ameter) in the Norelco micro diffraction camera, is almost identical to a rotating crystal diagram. The long dimension of crystal needles, corresponding to the "rotation axis" of the diagrams, coincides with the *b* axis of the monoclinic elementary cell of sucrose (*2*).

The observed crystallization is similar to the "recrystallization" of Al_2O_3 under the influence of ionizing radiation. According to Baskin and Semerchan (*3*), exposure to an electron beam or to hard x-rays increases the rate of crystal growth and makes the production of Al_2O_3 single crystals possible.

Although the formation of sucrose spherulites was surprising, it can be understood in view of the fact that microscopic spherulites of many substances have been observed during recent years, for instance in organic high polymers such as polyamides, polyesters, polyethylene, and rubber (*4*); spherulites of graphite have been observed in cast iron (*5*), and so on. Apparently the presence of foreign substances affecting the superficial tension of the medium from which crystallization takes place greatly influences the crystal habitus and causes the spherulitic growth of sucrose.

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27 March 1959

Photosensitive Site in Lettuce Seeds

Abstract. Red light is effective only in promoting germination of Grand Rapids lettuce seeds, and far-red light is effective only in inhibiting it, when the hypocotyl half of the seed is exposed to the light. It is concluded that the photoreceptor is probably located in the tip of the hypocotyl.

In recent years studies of the effect of light on the germination of photosensitive seeds have been focused upon the photoreversibility of the reaction between red and far-red light (*1*). The photoreceptor has been considered to be a pigment system which changes its absorbing form with red and far-red light and which may be identical with the system mediating other photoreversible reactions in plants (*2*). However, few attempts have been made to locate the actual site of the light-absorbing system in the seed. Klein and Preiss (*3*) reported that if the seeds are turned over between the illumination with red and far red, so that the two exposures are given to opposite sides, then the germination-promoting effect of the red is still reversed by the far red, and vice versa. Since very little light could be transmitted through the seed, these results raise the question of possible diffusion of the photoreceptor or of photoproducts across the seed tissue. However, these experiments did not show which morphological unit it is that reacts to the incident light. In the following paragraphs (*4*) it is shown that the light-absorbing system is present in the hypocotyl half of the seed, but not in the cotyledon half.

Table 1. Effect of 2 minutes' illumination with red or far-red light on half-exposed Grand Rapids lettuce seed. Red illumination was given at 2 hours and far-red at 3 hours following illumination with red at 2.5 hours (all times were measured from the beginning of imbibition).

Exposed part	Germination (%)				
	Normal seed: irradiation for				Seed with fruit coat off: irradiation for 2 min
	10 sec	30 sec	2 min	5 min	
		Red light			
Hypocotyl	55	89	93	88	98
Cotyledon	7	8	16	17	42
Whole seed	63	96	96	98	100
None	4	6	5	4	28
		Far-red light after red illumination of the whole seed			
Hypocotyl		14	2	1	
Cotyledon		91	74	41	
Whole seed		1	5	2	
None		92	89	93	

The seeds used were those of *Lactuca sativa* var. Grand Rapids, supplied by Breck's (Boston, Mass.). Fifty seeds were soaked in a 9-cm petri dish on two layers of black filter paper (Schleicher and Schüll No. 2490) with 5 ml of distilled water in darkness at 25°C. Since preliminary experiments had shown that a dark purple dye coming out of the filter paper inhibited the germination of the seeds considerably, the filter paper was washed thoroughly with running tap water for 24 hours beforehand. After 1.5 hours of imbibition, each seed was carefully covered with a piece of aluminum foil by means of a pair of fine forceps, under a green safe-lamp (20-watt fluorescent lamp filtered through two layers each of yellow and green cellophane), either the cotyledon half or the hypocotyl half of the seed being left uncovered. Completely covered and uncovered seeds were prepared as controls. The procedure took 20 to 25 minutes; the safe-lamp was known to produce very little effect on germination in this time. Exactly 2 hours after the beginning of imbibition, all seeds were irradiated for varying times up to 5 minutes with red light (100-watt incandescent lamp filtered through a Corning Signal Red glass filter, placed 25 cm above the level of the seeds). Similar experiments were run with seeds whose fruit coats had been removed, except that 25 seeds were used per petri dish instead of 50. Immediately after the red irradiation, the piece of aluminum foil was quickly removed from the seed, lest suppression of the respiration of the seed interfere with germination.

For experiments with far-red light, a 100-watt reflector flood lamp, with Corning glass filter No. 7-69 (2600) (50 percent transmission at 742 mμ) placed 25 cm above the level of the seeds, was used. After 2.5 hours' imbibition in the dark, all seeds were given 2 minutes' irradiation with red light, as discussed above, to induce germination. Either the cotyledon or the hypocotyl half of each seed was then covered with aluminum foil, and far-red light was given for various periods of time exactly 3 hours after the beginning of imbibition. After the light treatment the aluminum foil was quickly removed from the seed, as before.

Table 1 shows the results of the experiments, each reading being the average from two dishes. These results show that red light promotes gemination when only the hypocotyl is exposed almost as well as it does in control seeds which are wholly exposed. Similarly, far-red light inhibits germination whether the whole seed or only the hypocotyl is exposed. Exposure of the cotyledons, on the other hand, has little effect, since germination is about the same as that of the dark control, whichever light is used. The small extent of germination following longer irradiation with red light (2 and 5 minutes), or the corresponding inhibition following longer irradiation with far red, can be explained as the effect of scattered light due to the long exposure. Seeds from which the fruit coats have been removed show essentially the same behavior as the normal seeds with fruit coats on.

A number of reports on light-sensitive seeds have indicated that the seed covering restricts germination in darkness mechanically and that its integrity determines the light sensitivity of the seed (*5–7*). In lettuce the presence of the intact endosperm layer or "seedcoat" has been shown to be necessary for the light sensitivity of the seeds (*5, 7*). This, however, does not necessarily mean that the endosperm is the light-sensitive site. Should the pigment system be in the endosperm layer, its presence must evidently be limited to the half which covers the hypocotyl, but since that is the part of the seed which elongates in germination, it seems more reasonable to conclude that the photoreceptor pigment is present in the hypocotyl itself. That the photoreceptor should be close to the extreme tip of the seed would, of course, give a simple explanation of the observation of Klein and Preiss (*3*), since this is the only part which can receive light from either direction.

It can, therefore, be concluded that the light-sensitive site is either in the seed covering at the hypocotyl end, or, more probably, in the tip of the hypocotyl itself. The hypocotyl would thus be not only the site of elongation but also the region of light sensitivity.

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Magnitude of the Moon Illusion as a Function of the Age of the Observer

Abstract. The diminution in the apparent size of an object when viewed overhead as compared with its apparent size in the horizontal plane is greater for children than for adults. This relationship, of which the well-known moon illusion is a special case, is interpreted to be a consequence of the normal development of size constancy.

The relatively small perceived size of the moon when seen in elevation as compared with its large appearance at the horizon is one of the oldest recorded visual phenomena. Since the angle subtended by the moon's disk is actually somewhat smaller at the horizon, the striking difference in its perceived size has been referred to as the "moon illusion." A number of explanations have been offered for this phenomenon (*1*). It is the purpose of this report to attempt to relate the moon illusion to normal processes of perceptual development. To this end, the magnitude of the effect was determined for adults as well as for children of various ages.

Schur (*2*) has demonstrated that the essential feature of the illusion, that is, the change in apparent size as a function of elevation, holds not only for celestial but also for terrestrial objects. She projected a spot of light on the ceiling of a large room and asked adult subjects to adjust the size of a similar spot of light, at the same viewing distance but projected on a vertical screen at eye level, to match the overhead light. Under these conditions, the disk viewed overhead appears smaller than the one viewed in the horizontal plane.

We have repeated this experiment in a darkened theater at a viewing distance of 35 feet and also outdoors by extending a disk, parallel to the ground, from the roof of a building 85 feet high. In both experiments, the subjects sat directly below the overhead disk and compared its size with that of a similar disk in the horizontal plane at the same viewing distance. The subjects observed binocularly with unrestricted head, eye, and neck movements. In every case the disk in the horizontal plane judged equal in apparent size to the overhead disk was physically smaller than the overhead disk. Nineteen adults and nineteen children ranging in age from 4 to 11 years served in the outdoor experiment. The data plotted in Fig. 1 present the matched size of the horizontal disk

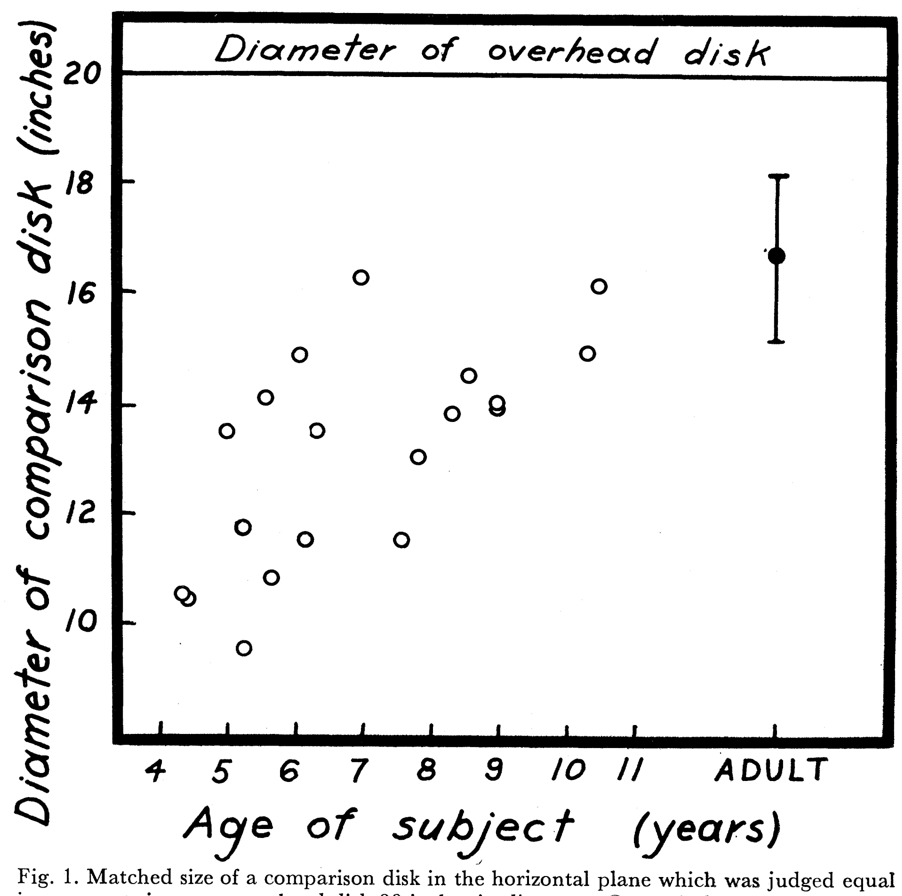

Fig. 1. Matched size of a comparison disk in the horizontal plane which was judged equal in apparent size to an overhead disk 20 inches in diameter. Open circles represent values for individual children. The mean for 19 adults, with the limits for one standard deviation, is given by the solid circle.