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SOME OBSERVATIONS ON SPECTRAL COLOR DISCRIMINATION

LE ROY D. WELD

Some years ago the writer encountered a reference to a certain spectral line which was there characterized as "blue," whereas I should without hesitation have called it violet. This suggested the question as to whether the common names of pure colors had ever been defined as to their wave length boundaries, and a surprising lack of agreement on the subject was shortly disclosed. For example, there appear in the literature the following designations of spectral color boundaries, in Angstrom units, incidentally with no indication as to how they were arrived at:

	R-O	O-Y	Y-G	G-B	B-V
Abney	6200	5920	5780	4920	4240
Kaye & Laby	6470	5880	5500	4920	4550
Listing	6470	5850	5750	4920	4240
Scripture (Psych.)	6560	5900	5490	5030	4310

The term *color*, when analyzed, turns out to be quite indefinite, and is in reality synonymous with *visible light*; including as it does all the variations which are expressed by the terms *brilliance*, *shade*, *saturation*, *purity*, and *tint*. A more specific term is *hue*, which may be defined as that characteristic of light which depends upon its wave length or its wave-length-intensity distribution.

A *spectral color* is a hue of one wave length; i.e., it is monochromatic. When the entire visible spectrum is arrayed before a normal eye, it may be divided into wave length ranges or intervals of such extent that the observer is conscious that each differs in hue from those adjacent to it. It appears that from twenty to thirty different spectral hues are thus ordinarily distinguishable in the spectrum.¹ But common practice has fixed upon six wave length ranges, within any one of which there is experienced a similarity, though not an identity, of sensation, but which, as a whole, contrast quite definitely with each other. We have acquired a terminology for these differing sensations through appeal to common experience, and by such statements as "grass is *green*, the sky is *blue*," etc.; while the names *violet* and *orange* call to mind associated

¹ Luckiesh, *Color and Its Applications*, Art. 35.

objects which render them sufficiently descriptive of themselves.

But these six spectral ranges, which we call red, orange, yellow, green, blue, and violet, shade rather imperceptibly into each other; so that there are spectral colors, for example, which one observer classifies as green and another as yellow. The exact location of the boundaries is, in fact, a matter of opinion or interpretation; and it would doubtless still be so even if we all had exactly the same color sensation under the same stimulus, which is obviously not the case.

It appears desirable to standardize the five wave length boundaries between the six spectral colors; and the writer can think of no better basis of doing this than to take the average judgment of a sufficient number of people. To this end, occasional observations have been taken over a period of several years, utilizing as observers people of various ages and types, casual visitors to the laboratory, students, artists, teachers, etc.; a total of thirty-eight having been examined to date. A spectrometer is set up with a plane grating and with a Nernst filament as a source of white light to furnish the continuous spectrum. The observer is asked simply to set the cross-hairs on what he considers the boundary between red and orange, orange and yellow, etc., the circle read at each setting, and the readings translated into wave lengths. No attempt is made to locate the outside visible limits of red and violet, as this would depend largely upon the intensity of the light and the acuity of the observer's vision. The results so far obtained are tabulated herewith, together with the mean for each color boundary and the average deviation from the mean both by color boundaries and by observers.

Some interesting contrasts are in evidence. Among the observers is one, perhaps two, who may be considered virtually color blind. For this reason the median is given along with the mean for each color boundary, the former being less influenced by such very erratic judgments, and therefore possibly to be preferred as the standard, at least for a limited number of observers. The average deviation for the twenty-one male observers was 147; of the seventeen female observers, only 96. But the two smallest deviations were both for men. It will be seen that the authorities quoted earlier in the paper vary among each other almost as much as an equal number of typical individuals, such as those tabulated.

It is probable that the means or medians here obtained differ but little from what would result from examining a much larger number of observers, and that therefore they represent what may,

for practical purposes, be regarded as the most logical positions of the spectral color boundaries.

Tabulated Results

Obs. No.	SEX	R-O	O-Y	Y-G	G-B	B-V	Ave. Dev.
1	M	6185	6129	5690	4761	4526	89
2	F	6123	6008	5827	5088	4587	83
3	M	6063	5953	5875	4997	4717	119
4	F	6066	5862	5813	5050	4652	121
5	F	6084	5959	5843	4801	4716	132
6	M	6162	5897	5555	4814	4574	105
7	F	6327	6021	5745	4906	4678	64
8	F	6225	5856	5650	5057	4566	69
9	M	6000	5846	5781	5094	4801	170
10	M	6299	6123	5917	5735	4993	320
11	F	5930	5800	5673	5013	4597	133
12	M	6085	5953	5663	5070	4546	74
13	F	6222	6024	5879	5034	4686	86
14	F	6295	6027	5820	4973	4618	53
15	M	6374	6066	5768	4879	4597	76
16	M	6513	6014	5820	4919	4757	128
17	M	6145	5917	5774	4979	4498	60
18	F	6232	5992	5872	4919	4634	61
19	M	6358	6339	5739	4783	4339	172
20	F	6186	5985	5803	5059	4637	70
21	F	6150	5940	5720	4850	4610	66
22	M	6714	6202	5879	5184	4320	256
23	M	6500	5223	4954	4853	4601	391
24	M	6311	6065	5865	4940	4470	75
25	F	6639	5801	5214	4878	4482	247
26	F	6399	5971	5742	4860	4445	80
27	M	6575	6081	5784	5116	4278	179
28	M	6280	6015	5698	4873	4443	52
29	F	6488	5927	5643	5067	4485	110
30	F	6098	5972	5793	4792	4542	64
31	M	6227	5981	5784	4970	4676	48
32	M	6134	6034	5841	4779	4529	95
33	M	6130	5900	5852	5197	4504	123
34	M	6319	6219	5247	4998	3975	274
35	M	6124	5827	5764	4870	4354	124
36	M	6160	5860	5590	4650	4430	156
37	F	6129	5870	5760	4803	4490	100
38	F	6171	5972	5642	4922	4328	87
Means		6248	5996	5718	4962	4544	
Ave. Dev.		135	107	126	125	124	(124)
Medians		6224	5972	5771	4920	4556	

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