trix was examined for presence of sperm; egg masses were held at 27° to 28°C for several weeks to permit embryonation, and then examined independently for fertility (*9*).

Fertility data from the four replicates of each treatment were pooled and compared with data from the appropriate check plots by means of χ^2 tests, with Yates's correction factor (Table 1). In seven of the eight treatments, suppression of mating was very highly significant ($P < .001$) in treated plots. In only one treatment, that with the lowest density of randomly placed insects, was mating suppression not significant. In three of the four replicates no females were mated; a single female was mated in the fourth replicate. However, male gypsy moths at this population density have difficulty locating females even in the absence of a treatment (test 1, random, two pairs per hectare—control). In four of eight tests less than 10 percent of the females were fertilized. On the assumption that gypsy moth populations have a net potential increase rate of 10, more than 90 percent of the reproductive potential of each generation must be eliminated to reduce populations (*2*). Our results suggest that disparlure treatments can reduce populations; with the highest application rate we used (15.0 g/ha), adequate suppression was obtained at both densities tested.

Since the adult flight season may last as long as 6 weeks at any location, it is important that disparlure retains its ability to disrupt mating over a period of time. In other tests conducted during this summer, from zero to 14.0 percent of the females, emerging from pupae placed in plots 29 days after the plots had been treated with disparlure, were fertilized during a 12-day test period. Suppression of mating, when compared with mating in control plots, was statistically very highly significant in all except the random, two pairs per hectare, dispersion (in which mating in the absence of treatment was only 17.4 percent) (*10*). This suggests that disparlure in the microencapsulated form is sufficiently persistent to reduce mating for a 6-week period after application.

Our results suggest that 15 g of disparlure per hectare may be capable of disrupting mating in incipient populations of the gypsy moth efficiently enough that population increase might be precluded. Improvements in formulation could well reduce the amount of lure required. The effective longevity of the lure against higher population densities, as well as the ability of disparlure to disrupt mating in residual populations after insecticide or pathogen treatments, or after population reduction through natural causes, remains to be determined. Ultimately, disparlure should play an important role in an integrated gypsy moth pest management program, and may aid in spot eradication and in the establishment of a barrier to further spread or reduction of the area of general infestation (or both) as has been proposed (*2, 3*).

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5. The disparlure was purchased from Chemical Samples Co., Columbus, Ohio (1972), and Storey Chemical Corp., Farchan Div., Willoughby, Ohio (1973). The formulation was a slurry consisting of 17.6 percent plastic-coated, gelatin-based microcapsules (about 80 percent, 100 to 250 μm in diameter) containing a 2.2 percent solution of disparlure in xylene; 2 percent UCAR latex 680 (Union Carbide Corp., New York); 29 percent of a 1 percent aqueous solution of Minidrift (Soilserve Inc., Salinas, Calif.) plus 1.7 percent of 1 percent aqueous potassium hydroxide; and 49.7 percent water. The microcapsules were provided as a 27 percent aqueous slurry by National Cash Register Co., Dayton, Ohio.
6. J. V. Richerson, paper read at the 44th Annual Meeting, Eastern Branch, Entomological Society of America, Atlantic City, N.J., October 1972; paper read at the joint meeting of the Entomological Society of America, the Entomological Society of Quebec, and the Entomological Society of Canada at Montreal, Quebec, November 1972; J. V. Richerson and E. A. Cameron, in preparation.
7. The disparlure formulation was applied from a Piper Pawnee aircraft, with No. 8010 tips on the spray boom nozzles, by J. Henderson, U.S. Department of Agriculture Methods Development Branch, Beltsville, Md.
8. Individual pupae were placed in small burlap pouches stapled to trees at breast height. A "random" dispersion consisted of randomly selected points at intervals along 8 or 16 equally spaced parallel lines traversing each plot, with enough points to provide for an average of two or eight pupae of each sex per hectare throughout the 16-ha plot. "Aggregate" dispersion consisted of 16 or 32 pupae of each sex placed individually in burlap pouches stapled to individual trees within each of four areas 30 m in diameter, which were equidistant from the edges of the plot and from each other. There were four simultaneous replications of each treatment and its appropriate control.
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Infant Color Perception

Abstract. *Human infants 4 to 6 months of age devoted more visual fixation to checkerboards composed of two Munsell hues equated for brightness and saturation than to unpatterned targets of either hue. Strength of pattern preference was positively related to degree of hue difference in the checkerboards.*

Little has been known about the infant's ability to discriminate among hues (*1*). One difficulty has been the lack of sensitive measures of infant discriminative ability, and a second has been the problem of providing adequate controls for variations in brightness which may accompany differences in hue. The most widely used measure of infant visual discrimination is the "visual preference test" (*2*), in which it is assumed that if the infant consistently gazes at certain stimuli more often than at others he must be able to perceive and differentiate among them. Such visual "preferences" have been found for a variety of stimulus comparisons, which attests to the usefulness of the procedure (*3*). One difficulty with the test is that lack of differential fixation may imply either lack of discrimination or the equal attention value of stimuli which are actually discriminable. For example, in studies where differently colored targets were paired and visual preferences were measured, no defined preferences were found (*4*). It may be that the infants were unable to make such differentiations or that their capacity was obscured because certain hues elicit as much attention as others.

One solution to the problem of equal visual fixation among a set of stimuli is to rely on a known visual preference to increase the salience of one of the members of a target pair. In the research reported here I examined the ability of the human infant to discriminate on the basis of hue. The choice of a naturally occurring preference which might allow hue discrimination to be tested was based on the infant's demonstrated preference for patterned over unpatterned stimuli (*3*). Variations in brightness contrast, for example, have typically been used to provide pattern information, as when checkerboards of light and dark squares are paired with plain gray control targets and strong preferences for the checkerboards are shown (*3*). Rather than depending on brightness contrast as the clue to patterning, I paired checkerboards composed of two Munsell papers differing in hue but equated for value (brightness) and chroma (saturation) with unpatterned targets of either paper and recorded the amount of visual fixation paid to patterned and unpatterned stimuli. Hence, any preference for a checkerboard over a plain target depended on the perception of hue differences.

As noted above, one difficulty in demonstrating infant hue discrimination lies in providing controls for brightness variations that may accompany differences in hue. The adult eye perceives some hues as brighter than others even though the particular hues may have the same physical intensity. This relation between hue and brightness is accounted for in the Munsell system by equating different hues for brightness on the basis of adult judgments. Observations have been made of the ocular-neck reflex of infants during the first 10 weeks of life to spectral lights equated for physical intensity but varying in wavelength (*5*). For all ages tested the relative brightness values obtained under conditions of light adaptation were characteristic of adult functioning. These data indicate that the most appropriate controls for brightness in the study of infant hue discrimination are those which would be employed with adults, and I used these controls in my study. Necessarily, when perceived brightness is equated for a number of hues, those hues will vary in physical intensity irrespective of wavelength. Thus, as a safeguard, I checked the possibility that the infants may have been responding to differences in physical intensity regardless of wavelength by determining if such variations corresponded to observed visual preferences.

Table 1. Characteristics of the Munsell samples: Munsell hue, C.I.E. tristimulus value X, and physical intensity (PI).

Hue	X	PI (μv)
5 Red	.2490	22
5 Green	.1378	16
5 Blue	.1621	36
5 Yellow Red	.2294	13
5 Purple Blue	.1975	11
10 Red	.2429	24
10 Green	.1388	18
10 Blue	.1784	30
2.5 Green	.0564	67
7.5 Green	.0566	90

The sample included 62 males and 62 females from 21 to 25 weeks old (mean age, 23.2 weeks) and 14 males and 19 females from 13 to 16 weeks old (mean age, 15.2 weeks). All were living at home and were free from any known visual abnormalities. Four were Negro. The balance were Caucasian. The visual preference apparatus (*6*) consisted of a portable testing chamber composed of a pivoting stimulus presentation "stage" mounted between side, top, and bottom panels. The inside of the chamber and stage was lined with light blue felt, which provided a contrasting and light-diffusing background for the stimulus targets. The illumination level in the test chamber was approximately 40 footcandles (400 lu/m^2) and was provided by miniature high-intensity incandescent bulbs. Removable stimulus plaques were attached on right and left surfaces of the stage with a distance of 30.5 cm from center to center. When the stage was closed, the targets were approximately 30 cm from the infant's eyes. Through a 0.64-cm peephole in the center of the stage, the observer could see corneal reflections of the stimulus targets. The length of superimposure of the left or right reflection over the pupil of either eye was recorded by means of two finger switches which activated markers on a Rustrak miniature even recorder.

Table 2. Percentage of total fixation paid to checked patterns; values are means ± standard deviations; N, number of infants in each comparison.

Pattern	Fixation (%)	N
5 Red–5 Green	81.6 ± 13.6*	48
10 Red–10 Green	84.1 ± 12.4*	24
5 Yellow Red–10 Green	84.5 ± 14.5*	28
5 Red–5 Blue	84.4 ± 11.7*	48
5 Red–5 Purple Blue	78.3 ± 17.1*	28
5 Blue–5 Purple Blue	71.7 ± 16.8*	28
5 Green–5 Blue	75.0 ± 15.0*	48
5 Red–5 Yellow Red	60.8 ± 17.5*	28
5 Blue–10 Blue	53.2 ± 25.3	20
5 Red–10 Red	50.8 ± 20.9	20
5 Green–10 Green	50.6 ± 22.2	20
2.5 Green–7.5 Green	49.9 ± 11.6	9

* $P < .001$.

Table 1 shows the Munsell hue, the tristimulus value X in the C.I.E. (Commission Internationale de l'Eclairage) color system (*7*), and the physical intensity irrespective of wavelength (*8*) for the Munsell papers. Differences in X correspond to variations in hue. With the exceptions of 2.5 Green and 7.5 Green, which had a value/chroma ratio of 4/10 and a glossy finish, all samples had a value/chroma ratio of 5/6 and a mat finish. The tristimulus value Y (*7*), or adult-perceived brightness, was constant for all papers with V5/C6 at 0.1977 and for those with V4/C10 at 0.1200 (*9*). Squares of 2.5 cm of a particular hue were pasted to a 12.7-cm square of a second hue to form a checkerboard pattern. Unpatterned targets for each checkerboard were constructed in a similar manner by pasting 2.5-cm squares of each hue on a 12.7-cm square of the same hue to control for possible visibility of and response to the edges of the pasted-on squares. Each target was centered on a 17.8-cm-square flat white stimulus plaque. Checked patterns were constructed to provide a range of hue differences within the pattern. Degree of hue difference within a pattern was estimated by obtaining the difference in X values ($X_1 - X_2$) between the two hues. The 12 checked patterns employed are listed in Table 2 in descending order of $X_1 - X_2$. A visual preference test consisted of two 10-second pairings of a checked pattern with each of its appropriate control patterns, reversing left-right positions from one pairing to the next; for example, 5 Red–5 Green with 5 Red for 10 seconds, followed by 5 Green with 5 Red–5 Green for 10 seconds. Whenever possible, two such 20-second tests were given to the infant in the same session. Some infants served as subjects for more than one visual preference test (*10*).

The percentages of total fixation elicited by checked patterns relative to plain control patterns are listed in Table 2, along with the number of infants contributing to each preference test.

Preliminary analyses indicated that responsiveness to patterning was not influenced by sex or by age; hence these factors were combined for testing the main effect of degree of hue difference on preference for pattern. The most apparent finding from the data in Table 2 is that pattern information provided by hue differences readily elicits the infant's natural preference for patterned over plain targets. The most disparate hue combinations, such as red-green or red-blue, elicit differential fixation as strong and as reliable as any found in infants for patterned over plain targets (*3*). Table 2 also shows that the greater the difference in the hues making up a checkerboard, the stronger is the preference for pattern. This is reflected in a large and highly significant Kendall rank correlation coefficient of .82 ($z = 3.71$, $N = 12$, $P < .001$) between the differences $X_1 - X_2$ and the percentages of total fixation to patterned targets. In contrast, a Kendall rank correlation coefficient of .01 between pattern preferences and physical intensity differences rules out an interpretation on the basis of within-pattern differences in physical intensity.

In short, infants are capable of discriminating on the basis of hue by 4 to 6 months. The greater the disparity in hue, the more easily is it discriminated. Perhaps more important is the method used to obtain these results. Selective attention to patterned stimuli is a basic visual preference demonstrated even in newborn infants. Hence, it should be possible to test the detection of patterning based on hue discrimination from birth and to observe the early development of color preception. In a more practical vein, it should also be possible to detect early deficiencies in color vision.

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9. The Munsell samples also varied in terms of tristimulus value *Z*, or saturation. Analyses showed that the variations in *Z* bore no reliable relation to obtained preferences. This does not imply that larger variations in saturation, with hue and brightness controlled, cannot be discriminated by the infant. Discrimination of saturation remains an interesting and testable problem.
10. A sample of 28 infants at 23 weeks and 20 at 15 weeks were tested on 5 Red–5 Green, 5 Red–5 Blue, and 5 Green–5 Blue. Tests with 5 Yellow Red–10 Green and 5 Purple Blue–5 Red, and tests with 5 Purple Blue–5 Blue and 5 Yellow Red–5 Red, were given to 28 infants at 23 weeks. Twenty 23-week-old infants were given 5 Red–10 Red, 5 Green–10 Green, and 5 Blue–10 Blue. Simultaneous observations by two observers using the technique described S. B. Miranda [*J. Exp. Child Psychol.* **10**, 189 (1970)] were made of 11 infants at 23 weeks and 13 infants at 15 weeks on tests of 10 Red–10 Green, and of 9 infants at 23 weeks on 2.5 Green–7.5 Green. The two observers were in good agreement on percentage of differential fixation, with means of 84.1 and 85.2 percent (Pearson correlation coefficient $r = .95$) for the 24 infants tested on 10 Red–10 Green and 49.9 and 49.4 percent (Pearson correlation coefficient $r = .98$) for the 9 infants given 2.5 Green–7.5 Green.
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Inhibition of Neighboring Motoneurons in Conscious Control of Single Spinal Motoneurons

Abstract. *Multiple fine-wire electrodes were implanted in the biceps brachii of five subjects, and artificial electronic feedback was provided to subjects from only one electrode. By this technique, it was shown that neighboring units progressively stop firing as subjects concentrate on activating an isolated unit. The inhibition of neighboring spinal motoneurons in the same pool further indicates that selective inhibition is an automatic part of single motor-unit training.*

Although single motor-unit training is now widely employed (*1*), some disagreement exists as to the degree of isolation achieved. Basmajian and Simard reported inhibition of adjacent muscles (*2*), and the immediately surrounding units monitored from the same electrode are rapidly inhibited. In an effort to study motor units some distance away in the same muscle which are not monitored by the subject on the feedback apparatus, we designed a simple multiple-electrode carrier that provided feedback to the experimenter from three sites but to the subject from only the middle site.

The subjects were five volunteers ranging in age from 14 to 30 years (three female, two male). None had previous experience in training a single motor unit, although all were familiar with the technique.

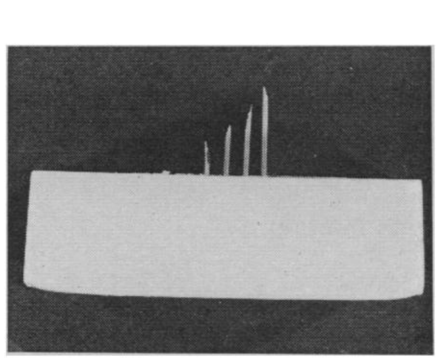

Fig. 1. Carrier block with four hollow channels of varied length for inserting electrodes (only three channels were normally used for these experiments).

The arrangement of the apparatus, including insertion of bipolar fine-wire electrodes, source followers, cathode-ray oscilloscope, monitor oscilloscope, loudspeaker, audio amplifier, and FM tape recorder, has been described (*3*). A unique carrier was devised to implant multiple electrodes at fixed depths and distances apart. In a rectangular Silastic block (17.5 by 59 by 30 mm), three 21-gauge needles were inserted 3 mm apart along the same plane (Fig. 1). These needles were sheared off so that one end of each was flush with one surface of the Silastic while the other ends protruded from the opposite surface 6.5, 9.5, and 12.5 mm, respectively.

We gave each subject a brief general explanation of the purpose of the experiment with emphasis on his task: to isolate the discrete activity of and to control successively three different single motor units registered from one electrode. He was comfortably seated in a suitable chair, with the carrier taped to his arm approximately parallel to the belly of the left biceps brachii. We then implanted electrodes by introducing a sterile 50-mm 25-gauge needle containing the electrode (*3*) as far as possible through each of the three carrier needles into the biceps. Three bipolar fine-wire electrodes were