Visual Form Discrimination on the Basis of Relative Distribution of Light

Winans (*1*) has reported that cats with lesions of the visual cortex can discriminate inverted from upright triangles but has cautioned that her subjects may have responded to the spatial distribution of light rather than to the form of the stimuli per se. Dodwell and Freedman (*2*) have reiterated this possible interpretation but offer no relevant data. Nor are there pertinent observations in the classical literature (*3*). In the course of a study unrelated to this question I have recorded some data with normal rats which suggest that a triangle discrimination based on spatial distribution of luminous flux is quite possible.

Eight rats which had previously learned to avoid shock by choosing either an inverted or an upright white triangle on a black background were given a free choice on ten consecutive trials between the same forms but with black and white areas interchanged; that is, they chose between an inverted and an upright black triangle on a white background. The triangle forms were shifted from one side of the choice point to the other according to a modified Gellerman (*4*) series. This was accomplished by rotating the stimulus cards 180° so that choice on the basis of olfactory cues from earlier choices is unlikely.

Note that the same forms (for example, upright white and upright black triangles) have opposite flux gradients from top to bottom, while opposite forms (for example, upright white and inverted black triangles) are similar in this respect. If the original discrimination were mainly on the basis of form, one would expect the animal to choose the new stimulus having within it the precise contours of the previously positive stimulus, oriented the same way (for example, going from an upright white triangle to an upright black triangle). If the original discrimination were mainly on the basis of relative distribution of light, one would expect the animal to disregard the contour and orientation cues and choose the stimulus with similar black-white gradients (for example, going from an upright white triangle to an inverted black triangle).

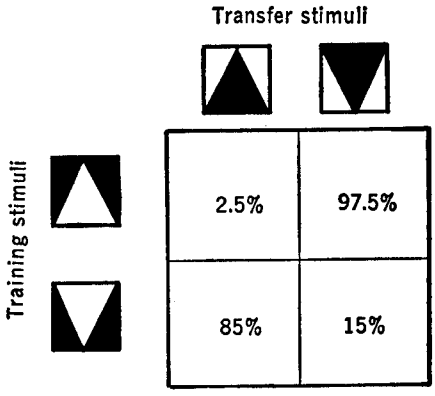

Fig. 1. Percent of choices to each transfer stimulus from the original training stimuli.

The data support the latter hypothesis. Seventy-three of the 80 possible choices were to the opposite form. This preference is statistically different from random choice ($\chi^2 = 29$, d.f. $= 1$; $P < .001$). All animals chose the opposite form on at least seven of the ten trials and half the subjects chose it every time. Figure 1 shows the percent of choices to each transfer stimulus from the original training stimuli.

Although one cannot conclude from these results with rats that Winans' cats were discriminating on the basis of spatial distribution of light, the possibility has some empirical support. As Winans pointed out, judgments on the basis of luminous flux can be made by animals with visual-cortex damage (*5*). Reducing the size of the figure as in the Winans study is not an unequivocal test, since the subjects may have learned to attend selectively to smaller black-white gradients. A simple control test such as the one described here gives an indication of whether the discrimination is based on form or on relative distribution of light within the figure.

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Buchtel's study with normal rats does not bear directly upon the major conclusion from my report—that, contrary to indications from previous studies, striate decorticate cats are capable of discriminating stimuli equated for total luminous flux (*1*). However, Buchtel's data are particularly relevant to a second consideration which I raised in that report concerning the possible cues for discrimination of the stimuli. The erect and inverted triangles which have been used in classical and recent studies of visual form discrimination (*2*) display localized flux cues on corresponding restricted regions of the stimuli, as well as flux gradients, either of which could facilitate the discrimination of these stimuli by animals capable of discriminating regional flux differences within areas equated for the total flux.

As I indicated in my reply to Dodwell and Freedman (*3*), after the striate decorticate cats had mastered the series of triangle discriminations, the cats were presented with a number of transfer tests. Among those tests was a black-white figure-ground reversal similar to that described by Buchtel. When three of the striate decorticate cats were presented with black triangles (7.62 cm high and 4 cm at the base) centered on lighted panels (21.6 cm by 11.4 cm) for 40 differentially reinforced trials (erect triangle rewarded, as in discrimination training), the correct responses averaged 53.3 percent. Similarly, unoperated cats which had mastered the same series of triangle discriminations responded to this test with an average of 50.6 percent correct responses over the 40 test trials. Unlike Buchtel's rats, the cats did not prefer the inverted triangle. However, in Buchtel's experiment, the rats were rewarded regardless of whether they chose the erect or inverted triangle, whereas in my study, the cats were rewarded only for selecting the erect triangle. This differential reinforcement may have counteracted a preference for the inverted triangle and resulted in the apparent absence of differential responses.

The results of this black-white figure-ground reversal test with the cats support the conclusion that these animals were dependent upon flux gradients or localized flux cues for discrimination of the triangles. But, in other transfer tests (in preparation for publication) these same lesioned and unoperated cats chose the erect triangle on critical trials (food behind both doors) when the triangles were presented in outline form and in outlines with the bases deleted. In these figures the flux gradients were greatly reduced and the localized flux cues were altered. Thus, if the striate decorticate cats relied on flux gradients or localized flux cues to discriminate the triangles, they were capable of utilizing surprisingly subtle cues of these types to guide their discrimination behavior.

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