cause, whenever fewer cells (or tubes) were used, the absorptions proved incomplete for the absorbing cells.

The extent of absorption also proved to be critical when agglutinating, rather than lytic, tests were performed with this same rabbit antiserum. After three absorptions performed at room temperature, only one antigenic factor could be distinguished. When sufficient blood was obtained from each fish for four absorptions, the antibodies directed against the individual antigen(s) previously detected were completely removed. The ease with which antibodies specific for individual differences were completely absorbed indicates that closely related antigens were involved in these antibody reactions. This finding is analogous to the well-known A_1 and A_2 specificities of human erythrocytes. Despite the difficulty of working with smaller species, it is probable that future investigations will show that inherited individual differences in erythrocyte antigens are widespread among fishes and other lower vertebrates.

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Visual Contour and Movement Perception

The means by which the visual system forms and maintains a contour is a central problem in vision, and one not well understood. By contour we mean the sharp boundary that separates two adjacent areas of the visual field. Specific studies of contour perception are few in number. Investigations of static and dynamic visual acuity, form perception, and visual-contrast phenomena all bear directly upon the subject of contour, but they all assume the operation of a contour-formation process without inquiring into the fundamental nature of the process itself. These allied phenomena in vision will be understood only when the essential facts of contour formation are known.

This report presents some preliminary observations on the subject of contour perception in relation to moving stimuli, a problem that has received little attention from those who have studied visual processes. The observations presented here stem from a phenomenon originally observed by Albert Michotte of the psychological laboratory at Louvain University in Belgium.

A stimulus (A) is observed moving horizontally through distance (D), from left to right. Its velocity (V) is increased until the contours of A cannot be seen clearly. At this velocity, if A is exposed for a brief interval in a fixed position prior to movement (this interval we shall call t_1) and then for another interval in a fixed position after movement (we shall call this interval t_2), A now is seen moving from left to right with sharp contours. This effect has been systematically explored by investigation of the quantitative relationship between the exposure durations of the stimulus in the fixed positions and the velocity of movement.

With an apparatus similar to the one employed by Michotte (*2*), a large white disk whose surface is perpendicular to the line of sight is rotated behind an aperture 6 in. long and 0.5 in. high. A concentric band on the disk is observed as a stationary square when the disk rotates. A band falling toward the center of the disk is translated into horizontal movement. By varying the speed of rotation of the disk and the length of the concentric bands, the necessary control over velocity of movement and exposure duration of the stimulus in the fixed positions is achieved. Figure 1 depicts the appearance of the black stimulus before, during, and after movement. The angular size of the stimulus object was 0.5°. The field of movement (D) was 5°.

For five subjects, the value of V at which contour was lost was determined with t_1 and $t_2 = 0$. At this velocity, t_1 and t_2 were increased by equal amounts in steps of 10 to 20 msec to some value (T) at which contour was regained. This procedure was continued until either the subject's limit of discrimination or the limitation of the apparatus was reached. The latter limitation concerned the exposure duration of t_1 and t_2. These values could not exceed 350 msec.

When the values of V are plotted against the values of T for each subject and these individual functions are combined, we get the relationship between V and T shown in Fig. 2. Because of the procedure employed, points were not always in common at different values of T for all subjects. Consequently, appropriate values of V were interpolated from the individual functions at 50-msec intervals of T. These values were averaged to give the points plotted in Fig. 2. Each point represents a mean of five values. This figure also includes data for vertical movement. The displacement of this function to the right is believed to be the result of a practice effect, a characteristic effect found in these kinds of observations. The data for vertical movement were gathered after the observations of horizontal movement.

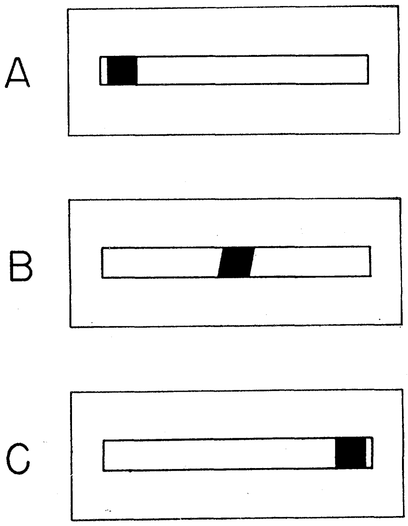

Fig. 1. Schematic illustration of the appearance of the stimulus as seen by the subject before movement (A), during movement (B), and after movement (C).

The linear functions in Fig. 2 may be thought of as *contour-contours*. All combinations of velocities and time values falling to the right of these lines will not produce contour, whereas all combinations to the left will. Figure 2 shows clearly that the contour of moving stimuli can be maintained as velocity increases, as long as the stimulus is exposed for a longer and longer time, both before and after movement. At some velocity this relationship breaks down, and the function becomes asymptotic to the ordinate. We cannot specify this critical velocity now because of apparatus limitations. The

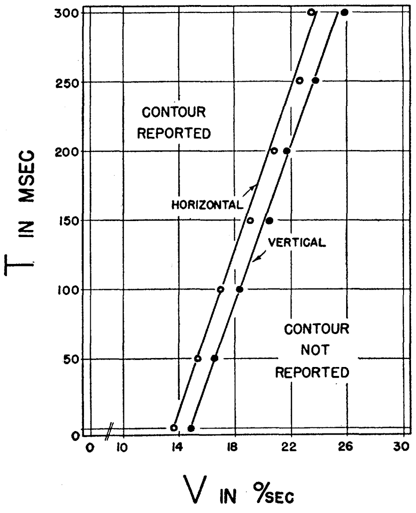

Fig. 2. A plot for horizontal and vertical movement showing the relationship between the velocity of the stimulus (V) and T, where T is the exposure duration of the stimulus before (t_1) and after (t_2) movement. In all instances $t_1 = t_2$.

results emphasize the critical importance of the temporal factor in contour perception. In order to maintain the contour of the moving stimulus, each increase in V of 1°/sec requires a corresponding increase in T of from 20 to 30 msec.

The criterion of judgment required of the subjects eliminates apparent movement as the explanation of the data reported here. The stimulus during movement was always tilted slightly to the right (see Fig. 1), because of the nature of the apparatus. As long as this feature of the stimulus was reported, it was taken to indicate that real movement was being discriminated. It is believed, however, that the visual mechanism underlying apparent movement is involved to some extent in these observations, as it probably is in *all* forms of movement perception.

Further experiments dealing with the effects of numerous stimulus variables in relation to contour perception of moving stimuli are in progress.

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Notes on the Ecology of West Indian Species of Malpighia

Interest in the West Indian or Barbados cherry (*Malpighia glabra* or *M. punicifolia*) becomes greater every year as the commercial use of this fruit increases. The discovery in 1946 of its unusually high vitamin-C content has led to the addition of its juice to other baby-food juices to fortify their vitamin content. Recent reports have shown that the fruit supplies thiamine, riboflavin, niacin, and vitamin A, besides calcium, iron, and some phosphorus. As a result, propagation and cultivation of the plant has reached unprecedented proportions in Puerto Rico. However, the incidence of nematodes in the soils of the northern coasts of Puerto Rico where cherry culture is well established has produced serious problems. Studies have been made of other species of the genus to determine their resistance to root knot and their compatibility as stock material on which to graft susceptible species.

Ledin stated that the West Indian cherry has been in Florida for more than 50 years, where it is called *M. glabra* (*1*). He further believes that it is the same plant that is called *M. punicifolia* in Puerto Rico or that the two may be different forms of the same species. Woodbury accepted two different cultivated species but is now willing to concede that there is confusion in the taxonomy of the group (*2*). The possibility that the cultivated material is of hybrid origin has also been suggested. Asenjo (*2*) finds no appreciable differences in the vitamin content of the taxa studied.

The taxonomy of the Caribbean species is highly confused. Studies now in progress by W. T. Stearn of the British Museum (Natural History) and N. Y. Sandwith of Kew, England, include the investigation of type and other classical specimens, most of which are in European herbaria. Pending the outcome of these basic studies, opinions of local botanists on the correct identity and names of these taxa seem to be purely conjectural.

Some species are more resistant to nematodes than others. Studies of graft compatibility between these species and cultivated material are in progress. Differences in stem size among plants of comparable age indicate that some species are unsuited as rootstock material. In this group are *M. linearis* and *M. coccigera*. In other instances, the abundance of deciduous stinging hairs reduces the desirability of otherwise potential understock species. This is especially true of *M. infestissima*, *M. shaferi*, and *M. fucata*.

Malpighia is a genus of some 30 species of shrubs and small trees of tropical and subtropical America, all of which are found in the native state in the West Indies. Cuba has some 20 wild species, six of which are endemic (*3*); Hispaniola has 15, which have been reported by Moscoso (*4*), but only five are endemic; Jamaica has eight with one endemic, as inferred from Fawcett and Rendle (*5*); and, in Puerto Rico, there are only six, two of which, and possibly a new one, are endemic. The distribution of these wild species is rather limited to the Greater Antilles. *Malpighia coccigera* extends as far south as Martinique and St. Lucia; *M. urens* reaches St. Vincent and Bequia of the Grenadines; and *M. linearis* reaches to Guadeloupe. Greater concentration seems to be northward and westward, especially on the larger bodies of land.

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Statistical Estimation of the Size of a Small Population

The technique of estimation discussed in this report is restricted to the following methodological approach. A sample of one is drawn at random, tallied, marked for future identification, and replaced. As trials progress, individuals that had been marked are drawn with increasing frequency. These, of course, are replaced without being tallied, and eventually the process is terminated on the assumption that the population has been exhausted. Estimate of the size of the population thus depends on the criterion selected by the observer.

The criterion proposed here provides not only an estimate but also a statement of confidence regarding the estimate. The rational basis for this criterion and the computation procedure that it demands are illustrated in the following two examples. In the interest of clarity, the result of each drawing is shown graphically with a check in the appropriate square on cross-section paper. Consecutive drawings are numbered on the abscissa, and occurrences of unmarked individuals on the ordinate. Since the first drawing invariably yields an unmarked individual, the first result is always recorded as a check in the square adjoining the origin.

Figure 1*A* illustrates a hypothetical case in which every drawing yields the same individual. At the end of r_1 drawings the observer may terminate the sequence with a statement that the population consists of a single member. In making this decision, the observer rejects the alternative hypothesis of a population consisting of two members with only one of these appearing in every sample. The probability of this alternative, $p = (\frac{1}{2})^{r_1 - 1}$, may be equated to any desired decimal, and the value of r_1 may be computed. This value represents the minimal number of times that the same individual must be drawn if the probability of type-II error is to be no greater than the selected decimal (*1*).

In the present illustration the probability of rejecting the alternative hypothesis when true has been set at 10 percent. The equality, $(\frac{1}{2})^{r_1 - 1} = 0.10$, yields 4.3 as the value of r_1. Since the nearest larger integral value is 5, the conclusion is that there must be at least five consecutive drawings of the same individual be-