4.205 mg yielded 2.710 mg	H_2O and 5.830 mg CO_2 Found	C = 37.85	H = 7.21
Octa-acetyl trehalose $C_{28}H_{38}O_{19}$	Theoretical	C = 49.54	H = 5.65
3.440 mg yielded 1.695 mg	H_2O and 6.305 mg CO_2 Found	C = 49.99	H = 5.51
4.310 mg yielded 2.23 mg	H_2O and 7.83 mg CO_2 Found	C = 49.55	H = 5.79

Trehalose may be determined quantitatively in one gm of yeast by adding 10 cc of NH_2SO_4, diluting with water and precipitating with heavy metal. The filtrate obtained does not reduce alkaline copper solution, provided glucose added prior to the extraction of the yeast has been allowed to ferment completely. The filtrate is made normal with H_2SO_4 and hydrolyzed for 8 hours in the water bath. This converts 95 to 98 per cent. of the trehalose present to glucose. After removal of the H_2SO_4 with barium carbonate the glucose content is determined by means of the Shaffer-Hartmann copper reagent.

Fresh baker's yeast contains from 0.5 to 1.5 grams trehalose per 100 grams moist weight, the amount depending on the medium on which the yeast was grown. Aeration of a yeast suspension without added substrate lowers the trehalose content markedly. During fermentation of glucose the trehalose content may increase to 2 to 3 per cent. The biological significance of trehalose in yeast will be dealt with in a later report.

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THE ASCORBIC ACID CONTENT OF CERTAIN ORGANS OF CHICKS RAISED ON VITAMIN C DEFICIENT RATION

The presence of a high concentration of vitamin C in the livers of chickens fed on a scorbutic diet has been reported by Hart, Steenbock and associates[1] and Carrick and Hauge[2] by biological tests. Recently Ray,[3] using the titrimetric dye method of Birch *et al.*,[4] found that although egg yolk and egg white both were devoid of vitamin C, after 4 days of incubation the embryo began to show the presence of ascorbic acid. The livers of the embryos after 15 to 19 days of incubation were found to contain 0.105 to 0.178 mg of ascorbic acid in the whole liver and after 21 to 24 days 0.226 to 0.273 per liver.

Using the titrimetric dye method, we have recently estimated the vitamin C content of different organs of over 20 chicks, fed on a diet free from vitamin C and with or without ultra-violet irradiation, from experiments on certain vitamin D studies and found that the adrenals, intestine and intestinal mucus as well as the liver all possess a high content of ascorbic acid, whether the chicks received ultra-violet irradiation or not, and further that the concentration of ascorbic acid in these organs did not vary during the growth period between the second and the third month.

Pancreas and kidney both contained a moderate amount of vitamin C, being about one third of that of the liver or intestine. The muscle was devoid of ascorbic acid. Both the intestinal contents of the small and of the large intestine possessed a trace of ascorbic acid, indicating that part of the ascorbic acid was excreted through the intestinal wall to the lumen.

Table I shows the average result obtained with the two groups.

TABLE I

Ascorbic Acid Content mg per gm of Tissue

Ultra-violet irradiation	Muscle	Adrenals	Liver	Intestine	Intestinal mucus	Small intestinal content	Large intestinal content	Pancreas	Kidney
Yes ..	0	0.811	0.335	0.380	0.375	0.052	0.045	0.128	.100
No ..	0	0.915	0.302	0.391	0.404	0.047	0.056	0.134	.120

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR THE STUDY OF SENSORY DISCRIMINATION IN MAMMALS

In the investigation of the functional characteristics of the receptors and nervous system of animals the need for methods permitting the elicitation and objective recording of responses to external stimulation is recognized. The present paper describes such a method, which has been found to be well suited to the analysis of all phases of the visually controlled behavior of the cat, and which may be modified for the investigation of the responses to other forms of exteroceptive stimulation in various typical laboratory mam-

[1] C. W. Carrick and S. M. Hauge, *Jour. Biol. Chem.*, 63: 115, 1925.

[2] E. B. Hart, H. Steenbock, S. Lepkovsky and J. G. Halpin, *Jour. Biol. Chem.*, 66: 813, 1925.

[3] S. N. Ray, *Biochem. Jour.*, 28: 189, 1934.

[4] T. W. Birch, L. J. Harris and S. N. Ray, *Biochem. Jour.*, 27: 590, 1933.

mals. The effectiveness of the apparatus is illustrated by presenting certain new findings concerning the discriminative behavior of the cat.

The apparatus here described (Diagram 1) is a

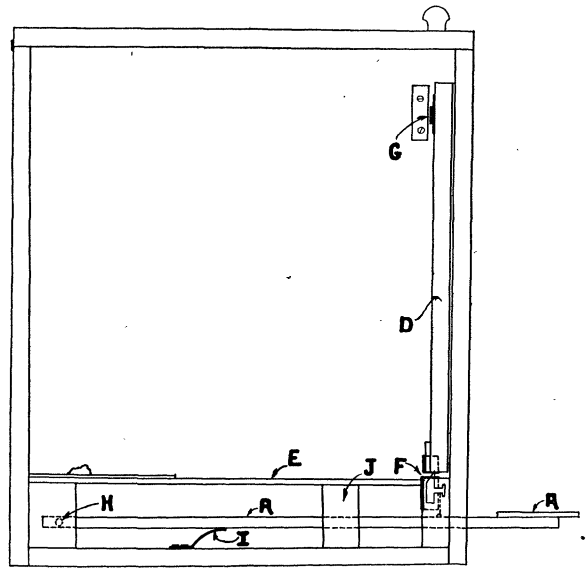

DIAGRAM 1. (A) lever, (D) door, (E) shelf, (F) latch, (G) rotary latch, (H) lever shaft, (I) spring support, (J) shelf support.

modified form of a method previously used by the writer in connection with experiments on pattern vision in the cat.[1] As arranged for work with this animal, the device consists of dressed poplar, 1.3 cm thick, cut and fitted into a box, 28 cm wide, 29 cm long, and 33 cm high. A door (D), a wooden frame 1.9 cm wide and 1.3 cm thick, swings inward by means of a light spring attached to its back. In the front side of the door are grooves into which ground optical glass or cards bearing various kinds of visual stimuli may be quickly inserted and removed. Inside the box, directly below the level of the door, is a shelf (E) for a food container. The shelf is so constructed that the door may swing inward without contact. The door is held tightly closed by a spring latch (F), to which is attached a brass lever (A), that extends 10.5 cm outward from the box and terminates in a brass plate of a size ample to accommodate the paw of the animal. The cat secures the food by depressing the lever and thrusting its head and forebody through the aperture of the opened door. The door may be closed by the rotary latch (G). Punishment by electric shock may be administered by leading a current through the lever and suitable conducting grills placed in front of the apparatus.

[1] K. U. Smith, *Jour. Genet. Psychol.*, 43: 462–466, 1933; 44: 301–320, 1934; 45: 336–357, 1934.

The lever consists of a 0.64 cm square brass rod, 32.4 cm long, to the outer end of which is screwed a small rectangular brass plate, 7.5 cm by 5 cm, rounded at the corners. A shaft (H) fitted into wooden supports (C), 2.5 cm high, serves as a fulcrum for the lever, the tension of the latter being controlled by a spring support (I). The shelf (E) is held 2.5 cm from the floor of the box by the supports (C) and (J).

Immediately below the door on the inside of the front panel is a spring latch (F), its catch being screwed to the inside of the door. The brass lever is drilled and fitted with a small hook directly underneath the plunger knob of the latch. Small rubber bands, giving greater tension than the latch spring, are led through the small hook and around the plunger knob of the latch. Thus, the door opens at the slightest touch of the lever, though the lever can thereafter be depressed to the floor. The rotary latch (G), which determines whether or not the door may be opened, is mounted on the upper edge of the frame of the door and catches against a wooden stop when rotated at a right angle.

With this apparatus, responses to pattern, brightness and movement differences in visual stimulation have been investigated so far in over thirty animals. In general, on the basis of these studies it can be said that cats learn situations involving brightness differences to a statistically significant criterion more quickly (100 to 200 trials) than they do situations involving any sort of pattern differences, whether moving or stationary (150 to 500 trials). Loud auditory stimuli, secured by sounding buzzers inside the box, have been demonstrated to elicit discriminative responses immediately in animals already trained to respond to visual differences. In further experiments, now being carried out, the apparatus has also been found to be suitable for the investigation of postoperative disturbances of visually controlled responses in relation to removal of limited regions of the cortex.

In the experiments just mentioned the following general procedure is followed. The animal is first trained in the habit of depressing the lever on a single box and obtaining a small bit of salmon placed on a food-tray inside. Two or more boxes, the doors of which contain appropriate visual stimuli, are then presented, and the animal is required to select an arbitrarily designated positive stimulus from one or more negative stimuli, the relative position of the stimuli in the boxes being changed from trial to trial in a chance order.

For establishing differential responses to visual patterns (for example, circles and triangles of equal area) two, three or four boxes are placed at the end of a long table, on the opposite end of which is located a restraining cage for the animal. Cards bearing visual figures are inserted in the doors. The same arrangement of the boxes may be successfully employed in the investigations of responses to brightness differences from reflected light by inserting standard neutral-tint papers in the doors. Buzzers or loud speakers mounted at the back of the boxes permit rapid investigation of differential responses to auditory stimuli. Determinations of responses to transmitted light are made by constructing diffusing screens and filter holders at the back of the boxes and inserting optical-glass plates in the doors. Intensity variations are quickly made by a series of neutral-tint filters (10.2 cm by 12.7 cm). For visual acuity measurements two boxes are mounted on runways, 5 cm wide by 215 cm long, and separated by a distance of 50 cm, which are connected to the end of the table. The animal is then required to make a differential response which is a function of the test stimuli (a horizontal and a vertical black line) at the end of the table. The stimulus distance is controlled by the position of the movable boxes along the elevated runways. When responses to moving stimuli are under investigation, boxes containing plate-glass backs are employed, and the shadows of moving figures projected upon optical-glass screens in the doors.

The following statements indicate something of the general nature of the visually controlled responses of the cat as determined by this method. Animals trained in the discrimination of visual patterns (circles and triangles of equal area) give generalized responses to similar forms of different brightness, size, figure-ground relation, etc., or are able to select a previously learned figure from among a number of different new patterns (8 animals). With transmitted light differences, the brighter of two lights may be decreased to a ratio of approximately 1.3 that of the second light at brightness levels of 0.5 and 50 apparent foot-candles and still elicit differential responses (7 animals). With reflected light differences, the threshold ratio is approximately 1.4 at a brightness level of approximately 40 apparent foot-candles (1 animal). The visual acuity varies with the stimulus distance, being best at 50 to 75 cm (0.45 to 1.7 minutes) and less precise at 100 to 125 cm (1.4 to 3.4 minutes), when the discrimination is based upon a black horizontal lines versus a black vertical line (2 animals). The threshold of discriminative response to a moving cross versus a non-moving cross is approximately 1 cm per second angular velocity (4 animals).[2]

In every case, the bona-fide nature of the responses may be established by check experiments made during the course of each investigation. The results indicate that the apparatus has the advantage not only of eliciting an unequivocal response which can be demonstrated to be a function of the differential stimuli presented, but also of providing general experimental conditions that are readily modifiable for different types of investigation and easily controlled. Olfactory influences, for example, are controlled by placing food behind the doors of each box, and by alternating the position of the stimuli independently of other parts of the apparatus. Extraneous auditory influences and cues from the experimenter are excluded, since the animal itself manipulates all movable parts of the apparatus when making a response, and since the observer is shielded from the apparatus by appropriate screens.

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[2] J. L. Kennedy and K. U. Smith, *Jour. Genet. Psychol.*, 46: 470–476, 1935.

THE "CONTOUR" CHART AND ITS IMPORTANCE IN PUBLIC HEALTH TABULATIONS[1]

IT is often necessary to express data in as little space as possible and at the same time make it immediately evident. I believe the chart herein described will aid in this respect.

Neyman[2] and Neyman and Pearson[3] used the term contour in describing lines representing a constant of different sizes of samples of population. Their diagrams were highly technical. Treolar and Wilder[4] also used the term contour with reference to lines in a highly technical diagram. In a recent study of the incidence of epidermophytosis[5] I have used the term with reference to certain charts. In these charts three factors are plotted: one, on the ordinate, one on the abscissa and a third on the chart. Increments plotted on the chart are equal. The term "contour lines" is used in the same sense on topographical maps in plotting equal increments of elevation or depression and they are defined as lines drawn for equal differences of elevation and hence steepness, or the reverse, according to whether they are crowded together or spread apart. As will be noted in my charts, the term contour is used somewhat broadly but in a highly descriptive sense.

In Fig. I, years are plotted on the abscissa, cumulative cases on the ordinate and age groups of 10 years on the chart. In this chart the term contour is used somewhat broadly, since the lines connecting the

[1] Contribution No. 59 from the Department of Biology and Public Health, Massachusetts Institute of Technology, Cambridge, Mass.

[2] J. Neyman, *Biometrika,* 18: 1926, 406.

[3] J. Neyman and E. S. Pearson, *Biometrika,* 20–A: 1928, 175–235.

[4] A. E. Treolar and M. A. Wilder, *Ann. Math. Stat.,* 5: 1934, 340.

[5] J. W. Williams, *Arch. Dermat. and Syph.* In press.