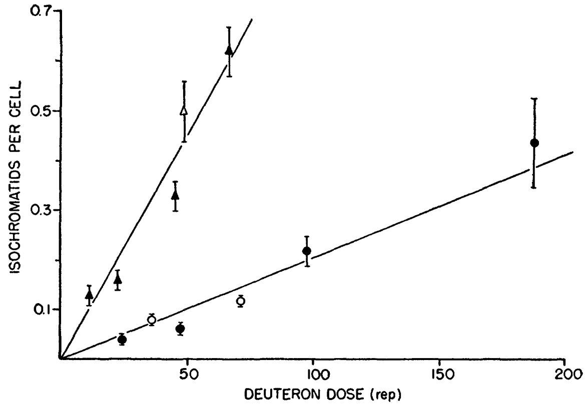

Fig. 1. Relationship between deuteron dose and isochromatid aberrations per cell. Position I, low LET: ○, expt. 1; ●, expt. 2. Position III, high LET: △, expt. 1; ▲, expt. 2.

Table 2. Frequencies of isochromatid aberrations induced by alpha particles in *Tradescantia* microspore chromosomes. All exposures at position I (low LET). Slides made 24 hr after irradiation.

	Dose (rep)	No. of cells	Isochromatid aberrations	Isochromatids per cell
Expt. 3	3.1	50	0	0.0
	6.0	100	2	.02 ± 0.014
	23.1	100	3	.03 ± .017
	46.5	100	10	.10 ± .03
	93	50	12	.24 ± .07
Expt. 4	25	107	6	.056 ± .02
	54	100	15	.15 ± .04
	107	40	18	.37 ± .10

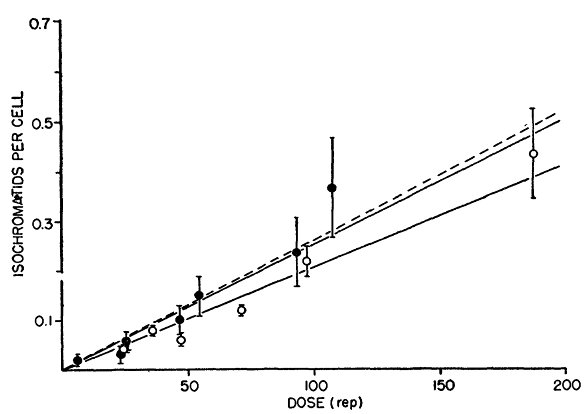

Fig. 2. Relationship between isochromatid aberrations per cell and radiation dose with three different radiations in exposures giving approximately equal linear energy transfer (LET): ○, 190-Mev deuterons; ●, 380-Mev alpha particles; - - -, about 100-kv x-rays.

Catcheside, Lea, and Thoday (*5*). Although in both instances the relationship between radiation dose and aberration yield has been plotted as linear, the possibility that the exponent in the dose-effect relationship may be somewhat greater than 1 is not excluded. It is clear that for both kinds of aberrations, there is a marked increase in yield with an increased rate of energy loss. The relative biological effectiveness for chromatid aberrations is approximately 2.7 and that for isochromatids, 4.5. Thus these observations agree with previous ones (*1*) in indicating a greater efficiency in chromosome aberration production by radiations having high specific ionization.

A further comparison was made of aberration production with 380-Mev alpha particles, exposures being made in the region of low rate of energy loss. These data are presented in Table 2 and are plotted in Fig. 2. Comparative data have also been included in Fig. 2 for two other radiations involving exposures at comparable rates of energy loss. The data for deuterons are those obtained in this study; those for x-rays are taken from the combined observations of several investigators, as reported by Lea (*6*, Fig. 34). It is clear that, within the limits of error, there is no difference in the effects of these three radiations when comparisons are made under comparable conditions of linear energy transfer. These results thus indicate in a striking manner that the important factor in determining radiobiological effectiveness is not the type of ionizing particle but rather the rate at which energy is dissipated along the particle path.

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Enzyme Concentrations in the Brain and Adjustive Behavior-Patterns

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This is a preliminary report of a close relationship between concentrations of an enzyme in the cerebral cortex of the rat and its adjustive behavior-patterns.

For our behavior test we used a standardized insoluble maze (*1*). The rat cannot learn the maze, since after each run the pattern of illumination cues and of

Table 1. Hypothesis-preference scores and cortical cholinesterase activity in 10 spatial-preference rats and 10 visual-preference rats, with *t*-tests for differences between groups.

Group I, spatial						Group II, visual					
Rat	Pref. scores*	Cholinesterase activity in different cortical areas†				Rat	Pref. scores	Cholinesterase activity in different cortical areas			
		V	S	M	(V+S)/2			V	S	M	(V+S)/2
B-1	+185	56	69	62	62	D-44	−250	41	66	76	54
B-7	+150	52	72	64	62	D-12	−173	47	57	64	52
C-1	+142	56	61	58	58	X-52	−165	40	46	49	43
C-17	+136	51	71	70	61	D-46	−162	52	78	80	65
(B-3)	(+121)	(27)	(47)	(46)	(37)	D-18	− 92	41	54	66	48
Y-74	+103	79	55	69	67	C-3	− 74	46	52	54	49
C-28	+ 69	55	64	65	60	C-10	− 58	48	53	59	50
B-9	+ 42	56	69	82	62	X-55	− 51	52	54	63	53
C-26	+ 36	56	68	73	62	X-51	− 49	45	54	61	50
C-9	+ 35	59	70	74	64	X-53	− 24	63	63	70	63
Means N=9	+ 99.8	57.8	66.6	68.6	62.0	Means N=10	−109.8	47.5	57.7	64.2	52.7
Over-all means (n=19)								52.4	61.9	66.3	57.1
t for differences between groups								2.96	2.54	1.12	3.92
p								.01	.02	.3	.001

* Plus values indicate spatial, minus values, visual preferences.
† Expressed as moles ACh × 10^{10} hydrolized per minute, per milligram of tissue.

correct alleys is changed. In its attempts to reach the food box the rat displays "hypotheses." Thus, for example, an animal may systematically choose the lighted alleys (a "visual hypothesis") or it may consistently choose the left alleys (a "spatial hypothesis"). This hypothesis behavior test has these advantages:

1) In 5 days of testing the rat makes 240 choices, and the strength of its hypotheses can be reliably quantified.

2) The rats show either visual or spatial hypothesis-preferences and large individual differences in the strengths of these preferences (*1*).

3) These preferences are stable over time (*2*) and are genetically determined (*3*).

4) This test requires a minimum of physiological intervention by the experimenter.

5) The behavior is significant in the organism's normal adjustments—it reflects a perceptual selectivity that must occur if the animal is to organize the welter of stimuli impinging upon it.

6) Finally, hypothesis-preference can be altered predictably by ablations in the visual and somesthetic areas of the cortex (*2*), thus suggesting the most profitable loci for chemical analysis.

Our chemical test measured the concentration of cholinesterase (ChE) in six areas of the cortex. In each hemisphere 10 to 20 mg of tissue was taken from the visual, somesthetic, and motor areas (the latter area for control purposes). It should be emphasized that the chemical tests were made in complete ignorance of the behavioral results; strictly comparable amounts of tissue were taken from animals of both groups. The samples of tissue were weighed and homogenized in cold 0.9-percent saline and diluted to 10 ml. In each determination 8 to 12 mg of tissue was used. The difference in tissue weight was not associated consistently with different areas. The rate of hydrolysis of acetylcholine perchlorate (ACh) at *p*H 7.95 and 37°C was determined anaerobically with a *p*H meter equipped to maintain constant *p*H through an automatic-recording syringe buret (*4*). Corrections were made for the "blank" hydrolysis of ACh (*5*).

Sixty male animals (between 80 and 90 days of age) were tested behaviorally. ChE analyses were made of the brains of 10 rats with strong spatial preferences (group I) and of 10 rats with strong visual preferences (group II). After behavioral testing, the animals were decapitated, and the samples of tissue were removed by gross dissection. The brains were preserved for exact determination of the sites of ablations.

The data are presented in Table 1. (The values for animal B-3, the first of our experimental animals to be tested chemically, deviate so widely—approximately *four* standard deviations—from the means of the rest of its group, that we have not used its data in the computations that follow.) The most general result is that the ChE activity of the rat's visual cortex is approximately 20 percent lower than that of either the somesthetic or the motor area. The respective *t* values are 3.83 and 5.92; thus, the probability of obtaining such differences by chance is approximately 1 in 1000. Tower and Elliott (*6*) reported no significant differences among cortical areas in the rat; however, they did not use areas defined functionally and cytoarchitectonically, and their observations were too few to permit tests of significance.

Perhaps even more interesting are the enzymatic differences observed when the animals are separated into two groups by the behavioral test. In the first place, the visual-hypothesis rats show a progressive and statistically significant increase in ChE activity from the visual, through the somesthetic, to the motor area. The spatial animals do not show this consistent pattering. Even more striking are the differences in *level* of ChE activity. Group I shows significantly higher ChE activity than group II in both sensory areas but not in the control motor area. The greatest difference is found when the ChE activities in the two sensory areas are averaged, (V + S)/2. All 9 of the spatial animals score *above* 57.1 (the mean for all 19 animals) and 8 of the 10 visual animals score *below* 57.1.

At present we would entertain two kinds of theoretical explanations to account for our data. The first would relate hypothesis-preference to ChE dominance of one of the sensory areas. The second theory would posit a general "power" factor—high ChE activity in the sensory ("cognitive"?) areas makes for a more generally adaptive animal (more "intelligent"?). We have begun research to test both the sensory-area dominance theory and the general "power" theory.

Most of the animals were drawn from Tryon's (*6*) three strains—maze-bright animals, maze-dull animals, and a cross between the two (labeled "B," "D," and "C," respectively in Table 1). Behaviorally, the B's are spatial, the D's visual, and the C's are found in both groups. Chemically, the B's tend to be high on the (V + S)/2 measure, the D's low, and the C's show a range that overlaps those of the other two strains. We have initiated a selective breeding experiment to test the suggestion that ACh metabolism in the cortex may be genetically determined and that this, in turn, determines hypothesis-preference (*8*).

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Preliminary Studies of the Intensity of Light Scattered by Water Fogs and Ice Fogs

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This study (*1*) was initiated to investigate photometrically the angular variation of the intensity of light scattered by artificially produced water and ice aerosols and to evaluate the usefulness of photometric techniques for the study of Alaskan ice fogs (*2*) and supercooled water fogs.

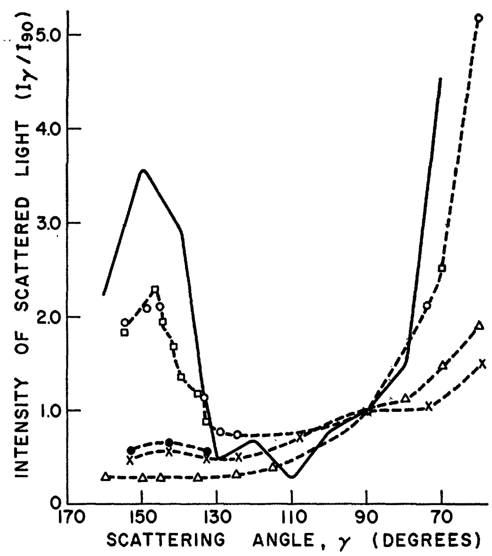

Fig. 1. Angular variation of intensity of light scattered in a horizontal plane by water fogs and ice aerosols. Interpretation of symbols: ○ water fog, −17°C; □ water fog, −12°C; ● ice aerosol, −16°C, Dry-Ice seeded; × ice aerosol, −10°C, AgI seeded; △ ice aerosol, −12°C, AgI seeded; —— theoretical curve for droplets of 3.5-μ radius (Gumprecht *et al.*).

Atmospheric optical phenomena caused by the scattering of light by water or ice particles (*3*) suggest that characteristic curves for the angular variation of scattered light would be different for ice and water fogs when observed photometrically. The fogbow seen on a sheet of water droplets at an angle between 140 and 143 deg to the incident rays of the sun and halos seen at an angular radius of 22 or 46 deg around the light source when looking through a suspension of ice crystals in the atmosphere are examples of these phenomena. Rainbows and halos are treated theoretically by Bucerius (*4*) and Ramachandran (*5*), respectively. Sinclair (*6*) has summarized investigations of the scattering of light by aerosols consisting of particles with a radius of 1.0 μ or less. In contrast, ice fog particles are most frequently 5 to 10 μ in radius (*2*), and water fog droplets have an average radius of about 20 μ and a minimum radius of about 2 μ (*7*).

The experiments reported here were carried out in a home freezer. Fogs were generated continuously by controlled heating of a beaker of water and were converted to ice form by seeding with either Dry Ice or silver iodide. The freezer contained a microphotometer (*8*) adapted to record the ratio of the intensity of scattered light to the intensity of the incident beam in a horizontal plane. The beam had a wavelength of 5460 A. Angles observed were from 0 to 160 deg. A second detector monitored the light scattered vertically at 90 deg to the incident beam to provide a continuous check on 90-deg scattering and on the symmetry of the scattering in the vertical and horizontal planes. Cor-