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EXPECTATION AND THE PERCEPTION OF COLOR

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The present experiment tests a proposition derived from a general theory of perception. Although the general theory has been stated in tentative terms elsewhere, a brief outline of it is necessary here as an introduction to our theme.[1]

We shall assume that perceiving can be analyzed as a three-step process. First, the organism gets set or prepared in a certain way, selectively 'tuned' toward some class of stimuli or events in the environment. When the organism is thus set or tuned, it is said to have an *hypothesis*. The second step consists of the *input of stimulus information*. By using the term 'stimulus-information,' or simply 'information,' we seek to indicate that we are dealing with the cue characteristics of the stimulus rather than with the energy characteristics of stimulation.[2] In the third step of the cycle the hypothesis is *confirmed* or *infirmed*. Given a certain quantity and kind of information, an hypothesis will be confirmed and lead to a stable perception. If the critical quantity of 'cue' information is not present, the hypothesis will be infirmed partially or fully. Under these circumstances, an unstable perceptual field will result and an alteration in hypothesis will follow, that will, in turn, be 'tested' against incoming information. The cycle of checking altered hypotheses against incoming information will continue until there is a stabilized perception. The range of information or of 'cues' which is known by independent test to be potentially confirming or infirming of an hypothesis, we shall call *appropriate* or *relevant* to that hypothesis. Thus, for example, an hypothesis about the size of an object can be confirmed by a variety of cues to magnitude, distance, and so on. The appropriateness of these cues can be

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[1] J. S. Bruner, Personality and the process of perceiving, in *Perception: An Approach to Personality*, edited by R. R. Blake and G. V. Ramsey, 1951 (in press); Leo Postman, Toward a general theory of cognition, in *Social Psychology at the Crossroads*, edited by J. H. Rohrer and M. Sherif, 1951 (in press). In our development of the concept of hypothesis we have, of course, leaned on the work of E. C. Tolman and I. Krechevsky, Means-and-readiness and hypothesis—a contribution to comparative psychology, *Psychol. Rev.*, 40, 1933, 60-70.

[2] R. S. Harper and E. G. Boring, Cues, this JOURNAL, 61, 1948, 119-123.

determined independently by traditional cue-reduction experiments familiar in the study of the constancies. Note particularly that appropriate information is necessary either to confirm *or* infirm an hypothesis.

The hypothesis with which an organism faces a situation at the moment of initial stimulus-input we shall refer to as the *initial hypothesis.* The hypotheses which develop when an initial hypothesis is not confirmed we shall refer to as *consequent hypotheses.* The difference is an heuristic one and does not connote a qualitative distinction in the operation of initial and consequent hypotheses.

An hypothesis may vary in strength. *The greater the strength of an hypothesis, the less the amount of appropriate information necessary to confirm it.* One may vary the amount of appropriate information given to the organism in numerous ways: by changing the amount of time a stimulus is available, by altering the illumination of the stimulus-field, by changing the extent to which a stimulus-field is in focus, and the like. The strength of an hypothesis (and, therefore, the amount of appropriate information necessary to confirm it) varies as a function of its past use, past success, the degree to which it competes with other hypotheses and many other conditions which need not concern us here.

In the present experiment, we shall not be concerned with varying the strength of hypotheses. We shall assume it to be constant. Our concern is rather with the rôle of *appropriateness of information* as it affects the confirming of initial hypotheses of equal strength. The specific proposition which we seek to test is the following; the smaller the quantity of appropriate information, the greater the probability of an established initial hypothesis being confirmed, even if environmental events fail to agree with such hypotheses. An inverse way of restating this proposition is to say that the greater the quantity of appropriate information present, the greater the opportunity for infirming an initial hypothesis where necessary and developing 'fitting' consequent hypotheses.

The Experiment

The basic task of all *S*s was to make a color match between a stimulus-patch and a variable color-mixer. Conditions of judgment and the color and shape of the stimulus-patch varied systematically in the four experimental conditions to be described.

Stimuli. The stimuli used consisted of eight patches cut from paper to represent the following objects:

Ovaloid objects: shaped to represent (and designated as)
Tomato (5.0 cm. horizontal axis, 3.0 cm. vertical axis)

Tangerine (5.1 cm. horizontal, 3.0 cm. vertical)
Lemon (5.1 cm. horizontal, 2.9 cm. vertical)
Neutral oval (5.1 cm. horizontal, 3.0 cm. vertical)

Elongated ellipsoid objects:

Boiled lobster claw (7.6 cm. horizontal, 2.4 cm. vertical)
Carrot (7.7 cm. horizontal, 2.2 cm. vertical)
Banana (7.7 cm. horizontal, 2.0 cm. vertical)
Neutral elongated ellipse (7.6 cm. horizontal, 2.3 cm. vertical)

The matching task. It was the task of *S* to match these patches, shaped and designated as specified, to a variable color-wheel (20 cm. in diameter) made up of yellow and red segments. The color-mixer could be shifted in hue from a well saturated red through the oranges to a well saturated yellow without stopping the wheel. A modified method of adjustment was used, *E* altering the color-wheel at the instruction of *S*. In all four conditions to be discussed, a group of 8 *S*s being allocated to each condition, the color-wheel was at a distance of 150 cm. from *S*, at approximate eye-level.

Order of presentation of the eight stimulus-patches was controlled in the same way throughout. Every object-patch appeared in each of the eight positions and, therefore, every serial position contained all of the eight objects for each of the four groups. Upon the presentation of an object-patch, *S* made two successive matches, one with the initial position of the color-wheel at red, the other with the initial position at yellow. Whether initial yellow or initial red came first for a given match was randomly determined.

The four experimental conditions. The four groups of eight *S*s were treated as follows.

Group I. Induced color group (uninformed). A stimulus-patch was placed on a table before *S*, illuminated by a 150-w. GE Reflector Spot sealed-beam in a shielded alcove 60 cm. above the table, shining directly on the patch. Each patch (tomato, tangerine ,etc.) was cut from neutral gray paper (Stoelting #19), and placed on a blue-green sheet of paper (Stoelting #10) of the dimensions 15 x 15 cm. Gray figure and blue-green background were covered by a finely ground glass, also 15 x 15 cm. All these operations were performed behind a cardboard screen which had been dropped between *S* and the field. When the screen was lifted, *S* saw before him on the brown table a poorly saturated blue-green square on which could be seen a brownish orange figure. The color-wheel and the rest of the field were illuminated by four 40-w. fluorescent lamps overhead.

S was instructed that his task was to match the color-wheel to the object before him on the table. Between the stimulus-patch and the color-wheel there was approximately 80° of visual arc so that the comparison was perforce successive rather than simultaneous. As each object-patch was presented for matching, *S* was told what it was, *e.g.* "This is a tangerine. Make the color-wheel the same color as it." As already indicated, two matches were made for each object-patch, one from the yellow and one from the red initial positions of the color-wheel. *S*s experienced some difficulty in making the match since the induced color was not sufficiently pronounced in hue to provide a good basis for judging. It was also impossible to reproduce a color on the wheel which was alike in surface and saturation to the stimulus-patch. Finally, the hue-match was only approximate, since no combination of the yellow and red sectors would yield a hue identical to the induced orange brown.

After making two matches to each of the eight stimulus-patches, *S* was given a 5-min. rest-period. Following this, he repeated the identical procedure. Then came a rest-period of 10 min., following which *S* was asked to make *from memory* settings on the color-wheel for each of the eight patches already seen. Again, two settings were made for each patch. In all, the first procedure required about an hour of S's time.

Group II. Induced color group (informed). This group received the same treatment as the preceding group, with one exception. At the end of the first judging-period and during the 5-min. rest, S was given a brief lecture on induced color and shown how the color was produced in the stimulus-patches judged. In short, their second series of judgments and their memory-matches were made with knowledge of the 'illusory' quality of the colors before them. A judging session required about an hour.

The second condition was designed, of course, to provide additional information to our Ss about the hue of the stimulus-patches which they were being asked to judge. The third and fourth groups, as we shall see, were provided with still more information.

Group III. Stable color group. The judging procedure for this group was exactly the same as for Group I, save that in place of induced color, a 'real' color was used for the stimulus-patches. This was a well saturated orange-color which matched very closely the middle region of the red-yellow mixture on the color-wheel both with respect to hue and to saturation. The stimulus-patches were pasted on glossy white cardboard plaques, again 15 x 15 cm. in dimension. As in the first two conditions, the cards bearing the stimuli were so placed before S on the table that about 80° of visual arc intervened between the stimulus and the color-wheel, thus necessitating successive comparison. The color-wheel and the stimulus-patch were illuminated by 150-w. sealed-beams of the type previously described at a distance of 60 cm. Judgments required about an hour.

Group IV. Optimal matching group. An effort was made in designing the procedure for this group to provide Ss with a maximum of appropriate information for making their matches with a minimum of irrelevant information in the situation. Put in communications-engineering terms, we sought to establish a judging condition in which the signal-to-noise ratio was at a maximum. A box was constructed, 150 cm. in length, 61 cm. in width, and 50 cm. in height. At one end of the box an eyepiece was inserted, approximately 3.5 x 11 cm. in size. At the far end of the box, the wheel of the color-mixer and the stimulus-patch appeared side by side. The inside floor, ceiling and the walls of the box were painted a homogeneous medium gray (matching Hering gray #15). Set in concealed alcoves on either side of the box were two spotlights (150 w., GE sealed-beams) which were trained from a distance of 60 cm. on the color-wheel and on the stimulus-patch. The appearance of the field, viewed from the eye-piece, was of a homogeneous, gray, well-lighted, closed tunnel, at the far end of which were the wheel of the color-mixer and a stimulus-patch in the same frontal parallel plane. Stimulus-patches were cut of orange paper of identical hue and saturation with those used in the immediately preceding condition and mounted on cardboard. The cardboard, 17.5 x 30.5 cm. in dimension, was inserted into the box through a slide opening. When the cardboard was thus inserted, there was a distance of 10 cm. from the edge of the stimulus-patch to the edge of the color-wheel. Such a separation of patch and wheel at a distance of 150 cm. from the eye made the task of simultaneous comparison quite easy. Group IV, then, was the only one which could make matches by simultaneous comparison. It should be remarked, finally, that Group IV had the very minimum of extraneous stimulus-input, competing cues from the room and general background of the room being eliminated by the use of the 'reduction' tunnel. Because of the easier judging conditions, Ss required but three-quarters of an hour to complete this procedure.

RESULTS

Recall the proposition advanced for testing. The smaller the quantity of appropriate information, the greater the probability of an initial hypothesis being confirmed even if environmental events fail to agree with such hypotheses. In proportion to the deficiency of stimulus-information, established initial hypotheses will determine the color match. The results, generally, confirm this prediction.

Table I contains a summary of the judgments made by the four groups during the first matching series. In order to estimate the effect of initial hypotheses in the matches, we computed first a grand mean in degrees of yellow on the wheel of all the matches made by a group in this series, regardless of the patch which was being matched. We then computed

TABLE I

AVERAGE SETTINGS OF COLOR-WHEEL FOR VARIOUS OBJECTS DURING FIRST SERIES OF MATCHES

Settings are expressed as deviations in degrees of yellow from the average of settings made for all objects by a given group. Positive sign denotes more yellow; negative sign, less yellow.

Stimulus-objects	Group I (Induced color, Ss uninformed)	Group II (Induced color, Ss informed)	Group III (Stable color)	Group IV (Stable color, optimal cond.)
Red	−14.2°	−12.1°	−3.6°	+2.9°
Orange	− 0.6°	− 0.2°	+3.4°	−4.5°
Yellow	+19.2°	+10.6°	−0.8°	+4.5°
Neutral	− 5.6°	+ 1.7°	+1.2°	−2.4°
Mean (yellow)	121.4°	118.5°	141.1°	191.6°
SD	39.9°	37.0°	23.4°	15.6°

the difference between this grand mean and the mean match made for each kind of stimulus patch: 'red' objects, 'orange' objects, 'yellow' objects, and neutral objects. The final row of Table I also contains the standard deviation of all the judgments of a group. The latter may be taken as a rough approximation of sensitivity to hue differences under the particular judging conditions imposed upon each group.

Consider first the matches made for 'red,' 'yellow,' and 'orange' objects. In both Groups I and II (the groups which worked with contrast-induced colors), normally red objects were judged considerably redder, normally yellow objects, considerably yellower than the average level. In both groups, moreover, the 'orange' objects were matched to a color almost exactly at average level. It is interesting to remark in passing that *Ss* in these groups proferred the information that they believed all their matches to be the same. Nevertheless there is between the setting made for 'red' objects and those made for 'yellow' objects for Group I an average difference of 33.4° of yellow segment on the wheel. The difference for Group II is 22.7° (Fig. 5). Both of these color-differences are grossly supraliminal, the difference between a yellowish orange and a reddish orange.

With improvement of judging conditions as provided in the procedures applied to Groups III and IV, the effect is first reduced and finally washed out. Sufficiently stable stimulus-information is provided to alter the initial hypothesis established by such instructions as "This is a lemon," or "This is a carrot." Note too in these groups a striking reduction in the standard deviation of all judgments which results from the increase in appropriate stimulus-information. Both 'orange' and neutral objects yield matches which fluctuate closely about the grand mean.

Table II contains a summary of matching in the second series—a second

TABLE II

Average Settings of Color-Wheel for Various Objects during Second Series of Matches

Settings are expressed as deviations in degrees of yellow from the average of settings made for all objects by a given group. Positive sign denotes more yellow; negative sign, less yellow.

Stimulus-objects	Group I (Induced color, Ss uninformed)	Group II (Induced color, Ss informed)	Group III (Stable color)	Group IV (Stable color, optimal cond.)
Red	− 9.9°	−15.9°	−5.4°	+3.6°
Orange	+ 3.7°	+ 0.5°	−0.2°	−2.8°
Yellow	+13.9°	+12.8°	+5.8°	−0.3°
Neutral	+ 2.2°	+ 2.5°	+0.4°	−0.3°
Mean (yellow)	113.3°	113.1°	142.1°	184.7°
SD	41.0°	35.5°	23.4°	15.9°

series of judgments of the eight patches after a 5-min. rest. Save in Group II, this second series may be regarded simply as a replication of the first series. Recall that Group II received a brief lecture on, and demonstration of, color contrast before embarking on these judgments. The results were substantially the same as before. Note that the lecture and demonstration seemed to have no effect on Group II. Where before the color-distance between 'yellow' and 'red' object matches was slightly less than 23° of yellow segment, now it is somewhat more than 28°. In this second series, Group III seems to succumb more to the effect of the labeling or meaning of the objects judged than in the first series. Note again that for Groups I, II, and III, 'orange' and neutral objects fall close to the grand mean.

Group IV, working with simultaneous comparison under optimal conditions of illumination and surround, shows no systematic effect at all and continues to exhibit a strikingly high sensitivity as one may infer from the size of the standard deviation of their judging distribution.

When we come to the third series of matches—matches made from memory—a striking effect is obtained. These results are summarized in Table III. Differences for the first three groups are of great magnitude.

Between the 'yellow' and 'red' matches of Group I, there is a separation of 48.2° of yellow segment; for Group II it is 24.5°; and for Group III, 24.7° (Fig. 5). Under memory-matching conditions, Group IV begins to exhibit a systematic judging tendency, although it is not great; a separation of 7.4° of yellow segment between 'red' and 'yellow' object matches, the meaning of which is rendered somewhat dubious by the lack of distinction between matches for 'red' and 'orange' objects.

The results reviewed above are presented in somewhat different arrangement in Figs. 1-4. In these figures, all scores are again expressed as deviations in degrees of yellow from grand means for each series of judgments.

TABLE III

AVERAGE SETTINGS OF COLOR-WHEEL FOR VARIOUS OBJECTS DURING MEMORY MATCHES

Settings are expressed as deviations in degrees of yellow from the average of settings made for all objects by a given group. Positive sign denotes more yellow; negative sign, less yellow.

Stimulus-objects	Group I (Induced color, *Ss* uninformed)	Group II (Induced color, *Ss* informed)	Group III (Stable color)	Group IV (Stable color, optimal cond.)
Red	−25.9°	−13.0°	−13.4°	−1.9°
Orange	+ 4.5°	+ 3.9°	+ 0.4°	−1.9°
Yellow	+22.3°	+11.5°	+11.3°	+5.5°
Neutral	− 0.4°	− 2.5°	+ 1.6°	−1.1°
Mean (yellow)	109.3°	103.0°	141.2°	187.3°
SD	44.7°	27.2°	20.2°	21.7°

The rearrangement of the data emphasizes the change in matches made by a group from series to series. Fig. 5 gives an overall view of the changing color-distance between matches made to designated red and yellow objects.

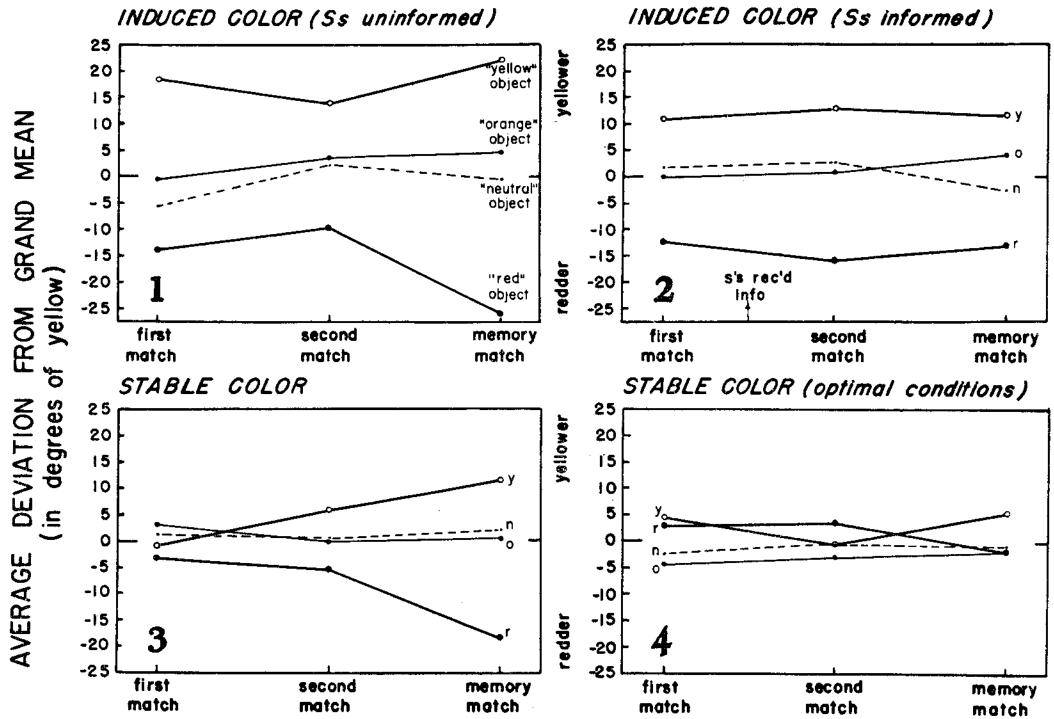
To test the significance of results, the matching data of each of the four groups were subjected to an analysis of variance. The contribution of the following sources of variance was tested.

Series (first, second, and memory matches)
Shape of objects (whether ovaloid or ellipsoid)
Designation of objects (whether normally red, orange, yellow, neutral)
Initial wheel position (whether judgment started from yellow or red position of color wheel)
Variance of individual *Ss*

The analysis was performed on untransformed data, entries comprising the number of degrees of yellow in each setting.

The analysis of Group I yielded highly significant F-scores, all the sources of variance, save one which was significant at less than the 0.1-% level of confidence. That was stimulus-shape, which was far short of significance.[3] Group II showed a

[3] The interested reader who may wish to examine in more detail the results of the statistical analysis of our data may obtain a fuller summary by writing directly to the authors at the Laboratory of Social Relations, Harvard University. Limitations of space permit the barest summary here.



FIGS. 1-4. AVERAGE SETTINGS OF COLOR-WHEELS FOR VARIOUS OBJECTS DURING TWO MATCHES WITH OBJECTS PRESENT AND MEMORY MATCHES

Settings are expressed as deviations in degrees of yellow from grand mean of settings made for all objects by a given group.

pattern much like the first group. All sources, save stimulus-shape, contributed significantly at levels beyond 0.1%. Shape was not significant. Two sources contribute at the 0.1-% level: *S*s and the designated color of the stimulus-objects. The variance due to initial color-wheel position is significant at a level between 5% and 1%. The contribution of the three matching series is insignificant as, again, is stimulus-shape.

Group IV presents a problem in the analysis of variance. All individual sources of variance contribute significantly, although designated color of objects is significant only at the 5-% level, while in all previous groups

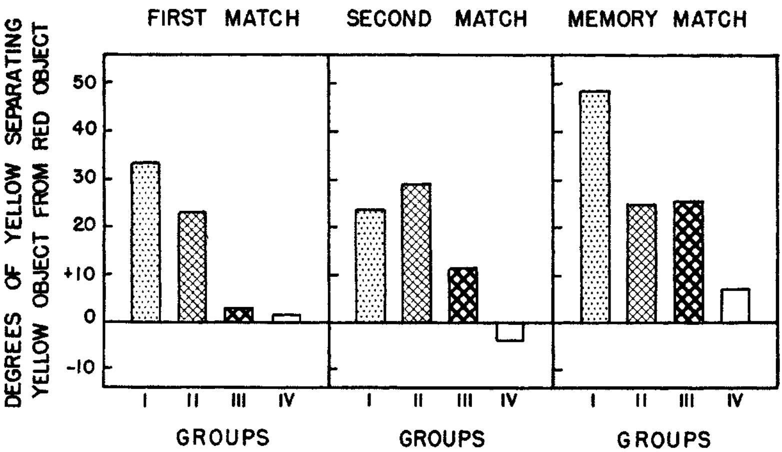


Fig. 5. Separation Between Settings for Color-Linked Objects
Differences between 'yellow' objects and 'red' objects are expressed in degrees of yellow.

designated color contributed at the 1-% level or better. It is important to remember that although a significant *F*-score was obtained for designated color, *no intelligible trend can be found in the means of this group.* 'Red' objects, for example, were sometimes judged yellower than 'yellow' objects. In general, the rank order of the settings approaches randomness. The remaining sources of variance for this group yielded *F*-scores significant at the 0.1-% level, variance of *S* being at the 0.1-% level of confidence. As to the question why judging series and the shape of the objects become significant sources without any discernible trend in means, we must simply say that the variability of judgments in Group IV, operating under optimal conditions of judgment, was so very small that *anything* (including the degree of incredulity in the *S*s' view of our proceedings) was likely to prove significant.

INTERPRETATION

We have reported an experiment which is at once as old as Hering's conception of memory-color[4] and at the same time is presented as supporting evidence for a contemporary theory of perception. Perhaps we should first come to terms with history. Hering, of course, introduced the conception of memory-color to account for certain phenomena of color-constancy.

Duncker showed that a notion such as memory-color or trace-color could be used in the interpretation of the mode of appearance of meaningful objects under constancy conditions using hidden illumination.[5] Duncker demonstrated, for example, that a leaf cut from green felt and bathed in a hidden red illumination was judged greener by his *Ss* than a donkey cut from identical material in identical illumination. Indeed, it is patent that the rôle of 'memory' as a determinant of attributive judgment has long been recognized as important in the field of perception.

A more recent and more systematic attempt to describe the effects of past experience with colors upon present judgments of them has been undertaken by Helson in a provocative paper on adaptation-level.[6] In very brief summary, adaptation-level theory would hold that, within limits, the judgment of an attribute will depend upon the relation of the stimulus judged at any one moment to the weighted geometric mean of the series of stimuli presented previously in the judging situation. It is difficult to apply Helson's conception to our own data for one quite obvious reason. Each of our judging groups judged only one color. The difference in the stimuli was not in their photometric colors, but in their designation as objects implying certain normal colors. The effect of the designation, however, may be referred not to the situational adaptation-level but to the adaptation-levels for various types of objects built up in the course of past commerce with tomatoes, tangerines, lemons, and other like objects. However clarifying such a statement may be, we should like to go beyond it to a consideration of the cognitive processes involved in the type of our own judging situations.

We turn accordingly to the theoretical framework presented in general terms in our introductory paragraphs. Let us interpret the behavior of our *Ss* in terms of the three-cycle conception of 'hypothesis-information-confirmation.' Assume the following sequence of events to be occurring, for example, in Group I. *S* is given the initial hypothesis by instruction that the poorly saturated patch before him represents a tomato, an hypothesis readily confirmed by shape cues from the stimulus-patch. The hypothesis 'tomato' is not, however, fully confirmed by the color cues provided. Because of the poorness or instability of the color-information, the initial

[4] E. Hering, *Grundzüge der Lehre vom Lichtsinn,* 1905, 1-80. See also G. K. Adams, An experimental study of memory color and related phenomenon, this JOURNAL, 34, 1923, 359-407.

[5] K. Duncker, The influence of past experience upon perceptual properties, this JOURNAL, 52, 1939, 255-265.

[6] H. Helson, Adaptation-level as a basis for a quantitative theory of frames of reference, *Psychol. Rev.,* 55, 1948, 297-313.

hypothesis is not, however, completely infirmed. That this initial hypothesis plays a large part in determining the final color match, in short is not fully replaced by a consequent 'corrected' hypothesis, is indicated by the systematic tendency of *S*s to make a redder match to objects designated as tomatoes and boiled lobster claws than to objects not normally red (see Fig. 1). Given an input of inadequate information, the initial hypothesis plays a proportionately greater rôle by virtue of not having been infirmed.

Nor are initial hypotheses infirmed appreciably by providing Group II with added verbal information about the nature of the contrast-color which is used in the stimulus-patch. From the first to the second matching situation, there is no discernible change (see Fig. 2). As in the case of verbal efforts to dispel such classical illusions as the Müller-Lyer, here too our instructions seemed to provide no effective perceptual information. Perhaps verbal instruction does not basically alter the *stimulus* information given *S*.

The only difference between Groups I and II appears to be in the tendency of the second group to show a decreasing variability of judgment with more experience in the judging situation (Tables I-II). We do not know why this occurred.

In Group III, stimulus-information is better, serves more adequately to infirm the initial hypothesis which links the various stimulus-patches with certain 'normal' object-colors. In consequence, the matches made by this group show less of a tendency to redden objects designated as 'normally red' and to yellow objects designated as 'normally yellow.' Yet the information, somewhat contaminated as it is by extraneous information in the perceptual field is not sufficiently appropriate to infirm the initial hypothesis altogether. In this group, moreover, as in the preceding groups, judgments are made under conditions of successive comparison. What does this imply? Essentially, it means that there is a moment intervening between looking at the stimulus-patch—the relevant stimulus-information—and making an adjustment on the color-wheel to match the patch. Granted, the intervals consumed in turning successively through the 80° separating patch and color are not great in duration, yet separation may serve to reinforce the systematic judging tendency by introducing reliance on memory-information. We shall return to this point shortly in discussing the results of the memory series.

Group IV, making its judgments under optimal conditions with a minimum of competing information in the situation and with opportunity for simultaneous comparison shows no systematic effect at all. Stimulus-information is sufficiently stable and adequate to infirm the initial hypothesis, and the matches which are made reflect not the color of objects designated by the *E* but rather the photometric color of the patches themselves.

We turn finally to the results of the memory series. Note that under all conditions represented by our four groups, some systematic effects were found; *e.g.* in memory, orange-colored tomatoes are redder than orange-colored lemons. The greatest effect was exhibited by the naïve groups operating with induced contrast-color (Group I). For them, there were 48.2° of yellow separating their matches for red and yellow designated objects (Fig. 5). Note the marked difference, however, between Groups I and II. The only distinction between the two groups was that the second was given information about color-contrast. Whether for this, or for some other reason, the memory effect of object-color designation was markedly reduced in spite of an equality of the effect in the second perceptual matching situation.

How may we account for the heightened effect of the initial hypothesis on memory matches? We should like to propose the following approach, one which recommends itself for the continuity it suggests between phenomena usually called perceptual and phenomena conventionally designated as memory. In any given situation, the individual may depend upon input stimulus-information for the confirmation of hypotheses or, lacking such perceptual input, upon memory-information as represented by traces. We suggest, furthermore, that trace-information is less stable, or less appropriate information, or both, for confirming or infirming initial hypotheses of the kind built into our *S*s. This being the case, initial hypotheses should have a determinative effect upon memory-matches in much the same way that the initial hypotheses of Groups I and II had a determinative effect upon the perceptual matches because of poor stimulus-information provided.

Conclusion

Given less than optimal stimulus-conditions, certain factors of past experience may play a determinative part in perceptual organization. For past experience is normally among the determinants of initial hypotheses.

Insofar as we may adopt the above as a general conclusion, it is also possible to draw a methodological lesson from our results. When an experiment demonstrates under certain conditions an effect of needs or past experience on perception, that experiment is not necessarily invalidated by another done under other conditions and showing that the alleged effect has not appeared. The basic question is under what conditions of stimulus-information does the effect occur and by what improvement in stimulus-information can it be destroyed.