Table 2. Coefficients of correlation: within subjects and condition, and within subjects and between conditions.

| Condition | Response category | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Subject MN | | | | | Subject WS | | | | |
| | B | G | Y | R | S | B | G | Y | R | S |
| *Within subjects and condition (split-half reliability, no correction)* | | | | | | | | | | |
| 0° | .999 | .999 | .988 | .999 | .756 | .996 | .994 | .994 | .999 | .696 |
| 20° | .998 | .989 | .966 | .994 | .721 | .957 | .964 | .854 | .719 | .878 |
| 40° | .977 | .376 | .842 | .967 | .892 | .908 | .653 | .834 | .910 | .810 |
| *Within subjects and between conditions* | | | | | | | | | | |
| 0°–20° | .988 | .980 | .980 | .980 | −.038 | .974 | .977 | .926 | .989 | .133 |
| 20°–40° | .962 | .718 | .758 | .956 | .664 | .919 | .607 | .725 | .968 | .908 |
| 0°–40° | .925 | .740 | .766 | .945 | .152 | .925 | .749 | .287 | .975 | −.112 |

Table 3. Coefficients of correlation: between subjects and within conditions.

| Comparison | | Response category | | | | |
|---|---|---|---|---|---|---|
| Subjects | Condition | B | G | Y | R | S |
| MN-WS | 0° | .995 | .962 | .976 | .996 | .474 |
| MN-WS | 20° | .961 | .951 | .841 | .984 | .292 |
| MN-WS | 40° | .960 | .940 | .686 | .954 | .542 |

curves intersect. From 478 to 502 nm, the blues became progressively more greenish until unique green was reached at 502 nm where the yellow and blue curves intersect. A long region of yellowish greens and greenish yellows extended to unique yellow where the red and green curves cross at 565 nm. Yellow became progressively more reddish as the wavelength was further increased; red at 660 nm was still slightly yellowish.

Similar data were obtained with the other subject, although his unique wavelengths were somewhat different and he saw unique red at the extreme longwave end of the spectrum. As stimuli were moved into the periphery, little change in hue was noted at 20 degrees for subject MN, although an increasing desaturation was already quite evident. For WS, this desaturation was accompanied by increasing irregularity of the functions and some reduction in green responses that were replaced mainly by blue ones. At 40 degrees, it was quite clear that the color vision of both subjects had become strikingly deficient: blue and yellow responses predominated and saturation had become still less.

The results are compatible with those that have been reported with less precise methods (*1*, p. 73). Somewhere between 20 and 40 degrees there is a marked attenuation of red and green responses and a predominance of yellow and blue ones. This degeneration of peripheral color vision resembles that for deuteranomalous observers when compared to normals using central vision.

To assess the reliability of the method, split-half reliability coefficients of correlation were computed by repeatedly dividing the trials of the experiment (for a given subject and condition) randomly into two groups. For each of the response categories, summated point values (based on the 10 responses at each wavelength) were ordered from most to least for one of the two halves of the sample. This rank order was compared with that for the summated point values corresponding to the same wavelengths from the other half of the sample, and rank-difference coefficients of correlation were computed. In addition, correlations were computed between subjects for the same conditions, and between conditions for the same subjects. The correlations are shown in Table 2. From these one can conclude that: (i) the measurement of hue by our technique, for central fixation, is very reliable; (ii) reliability for hue decreases with increasing eccentricity of view; (iii) saturation measures are less reliable than hue measures for central viewing but become more reliable in peripheral viewing; (iv) the blue and red response categories yield the most reliable data; (v) saturation measures for central viewing are uncorrelated with those for peripheral viewing; (vi) the reliability between observers is quite high for hue, but rather low for saturation measures.

The results generally would seem to suggest a differential distribution of the various types of cones as a function of retinal location. On a five-cone theory (*6*) the results suggest that the density of green and red cones falls off with increasing eccentricity, more than does that for yellow and blue ones. Achromatic (white) cones increase in their relative density, accounting for the decreased saturation. Other theoretical interpretations are, of course, possible.

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12 August 1964

## Visual Experience in Infants: Decreased Attention to Familiar Patterns Relative to Novel Ones

Abstract. *A complex visual pattern presented for ten successive 1-minute exposure periods was fixated progressively less than comparable novel stimuli by infants 2 to 6 months old. This indicates the occurrence of recognition and habituation of visual responsiveness to specific patterns, and suggests that familiarization with the environment begins through visual exploration before more active exploration is possible.*

The eyes of the human infant are open, active, and sensitive to light soon after birth, thus providing the means for visual exploration of the environment. For early visual explorations to be important in the development of perception and behavior, it is further necessary that (i) the ocular movements and fixations be selective rather than random so that specific objects or areas of the environment can be looked at; (ii) what is looked at be seen with sufficient clarity that they may be distinguished from other objects or

areas; (iii) what is seen be "remembered," as indicated by a change in later responsiveness to the same stimuli. Recent experiments have proved that requirements (i) and (ii) are met by the visual behavior of even the newborn infant: fixation times were found to be consistently different among stimulus targets differing in pattern, indicating both unlearned selective attention to patterning and the initial ability to resolve fine patterns (*1*, *2*). In the study reported here, the aim was to obtain data on requirement (iii).

The visual preference test of early perceptual development (*1*) was adapted to reveal changes in preference during a test session. The infant was face up in a small hammock crib inside a test chamber which provided a uniform background for two stimulus cards. The cards were placed over holes (measuring 20 cm by 15 cm) in the chamber ceiling. The cards were 38 cm above the infant's head and were separated from each other by 15 cm. Illumination was provided by a 75-watt incandescent lamp underneath and between the cards and out of sight of the infant. Two window shades were drawn horizontally across the chamber to hide the patterns between exposures.

The patterns on the cards were 11 photographs or advertisements cut from magazines. They were chosen to give maximum variation among patterns in aspects such as size of detail, regularity, color, contrast, and predominant shape of contours, and yet so that each would be complex and have high attention value. Six were color photographs; five were black-and-white. Gross variations in overall brightness were avoided.

One of the photographs (varied among the subjects) served as a constant pattern. It was presented for 1 minute, ten times in succession. During each exposure period it was paired with one of the remaining ten photographs (variable pattern) in random order. Constant and variable patterns were reversed in right and left positions for the last 30 seconds of each exposure period; the initial positions were random. The entire test lasted about 15 minutes including between-exposure intervals.

The eyes of the subject were observed through a 0.6-cm hole in the ceiling of the chamber, midway between the patterns. Corneal reflections of the outline of the two patterns were clearly visible under the conditions of the experiment. The location of these reflections provided an objective criterion of fixation. Thus the superposition of the left reflection over the pupil of either eye indicated the left pattern was being fixated; this was recorded by pushing the left of two finger switches operating electric timers. A second person put the patterns in place so that the observer did not know which was the constant, except on those occasions when it was recognizable in the corneal reflection.

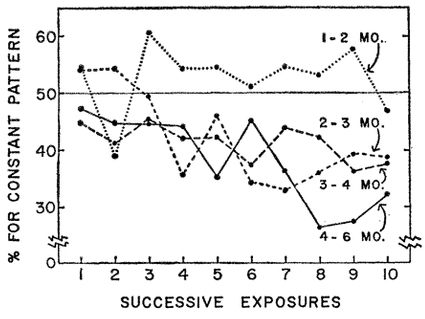


Fig. 1. Change in relative duration of fixation of a repeatedly exposed (constant) pattern relative to a novel (variable) pattern (the position of each being controlled) during a series of exposure periods. Each curve is the mean for six to eight infants.

All the infants available at a foundling home who could be given the entire test without crying or falling asleep were used as subjects. They ranged from 6 to 25 weeks of age; six infants were under 2 months, seven were from 2 to 3 months, eight from 3 to 4 months, and seven over 4 months.

Figure 1 shows the percentage of the combined fixation time given to the constant pattern during successive exposure periods. While the variability in response during successive exposure periods and among individuals was high, the overall trend is clear. The curve for the youngest group showed no change in either direction; the suggested slight preference for the constant pattern was not consistent among infants. Each of the groups over 2 months of age gave decreasing attention to the constant pattern during the test. From the first five to the last five exposure periods the decrease was significant for the 2- to 3-month and for the 4- to 6-month groups separately ($p < .02$); and for the three older groups combined ($p < .01$), according to the Wilcoxon matched-pairs signed-ranks test. The decrease was significant for those infants over 2 months old exposed to an achromatic constant pattern as well as for those exposed to a chromatic one, indicating that color was not essential for recognition. During the last five exposure periods the novel pattern was fixated longer than the familiar one by all but four of the 22 infants over 2 months; these four were widely distributed in age.

Decreasing fixation of the familiar pattern was accompanied by increasing fixation of the novel pattern, resulting in a high response level throughout the test. Fixation of both patterns averaged 47 seconds out of 60 during the first five exposure periods and 46 during the second five. There is no evidence here of a response decrement due to fatigue, sensory adaptation, decreased arousal, or extinction of the orienting reflex. While infants under other conditions have shown some such nonspecific effects of being repeatedly exposed to stimuli (*2*), the present results indicate perception, recognition, and satiation of interest in a particular pattern. This effect of specific previous visual experiences is "learning" in the broad meaning of the term, even though it does not involve traditional experimental operations or explanations such as conditioning, practice, reinforcement, or association.

The initial attentiveness to all the patterns was a function both of novelty and of intrinsic stimulus characteristics such as complexity. The importance of novelty is evident from the differential fixation of novel and familiar patterns in the later exposure periods; the importance of intrinsic stimulus characteristics has been shown elsewhere by differential fixation of equally-novel targets, in which case the more complex are usually favored (*1–3*). The two factors probably function in a complementary way in the infants' visual explorations. Familiarization with potentially important parts of the environment is at first facilitated by selective attention and differential exposure to patterned surfaces and complex objects. Eventually, at least by 2 months of age, this information-gathering process is made more efficient by concentration of attention on the less-known objects and patterns. Response to novelty might thus be described as an unlearned visual interest in a complex stimulus which has not been habituated by experience.

Concurring results have been obtained by other investigators using dif-

ferent familiarization procedures (*4*). Three-month-old infants were exposed for 4½ minutes to a cross or a circle, whichever form was preferred in initial exposure periods when both forms were presented simultaneously. During subsequent periods of exposure to both forms, the infants showed a decrease in fixation of the familiarized form. A greater effect of the familiarization period was shown when the two stimuli differed in color as well as form. No significant effect was shown as a result of exposure to the initially nonpreferred stimulus.

Evidently, incidental visual experiences can be retained by infants over 2 months of age, at least for a short period of time. This satisfies the third prerequisite given above for a possible developmental influence of early visual explorations. To what extent and under what conditions this influence actually occurs are questions for further study. The determination of changes in visual preferences following various types of experience will be useful in such studies, since the technique can be used at an age when other response measures are not available.

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2 September 1964

## Crown Gall and Tomatine

I object strenuously to the presumption tacit in the title of the report "Isolation of an antihistaminic principle resembling tomatine from crown gall tumors," by B. A. Kovacs, J. A. Wakkary, L. Goodfriend, and B. Rose (17 April, p. 295), that the principle isolated was intrinsically related to crown gall.

My objection was communicated to Kovacs and in reply he cited, among other facts, the isolation of a presumably similar principle from a variety of oak galls. These are not crown gall and in my opinion weaken rather than strengthen the assumption to which I objected.

In the report only one type of crown gall was cited, that on tomato; the substance isolated, which was not purified, was said to "resemble tomatine," an alkaloid known to be synthesized by healthy tomato plants. Crown gall tissue is an exuberant growth of whichever of the hundreds of possible hosts is involved, and as such may be expected to produce quantities of host-specific metabolites which are not necessarily disease-specific. Identification of the isolated substance with "tomatine" rests on reasonable presumptive grounds. Analogy with similar alkaloids produced in other galls such as those on oak leaves has some basis. The presumption, however, that the principle is intrinsic in crown galls appears to have no basis other than coincidence.

Unless the substance in question can be isolated in identifiable form from tissues of taxonomically unrelated hosts affected by the same disease, in this case crown gall, its demonstration carries no evidence of relation to the disease. The critical experiment by which Stanley established the crystalline nature of tobacco mosaic virus was the isolation of physically identical and biologically active crystals from tobacco and spinach.

This sort of report can only serve to becloud our understanding of the processes of tumefaction exemplified by crown gall.

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17 July 1964

White objects to what he thinks is a tacit presumption that the principle isolated from crown gall tumors, stimulated by infecting tomato stalks with *Agrobacterium tumefaciens*, is a characteristic of crown gall tumors per se. We should like to point out that although no such assumption was made, the fact that the principle is found in large quantities in crown gall indicates that the two must be related but does not necessarily indicate that the principle may not be found elsewhere. Furthermore, we do not think, as does White, that any issue has been beclouded.

It should be noted, as was already pointed out in a personal letter to him, that a similar principle has been found in crown gall tumors of the roots of apple trees, as well as in different forms of oak galls.

We stated in the paper, and would like to reiterate now, that whereas the principle resembled tomatine, it was not identical with it. Consequently, his contention that the principle has nothing to do with crown gall tumors hangs in mid-air.

Finally, since in all the experiments the starting materials used for the isolation of active principle were crown galls of tomato, we do not see how the wording could be changed unless White thinks that crown galls should be called something else.

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16 September 1964

## Intrauterine Ring

In his letter concerning the uses of the intrauterine ring for contraceptive purposes (7 Aug., p. 536), Josef Novak presents no facts to support his claim that it produces "adverse effects" in what he calls a "considerable" percentage of cases. Furthermore, it is difficult to believe that there are any figures to support his contention that it is more likely that a couple will conceive while using the intrauterine ring than while using other forms of contraception; yet that is what he is claiming when he says, "There are other more reliable" forms of contraception available. The comparison of reliability need not even include the many pregnancies that occur when couples who have adopted other forms of contraception fail to use them consistently; it need present only the rate of conception of couples using the ring, compared with that for each of the other contraceptive methods. If Novak has figures to support his statement, he should present them to the scientific community.

I question also his claim that this method is not cheap. It does not entail the frequently repeated cost incurred for every other form of contraception except the highly unreliable rhythm method. The total cost for contraception is the cost of the insertion of the ring. In private practice, this fee is not much higher than the fee charged