Thus, the learning curve in Fig. 2, or a typically normal learning curve, represents the function of both cerebral hemispheres during learning. The learning curve in Fig. 3 must then represent the function of only one hemisphere during learning. They are respective "bilateral hemispheric" and "unilateral hemispheric" products.

Participation of only one hemisphere during learning would necessarily limit by one-half the available amount of brain tissue. If this is so, differences in learning rates between animals capable of interhemispheric transfer and animals incapable of interhemispheric transfer could be explained by Lashley's principle of cortical mass action (*11*). With this hypothesis it is not unreasonable to expect that the animal with both cerebral hemispheres interacting during learning should require less training than the animal with only one hemisphere participating in the same learning situation. We would also expect retention to be different since, in the unilateral hemispheric situation, there is less brain mass available for memory storage during and after acquisition.

Although the underlying mechanisms are unknown, the main conclusions suggested by these studies are that (i) both cerebral hemispheres usually participate during learning, (ii) the normal learning curve and thus the normal rate of learning appears to be a function of bihemispheric processing of information, and (iii) memory during and after acquisition is one of the functional relationships between the hemispheres.

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Photoreception in Sparrows: Response to Photoperiodic Stimuli

Underwood and Menaker (*1*) exposed blinded and normal house sparrows (in about equal numbers) to 18 different photoperiod treatments. Testicular weights were recorded at autopsy for each member of each group. The difference in testes size between the two groups (normal and blinded) in each condition was evaluated by Student's t-test. The t value obtained had a probability of less than .05 in only one condition. The authors conclude: "Our data offer no support for the hypothesis that the retina is involved in this [the testis] response." Their data not only do not support this conclusion, but very strongly support the opposite conclusion.

Their statistical logic is profoundly faulty, for they have confused failing to reject the null hypothesis with confirming it. Failure to reject the null hypothesis does not mean that it is true, but only that there is some chance that it is true. When the null hypothesis is not rejected at .05, we know only that there is better than one chance in 20 that it is true. Knowledge would progress very little if we accepted every hypothesis that has at least one chance in 20 of being true. Therefore, the null hypothesis is never confirmed by a statistical test, but only rejected or not rejected. Rozeboom (*2*) discusses this matter at greater length and with exceptional clarity.

Table 1. The number of blinded and sighted individuals in groups with larger or smaller average testes summed across all photoperiod conditions.

Average testes	Sparrows (No.)	
	Blind	Normal
Larger	48	114
Smaller	97	52

Thus this statistical analysis did not (and could not) support their conclusion. However, it seems quite likely that a different analysis of their data might have supported the opposite conclusion.

When the results of their experiment are considered as a whole, the differences between blinded and normal birds begin to look distinctly nonrandom. Their graphs show a consistent, though not invariable, tendency for normal birds to have larger testes. Their table shows that normal birds have heavier testes in 12 of the 18 different lighting conditions, while blinded birds have heavier testes in only six. The larger the group of animals in each condition (and therefore the better the sample) the more pronounced is this tendency.

One can fairly ask why this tendency, if it reflected a real difference, would not produce statistically reliable differences. There are two important reasons why it might not, both having to do with the lack of statistical power in Underwood and Menaker's experimental design and data analysis.

Some power was lost by their choice of a two-tailed rather than a one-tailed test. A one-tailed test (appropriate in view of the existence of a strong theory) would have led them to reject the null hypothesis in three of the 18 conditions. But this is not so much a problem in itself as a reflection of the second, more fundamental, problem—their experimental design had far too few animals in each condition. The number of subjects in several conditions is so small that it makes rejection of the null hypothesis very unlikely, no matter how much the groups differ.

Underwood and Menaker could still have salvaged some data despite their design by increasing the sizes of the groups during analysis. Probably the best technique would have been to calculate the mean testis weight for each condition and then to determine how many sighted and blinded subjects fell above this mean, and how many below it. The number of sighted and blinded birds in each category could then be compared by χ^2.

Unfortunately, this analysis cannot be performed on the data in Underwood and Menaker's report, but the χ^2 can be estimated. The fourfold table can be generated in the following way. For one cell, use the total number of sighted birds in all conditions where sighted birds had a larger mean testis weight than blinded birds as an estimate of the total number of sighted birds with larger than average testes in all conditions, and so forth. In the 12 photoperiod treatments in which normal birds had heavier testes than blinded birds, there were 114 normal birds and 97 blinded birds. In the six conditions in which the blinded birds had larger testes, there were 48 blinded and 52 normal birds. This categorization generates Table 1.

When the population is dichotomized this way and the reliability of these differences in the numbers of blinded and sighted individuals in groups with larger or smaller average testes is evaluated by χ^2, then $\chi^2 = 37.826$; $P < .001$. As I noted above, a foolproof statistical evaluation would have to be based on Underwood and Menaker's raw data, but the present analysis strongly supports the conclusion that the retina is involved in the photoperiod response of house sparrows.

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Lott states that failure to reject the null hypothesis in our experiments does not mean that there is no difference between blind and normal birds but only that there is some *chance* that there is no difference. Clearly, failure to reject the null hypothesis does not prove that there is no difference but simply that no difference could be shown within the resolution of the experiment [see any of several discussions of power of tests of significance, for example, in (*1*) or (*2*)]. This is precisely why we concluded, "Our data offer no support for the hypothesis that the retina is involved in this response." The reader should be convinced by this argument only to the degree that he feels our experimental design and statistical analysis maximizes the chance of observing retinal involvement should it exist.

Lott claims that an alternative conclusion can be drawn from our data by use of a χ^2 test (Lott, table 1). However, in the construction of this table he ignores the fact that some birds which he places in the "blind-smaller" category had testes that were as large or larger than the testes of the normal birds in those samples. Lott places all blind birds of a particular sample in this category simply on the basis that their average testis weight is less. The same criticism applies to the way in which he forms the remaining three categories. A specific example will suffice to show that Lott's reanalysis of our data is inappropriate. The individual testis weights in one of the 12 samples in which the normal birds had the larger average testis weight are shown in Table 1. Lott (see his table 1) assigned the seven normal birds in this sample to the "normal-larger" category and the seven blind birds to the "blind-smaller" category simply because the average testis weight of the blind birds (185 mg) is less than the average testis weight of the normal birds (197 mg). It is quite clear, however, that many of the blind birds in this sample had testes as large or larger than the testes of the normal birds. A valid χ^2 could be performed on our data, for example, by using the median testis weight of all 311 birds in the 18 samples as the dividing line between "larger" and "smaller." The resulting χ^2 is not significant; $\chi^2 = 2.68$, $.10 < P < .25$ (Table 2).

It is true that there are other statistics one could apply, such as combined probabilities from tests of significance or signed rank tests of the differences between the means, in an attempt to get an overall view of the significance of the data. Neither of these tests show significant differences between the blind and normal birds at the 5 percent level, but neither these nor any other statistics with which we are familiar are completely adequate to test the overall significance of data drawn from a population that is changing with time. Accordingly, we employed a straightforward statistic, Student's *t*, to test for differences between blind and normal birds in each sample, and published the data in extenso. We see no reason to alter our conclusion that an extraretinal photoreceptor exists in the sparrow which is fully capable of mediating the gonadal response to photoperiodic stimuli.

Table 1. Individual testis weights from the birds in experiment C, day 26 (*3*).

Blind birds (mg)	Normal birds (mg)
5	12
24	102
35	142
226	197
308	212
308	276
391	436
Average 185	Average 197

Table 2. Number of blinded and sighted birds placed in larger or smaller categories according to whether or not their testis weights were greater or smaller than the median testis weight of all birds.

Category	Birds	
	Blind	Normal
Larger	65	91
Smaller	80	75

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Controlled Fusion: Plasma Confinement with Lasers

Holcomb (*1*) indicates that the effort to produce controlled fusion is being aided by developments in laser technology. However, there is one laser technique that has apparently been overlooked by him and other workers in the field of nuclear fusion. Theory indicates that a circularly polarized laser beam in a plasma can create a strong magnetic field along the light path. Sufficiently strong fields would be extremely valuable in extending inertial confinement times, or in supplementing external magnetic fields used for long-term confinement.

The size of the magnetic field can be estimated by using the classical linear equations (*2*)

$$B = (e/2mc^2)(\omega_p^2/\omega^3)E_0^2 \qquad (1)$$

$$\omega_p^2 = e^2n/\epsilon_0 m \qquad (2)$$

where m and e are the mass and charge of the electron; ω_p and ω, the plasma and laser frequencies in radians per second; E_0, the electric field in the light beam; and n, the free electron density. A field of over a megagauss results from a 2000-joule, 100-psec pulse of 1 μ wavelength light focused on a 50 μ^2 area if there are 10^{21} electron/