filled space between the observer and the horizon produces an impression of greater extensity than the unfilled space between the observer and the zenith (Kaufman and Rock, 1962).

Many studies indicate that the terrain, that is the texture gradient of the earth, acts as a main stimulus cue which makes the moon appear phenomenally closer when it is over the horizon (Dadourian, 1946; Gibson, 1950; McNulty and St. Clair-Smith, 1964; Kaufman and Rock, 1962;

Rock and Kaufman 1963; King and Hayes, 1966).

Dadourian (1946) observed that when a piece of over-exposed film was interposed between the eyes and the horizon moon, the horizon moon became the same size as the zenith moon. He thus concluded that the distant object appears larger when its image is accompanied by intervening terrestrial objects.

In a series of experiments Rock and Kaufman (1962) concluded that the presence of terrain was crucial for the existence of the moon illusion. The illusion disappeared when the terrain was obstructed from the observer's view.

These studies do indicate that terrain as a texture gradient does effect the apparent distance of the moon and other distant objects.

Gibson (1950) hypothesizes that there is no such thing as a perception of space without the perception of a continuous background surface. The physical irregularities of the surface are projected as correlated irregularities in the image. A tiny depression of the surface is focused as a dark spot, a slight protuberance as a minute highlight, and an array of such surface-elements as an array of dark and light spots. This type of stimulation gives rise to the quality of visual texture. The correlation between texture density and distance provides a powerful distance cue.

If physical surfaces have regular structures peculiar to them (wood, cloth, earth) the regularity will be projected in a focused image, and this repetitive character of the stimulation, Gibson hypothesizes, is the basis for the perception of a surface and of distance. If a repetitive order is the stimulus for visual texture this would constitute a gradient of the density of texture. Gibson suggests that the gradation of the texture elements is the principal cause of depth perception.

That surface texture facilitates visual space perception has been reported by Gibson (1950), Gerathewol and Gibis (1957), Kaufman and Rock (1962) and Bevon and Dukes (1957). Thus the questions posed in this study are (a) if a gradient of texture (terrain) facilitates visual depth perception, what will be the effect on the apparent distance of coloured targets (moons) when viewed above coloured textured backgrounds; and (b) is there a significant difference between viewing the coloured targets against a plain non-textured background?

CHAPTER II

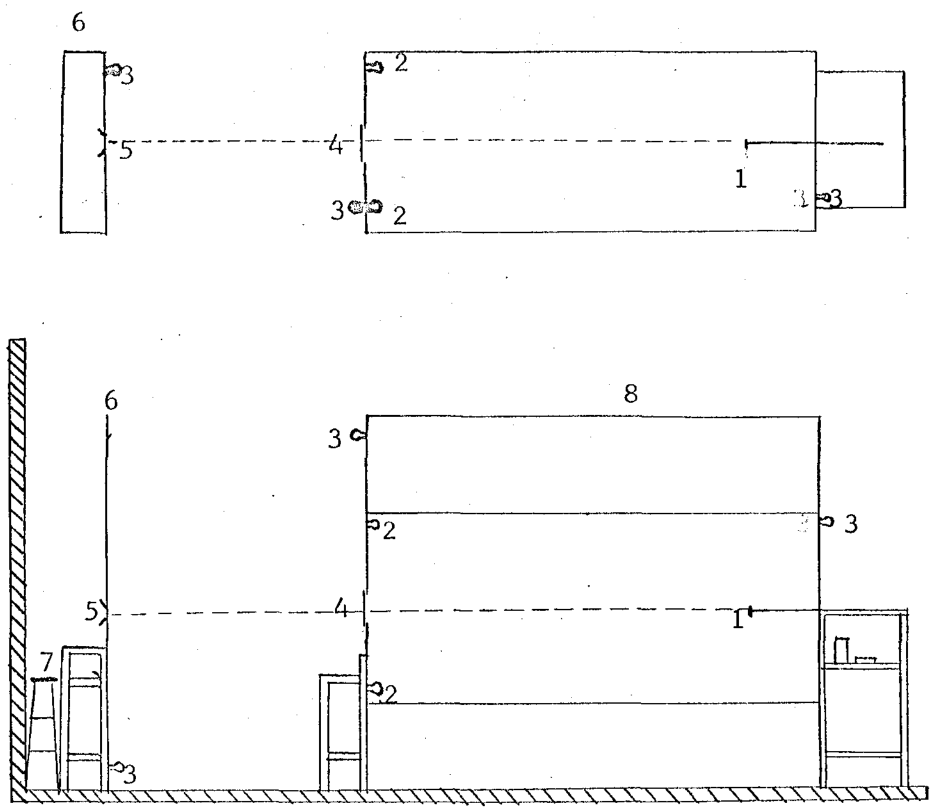
METHOD

Subjects

The subjects were 16 male students between the ages of 18 and 25 attending the University of Windsor. They were tested prior to the experiment for normal colour vision, visual acuity, and stereopsis with the Bausch and Lomb Orthorater. Twenty-twenty vision, corrected, was required.

Apparatus

The apparatus was essentially that used by Stelmack (1965) in a previous study of the effect of hue and saturation on apparent distance judgments, and by Bonner (1966) in her study of the effects of shock punishment associations on the apparent distance of coloured stimuli. The essential features are shown in Figure 1. Dimensions of the viewing box were 4' by 4' by 8' long, with S's viewing position 16' from the back surface. The interior was illuminated by incandescent bulbs concealed from the S. where the only view of the interior was a 20" by 40" rectangular portion at the far end which



1. Stimulus Target
2. Interior Lamps
3. Exterior Lamps
4. Shutter
5. Viewing Hood
6. Observer Screen
7. Bench
8. Pully

Figure 1: Schematic Diagram of Apparatus Side View and Top View

was covered by the eight various coloured backgrounds. To provide daylight viewing conditions, 2" by 2" colour temperature altering filters were maintained at the viewing position.

The stimulus targets consisted of four colours:[1] red, green, blue, and yellow. A neutral grey target was used as a modulus. They were seen against the horizon backgrounds of the same four colours, two conditions of background being used, plain and textured. The four coloured targets were cut from the same masonite material as was used for the backgrounds.

Both targets and backgrounds were prepared by the application of two coats of Cilux Acrylic Latex Exterior 600 White Paint followed by two coats of each of the four colours. The paints used were Cilux Super Gloss Interior/Exterior Enamels: Orange 1778, Bright Yellow 1777, Chinese Jade 1770 and Sea Blue 1781. All paints were manufactured by Canadian Industries Limited. The respective Munsell values as determined by using the Munsell Book of Colours in daylight viewing conditions were 7.5R 5/14, 2.5 Y 8/12, 5 G 5.5/8 and 2.5 B 5.3/6.

The targets were cemented to metal discs one inch in diameter and coupled to a thin metal rod projecting a quarter of an inch from the wooden dowel. The dowel was a fixed rod on which the target was mounted. It extended 18 inches in front of the background surface.

1. Colour in this experiment is defined as the qualities of hue, brightness and saturation combined.

The background 40" by 20" simulated the horizon. The colour in both the plain and textured backgrounds comprised the bottom half of the viewing area, 40" by 10". The top half, 40" by 10" consisted of the black velvet, simulating a black sky. The texture was simulated by drawing black lines, in a diminishing gradient, horizontally on the coloured backgrounds to give the impression of receding distance, according to the formula $Hn = \frac{n\,ZY}{x + nZ}$.

H is the height of the line, x is the distance (192") from the viewer's eyes to the background, Y is the height (10") of the coloured background, Z is an arbitrary value (35) to determine the degree of slant.

Procedure

All Ss were tested initially for visual acuity, colour vision and stereopsis. Of the 16 Ss used in this study, eight viewed the targets against the four coloured plain backgrounds, and eight against the four coloured textured backgrounds. Each S was required to make by way of magnitude estimation, (Andreas, 1964, p. 130) 160 judgments as to the perceived distance of the coloured targets relative to the modulus target, 16 combinations of target and background being presented 10 times. The modulus target was a neutral grey and was assigned a value of 100. It was presented to S at the beginning of each trial and after every twentieth judgment. Values given the variable coloured targets depended on the S in terms of his perceived distance. Each S was asked to respond within the time the stimulus array was exposed to view, that is within four seconds. The experimental procedure was identical for both the plain and textured viewing conditions. 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 cover raised and the interior apparatus lights turned on. Exposed to view was a neutral grey target against a black background. At this point the S was read the instructions. See Appendix A. Each S was then given an initial practice trial viewing each target twice against the plain background. This familiarized him with the method used in assigning values to the judged distance of the targets. Also at the beginning of each trial, a trial consisting of ten judgments with each of the four coloured targets seen against one coloured background, each of the four targets was presented in random order to allow S to adapt to the "vividness" of the background colours. Judgments were then recorded after the targets had been presented twice against the background. All targets were presented in a modified random order, that is no one coloured target was presented more than three times in succession.

CHAPTER III

RESULTS

The ten estimates of perceived distance given by each S to each of the combinations of the stimulus variables were first averaged. The mean estimates for each S are given in Appendix B. These data were then further averaged to show the means for the perceived distance of the target colours as a function of the background texture condition and also of background colour. These results are shown in Tables 1 and 2 respectively. The consequent graphs are shown in Figures 2 and 3 respectively.

Analysis of variance, as shown in Table 3, indicates that background colour and target colour significantly affected the judgment of perceived distance. The nearest appearing colour was yellow, followed by red, then green, and lastly, blue.

Table 1.

Mean Average Estimates of Judgements of Perceived Distance of 4 Coloured Targets as Viewed Against 4 Coloured Backgrounds Under 2 Conditions of Texture. N = 8 for Each Condition.

	Background Colour	RED				YELLOW			
	Target Colour	R	Y	G	B	R	Y	G	B
Texture Condition	Plain	107.42	97.57	103.40	106.35	103.08	101.96	100.63	102.80
	Textured	101.81	100.13	105.17	105.67	105.58	103.55	110.62	110.81
	Plain and Textured	104.18	98.85	104.28	106.01	104.33	102.75	105.63	106.80

	Background Colour	GREEN				BLUE			
	Target Colour	R	Y	G	B	R	Y	G	B
Texture Condition	Plain	102.91	91.52	101.96	100.47	98.1	93.06	100.28	101.07
	Textured	99.28	96.32	100.03	100.62	102.60	96.3	101.70	99.3
	Plain and Textured	101.10	93.92	101.0	100.55	100.35	94.68	100.99	100.18

Table 2

Mean Average Estimates of Judgments of Perceived Distance of 4 Coloured Targets As Viewed Against the Combined 4 Backgrounds Under 2 Conditions of Texture. N = 8 for Each Condition.

Target Colour	Red	Yellow	Green	Blue
Condition Plain	102.88	96.03	101.57	102.67
Textured	102.32	100.65	104.38	104.10
Plain+ Textured	102.60	98.34	102.97	103.39

Table 3

Analysis of Variance for Mean Judged Distances by 16 Observers for 4 Target Colours, 4 Background Colours and 2 Texture Conditions

Source	Sums of Squares	df	Mean Squares	F
Between Subjects				
Texture Condition (T) plain and textured	193.036	1	193.036	
Error T	7848.364	14	560.597	
Within Subjects				
Background Colour (B)	1683.495	3	561.165	6.126*
(B) x (T)	350.728	3	116.909	1.276
Error (B)	3847.277	42	91.602	
Target Colour (TC)	1424.671	3	474.890	4.455*
(TC) x (T)	116.550	3	38.850	
Error (TC)	4476.679	42	106.588	
(B) x (TC)	179.561	9	19.951	
(B) x (TC) x (T)	464.178	9	51.575	1.364
Error (B) x (TC)	4764.061	126	37.810	

* = 0.01

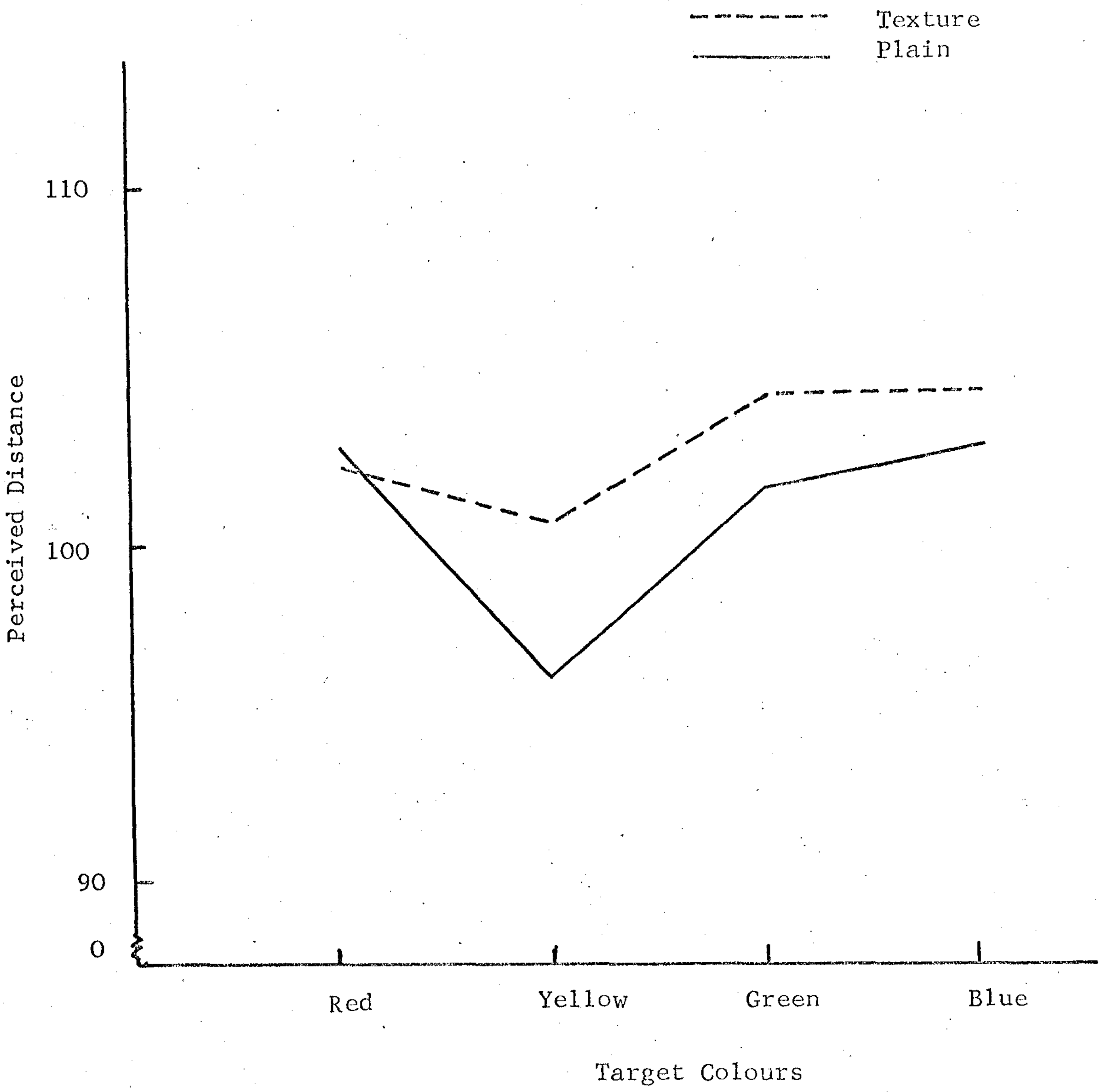


Figure 2: Perceived Distance as a Function of Four Target Colours for Both Plain and Textured Backgrounds. N = 8 for each Condition.

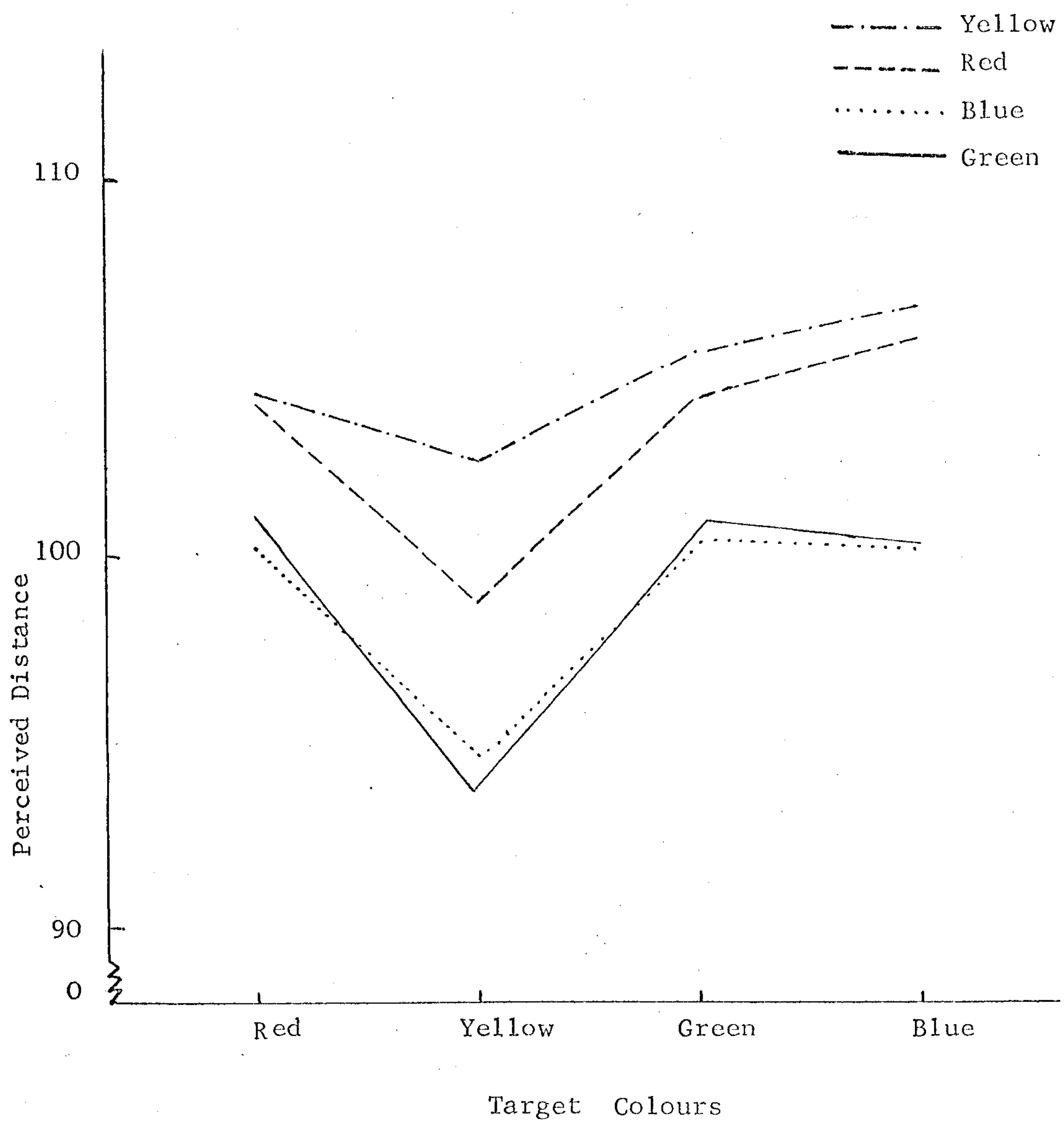


Figure 3: Perceived Distance as a Function of Four Target Colours Viewed Against Four Background Colours, N = 16.

CHAPTER IV

DISCUSSION

Influence of Target Colour

Analysis of variance, Table 1, clearly indicates a significant difference in the perceived distance of the target colours at the .01 level. Stelmack (1965) found that (a) yellow was the nearest appearing colour, followed by red, green, and blue; and (b) that colours of high chroma values appeared nearer than those of lower chroma values. On the basis of these findings it can be predicted that the yellow and red targets of chroma values 12 and 14 would be judged nearer than the less saturated green and blue targets with chroma values 8 and 6. This prediction is essentially confirmed as the results of Table 2 show.

Influence of Background Colour

The same factors of hue and saturation should apply to produce a phenomenal approach of some backgrounds, and a phenomenal recession of others. Since, however, the subject was not asked to judge the distance of the backgrounds, but of the targets, the relative approach or recession of the background might well act to cause the targets, on the average, to appear nearer to the approaching red and yellow backgrounds and further from the receding green and blue backgrounds. Also, by assuming that closer to the background is equivalent to further from the subject, and conversely, that further from the background is nearer to the subject, it would be predicted that targets seen against red and yellow backgrounds would be reported as more distant, and when seen against green and blue backgrounds would be reported as nearer. This prediction is approximately borne out and is clearly seen in Figure 3.

Influence of Background Texture

It must be noted, however, that the targets did not appear against the background, but just above it, appearing like coloured "moons" in a black sky with a coloured ground plane and horizon line. If Gibson (1950) is correct in his emphasis of the effect of texture gradients, the horizon line for the textured backgrounds should have appeared more remote than with the plain ones and hence it might be expected that "moons" being above a more distant horizon should be judged more distant. This, in effect, is what generally occurred as is seen in both Figure 2 and Table 3.

The differences between the plain and textured backgrounds, however, unlike the case with the colour factor, were not statistically significant. This failure to meet the statistical criterion may have arisen from the joint operation of two causes, one phenomenal in nature, the other a question of experimental design.

Phenomenally, as indicated by reports of Ss in post experiment interviews, the "vividness" of the colours appears to be a dominant factor. Indeed, many Ss reported that this "vividness" of the background colours interferred with their ability to make at least initial judgments of the apparent distance of the targets. This dominant colour factor may well have obscured the action of any texture effect. It would therefore appear desirable to repeat the present study, using, however, colours lower both in brightness and in saturation.

The design factor arises from the fact that different groups of subjects were used for the two texture conditions where each subject reported on all colours both of target and of background. That is, to use the technical language of the statistitian, the test for texture differences was "between groups", while the tests for colour were "within groups". It is of course, notorious that "between group" tests are much less sensitive, due to a generally larger error term, than are the comparable "within groups" comparisons. In the present case, although the mean differences between the plain and textured backgrounds are not much different than those between colours, the corresponding error terms as seen in Table 1, vary by a factor of five to one.

Another consideration of the design involves the use of the method of magnitude estimation by Ss in judging the distance of the targets. The present study is one of an ongoing series by the

Department of Psychology investigating the direct methods of measurement in the area of visual perception as outlined by S. S. Stevens (1957). With this method the S is expected to understand and to use a numerical scale in making the distance judgments and the experimenter assumes that the properties of the number scale have been correctly used by the S. Granted this assumption, however, the inter-subject variability as seen in Appendix B is considerable. According to Garner (1958) this variability would be greatly reduced by the use of the more traditional indirect methods of measurement.

Another difficulty arising from the method of magnitude estimation results from the stability of a single S's judgments in the course of the experiment. Garner (1958) refers to this as the "context effect" in which the judgments of a S seem to be more influenced by the context of the stimuli provided him than they are by his use of a numerical distance scale. As seen in Appendix B the variability of many Ss' judgments is considerable and suggests that many Ss had no confidence in their judgments of apparent distant.

It therefore appears that any further experimentation would demand a more sensitive statistical design if texture differences are to be demonstrated.

Recommended Modifications of Apparatus

Several modifications of the present apparatus are recommended.

The target and background colours should be equated in both brightness and saturation, and these values should be lower than those used in the present study in order to avoid the "vividness" colour factor. The present study indicates that in order to properly evaluate a true hue effect, all other variables must be controlled.

An investigation of the functions of self-luminous stimuli both for the targets and the backgrounds would be permitted by simple modifications in the apparatus. Self-luminous target stimuli would be provided if light pipes fitted with mono-chromatic light sources and appropriate filters were substituted for the wooden dowel used in the present study. A similar arrangement employing a projection technique could be used to provide self-luminous backgrounds.

CHAPTER V

SUMMARY

This study was an attempt to determine the effect of background colour and texture on the apparent distance of small circular coloured targets.

The stimulus targets were four coloured discs, red, yellow, green, and blue, of one inch in diameter. The discs were viewed against "horizon" backgrounds of the four same colours under two conditions of texture. The background, 40" by 20", simulated the horizon. The colour in both the plain and textured backgrounds comprised the bottom half of the viewing area, 40" by 10". The top half, 40" by 10", consisted of black velvet. Texture was simulated by drawing black lines, in a diminishing gradient, horizontally on the coloured background to give the impression of receding distance. The coloured targets appeared just above the "horizon" of each background.

Sixteen Ss tested initially for visual acuity, stereopsis and colour vision were divided into plain and textured viewing groups. Their task was to judge the apparent distance of the coloured targets in relation to a standard modulus target using the method of magnitude estimation. All targets remained physically fixed. For each presentation the stimulus array was exposed to view for four seconds.

The results showed that colour affected perceived distance. The nearest appearing colour was yellow, followed by red, green, and then blue.

All target colours appeared nearer when viewed against the green and blue backgrounds and appeared further when viewed against the red and yellow backgrounds under both the plain and textured conditions. The apparent distance of the coloured targets was judged as a function of the advancing and receding qualities of the background colours.

There was no significant difference between the plain and textured viewing conditions, although targets were generally judged as further when viewed against the textured backgrounds and as nearer when viewed against the plain backgrounds. An explanation was offered that the "vividness" of the background colours and a lack of sensitivity in the experimental design obscured a possible significant texture effect.

Suggestions were made for further research to clarify the precise effects of a true hue factor and for the investigation of texture gradients as related to depth perception.

Appendix A.

Instructions

You will notice that when the shutter is opened there appears in front of you a grey coloured disc against a black background. The distance of the grey disc is assigned the value of 100 and will always remain the same distance from you during the experiment. The coloured discs which you will see may vary in distance. Each time the shutter is raised you are to tell me how far the coloured disc is from you by assigning to it a value that is proportional to the value of 100 of the grey disc. If the coloured disc appears further away than the grey disc assign to it a value greater than 100 which represents the distance away from you at which it appears. If the coloured disc appears nearer to you than the grey disc, assign to it a value less than 100 which corresponds to how near you see it. The shutter will remain open for only four seconds and you must give me your answer in that period of time. Please do not remove your head from the viewing mask until I indicate that the experiment has ended. Remember, the grey disc will always be the same distance from you, having the value 100. Only the coloured discs may vary. You must answer in the four seconds that the shutter is open. Do you have any questions?

Appendix B.

Mean Estimates of the Perceived Distances of 4 Target Colours Viewed Against 4 Background Colours, Under 2 Conditions of Texture. N = 8 for Each Condition

Background Condition	Ss	RED: R	RED: Y	RED: G	RED: B	YELLOW: R	YELLOW: Y	YELLOW: G	YELLOW: B
Plain	1	100.3	105.2	106.3	103.7	102.8	101.3	99.4	104.7
A1	2	108.5	109.0	108.0	105.5	105.5	100.0	99.5	98.5
	3	100.8	95.8	98.9	100.2	99.5	102.8	98.2	97.2
	4	125.0	85.0	107.0	113.5	94.0	119.0	92.0	86.0
	5	101.0	86.0	99.0	111.0	101.0	89.0	100.0	112.0
	6	106.0	97.0	99.0	102.0	107.0	102.0	97.0	104.0
	7	103.8	104.6	107.0	102.9	103.4	101.6	102.0	101.0
	8	107.0	98.0	102.0	112.0	111.5	100.0	117.0	119.0
Texture									
A2	9	109.0	106.5	108.0	106.0	111.0	105.5	112.0	107.5
	10	94.5	95.5	95.0	100.5	88.0	97.0	102.0	99.0
	11	122.0	102.5	105.0	115.5	122.0	109.5	107.0	109.0
	12	105.0	93.0	95.5	100.0	104.0	101.5	108.5	110.5
	13	109.0	123.0	129.0	117.0	139.0	125.0	133.0	138.0
	14	88.0	93.0	95.5	91.0	87.0	89.0	90.0	86.5
	15	88.0	87.0	112.0	115.5	92.5	99.0	132.0	134.0
	16	99.0	100.6	101.4	99.9	101.2	101.9	100.5	102.0

Appendix B Continued

Background Condition	Ss	GREEN R	GREEN Y	GREEN G	GREEN B	BLUE R	BLUE Y	BLUE G	BLUE B
		Backgrounds Target Colours							
Plain	1	102.8	104.0	105.5	102.7	98.3	91.2	90.5	95.8
A1	2	110.0	100.0	100.5	101.0	102.5	100.5	105.5	100.5
	3	99.4	93.8	98.5	96.4	100.4	102.5	101.7	100.8
	4	128.0	59.0	99.0	93.0	95.0	74.0	91.0	99.0
	5	84.0	86.0	108.0	104.0	92.0	85.0	110.0	113.0
	6	96.0	97.0	100.0	97.0	101.0	107.0	94.0	95.0
	7	102.1	102.4	102.2	102.7	100.6	100.3	102.6	103.5
	8	101.0	90.0	102.0	107.0	95.0	84.0	107.0	101.0
Texture	9	106.5	83.5	95.0	97.5	107.5	93.5	101.5	100.0
A2	10	96.5	96.5	99.5	98.0	95.0	86.0	98.0	97.0
	11	117.5	108.5	113.0	113.0	110.0	93.0	110.5	97.0
	12	101.0	96.0	101.5	101.5	105.0	97.5	105.0	102.0
	13	102.0	103.0	101.0	105.0	112.0	111.0	113.0	110.0
	14	83.0	94.5	91.0	87.5	94.0	94.5	89.0	90.0
	15	89.0	84.5	98.0	102.0	96.0	92.0	95.0	96.0
	16	98.8	104.1	101.3	100.5	101.3	102.9	101.6	102.4

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