ÆSTHETIC APPEAL OF OSTWALD'S CHROMATIC STANDARDS

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IN NATURE of May 31, p. 682, Dr. H. J. Eysenck has examined a number of claims made by Ostwald for his colour system. It may be of interest to put on record two experiments I have recently carried out relating to the æsthetic appeal of Ostwald's chromatic circles; the first deals with the appeal of single hues, the second with that of triple combinations. The detailed account of the experiments will be found in my Ph.D. thesis (London, 1940) entitled "The Rôle of Attention in Æsthetic Experience".

PREFERENCES FOR SINGLE HUES

It is desirable to explain that, according to Ostwald, the physical composition of any colour stimulus may be shown by an equation of the form: Hue + Black + White = 1. Circles, known as isovalents, can be defined, for any one of which the same equation holds for all its members, only the hue quality varying from one member to another. A condensed formula for each circle is given by two letters, the first indicating the proportion of white content, the second that of black content. There are of course many tint circles ranging from near white to near saturation and many shade circles from near black to near saturation; those selected here are intermediate.

The materials for the first experiment were twenty-four Ostwald papers cut to the size of $3\frac{1}{4}$ in. square and backed with stiff cardboard. The selection comprised three sets of eight items each, the first containing fully saturated hues (circle *na*), the second tints (circle *ga*) and the third shades (circle *ng*). In each set the middle values of the eight principal hues were chosen. Fifteen educated persons were asked to grade these items according to preference by linear ranking, the test being performed in daylight against a background of white blotting-paper.

Factorial analysis of the resultant intercorrelations of persons by simple summation revealed a first factor responsible for 26.5 per cent of the variance. From this it seems clear that there is a strong tendency to general agreement as to the pleasantness or unpleasantness of single hues.

The relative popularity of the individual items may be estimated by summing the positions allotted to each by the fifteen subjects. From the resultant order of popularity of twenty-four items one can of course abstract an order of popularity for the eight hues in each of the three circles. These latter orders are shown in the following table, the figures in brackets showing the positions of the items in the order of popularity of all twenty-four items.

ORDER OF POPULARITY OF THE ITEMS IN THE THREE CIRCLES

Circle Hue		<i>na</i> (Full Saturation)	<i>ga</i> (Tints)	<i>ng</i> (Shades)
Yellow	..	7 (20)	8 (18)	8 (24)
Orange	..	6 (15)	7 (22)	6 (17)
Red	..	1 (1)	4 (9)	4 (13)
Purple	..	5 (14)	6 (21)	5 (16)
Ultramarine	..	2 (2)	3 (8)	1 (7)
Turquoise	..	4 (6)	1 (3)	7 (19)
Sea Green	..	3 (4)	2 (4)	2 (11)
Leaf Green	..	8 (23)	5 (10)	3 (11)

The high positions of all three ultramarines and sea greens and the marked unpopularity of the oranges and yellows will be noted.

PREFERENCE FOR TRIPLE COMBINATIONS

Ostwald makes two specific claims regarding the appeal of triple combinations: first, that membership of the same circle is a condition favouring harmony; secondly, that among terms fulfilling this condition, equality in the psychological intervals between the terms is a further favouring condition (this second claim rests on the assumption that the intervals between successive terms on any Ostwald circle are all psychologically equal); this point was one of many investigated by Prof. C. Burt a number of years ago—he reached the conclusion that the intervals were often far from equal, an opinion also expressed by Eysenck in his recent article in this journal.

In framing the following test Ostwald's claims were borne in mind. The materials for this second test consisted of 24 triple combinations, comprising four groups:

(1) Eight equally spaced combinations from the standard hue circle *na* (for example, 1, 9, 17; 7, 15, 23, etc.). In this group both the above conditions are realized.

(2) Eight unequally spaced combinations from the standard hue circle, each of the four possible degrees of inequality being represented twice (for example, 1, 16, 17; 2, 15, 18; 3, 14, 19; 4, 13, 20). In this group the first of the above conditions is realized, the second is violated.

(3) Four equally spaced combinations, the three terms of each combination being drawn from three different circles, namely, the standard hue circle *na*, a tint circle *ia*, and a shade circle *ne*. Here the first condition is violated and the second observed.

(4) Four combinations (two equally spaced, two unequally spaced) from a grey shade circle *ie*.

Fourteen persons, all but one adult, were asked to award marks to groups of these on the principle: 8 marks to the one liked best, 7 to the next best, 6 to each of the next three . . . 0 to the one liked least. The test was carried out in daylight against a background of ordinary newsprint. Factorial analysis showed a first factor covering 31.66 per cent of the variance and a significant second factor accounting for a further 22.81 per cent.

The most impressive fact revealed by inspection of the preferences is that the seven subjects whose rankings approximate most closely to the average order have accorded maximum marks to the four greyed combinations; of the remaining seven, five have placed the members of this group slightly lower than midway, one has marked them very high and one very low. But this preference does not entirely account for the first factor discovered.

The four combinations with very unequal intervals were found extremely displeasing by all but one of the subjects. This appears at first to support Ost-

wald's contention that the basis of harmony is equality of spacing; when, however, we compare the marks allotted to the equally spaced combinations with those that show a moderate inequality we find no further confirmation of the claim. As for the claim that membership of the same circle is a condition favouring harmony, the evidence at our disposal points, if anything, the other way.

Since no amount of inspection enabled me to discern the nature of the second factor, I decided to carry out a second test removing the four greyed combinations and the three least popular of the unequally spaced combinations. I then asked a dozen people (ten of whom had done the previous test) to range the remaining seventeen combinations by linear method. The results brought to light a truly dominating bipolar factor. Inspection of the items most diversely judged reveals two characters that it is easier to perceive than name. Some idea of the characters may possibly be indicated by pointing out that the leading members of one set each contained a pale green and a pale red, while those of the other set contained orange-yellows and

deep greens. What is of special psychological interest is that no trace of this factor can be seen in the results of the original test, in which, of course, all the seventeen items were included. It appears that before these characters could be attended to, other more striking qualities such as greyedness and wide inequality of interval had to be eliminated. Once this has been done, these characters carry all before them.

In these tests of triple combinations, the three terms in each item were made to cover equal areas. This, of course, made it improbable that anything like the most pleasing combinations were reached. To achieve this result many more experiments would be necessary, and I hope in due time to carry these out. But the relative unpleasantness of the items in the tests so far done has not made it impossible to discern some of the principles influencing subjects in their assessment of the relative merits of colour combinations. What stands out with especial clearness is the complexity of the problem of colour harmony; any attempt, like Ostwald's, to explain it by a single principle seems foredoomed to failure.

THE BONE-BEARING BEDS OF BETHLEHEM

THE excavation of the bone-bearing beds of Bethlehem was undertaken by the Wellcome Archaeological Expedition to the Near East under the auspices of the Department of Antiquities, Palestine, and work was carried on for three seasons (1935-7) with E. W. Gardner as geologist and D. M. A. Bate as palaeontologist. The continuation of the work in 1937 was made possible through the support of the trustees of the late Sir Henry Wellcome, and of the late Sir Robert Mond. A preliminary account of the results was published in *NATURE* of September 4, 1937.

No work was done on the site in 1938 or 1939, but last year (1940) the co-operation of Dr. Stekelis of the Hebrew University was enlisted to complete the excavation so far as possible. His report has now been received and shows that some notable results have been achieved. In the area from which specimens had already been obtained, work was continued to a depth of several metres below the last occurrence of animal remains, but it was not possible to test the horizontal extent of the bone bed. The geological and archaeological finds do not seem to provide very definite or final evidence regarding the history, or the possible human occupation of the site, but an interesting suggestion is made by Dr. Stekelis that a

number of split bones collected may have been worked by man. A detailed study and comparison of these specimens should prove of exceptional interest.

A considerable quantity of animal remains was obtained, and the specimens will be sent in due course to the British Museum (Natural History) for study and description, together with those of the earlier collections. Dr. Stekelis's list shows that at least six species are recognized; they are as follows:

Bos sp.	Rhinoceros sp.
Antelope	Elephas sp.
Equus sp. (? Hipparion)	Testudo sp.

A number of valuable specimens were recovered and these include a mandibular ramus with teeth, and an almost complete skull with cheek teeth of Rhinoceros; Elephas or Stegodon is represented by a ramus with molars, as well as by isolated teeth and limb bones. Portions of jaws with teeth of antelope, and various remains of ox are also present. All these should be of value not only for determining the species, but also in interpreting the geological age and the relationship and status of this very interesting fossil fauna.

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VELOCITIES OF EARTHQUAKE WAVES

FRANCIS BIRCH has published a paper entitled "The Variation of Seismic Velocities within a Simplified Earth Model, in accordance with the Theory of Finite Strain" (Paper 55, Geophysical Research, Harvard University), which marks a somewhat new direction for seismological research.

The author states that the treatment of many problems concerning the elasticity of the earth as a

whole has been handicapped by the lack of an adequate theory of finite deformation, which would permit quantitative estimation of the effects of the initial strain of the material below the surface. While certain artifices which have been employed to evade this difficulty have had the merit of adding a sufficient number of conditions to allow the solution of various special problems, they have proved