accidentally, was quickly adopted as a hunting strategy by adult males. Subsequent episodes in which this rudimentary cooperative technique was used were much more successful than those in which only one baboon pursued a prey animal (*4, 10*).

In many ways, baboon predatory behavior is now comparable to that described for chimpanzees (*1, 11*), although baboons do not exhibit the elaborate sharing behavior of chimpanzees engaged in meat-eating. Nevertheless, the carcass of the baboon prey was shared, after a fashion, since it often passed from one individual to another when participants aggressively displaced each other or became sated and lost interest. At the same time, bits and pieces of meat and bone, which were dropped during normal social interactions around the kill, were consumed by the hangers-on.

In addition, I witnessed several incidents that, although more rudimentary than the chimpanzee pattern in that they were not preceded by elaborate communicative gestures, qualified as sharing. This sharing was of two types, that between a female and her offspring and that between an adult male and an adult female. The adult pairs were sometimes involved in a consort (that is, sexual) relationship and sometimes not. In both types of sharing, members ate in close proximity either from the same pile of meat or from the same piece of meat simultaneously. Frequently, one individual moved to allow another access to the meat. Such behavior was not exhibited by the baboons in any other circumstances (including other feeding situations).

These observations on baboon predation add further detail to our knowledge of the development of social traditions in a nonhuman primate group. The data also yield important information on the elaboration, sophistication, and success of predation in a primate species without tools or language. At the same time, they may illustrate the limitations which the lack of these advantages imposes on primate hunting patterns. In this manner, observations of meat-getting and meat-eating in nonhuman primates are relevant to an understanding of the evolution of hunting in *Homo sapiens* (*4*).

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2. R. S. O. Harding, *Am. J. Phys. Anthropol.* **38**, 587 (1973); paper presented at the 9th International Congress of Anthropological and Ethnological Sciences, Chicago, 1973; paper presented at the meeting of the American Anthropological Association, New Orleans, 1973.
3. All data on baboon predation in the earlier study period are taken from Harding (*2*). Harding also includes details of the study area.
4. S. C. Strum, in preparation.
5. Predatory episodes ranged from a few minutes to several hours, depending on the prey species. The baboon seldom ate the prey at the capture site, but transported it in its mouth to the shade, toward the group, or away from approaching males. The baboon usually did not kill the prey until eating it, but the prey often suffered a broken neck during transport and died.
6. Only 91 of the 100 predatory episodes were used in calculating scores for attendance and meat-eating since identification of participants in the remaining episodes was not comparable. Scores are adjusted to the length of an individual's membership in the troop and the number of kills during that time. In this way percentage figures are comparable across individuals despite the fact that 2 males, 2 females, and 4 infants died, 11 infants were born, 3 males and 1 juvenile immigrated, and 3 males emigrated during the study period. Individual attendance scores range from 23 to 75 percent for males, 2 to 41 percent for females, 3 to 19 percent for juveniles, and 2 to 27 percent for infants. Individual meat-eating scores range from 11 to 63 percent for males, 0 to 32 percent for females, 0 to 11 percent for juveniles, and 0 to 8 percent for infants. At least one juvenile attended 54 percent of the kills and obtained meat in 27 percent of kills. Meat-eating was scored as 0 if none occurred and 1 if any occurred, irrespective of the type of eating (carcass or scraps) or of the time spent in meat-eating (*4*).
7. The pattern differs from that of males in that males with a high score in capture also had a relatively high score in consumption, whereas the opposite is true for females.
8. S. C. Strum, in preparation; T. W. Ransom and B. S. Ransom, *Folia Primatol.* **16**, 179 (1971).
9. Other factors limited participation scores in meat-eating phases of predatory episodes. Because only adult males ventured regularly beyond the periphery of the troop, participation in kills by other age and sex classes was contingent upon their occurring within or near the troop. Some kills were 3.2 km from the troop, while others, although closer, went unobserved by most troop members. The total figures for participation of females, juveniles, and infants do not reveal the great increase in their participation during the year.
10. Although predatory behavior represents an increasingly larger investment of time, meat still makes up only a small proportion of the baboon diet.
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Visual Construction of Color is Digital

Abstract. *When disparate shapes are flashed under the appropriate temporal and spatial conditions, the human visual system resolves their disparity smoothly and continuously. No equivalent supplementations are found for color, which the system resolves by abrupt transformation. Shape and color reveal themselves, contrary to some modern theorizing, as properties handled in different ways by the visual nervous system, continuous or analog for shape, abrupt or digital for color.*

When two solid or outline shapes are illuminated briefly at a rate of 3 or 4 hertz, they appear to change into each other in a smooth and continuous fashion. The visual system supplements the optical array in a manner that resolves many of the figural disparities. If, for example, the two shapes are a square and a triangle, each exposed for about 150 msec with a pause of about 50 msec between the offset of one and the onset of the other, most people report seeing the shapes change smoothly and continuously into each other. The two shapes can be separated by a few degrees of visual angle without loss of this plasticity of appearance. When separated, they seem to be in motion, changing as they move (*1*).

We emphasize that the transformations of shape are smooth and continuous, over a large range of stimulus conditions; moreover, they do not conform to any simple theory (*2*). The resolutions, as supplementations of the visual array, stand in contrast to the more familiar analysis and decomposition of optical inputs that characterize perception. Study of this perceptual "resolving power" motivated the work reported here, where the query concerned resolution not of shape, but of color. The question was, If the alternated flashes were red and green, say, would the visual system transform red into green smoothly by going through gray, by going through yellow, or by changing in still some other way? That is, what is the nature of the representational space for color change, and is it the same for color and for shape (*3*)?

The measurements were made as follows. Two pieces of colored paper, approximately equal in brightness and saturation (*4*), appeared alternately in a tachistoscope on a matte white background, illuminated by commercial "white" gas-discharge lamps which were controlled by suitable circuitry. The flashes illuminating the colored papers were each 150 msec long; 50 msec separated the offset of the first flash from the onset of the second, and 1.5 seconds intervened between the offset of the second flash and reillumination of the first. The steady-state luminance of the matte white background on which the colored papers appeared was approximately 4 mlam. The luminance of the colored papers was slightly less than that, varying with the particular papers used (*4*). The subject's view, therefore, was of a continuously lighted screen on which appeared first one and then another flash of color, cycling about once every 1.75 seconds. The appearance was of a colored shape moving from the first location to the second, changing during the course of the movement.

The subject looked at a small neon fixation point that appeared, on any trial, at one of many positions parallel to the path of movement, some of which are indicated in Fig. 1. Immediately above the fixation point active on any trial appeared a small patch of spectral light. The subject adjusted the source monochromator until the spectral light "matched" the color of the apparently moving shape when the latter seemed to be immediately below the fixation point. Subjects typically used three to five cycles of stimulus presentation to make the match. The data to be shown are the wavelength settings of a Bausch & Lomb grating monochromator as a function of the distance of the illusory object along the perceived path of movement. Five measurements were made in random order by each of three subjects at each of the points along the path. The subjects were visually normal, as assessed by Hardy-Rand-Rittler (H-R-R) pseudoisochromatic plates and a Bausch & Lomb Orthorater.

Figure 2 shows the results for a single subject when similar shapes were alternated in dissimilar colors. A green square was alternated with a red one, a green triangle with a red triangle, and the same for blue and yellow. (The triangles had approximately the same area as the squares.) The arrows in Fig. 2 point to the settings of the monochromator that matched the stimuli presented singly; the small vertical lines mark ± 1 standard deviation, speaking in part to the variability of matching spectral hues to colored papers. The curves reveal no systematic difference between triangles and squares. The feature of main interest is the transition between a red and a green and between a blue and a yellow. That transition was always abrupt. It did not go through gray from red to green or from blue to yellow, through yellow from red to green, or through green from blue to yellow; it went directly from red to green and directly from blue to yellow (*5*). With this subject the transition occurred typically before the halfway point in the traverse.

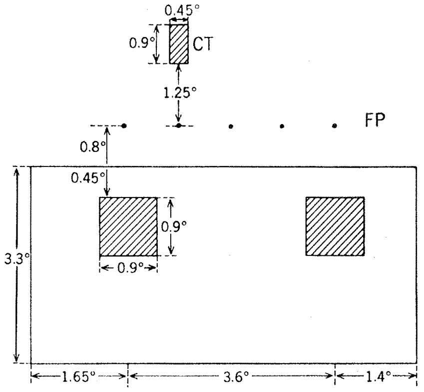

Fig. 1. The visual field 3.3° high and 6.65° wide was always illuminated. On it two patches of color (hatching) appeared briefly, in sequence. Above the field were the neon fixation points (*FP*), and above them a movable comparison target (*CT*), a spectral beam from a monochromator. Everything else outside the illuminated field was dark.

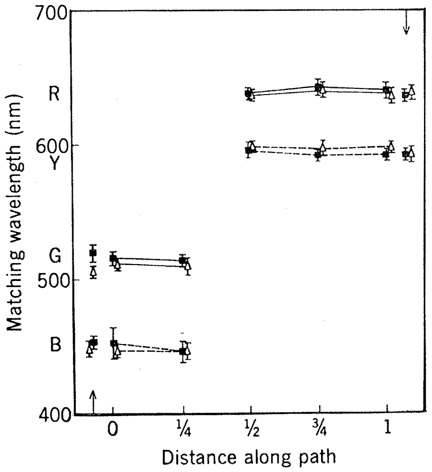

Fig. 2. Transition between (dashed lines) blue and yellow squares or triangles, and between (solid lines) green and red squares or triangles. Arrows point to the matching measurement of the single flash. The abscissa shows the fraction of the distance along the path at which a comparison was made. The data are for a single subject.

This abrupt change in color was found for all three subjects. For two subjects the color transition always occurred before the halfway point; for the third subject the transition always occurred after the halfway point. These individual differences in the location of the transition aside, the main finding was always of abrupt change of color for all combinations tested.

As it could be argued that in perceptual space the distance between triangle and square is less in some important way than the distance between red and green, it could then follow that the finding of abruptness is a matter of perceptual distance, not of operational difference. To test this possibility, measurements were made of the transition between two reds in one case and between two greens in another (*6*). Refuting the distance hypothesis, the resolution of the disparity was always abrupt whenever a discrimination could be made between the patches at their termini.

Observations but not quantitative measurements were also made of the results of alternating achromatic with chromatic colors; for example, alternating a black, gray, or white square with a green or other-colored triangle. Subjects here reported directly their observation of continuous change of shape but abrupt change of color. The same appearances were reported for two achromatically colored shapes, as a gray alternated with a black or a white. Color and shape thus appear as properties that are processed in quite different ways. The suggestion of some authors that dual-purpose channels mediate the two are questioned by these results (*7*).

Many studies of visual perception explore the way the visual system loses information from the array presented to it, such as information about borders, brightness, colors, and similar properties (*8*). The work reported here shows the visual system supplementing the information in an array, creating the shape and color of the perceived object in its traverse from one position to another. The rules governing these supplementations are not fully known, nor is the mechanism mediating them (*2*); we have shown that they may not be the same for color and shape (*9*).

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4. Colored papers are polychromatic but have a dominant wavelength. The papers used were Color Aid 17 (yellow), 49 (red), 129 (blue), and 177 (green).
5. The gray alternative would not be shown by a monochromator setting. It was inquired after and never reported.
6. Color Aid 49 and 65 (red), and 161 and 177 (green).
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10. We thank N. Goodman for stimulating this inquiry. The work was supported by grant A 7655 from the National Research Council of Canada. M.v.G. was supported in part by a predoctoral fellowship from the Nation Research Council of Canada.

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Innate Recognition of Coral Snake Pattern by a Possible Avian Predator

Abstract. *Inexperienced hand-reared motmots avoided a pattern of red and yellow rings but readily attacked a pattern of green and blue rings and also one of red and yellow stripes. The motmots' avoidance of the "coral snake" pattern indicates that mimic snake species can derive protection from some potential predators.*

A large complex of neotropical snakes from at least two families have ringed or banded patterns which usually involve red, yellow (or white), and black, but sometimes involve only two of these colors. They tend to be relatively small snakes, the majority being only 1 m or less in length (*1, 2*). Among these are the "true" coral snakes—the front-fanged elapid genera *Micrurus* and *Leptomicrurus,* whose venom can kill a small bird or mammal in minutes (*1*). Others, such as the rear-fanged colubrid genera *Erythrolamprus* and *Rhinobothryum*, are also venomous, but possess somewhat less virulent poison. Still others, like the colubrid *Lampropeltis,* are nonvenomous (*2*).

Considerable controversy exists in the literature as to whether this complex involves any mimicry at all, and if so, what kinds are included (*1–4*). Many believe that the true coral snakes are aposematically colored and serve as models for both Batesian and Müllerian mimics [for example, see (*4*)]. Wickler (*1*) proposed another interpretation, suggesting that if mimicry depends on predator learning, *Micrurus* and its allies are too deadly to serve as models; hence they are instead mimics of the more mildly poisonous rear-fanged colubrids of the complex. This he termed Mertensian mimicry. He also stated that there was no evidence that any predator can recognize a coral snake innately. The experiments described here now demonstrate that hand-reared turquoise-browed motmots (*Eumomota superciliosa*) do have an innate aversion to a generalized coral snake pattern. This motmot species, a neotropical relative of the kingfishers that inhabits dry forest regions from México to Costa Rica, regularly eats lizards (*5*) and probably small snakes as well. *Micrurus* species and several of their mimic forms are common throughout the motmots' range.

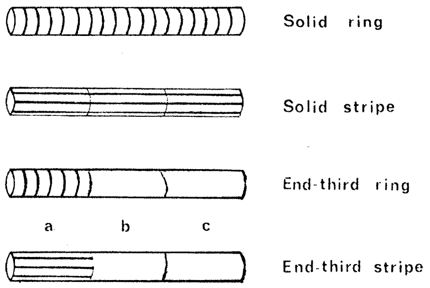

Fig. 1. Models used in the experiments, showing both solid and end-third forms. The ring pattern was given both as wide yellow and narrow red rings and as wide green and narrow blue rings. The striped pattern was given only as wide yellow and narrow red stripes. The models were divided into thirds by light pencil marks to aid in recording the location of the pecks; the birds did not peck at these marks. In the end-third models, (a) refers to the patterned third, (b) to the middle, and (c) to the other end.

Nine young motmots from four broods were removed from their nest burrows at ages ranging from 6 to 20 days and raised in the laboratory until they were old enough to catch their own prey. Each brood was kept in a separate cage made of hardware cloth on wooden frames and measuring 91 by 46 by 46 cm. The experiments consisted of placing a cylindrical wooden model (8.2 cm long and 1 cm in diameter) on the floor of a cage and recording the number and location of the birds' pecks for a 5-minute period. Models were painted with nontoxic tempera colors in the following patterns: yellow with red rings, yellow with red stripes, green with blue rings. Two models were made for each pattern: a "solid" model completely covered with the pattern and an "end-third" model in which only one end was painted, the other two-thirds being plain wood (Fig. 1).

Experiments with other models showed that the motmots had no hesitation in pecking at plain red, yellow, green, blue, or unpainted wooden models (*6*). However, the birds' initial reaction to the solid yellow and red ring model was one of avoidance: all flew up to the opposite corner of the cage and in many cases gave alarm notes. Only one bird approached this model voluntarily, twice landing about 10 cm away but immediately taking off again in apparent fright. No motmot made any attempt to peck at this model (Table 1). By contrast, the birds readily attacked the solid yellow and red stripe model, even though the colored bands had the same widths as those of the ring model, and hence the proportion of the two colors was also the same. The results for the solid green and blue ring model show that the birds were not inhibited by the ring pattern per se.

Similarly, in the responses to the end-third models (Table 1) the birds directed most of their pecks at the patterned third (Fig. 1a) of both the striped and the green and blue ring models, yet gave a highly significant response to the end farthest away from the pattern in the yellow and red ring model.