Modifying the Color Preference of Newly Hatched Chicks[1]

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Abstract

If color preference is biologically determined, one should be able to demonstrate such preference in environmentally naive animals. If color preference and mood state are effected by similar biological mediators, one should moreover be able to modify preference by means of pharmacological agents. These hypotheses were investigated by administering frenquel, meratran or a placebo to groups of newly hatched chicks and testing the animals' color preference in a pecking apparatus. Four groups of 30 chicks were tested under each treatment. Significant preference patterns and their modification were demonstrated after controlling for the effect of color saturation and time of day of test administration.

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Introduction

Is color preference biologically determined or is such preference behavior an acquired trait? This question is one of the few side issues of the nature-nurture controversy which may be amenable to relatively clear-cut experimental attack, at least when dealing with infra-human species. Indeed, Hess (1956 and 1957) has shown that there is clear evidence of color preference behavior in newly hatched chicks. The study of such behavior in chicks, however, is of considerable interest also for the comparative psychologist since the visible color spectrum of the chick is, with minor exceptions, quite similar to that of humans.

Theories purporting to provide a rationale for color preference behavior range all the way from those which are entirely oriented in the hereditary origin direction to those which reject the presence of any biological basis for the preference behavior. Guilford (1934) maintains the view that color preference is innate and is little influenced by the environment or by learning experiences. This position is supported by experimental evidence showing that the affective value or preference for colors in humans can be predicted with considerable accuracy after certain initial information about the physical atrributes of the judged colors have been obtained (Guilford & Smith, 1959). Guilford found high internal consistency in the preference ratings of his subjects and concluded that "with few exceptions, affective value is positively related to brightness and saturation, all relationships being curvilinear". Guilford nowhere indicates that learning plays a part in color preference behavior and he leaves the reader with the clear implication that the basis for judging the affective value of colors is primarily innate.

Osgood (1953), on the other hand holds a rather contrary position, contending that the more complex perceptual phenomena, of which color preference can be considered a part, are "clearly shown to be the results of learning, slow and arduous learning at that". Consequently, the role of mediated learning processes is then invoked as an explanatory concept basic to the preference.

In human color preference the issue is further confounded by the interposition of semantic mediators (Pressy, 1921; Norman & Scott, 1952; Schaie, 1966). In fact, the interaction between hereditary and acquired components is so complex that clearcut isolation may be virtually impossible. In an animal such as the chick, however, the environment can be well controlled and the possibility of acquiring preference patterns can be denied so completely that it becomes possible to observe the organism's innate behavior in relatively pure form.

The existence of innately determined color preference in the chick has been fairly well demonstrated (Hess & Gogel, 1954; Hess, 1956). Hess (1957) has also shown that drugs such as meprobamate and nembutal modify and in some instances nullify earlier imprinting in chicks. Since Hess is primarily interested in the imprinting effects, he has not addressed himself unequivocally to the issue of demonstrating color preference and its modification at the point at which the organism enters the environment and where it has therefore had no demonstrable opportunity to acquire any preference pattern whatsoever.

It is the purpose of the present study to test the hypothesis that color preference is innately determined by demonstrating such preference in animals which are totally naive of environmental influences. It is further proposed to test the hypothesis that color and associated mood states are affected by similar biological mediators by demonstrating that color preference of environmentally naive chicks can be modified by a depressant or an energizer. The chick is used as that experimental organism of choice, since its visual spectrum is quite similar to that of humans (Hess, 1954). More important for this choice is the fact that the chick is able to respond and show preferences by his pecking behavior, which is available upon leaving the shell, at the immediate point of entrance into the environment.

Procedure

Apparatus. Our apparatus was an adaptation of the one used by Hess (1956) in his study of the color preference of chicks and ducklings. The color pecking apparatus is a large octagonal wooden box resting on a table approximately 36 inches high. The dimensions of the testing apparatus were: Diameter of inscribed circle, 47 inches; area of floor space, 12.7 square feet. The floor of the box has neutral gray wire mesh and the top of the box is left open. The interior of the box was painted neutral gray and was illuminated by a 200 Watt light bulb suspended approximately 15 inches above the center of the floor of the pecking box. Outside distractions such as drafts, color of the wall, etc., were minimized by draping white sheets around the apparatus.

Two equally spaced holes, one inch in diameter, were drilled into each panel of the octagonal box. A plexiglass disc containing a round colored stimulus a quarter of an inch in diameter was displayed through each hole. The plexiglass disc was suspended on wires to permit free movement. Adjacent to each hole, a microswitch (BZ-RW84-A2) was mounted in such a manner that minimal force applied to any part of the plastic disc would trigger the switch. Since each panel displayed two stimuli, the entire apparatus can accommodate sixteen stimuli at one time. To reduce position effects, the stimuli on one side of the box were replicated on the other side and counters were wired in series to a set of eight impulse counters. To avoid any distraction, the apparatus was placed into a small experimental room, and the counters and light controls were placed in an anteroom. Figure 1 gives the dimensions and rear view of one of the eight sides of the pecking box.

The stimuli were colors selected from those used in the Color Pyramid Test (Schaie & Heiss, 1964). The colors were matched for saturation and reflectance and two parallel series (hereafter called saturated and desaturated) were established. The colors used in each series were red, orange, yellow, green, blue, white, gray and black.[2]

[2]Munsell values of the saturated series were: Red, 5R 3/12; Orange, 2.5YR 6/14; Yellow, 2.5Y 8/12; Green, 7.5GY 7/10; Blue, 5PB 4/10; White, N 9.5; Gray, 5Y 7/2; Black, N 1.

Subjects. A total of 360 chicks were used of whom groups of 30 were assigned to each of twelve experimental conditions. All chicks were Hy-line Hybrid cockereles which are reported to be a very active and energetic chicken species. The same species was used for all experimental conditions to eliminate species differences as a confounding factor. All animals were tested on the first day after hatching. The animals were considered to be visually naive. Their only visual experience consisted of the opaque shipping boxes in which they were kept, and the few minutes during which they were uncovered in the lighted laboratory while the drugs or placebo were administered.

Drugs. The drugs, Frenquel and Meratran, were selected primarily because they are chemical analogs; i.e., they are structurally identical with the exception of the methyl grouping which has been rotated to a different position. Figure 2 illustrates the structural similarity between the two drugs (Allin & Pogge, 1956). Both Frenquel and Meratran are said to act upon that portion of the brain connected with the alerting function and furthermore are considered to affect behavior in opposite ways. It was expected that the drugs might alter physiological states in a manner which would actually modify the perception of color, or that they might affect the preference because of activity level changes. Upon the manufacturer's recommendations the dosages used were: Frenquel, 72 mg/kgm; and Meratran, 3 mg/kgm.[3] These dosages are considered to be effective for from four to six hours (Brown, et. al., 1954; 1956), and no re-administration of the drugs was therefore required during the two-hour testing period.

Testing procedure. Each group of animals was removed from the opaque shipping box, the drug or placebo was administered and the animals were then placed in the packing box. They were allowed to explore the pecking box for one hour before pecking preference was recorded. During the second hour pecking frequency counts for each color were taken at fifteen minute intervals.

Two series of tests were conducted. The first series used the stimuli as described in the section on apparatus. For the second (desaturated) series a thin piece of tissue paper was placed over each stimulus to reduce saturation and reflectance in a uniform manner. Tests were conducted at noon and in mid-afternoon for separate groups of animals under each treatment and saturation condition. Figure 3 gives the counter-balanced testing schedule.

Results

Table 1 gives the total pecking frequencies for each of the eight colors for each of the twelve groups of animals. It will be remembered that each set of these frequencies is based on the performance of a group of 30 animals under each treatment condition. Since separate counts were made for each of the four 15 minute intervals within the hour used

[3]The drugs were obtained through the cooperation of the Wm. S. Merrell Company. Information concerning drug dosage was graciously furnished by Dr. F. J. Murray of the Wm. S. Merrell Co.

for the pecking frequency count it is possible to utilize variability among these periods as the estimate of error variance which may be appropriately used in the analysis of variance to assess the hypotheses of central interest. Table 2 gives the results of the overall analysis of variance. These results well illustrate the complexity of our problems.

The overall mean differences in color preference were highly significant (P = .001). Over all treatment groups, the preferred colors were white, green, gray and yellow in that order. Red, orange and black were the least preferred colors. These findings seem to be evidence in support of Hess' finding of innate color preference gradients in chicks. Our particular preference pattern, however, differs from Hess' findings. These differences could be attributed to the fact that we have used a different species of chicks, but we think that a more sophisticated analysis is in order.

Further examination of Table 2 shows that no significant differences in pecking frequencies could be found for the independent (treatment) main effects or their simple interaction. However, a significant (P = .05) triple interaction occurred involving treatment, time of day and color saturation. This finding suggests that the overall pecking frequency of the animals is subject to variation depending upon the particular experimental arrangement and that separate analyses under each of these conditions may be in order. Before proceeding to such separate analysis, let us summarize some other aspects of the overall findings.

It had been hypothesized that different preference patterns might occur under conditions of high and low intensity of color saturation. Such is indeed the case with a highly significant interaction (P = .001) occurring between saturation and color choice. Thus it is found that separately analyzed green and yellow become the overall preferences under the condition of high saturation while gray and green (with green becoming second choice) are preferred under the low saturation condition. But no change occurs in the least preferred colors.

As further possible evidence of the physiological mediation of color preference it had been hypothesized that color preference should be modified by the administration of pharmacological agents which are said to affect mood states. If this is the case, then the overall analysis of variance should show a significant interaction between colors and type of drug treatment. As shown in Table 2, this interaction is significant at the 5% level of confidence. Inspection of proportionate pecking frequencies for the different treatment conditions, shown in Table 3, indicates that rather different preference patterns prevail under the three treatment conditions. Thus overall preference for the control samples is clearly in favor of white which receives twice as great a proportion of pecks as the next favored hue (gray). For the controls, the least preferred colors are red and black. Under the Frenquel treatment first preference is given to green followed about equally by white and yellow. Least preferred colors under the depressant condition appear to be black and orange. The Meratran treatment groups, on the other hand, show greatest preference for gray, green and white while least favoring red and orange. Matters are further complicated by the presence of a significant fourfold interaction (P = .05) between color and the independent treatment variables.

As a first step to clarify matters, analyses of variance were conducted separately for the two levels of saturation. Highly significant ($P = .001$) differences in pecking frequency for different colors appear in both analyses. A significant interaction between colors and drug treatment occurred only under the high level of saturation. Under this condition, moreover, a significant simple interaction also occurred between drug treatment and time of day ($P = .001$) and a significant triple interaction was found between these two treatment variables and the colors. A further analysis was therefore made separately for the treatments administered at noon and in mid-afternoon for the high level saturation condition. Again, significantly different frequencies and significant interactions between color and drug treatment conditions are observed. The main effect of drug treatment condition, however, is significant only for the samples tested at noon. Figure 4 finally lists the most preferred colors under each of the twelve treatment conditions.

Conclusions

The presence of color preference patterns in newly hatched and thus environmentally naive chicks under different conditions of drug treatment, times of day and intensity of color saturation lends strong support to the theoretical position that color preference behavior is substantially mediated by biological factors. The nature of the particular preference pattern, however, is likely to be species specific and moreover highly affected by those conditions of the colored stimuli and the environment which may effect whatever physiological mechanisms may be involved in the preference behavior. These conclusions seem to be supported further by the demonstration that color preference can be modified by means of pharmacological agents, albeit for a series of strongly saturated hues and in alternate ways at different times of day.

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Table 1. Pecking frequencies for the different colors under the various experimental conditions

			Red	Orange	Yellow	Green	Blue	White	Gray	Black	All Colors
Controls	Saturated	Noon	30	97	123	52	26	64	128	120	640
		P.M.	51	129	254	462	53	331	130	51	1461
	Desaturated	Noon	67	190	153	203	261	1626	440	49	2989
		P.M.	88	14	206	25	225	42	287	11	898
Frenquel	Saturated	Noon	106	71	1347	1036	762	434	628	163	4547
		P.M.	68	36	301	106	475	46	198	14	1244
	Desaturated	Noon	215	26	237	506	123	943	710	9	2769
		P.M.	113	135	439	956	216	886	298	71	3114
Meratran	Saturated	Noon	51	91	97	79	190	83	176	125	892
		P.M.	35	66	342	820	161	91	144	164	1823
	Desaturated	Noon	104	17	170	67	248	283	321	13	1223
		P.M.	35	59	65	195	54	591	536	266	1801
	All Controls		236	430	736	742	565	2063	985	231	5988
	All Frenquel		502	268	2334	2604	1576	2309	1834	257	11674
	All Meratran		225	233	674	1161	653	1048	1177	568	5739
	All Animals		963	931	3734	4507	2794	5420	3996	1056	

Table 2. Analysis of Variance of Pecking Preference

to Colored Stimuli by Newly Hatched Chicks

(30 Animals in each Group)

Source of Variation	d.f.	Mean Square	Error Mean Square	F ratio
A. Drug Treatment	2	88,043	AE	3.81
B. Time of Day	1	19,253	BE	3.43
C. Saturation	1	12,456	CE	2.56
A x B Interaction	2	39,748	ABE	3.99
A x C Interaction	2	6,638	ACE	. .
B x C Interaction	1	382	BCE	. .
A x B x C Interaction	2	85,404	ABCE	8.52*
D. Colors	7	65,075	DE	22.76***
A x D Interaction	14	12,943	ADE	2.24*
B x D Interaction	7	8,054	BDE	. .
C x D Interaction	7	41,842	CDE	13.71***
A x B x D Interaction	14	10,560	ABDE	1.88
A x C x D Interaction	14	8,878	ACDE	1.32
B x C x D Interaction	7	7,236	BCDE	1.91
A x B x C x D Interaction	14	21,361	ABCDE	2.45*
E. Measurement Replication	3	23,630		
A x E Interaction	6	23,108		
B x E Interaction	3	5,619		
C x E Interaction	3	4,860		
D x E Interaction	21	2,859		
A x B x E Interaction	6	9,952		
A x C x E Interaction	6	34,704		
A x D x E Interaction	42	5,774		
B x C x E Interaction	3	8,573		
C x D x E Interaction	21	8,097		
A x B x C x E Interaction	6	10,027		
A x B x D x E Interaction	42	5,616		
A x C x D x E Interaction	42	6,715		
B x C x D x E Interaction	21	3,798		
A x B x C x D x E Interaction	42	8,723		

* 5% level of confidence
** 1% level of confidence
*** .01% level of confidence

Table 3. Proportions of pecks given to different colors under the various experimental conditions

			Red	Orange	Yellow	Green	Blue	White	Gray	Black
Controls	Saturated	Noon	4.7	15.2	19.2	8.1	4.1	10.0	20.0	18.8
		P.M.	3.5	8.8	17.4	31.6	3.6	22.7	8.9	3.5
	Desaturated	Noon	2.3	6.4	5.1	6.8	8.7	54.4	14.7	1.6
		P.M.	9.8	1.5	22.9	2.8	25.1	4.7	32.0	1.2
Frenquel	Saturated	Noon	2.3	1.6	29.6	22.8	16.8	9.5	13.8	3.6
		P.M.	5.5	2.9	24.2	8.5	38.2	3.7	15.9	1.1
	Desaturated	Noon	7.8	0.9	8.6	18.3	4.4	34.1	25.6	0.3
		P.M.	3.6	4.3	14.1	30.7	6.9	28.5	9.6	2.3
Meratran	Saturated	Noon	5.7	10.2	10.9	8.9	21.3	9.3	19.7	14.0
		P.M.	1.9	3.6	18.8	45.0	8.8	5.0	7.9	9.0
	Desaturated	Noon	8.5	1.4	13.9	5.5	20.3	23.1	26.2	1.1
		P.M.	1.9	3.3	3.6	10.8	3.0	32.8	29.8	14.8
	All controls		3.9	7.2	12.3	12.4	9.4	34.5	16.4	3.9
	All Frenquel		4.3	2.3	19.9	22.3	13.5	19.8	15.7	2.2
	All Meratran		3.9	4.1	11.7	20.2	11.4	13.3	20.5	9.9
	All Animals		4.1	4.0	15.9	19.3	11.9	23.2	17.1	4.5

Figure 1. Dimensions and Rear View of one Side of the Octagonal Color Preference Apparatus

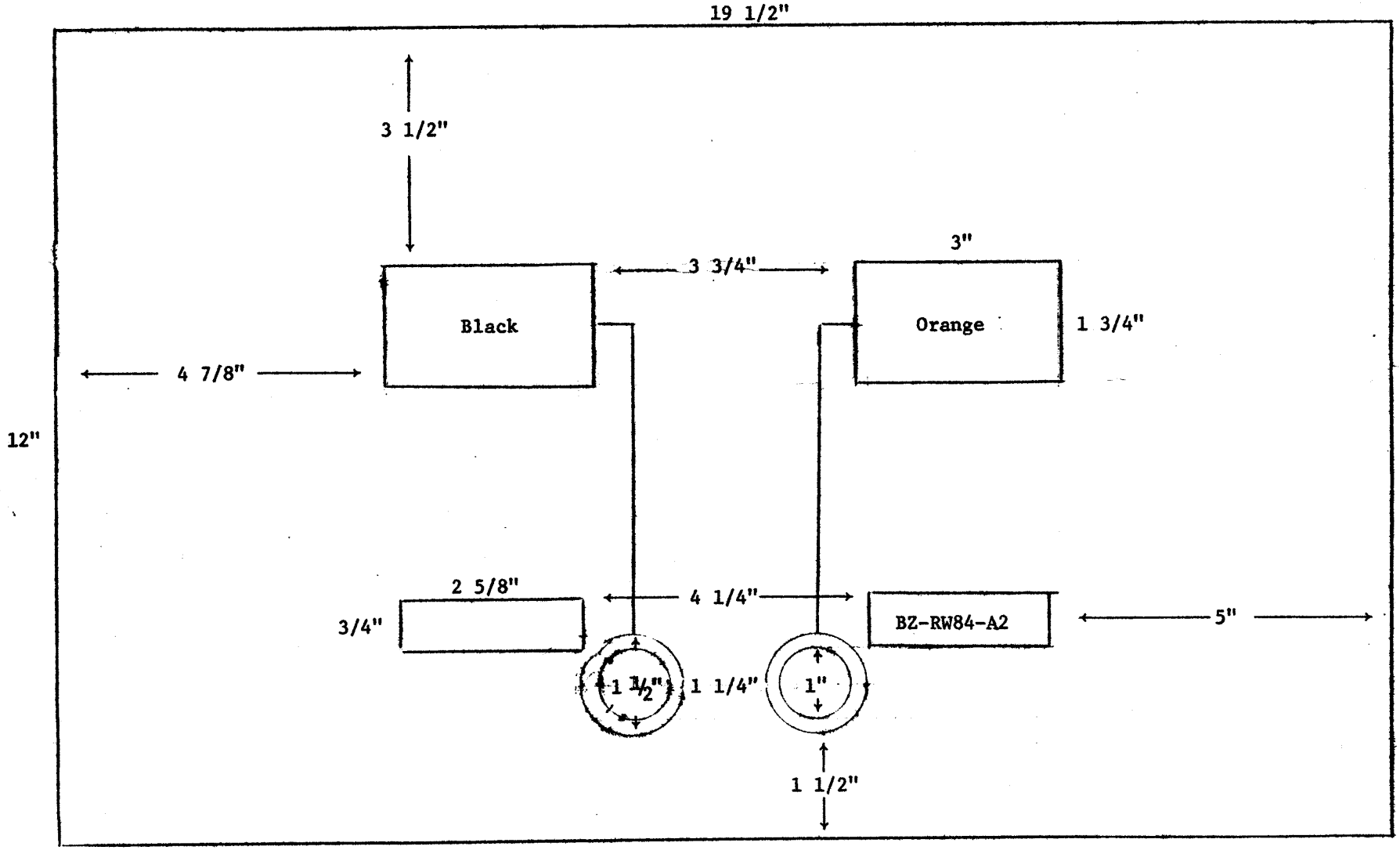
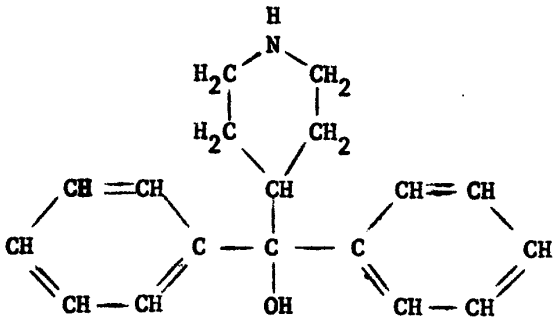


Figure 2

Chemical Structure of Drugs Administered to Treatment Groups

Frenquel
(Azacyclonal)



Marstran
(Pipradol)

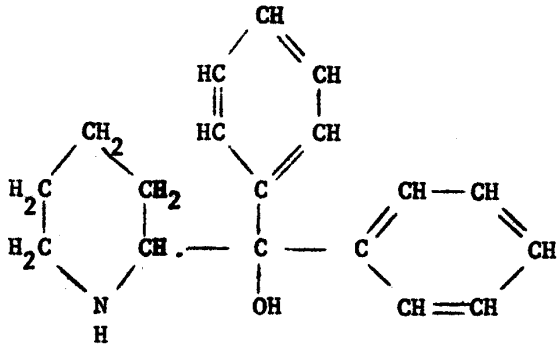


Figure 3. Testing Schedule for the

Color Preference Experiments

	Noon	P.M.
Day 1	Frenquel Saturated series	Meratran Saturated series
Day 2	Controls Saturated series	Frenquel Saturated series
Day 3	Meratran Saturated series	Controls Saturated series
Day 4	Frenquel Desaturated series	Meratran Desaturated series
Day 5	Controls Desaturated series	Frenquel Desaturated series
Day 6	Meratran Desaturated series	Controls Desaturated series

Figure 4. Preferred Colors under the Different Treatment Conditions

		Controls	Frenquel	Meratran
	Saturated	Gray,	Yellow,	Blue,
	Colors	Yellow	Green	Gray
Noon				
	Desaturated	White,	White,	Gray,
	Colors	Gray	Gray	White, Blue
	Saturated	Green,	Blue,	Green,
	Colors	White	Yellow	Yellow
P.M.				
	Desaturated	Gray, Blue,	Green,	White,
	Colors	Yellow	White	Gray