4.2.4. Recording Colour Preference Data

The third requirement posed by colour dynamics as a science and the practice of environment colour design for colour preference experiments and their results is that it should be possible to express preference data on a scale with limits. In the current practice of processing colour preference experiments numbers represent only the preference order of colours. For instance, in FRIELING's experiments (1968), red was the first, purple the second, greenish blue the eleventh among the tested 25 colours as valued by girls 5 to 8 years old. This scale of orders simply means that under certain environmental conditions, girls aged 5 to 8 prefer red to purple, and purple overtakes greenish blue by ten colours. It is not known, however, by how much red is preferred to purple and purple to greenish blue.

This scale of orders is unable to demonstrate the degree of liking, albeit preference should be considered in the selection of colours for a space to be designed, it is just the degree of liking that decides whether a certain colour is suitable in a given surrounding for a given population. That is, for the purposes of colour dynamics colour preference values are ordered according to a proportional psychometric scale with beginning and end points. The colour preference index number system was built up from such scales.

4.2.5. Colour Selection in Practice

The fourth requirement of the science of colour dynamics and of practical environment colour design for colour preference experiments and results is that they should express the active relation of man to colour.

In addition to passively perceiving colours, man's attitude to colour has also active components. Man is active when deciding about the colour of a hat he buys, the colour of his walls to be painted. A schoolchild is active when selecting colours for a drawing. An essential problem of practical colour dynamics is the relation between this active colour selection and colour preference diagrams obtained in tests. If colour preference results obtained in tests do not perfectly fit practical colour selection they are useless for design. Therefore experiments have to be made in stages, so that the test person should be induced to exhibit an active attitude toward colours.

Such a multistage test series performed with the needs of colour dynamics in mind served to create the colour preference index number system for use in practical environment colour design. Test results have been compared to colour preferences manifested, on one hand, in colour drawings of a child spontaneously depicting his sensations, and on the other, in creations of painters. In Fig. 4.31, colour averages found in drawings and experimental colour preferences of six year old children have been compared to average colour preferences proper to their ages given by the index number system. According to all three, concordant results, children of six years prefer and utilize most frequently red and orange. It is even more striking to compare colours in "Still Life with Sunflowers" painted by VAN GOGH at 35 years, "Senecio" painted by KLEE at 43 years, and "Ox Skull" painted by PICASSO at 74 years, and the given age-dependent colour preference average curves (Figs 4.32 to 4.34). Test results from pair-wise comparisons and from ranking methods are represented by separate curves. Ranking test results have been separated between those for saturated and for dull colours. Special curves represent

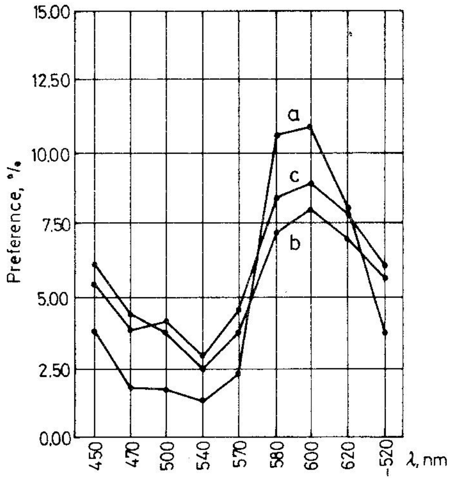


Fig. 4.31. Comparison of colour preferences in % vs. dominant wavelengths of the hues (after NEMCSICS). Curve a) preference shown in drawings of a boy aged 6, curve b) preferences of the same boy in test, c) average preference for the age group

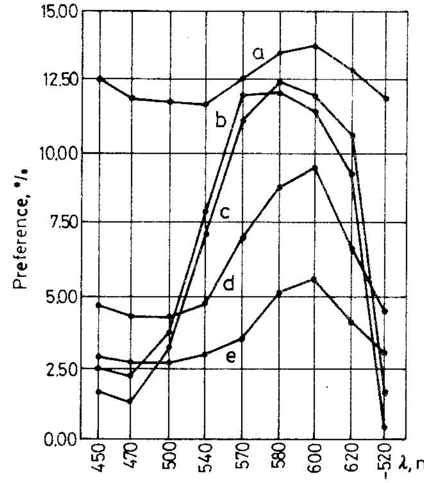


Fig. 4.32. Colour preference expressed in VAN GOGH's "Sunflowers", typical of men aged 35. Notations as in Fig. 4.31. a) Preferences by men aged 35 obtained by pair-wise comparisons, b) preferences in VAN GOGH's picture, c) colour selection for the concept of summer, d) preferences for saturated colours obtained by ranking, for men aged 35, e) preferences for dull colours obtained by ranking, for men aged 35

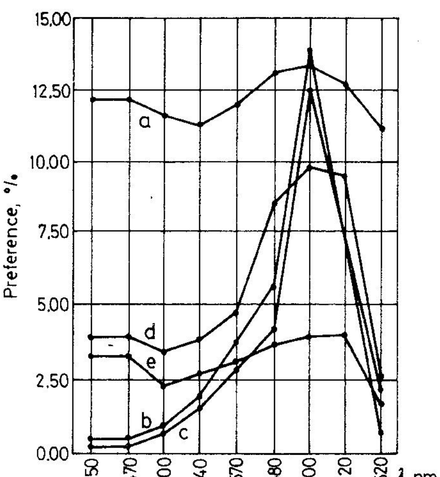


Fig. 4.33. Colour preference manifest in KLEE's "Senecio" typical of men aged 43. Curve a) as in Fig. 4.32. Curve b) refers to preference manifest in colours of KLEE's picture, while curve c) to colour selection for the concept of love

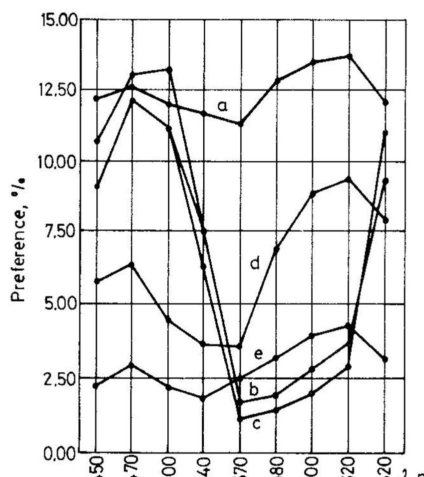


Fig. 4.34. Colour preference manifest in PICASSO's "Ox Scull" typical of men aged 74. Notations as in Fig. 4.32. except curves b) and c). Curve b) refers to preference manifest in colours of PICASSO's picture, while curve c) to colour selection for the concept of fear

colour percentages in the pictures, as well as relative proportions of colours related to the conceptual message of the pictures, i.e. their colour association content. Diagrams demonstrate that in the pictures by VAN GOGH and KLEE, preferences of the artists were in conformity with preference test results. This is not true for PICASSO's picture where the message overwhelms colour preference in his age group.

4.2.6. Multistage Colour Dynamic Experiment

In conformity with the aspects above, we undertook at the Technical University of Budapest a multistage colour preference test series in order to create a colour preference index number system (NEMCSICS 1967b, 1977d, 1980c). The experiments comprised six stages, such as: determination of 24 representative points of the colour space, of the continuous colour circle, of the achromatic and lightness scale, of the saturation scale, of colour preferences for discrete colour planes of the colour space, and lastly, recording colour preference surfaces and the inherent colour preference index numbers.

Experiments involved over seventy-thousand test persons, and were carried out under the following personal and material conditions: Ages covered a very wide range, from babies to very old people, classified in 12 age groups. Results were processed group-wise according to sex, age, education, profession, and environmental conditions, using punched cards, sorting devices, and computers.

Colour samples of 15 to 100 sq.cm area were displayed on horizontal surfaces in light incident through the window at about 45°, samples were observed at 90° from a distance of 100 cm. Care was taken not to have reflective coloured surfaces in the room and to have an achromatic ambience. Before the test, persons spent at least five minutes in the room to let their eyes adapt to the illumination level and the achromatic surrounding.

In order simultaneously and uniformly to perform this experiment involving a high number of test subjects, a large team was required. Identity of conditions was carefully checked. Test samples were selected from among a very high number of painted colour samples, on the basis of tristimulus colorimetry data. Correctness of colorimetry data was checked at random by means of a spectrophotometer. Coloroid and CIE *XYZ* coordinates of every test colour have been recorded. Test results refer to Coloroid coordinates.

4.2.7. Preferences for Representative Points of the Colour Space

The first step in our tests was to determine preferences for colour points representing the entire colour space, to serve as references in subsequent tests. Test colours were of different hues and lightnesses. Test persons were selected so as to embrace in correct proportions all age groups of both sexes. The twelve age groups were: 0 to 3, 4 to 5; 6 to 8; 9 to 10; 11 to 12; 13 to 14; 15 to 16; 17 to 20; 21 to 30; 31 to 40; 41 to 50, and over 50 years (NEMCSICS, 1967). Testing teams worked simultaneously. Identity of test materials between all the groups was safeguarded; also test conditions were kept uniform in each group. Test samples were illuminated by reflected daylight incident from the

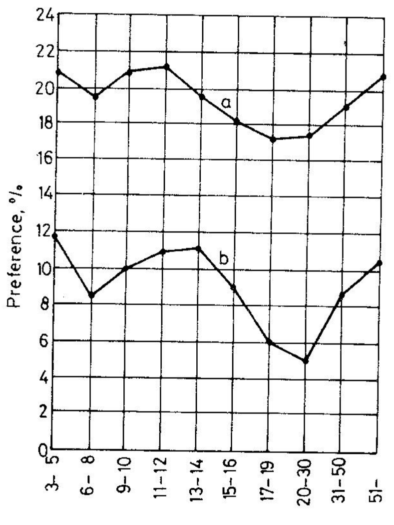


Fig. 4.35. Comparison of women's preferences vs. age groups for red obtained by (a) pairwise comparison and (b) ranking based on tests by Nemcsics

north sky. Illumination was about 1500 lx. Circumstances, environment, weather, and illumination were recorded on special sheets.

Tests were made both by ranking and pair-wise comparison. For both methods, colours were presented to test persons in a definite arrangement. In the ranking experiments, all the test colours were simultaneously presented and the persons were invited to arrange them in the order of their liking. In pair-wise comparison, test persons had to choose from each two colours until all the possible pairs were judged. Test sheets were such as to be compatible with computer processing. Millions of data from test sheets were punched on cards, then classified by computer and colour preferences by age groups of both sexes were expressed in percentages, such as:

$$x_p = \frac{100 n_P}{m}, \tag{114}$$

where x_P is the preference percentage for colour P; n_P is the number of votes for colour P; and m the total number of test persons. Processing involved principal colours, colour pairs, colour groups, colour series, and perceptional colour characteristics.

Some of the results which are already useful for environment colour design, will now be presented. Figure 4.35 showing preferences for red by women of different ages serves only to illustrate differences between results obtained by pair-wise comparison and by ranking. The two curves are strikingly similar, which means that for a sufficiently large number of test persons, both methods yield similar results.

Environment colour design may directly exploit results for colour pair preferences (Figs 4.36 through 4.40). These figures demonstrate how much the preference for a colour is affected by the colour adjacent to it. It also shows that at different ages of life not only the relation to a given colour varies but also the other colour to which the given colour is preferred. Let us see some examples.

Co-preference for red and orange is about uniform throughout one's life, except for women aged 20 to 30 significantly preferring orange emitting warmth to red (Fig. 4.36). For pairs of red and green, preference is given to red at any age, albeit in different percentage (Fig. 4.37). In general, red is preferred to almost any accompanying colour and even if displaced by blue for a significant period of life, it loses ground gradually.

The situation is different in ranking yellow and violet. Boys aged 18 definitely prefer yellow, while men aged 31 to 50, violet (Fig. 4.38). Interestingly, women react to this pair of colours less extremely than do men; in spite of that they are more sensitive to any of these colours when seen isolated than are men. In contrast, women's preference for a

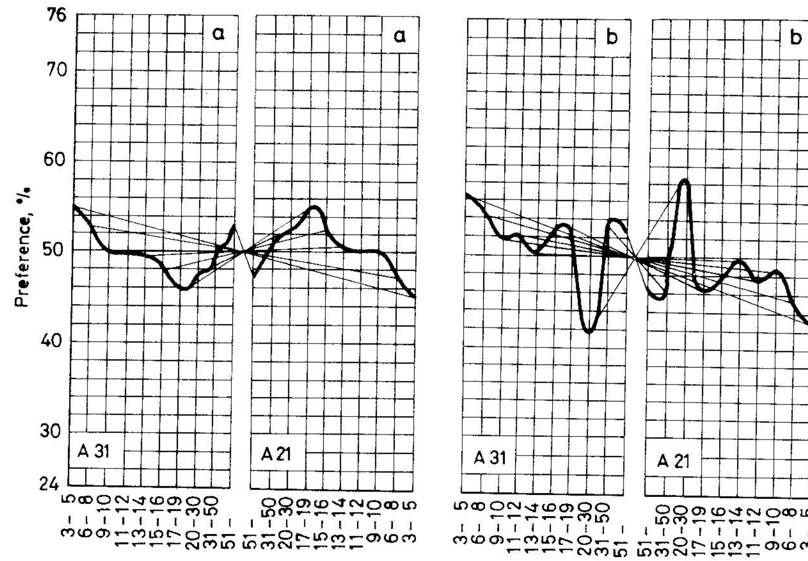


Fig. 4.36. Preferences vs. age groups for the pair of colours red (*A*31) and orange (*A*21) by men (a) and women (b)

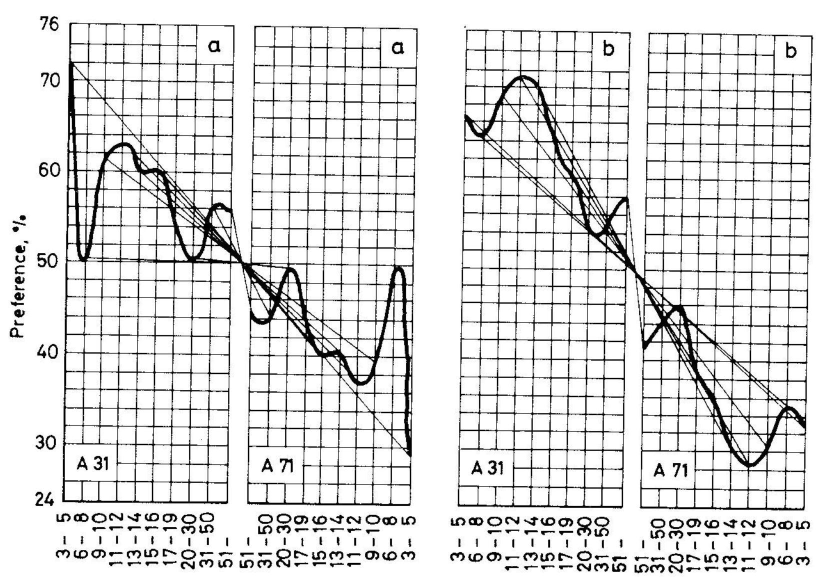


Fig. 4.37. Preferences vs. age groups for the pair of colours red (*A*31) and green (*A*71) by men (a) and women (b)

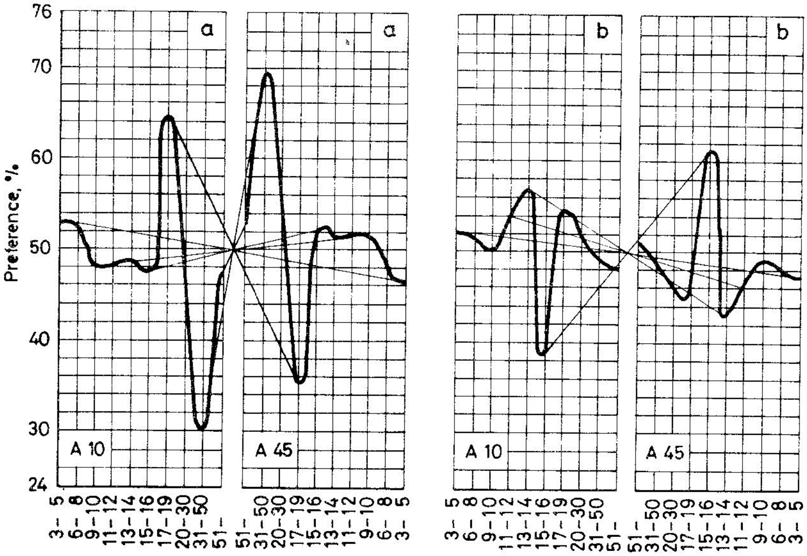


Fig. 4.38. Preferences vs. age groups for the pair of colours yellow (*A*10) and violet (*A*45) by men (a) and women (b)

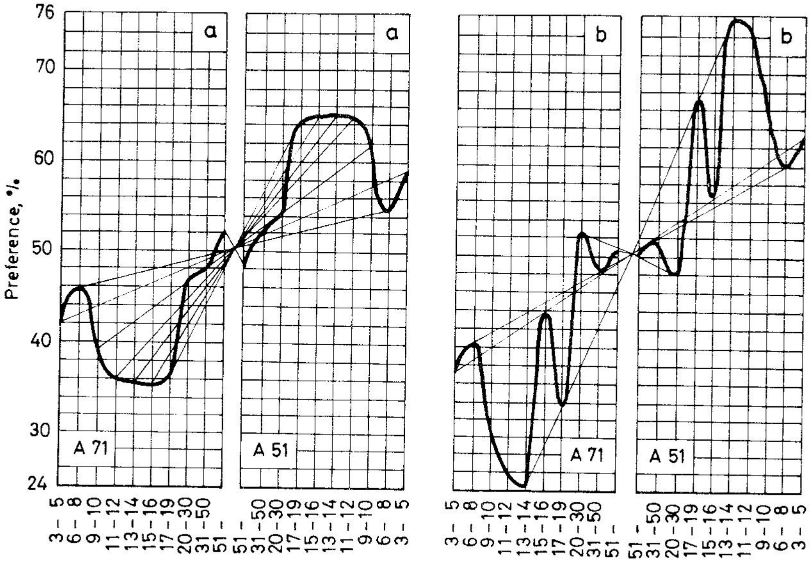


Fig. 4.39. Preferences vs. age groups for the pair of colours green (*A*71) and blue (*A*51) by men (a) and women (b)

combination of green and blue varies dynamically with age (Fig. 4.39). Young boys are especially sensitive to the combination of orange and yellow (Fig. 4.40). Such findings are useful in colour design because they inform us about which colour combinations are to be applied for an environment intended for a given age group.

Comparison of preferences in given age groups for colours in a given domain of different saturations and lightnesses in various colour domains yields, depending on the hue, rather different conclusions. In the red domain the most saturated red is preferred by any age group, save men aged 20 to 30 who prefer red-brown to scarlet. Preference curves for colours throughout the red domain are rather similar (Fig. 4.41). On the other hand, preferences for colours in the green and blue domains are more differentiated. Notably for any hue, the most saturated colours are not those which are preferred. In both colour domains women react more sensitively to colours than men (Figs 4.42, 4.43).

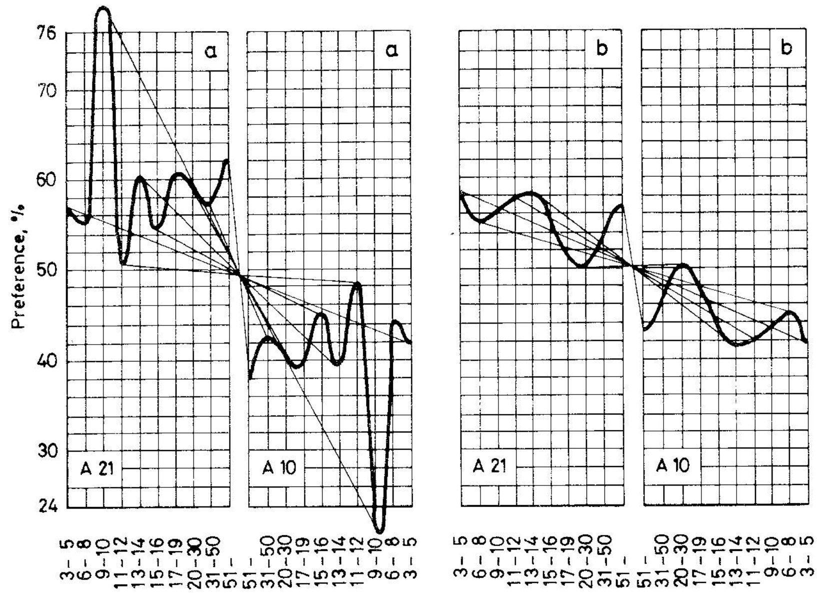


Fig. 4.40. Preferences vs. age groups for the pair of colours orange (*A*21) and yellow (*A*10) by men (a) and women (b)

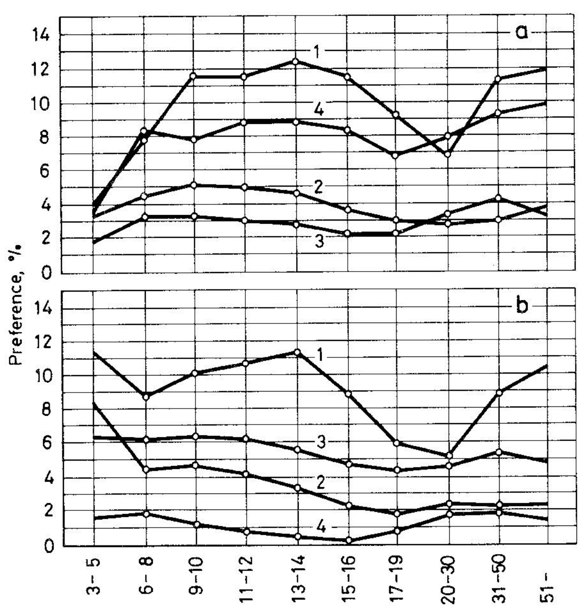


Fig. 4.41. Preferences vs. age groups for different shades of red by men (a) and women (b). 1. vermilion, 2. carmine, 3. pink, 4. English red

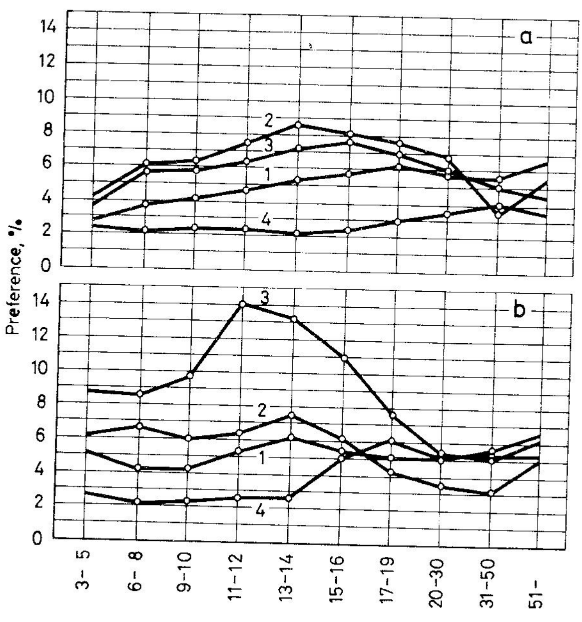


Fig. 4.42. Preferences for age groups for different shades of blue by men (a) and women (b). 1. cobalt blue, 2. ultramarine, 3. manganese blue, 4. light blue

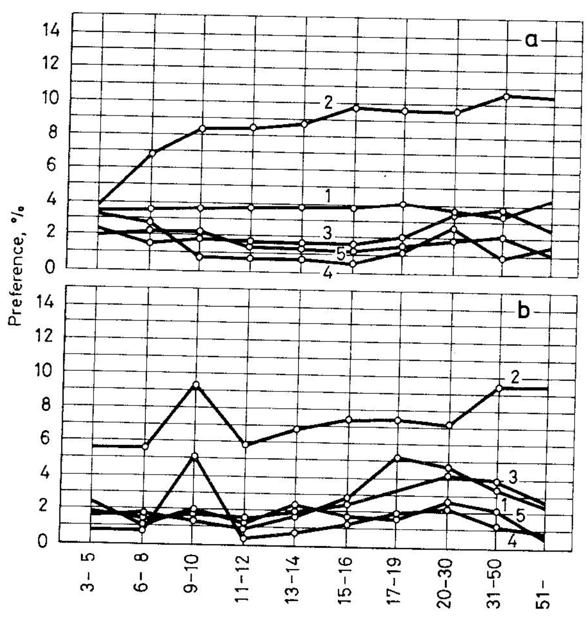


Fig. 4.43. Preferences vs. age groups for different shades of green by men (a) and women (b) in different age groups. 1. viridian dull, 2. yellowish green, 3. viridian hydrate, 4. olive green, 5. light green

It is striking to compare preferences for saturated and dull colours. It is obvious from Fig. 4.44 that saturated colours are preferred by women up to 19 years, and by men up to 20 years, but while thereafter the relation of men to colours hardly varies, women of 20 to 50 years—against the common belief—definitely prefer dull colours, only to return to saturated colours over 50. Sexes agree much more in their attitude towards light and dark colours. Both prefer light colours throughout their whole lives. Preferences for light and for dark colours differ the least at about 18 years for both sexes (Fig. 4.45). Sorting colours according to their associative messages as cold and warm ones, it is found that men prefer warm colours up to 15 years, then, from 15 to 30 years, cold ones, only to return later to warm colours. On the other hand, women prefer emotional, warm colours nearly throughout their lives, except for 17 to 19 years, the age of mental maturation (Fig. 4.46).

The above and similar result were both tabulated and plotted. In order to apply results as references for proportional scales to be set up in subsequent experiments, preference

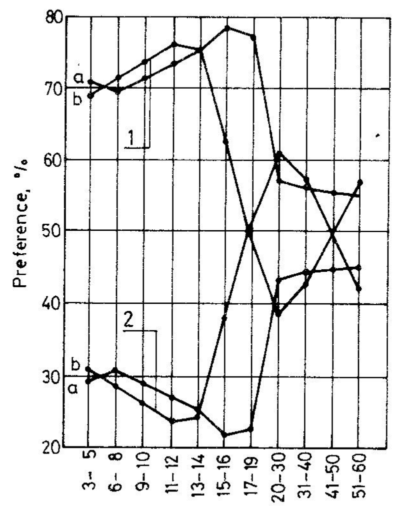


Fig. 4.44. Preferences vs. age groups for saturated (1) and dull (2) colours by men (a) and women (b)

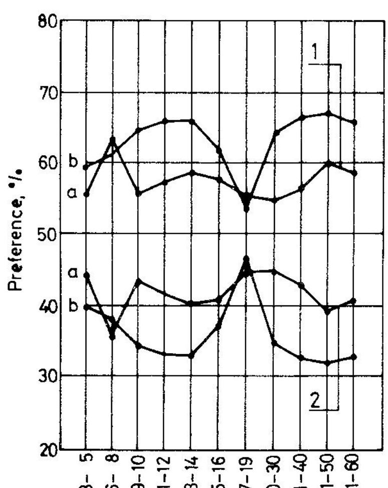


Fig. 4.45. Preferences vs. age groups for light (1) and dark (2) colours by men (a) and women (b)

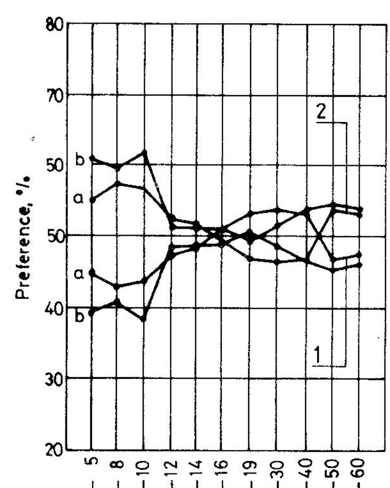


Fig. 4.46. Preferences vs. age groups for cold (1) and warm (2) colours by men (a) and women (b)

percentages were converted to *relative preferences* rated from 0 to 100:

$$x_{P_{rel}} = \frac{100x_P}{x_{P_{max}}}, \tag{115}$$

where $x_{P_{rel}}$ is the relative preference for colour P; x_P is preference for the colour defined by (114), and $x_{P_{max}}$ is the highest preference percentage among the tested colours.

4.2.8. Preferences in the Continuous Colour Circle

The second stage of our test series was to determine preferences for members of the colour circle comprising surface colours of the highest saturations possible. For the experiment the most saturated colours which could be mixed out of paints, representing the 48 Coloroid hues, were assorted. Care was taken that the lightness of the selected colours should vary continuously. Colours were presented to test persons together, i.e. six samples were fixed on a board each. Test conditions, observation and illumination geometries, light intensity, and spectral energy distribution of the light source were as before and the ranking approach was used.

Results have led to the conclusion that among saturated colours, children prefer two colours: red and blue, adding up later to three: red, green and blue, i.e. the basic colours of colour vision.

In order to enable comparison between "preference for saturated colours" of the colour circle with "preference for dull colour" in former tests, the "preferences for the continuous colour circle" curves were transformed so as to be comparable to curves for "preferences for representative points of the colour space". Transformation was made normally to axis t defined by test preferences for two colours (Fig. 4.47). Coloroid and CIE XYZ coordinates of these two colours were:

	Coloroid			CIE		
	A	T	V	x	y	Y
Colour P_1	22.00–	57.00–	71.00	0.5220	0.4289	50.41
Colour P_2	51.00–	28.00–	33.00	0.1945	0.1492	10.89

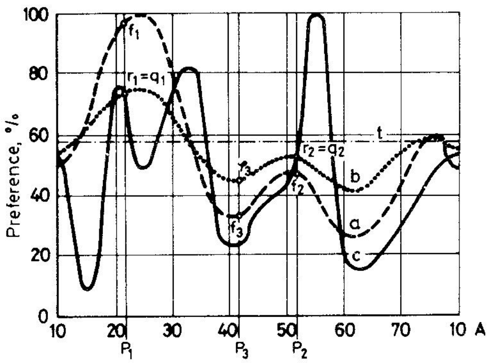


Fig. 4.47. Transform (b) of the preference curve of the continuous colour circle (a) in the reference system defined by curve (c) for the relative preferences for representative points of the colour circle. Horizontal axis shows hues in the Coloroid colour circle

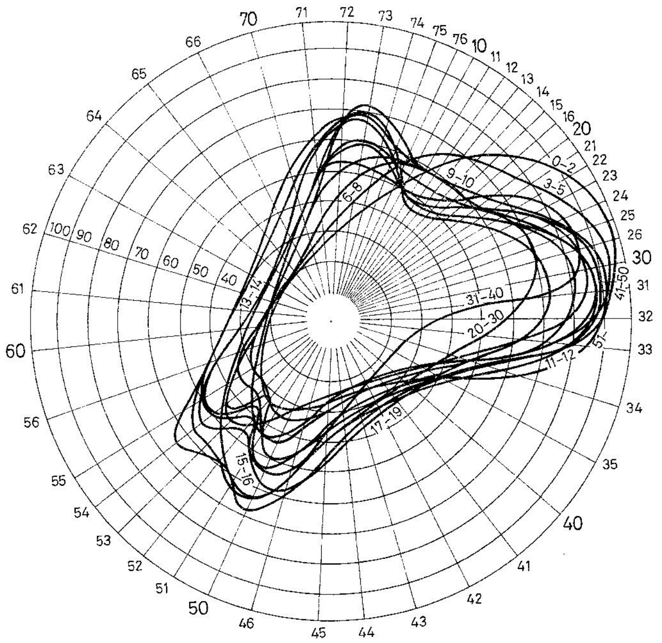


Fig. 4.48. Preferences by men of different ages for colours of the saturated colour circle. Perimeter of the circular diagram shows various Coloroid hues. Preference increases from the centre toward the perimeter. Curves refer to different age groups

Preference percentages for colours P_1 and P_2 among "representative points", that is, in our reference system, and in the "continuous colour system" are marked r_1, and f_1, respectively. According to Fig. 4.47:

$$(r_1-t):(f_1-t)=(r_2-t):(f_2-t) \tag{116}$$

whence the axis of normal affinity applied for transformation is defined as:

$$t=\frac{r_2 f_1-f_2 r_1}{f_1-f_2+r_2-r_1}. \tag{117}$$

In Fig. 4.47 relative preferences by boys aged 17 to 19 for representative points of various hues is shown by a solid line, preference for the continuous colour circle by a dashed line, and transformed of this latter by a dotted line.

If f_3 be the preference for an arbitrary colour P_3 out of the test on preference for the continuous colour circle and q_3 its transformed in the reference system, then, according to Fig. 4.47:

$$(q_3-t):(f_3-t)=(r_2-t):(f_2-t), \tag{118}$$

yielding the degree of affinity as:

$$q_3=\frac{r_2 f_3-t(r_2+f_3-f_2)}{f_2-t}. \tag{119}$$

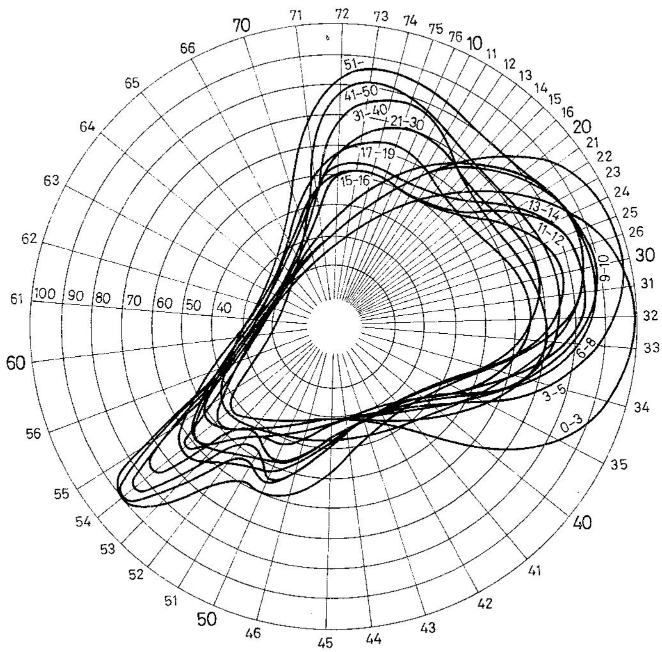


Fig. 4.49. Preferences by women of different age groups for colours of the saturated colour circle. Notations as in Fig. 4.48

Owing to this transformation comparison of colour preferences of different age groups can be conveniently illustrated on a circular diagram. Colour preferences of men and women in different age groups were represented in Figs 4.48 and 4.49, respectively. Diagram circumferences show preference values for various Coloroid hues, while radii show those for saturated colours of the given hue on the colour circle. Figures point out important variations with age in preferences primarily for yellowish green, red and blue, while those for bluish green and violet hardly vary throughout one's life. Attitudes of women to colours vary much more than those of men. For women, variation is most conspicuous in the domain of cold blues, and for men in that of warm blues.

4.2.9. Preferences on the Achromatic and Lightness Scales

Tests on representative points of the colour space involved also white, medium gray and black. Among the achromatic colours in most age groups medium gray was the least preferred. No data were, however, available, such as to indicate whether the preference varies continuously with decreasing lightness. This prompted us to perform an additional preference test on nine achromatic colours. Achromatic colours presented to test persons had Coloroid lightnesses of 95, 85, 75, 65, 55, 45, 35, 25, 20. Tests were also made with colours of different Coloroid lightnesses, hues and saturations. Colours were fixed on boards but not in the order of their lightness. Colour sample sizes, test circumstances, observation and illumination geometries, light intensity and spectral energy distribution of the light source were as above. The tests were conducted by the ranking method.

Results are shown in Figs 4.50 and 4.51, referring to achromatic scale preferences of men in different age groups. The same for women is shown in Figs 4.52 and 4.53. From the diagrams it is obvious that preference variation can be described by a continuous curve parallel to colour lightness variation, as well as, that it is the preference for middle gray which varies the most with age. Grays somewhat lighter or darker than medium are always more popular than medium gray.

As before results were transformed to preference system serving as reference. Coloroid and CIE XYZ coordinates of colours P_1 and P_2 defining the axis of transformation

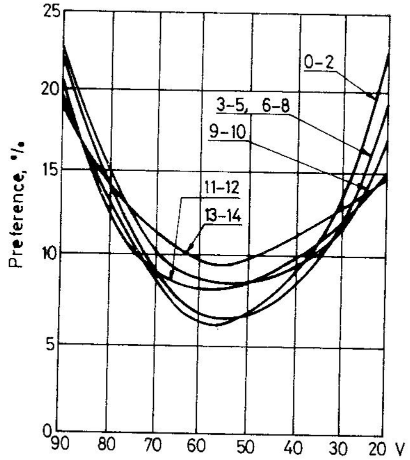


Fig. 4.50. Preferences vs. lightness by boys of different ages for colours in the achromatic scale. Horizontal axis shows lightnesses, vertical axis shows preferences in per cents. Curves refer to different age groups

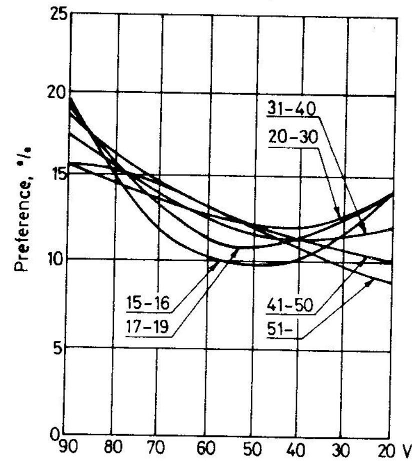


Fig. 4.51. Preferences vs. lightness by men of different ages for colours in the achromatic scale. Notations as in Fig. 4.50

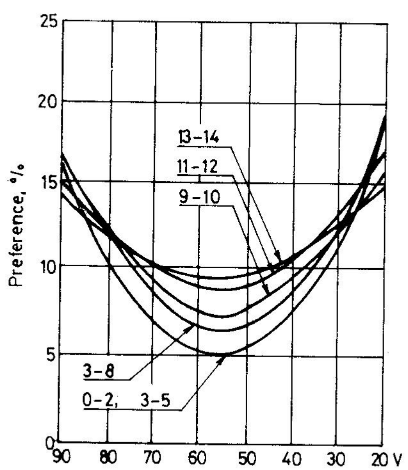


Fig. 4.52. Preferences vs. lightness by girls of different ages for colours in the achromatic scale. Notations as in Fig. 4.50

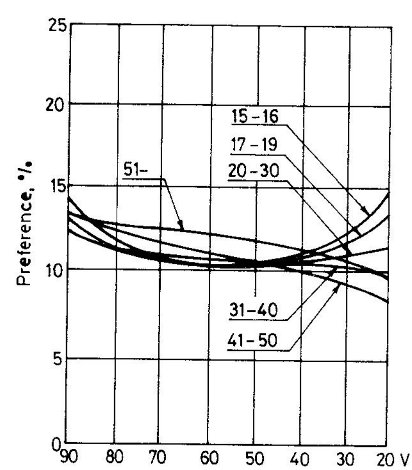


Fig. 4.53. Preferences vs. lightness by women of different ages for colours in the achromatic scale. Notations as in Fig. 4.50

are:

	Coloroid	CIE		
	A *T* *V*	*x*	*y*	*Y*
Colour P_1	00.00–00.00–55.00	0.31006	0.31616	30.25
Colour P_2	00.00–00.00–20.00	0.31006	0.31616	4.00

Transformation applied Eqs (119) and (121).

4.2.10. Preferences in the Saturation Scale

Again we wished to collect data concerning the effect of saturation on preference for different hues. Four hues were selected and saturation scales comprising colours of equal lightnesses were prepared.

Test persons were presented colour samples fixed on boards and grouped by hues but not ordered according to saturations. Otherwise, conditions were as before.

Results showed preferences to vary along a continuous curve parallel to the variation of saturation. Preference was found to vary unevenly between the most saturated surface colour and gray of the same lightness. Preferences for points at one third of scale can be used to characterize preferences for other scale points. This finding was utilized later, in selecting colours for preference tests on discrete colour planes of the colour space. The statements above are illustrated by Figs 4.54 through 4.59, referring to preferences for given hues and lightnesses by men and women in different age groups.

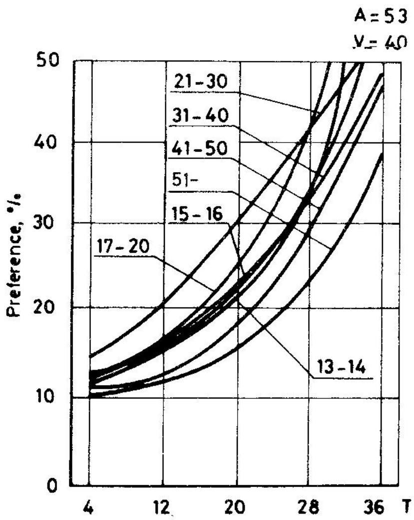


Fig. 4.54. Preferences vs. saturation by men of different ages for blues (*A*53) of different saturations, darker than medium gray (*V*40). Horizontal axis shows saturations, vertical axis shows preference in per cents. Curves refer to different age groups

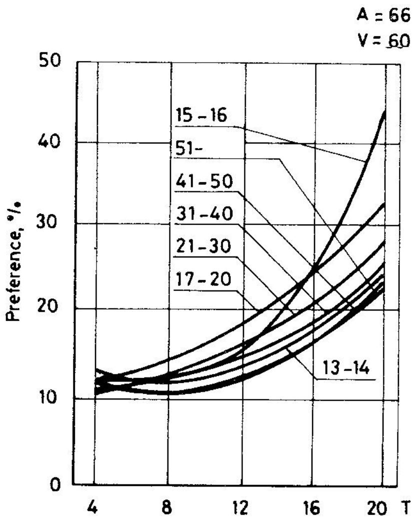


Fig. 4.55. Preferences vs. saturation by men of different ages for greens (*A*66) of different saturations, lighter than medium gray (*V*60). Notations as in Fig. 4.54

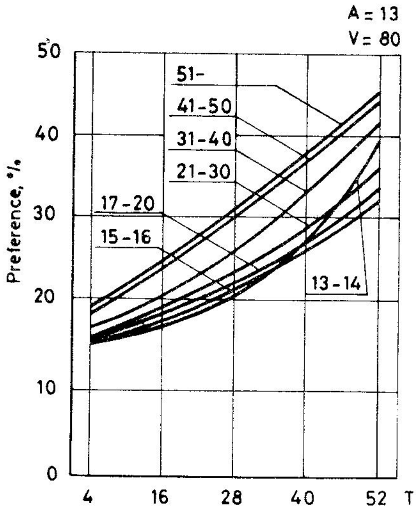


Fig. 4.56. Preferences vs. saturation by men of different ages for very light (*V*80) yellows (*A*13). Notations as in Fig. 4.54

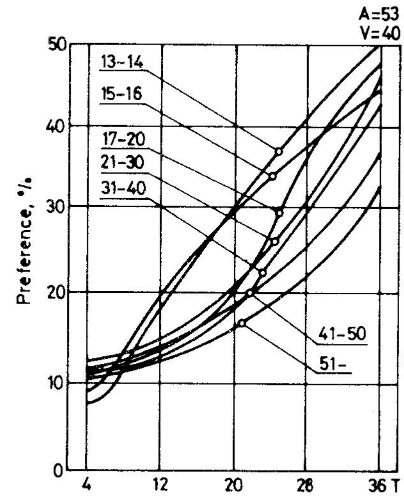


Fig. 4.57. Preferences vs. saturation by women of different ages for blues (*A*53), darker than medium gray (*V*40). Notations as in Fig. 4.54

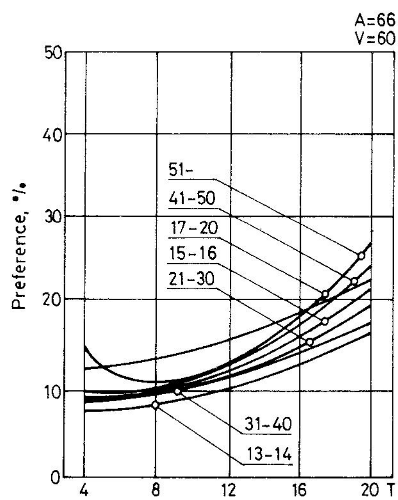


Fig. 4.58. Preferences vs. saturation by women of different ages for greens (*A*66), lighter than medium gray (*V*60). Notations as in Fig. 4.54

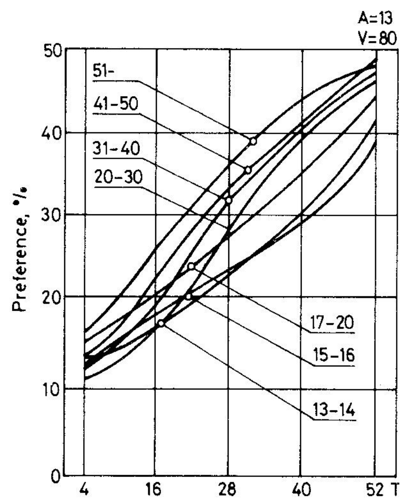


Fig. 4.59. Preferences vs. saturation of women of different ages for very light (*V*80) yellows (*A*13). Notations as in Fig. 4.54

4.2.11. Preferences in Discrete Colour Planes of the Colour Space

The last test series dealt with discrete colour planes of the colour space. Since within the planned system, we wished to assign preference value to each surface colour of the colour space, data for those points of the colour space were needed between which preferences for the intermediate colours could be determined by relationships resulting from correlations described before. In view of previous tests we thought that the knowledge of preferences for nine colour points each, properly selected in 48 discrete colour planes for Coloroid basic hues would suffice to approximate preferences for all the surface colours.

Examination of preference curves obtained from tests on lightness and saturation scales has led to the conclusion that by preference values for colour points pertinent to a colour plane a continuous preference surface situated above the given colour plane can be defined (Fig. 4.60). The distance of the surface points from the colour plane is proportional to the preference value of the colour represented by that point. These

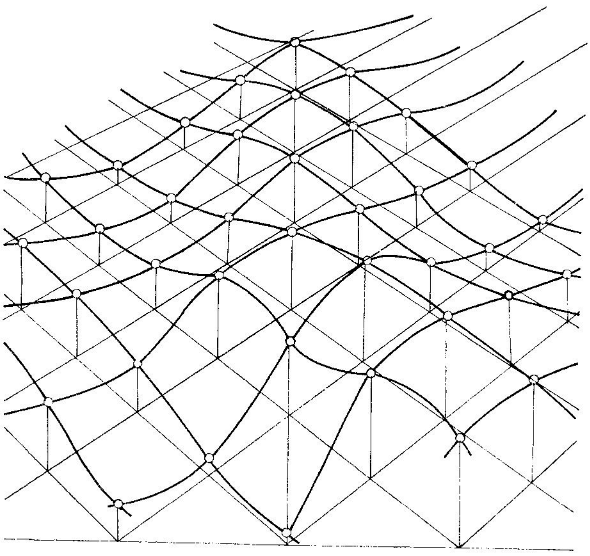


Fig. 4.60. Colour preference surface overlying a Coloroid colour plane. Distances of the intersections of normals at colour points and the preference surface are characteristic of the preference for that colour point

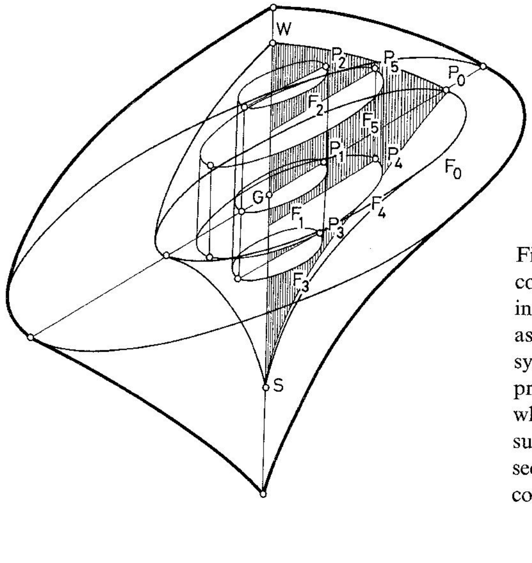


Fig. 4.61. Geometric loci (F_0, F_1, F_2, F_3, F_4, F_5) of colours of discrete colour planes of the colour space in the Coloroid colour solid with preferences serving as the basis of the colour preference index number system. Basic data for preference surfaces are preferences for 9 points in every colour plane, such as white (W), gray (G), black (S), the most saturated surface colour (P_0) in the colour plane, and intersection points P_1, P_2, P_3, P_4, P_5 of curves in the colour plane

preference surfaces are closely approximated to by a quadratic two-variable function written for nine, adequately selected points. Out of the nine colours, three are achromatic, one saturated, and the other five properly selected dull colours.

Preferences for achromatic and saturated colours being available from previous tests, the actual test was expected to furnish preferences for five differently dull colours for each hue, totalling 240, to make up the still missing basic data of the colour preference index number system. These 240 surface colours were located within the colour space under the following conditions: colours represented two saturations for each hue, dividing into three parts the saturation scale. Less saturated colours occurred in three, more saturated ones in two varieties for each hue.

Locations within the Coloroid colour space of the selected colours are shown by curves in Fig. 4.61. Colours applied to determine preferences for discrete colour planes of the colour space lie on curves F_0, F_1, F_2, F_3, F_4, F_5. For the construction of preference surfaces, initial data were obtained from preferences for the nine points i.e. white (W), gray (G), black (S), the most saturated surface colour in the colour plane (P_0), and intersection points of the curves and the colour plane (P_1, P_2, P_3, P_4, P_5).

Colour samples were fixed on boards and presented to test persons one Coloroid hue after the other. Test conditions were as before, evaluation was by ranking. Test results were transformed to the reference preference system. Transformation axis was defined by the preference for the most saturated colour of each hue, and for gray of Coloroid lightness V55.

4.2.12. The Colour Preference Index Number System

Preference values for 291 colours uniformly distributed over the colour space are the basic data of the colour preference index number system. Using these data, to every colour of the colour space a number from 0 to 100, proportional to its preference can be assigned, making up the colour preference index number system.

Colour preference conditions in various domains of the colour space can be best visualized by plotting the basic data in circular diagrams. Preferences for colours in the colour space based on a total of 6912 basic data obtained in twelve age groups each of both sexes were plotted in Figs 4.62 through 4.85. Curves show preference rates of colours of different saturations and different lightnesses of the 48 Coloroid basic hues. Preference values range from 0 to 100, increasing from the centre of the diagram to its periphery. Curves P_0, P_1, P_2, P_3, P_4, P_5 refer to the most saturated surface colours, to unsaturated medium light, unsaturated very light, unsaturated very dark, medium saturated dark, and medium saturated light colours, respectively.

Some typical conclusions to be drawn from these diagrams are as follows: Both girls and boys up to 8 years prefer mainly red and at this young age, saturated colours are preferred. But there are also differences. For instance, orange is preferred by girls two years old, and by boys eight years old. The opposite is true for vermilion. Up to eight years of age, boys and girls prefer colours of different saturations and lightnesses in the same order. Over this age, colour preferences of boys and girls gradually diverge. At ten years of age, boys increasingly prefer yellowish green and warm blue, while girls prefer orange and cold blue. Girls aged 14 definitely prefer cold blue to red, while boys of the same age still prefer red. Boys place medium saturated light colours before medium

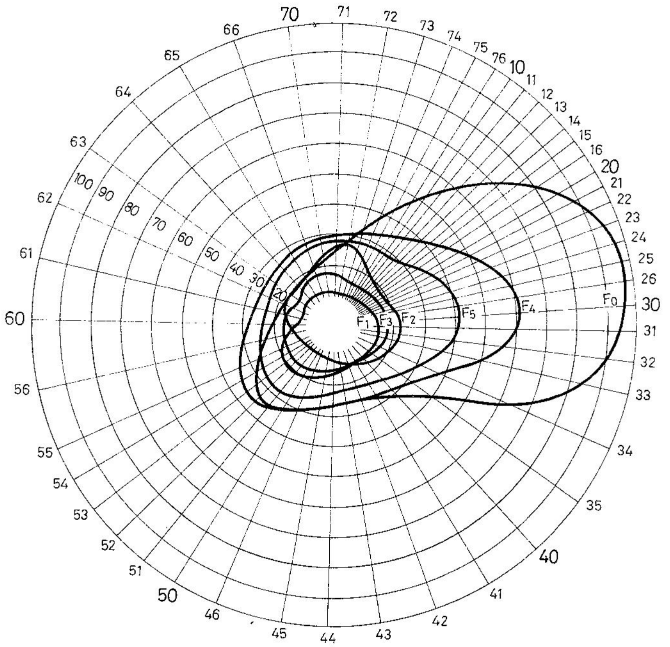


Fig. 4.62. Preferences by boys aged 0 to 2 for 291 colours uniformly distributed in the colour space

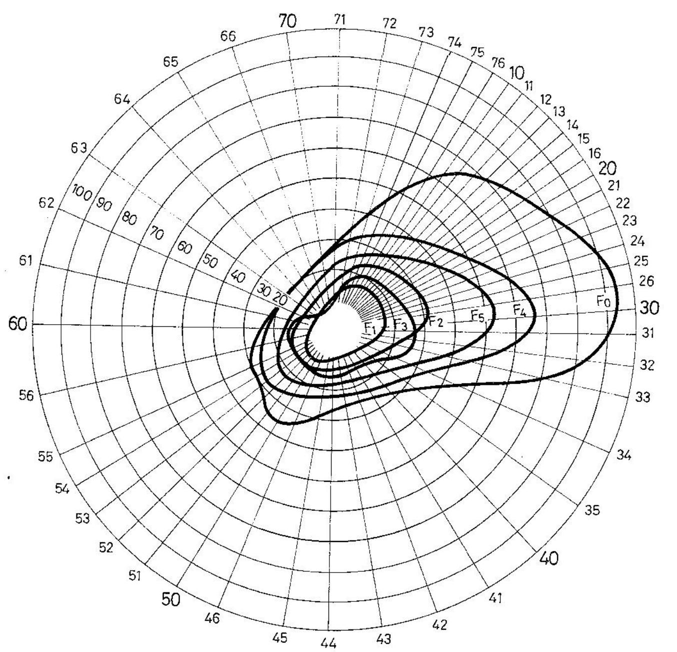


Fig. 4.63. Preferences by boys aged 3 to 5 for 291 colours uniformly distributed in the colour space

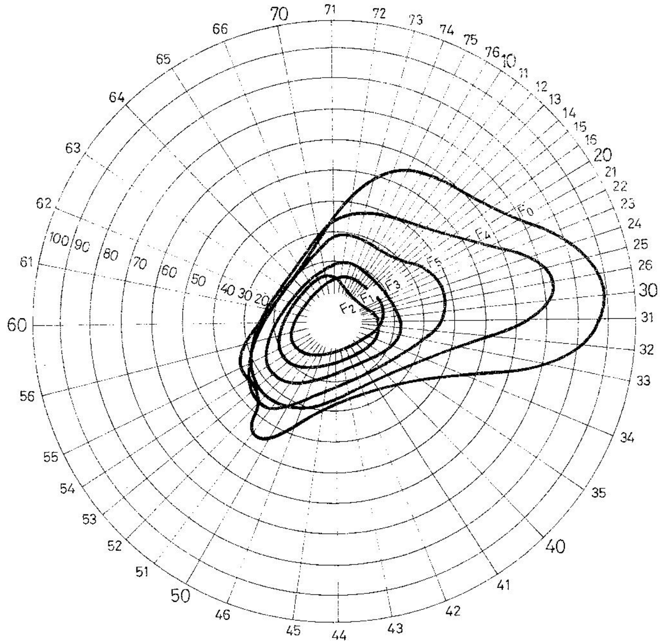


Fig. 4.64. Preferences by boys aged 6 to 8 for 291 colours uniformly distributed in the colour space

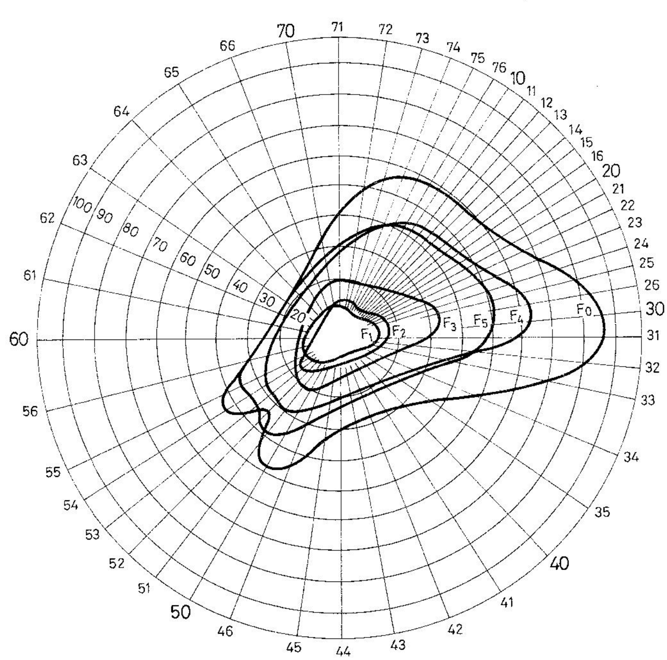


Fig. 4.65. Preferences by boys aged 9 to 10 for 291 colours uniformly distributed in the colour space

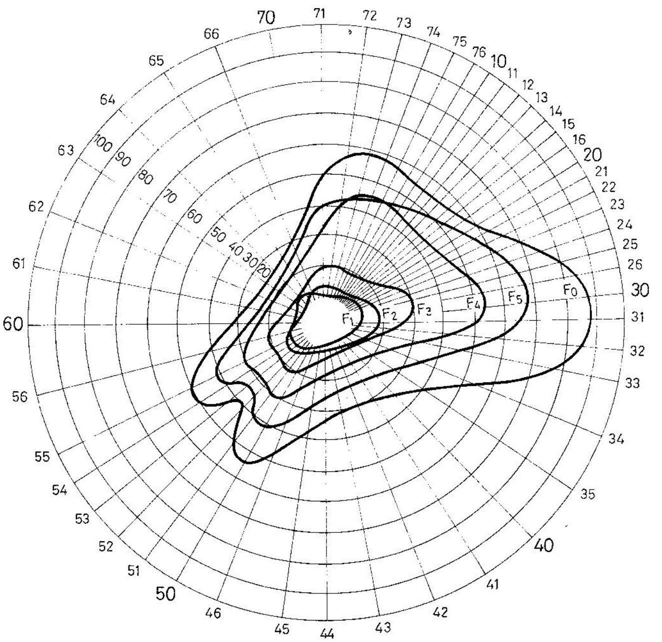


Fig. 4.66. Preferences by boys aged 11 to 12 for 291 colours uniformly distributed in the colour space

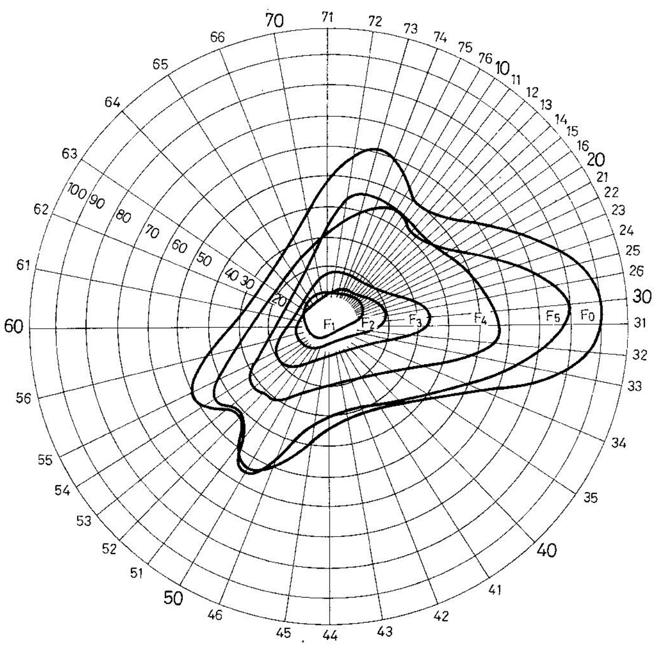


Fig. 4.67. Preferences by boys aged 13 to 14 for 291 colours uniformly distributed in the colour space

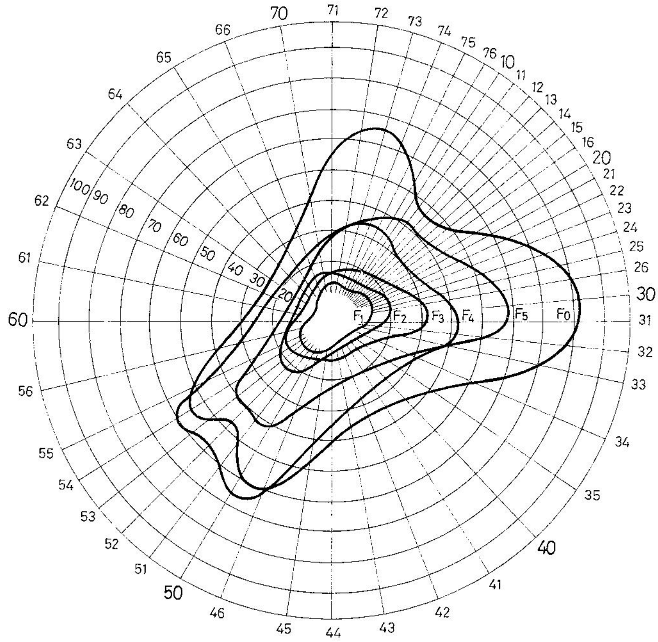


Fig. 4.68. Preferences by boys aged 15 to 16 for 291 colours uniformly distributed in the colour space

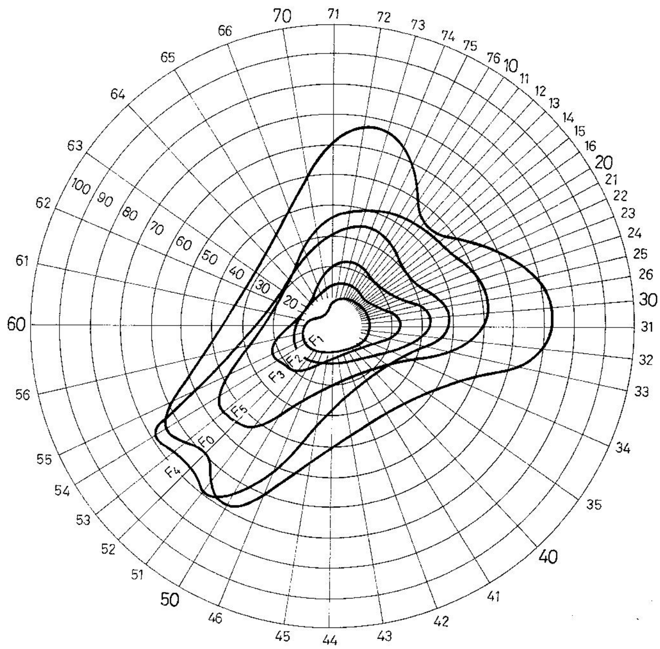


Fig. 4.69. Preferences by boys aged 17 to 19 for 291 colours uniformly distributed in the colour space

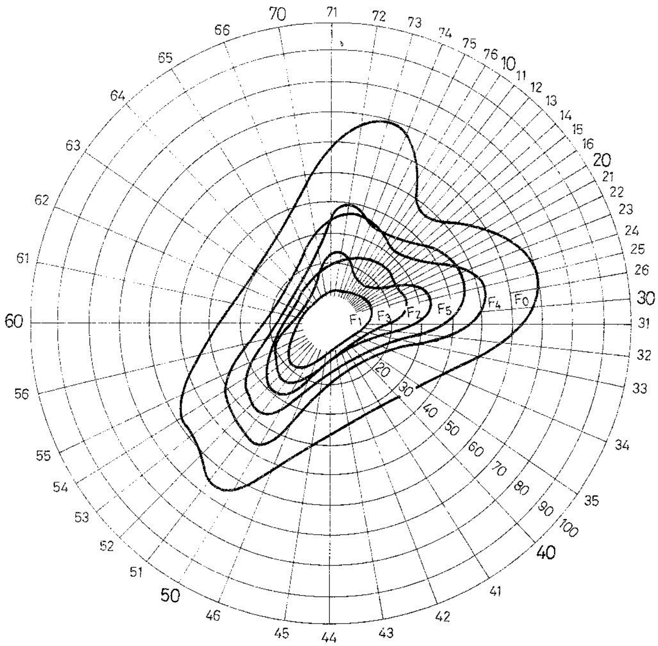


Fig. 4.70. Preferences by men aged 20 to 30 for 291 colours uniformly distributed in the colour space

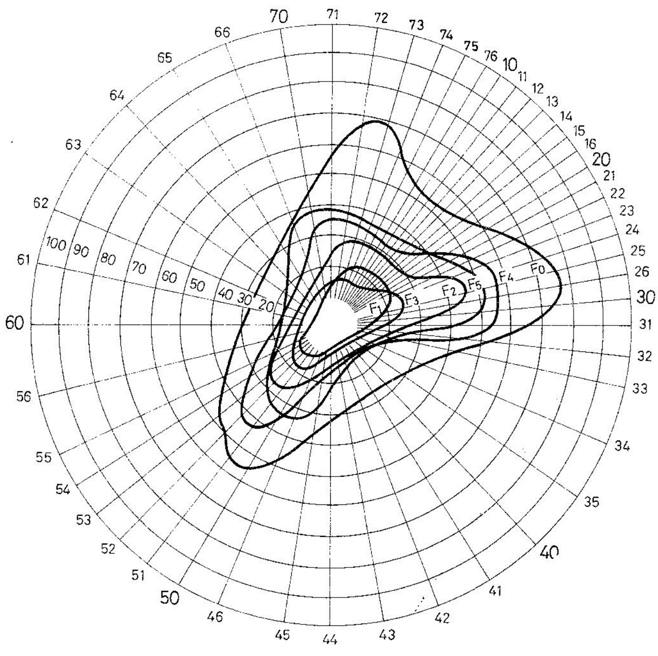


Fig. 4.71. Preferences by men aged 31 to 40 for 291 colours uniformly distributed in the colour space

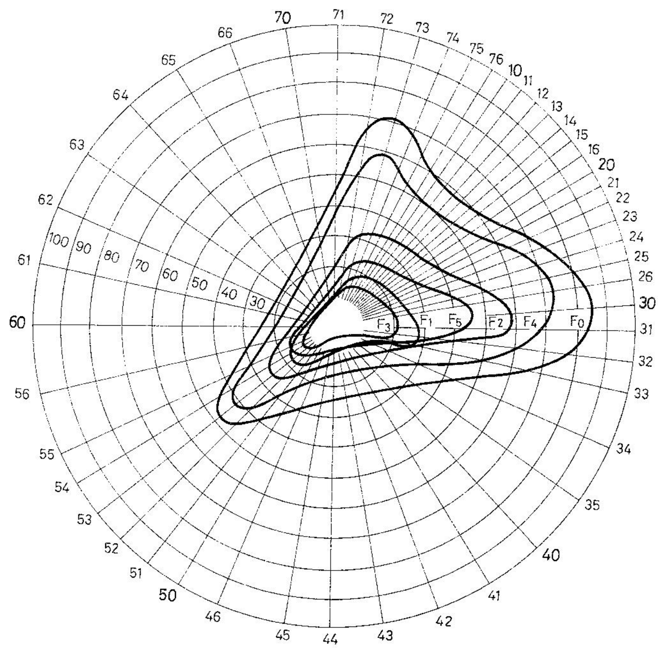


Fig. 4.72. Preferences by men aged 41 to 50 for 291 colours uniformly distributed in the colour space

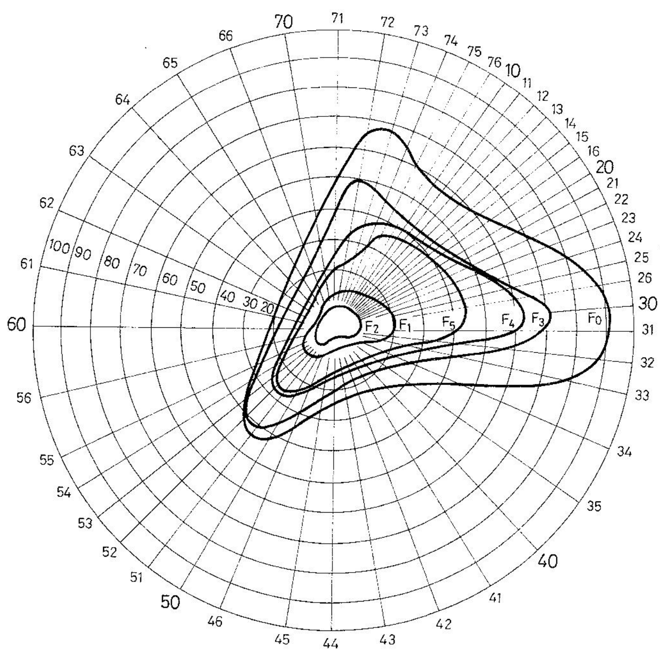


Fig. 4.73. Preferences by men over 51 years for 291 colours uniformly distributed in the colour space

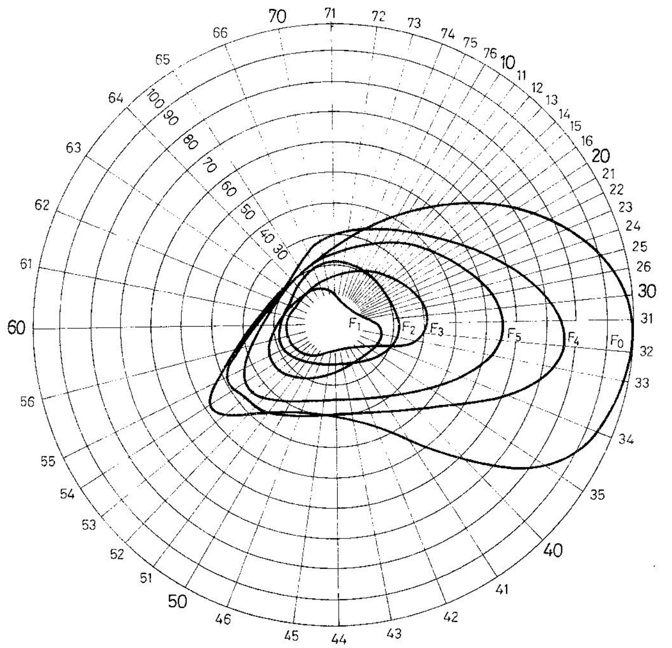


Fig. 4.74. Preferences by girls aged 0 to 2 for 291 colours uniformly distributed in the colour space

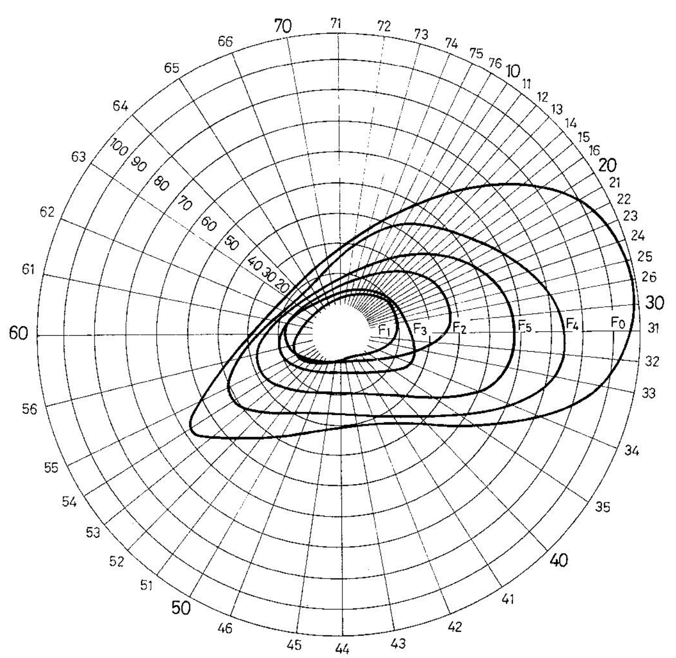


Fig. 4.75. Preferences by girls aged 3 to 5 for 291 colours uniformly distributed in the colour space

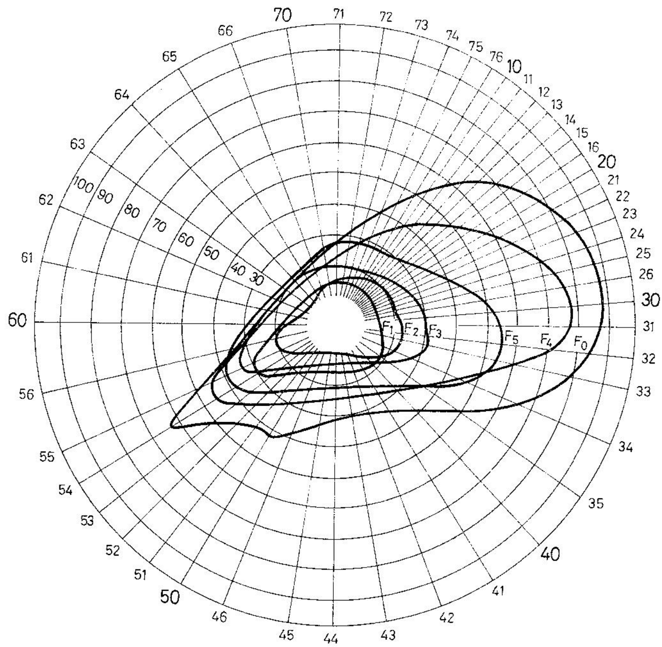


Fig. 4.76. Preferences by girls aged 6 to 8 for 291 colours uniformly distributed in the colour space

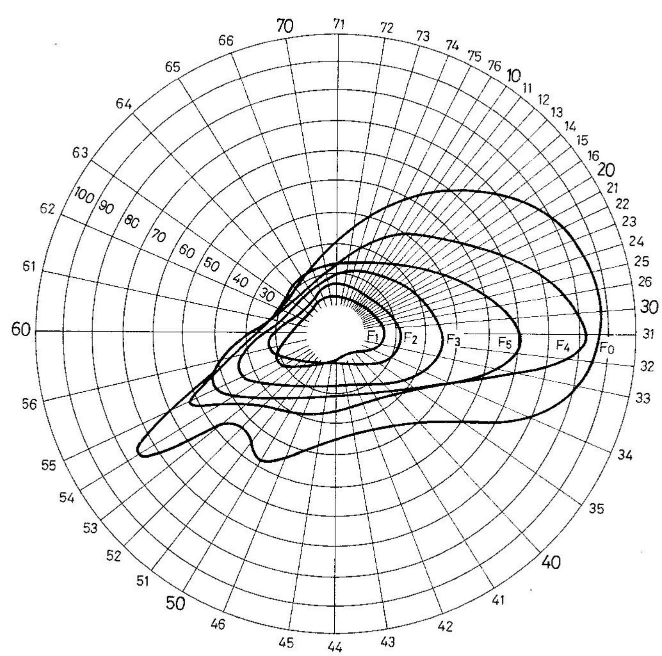


Fig. 4.77. Preferences by girls aged 9 to 10 for 291 colours uniformly distributed in the colour space

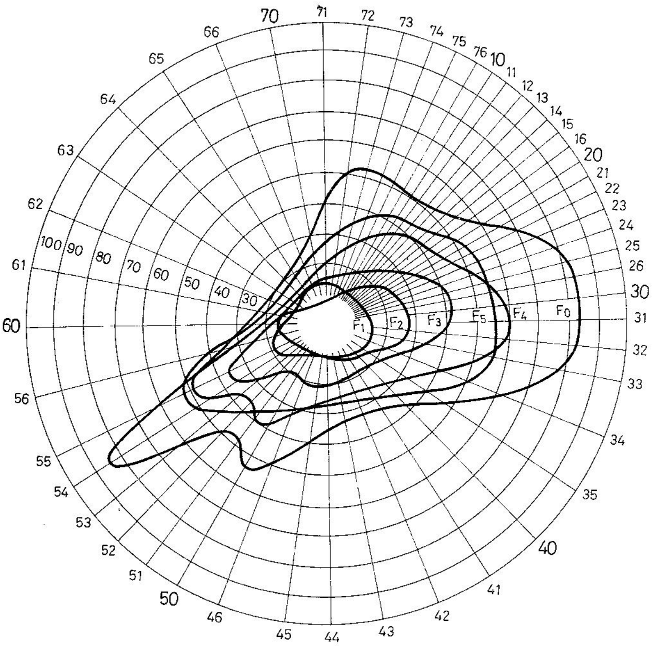


Fig. 4.78. Preferences by girls aged 11 to 12 for 291 colours uniformly distributed in the colour space

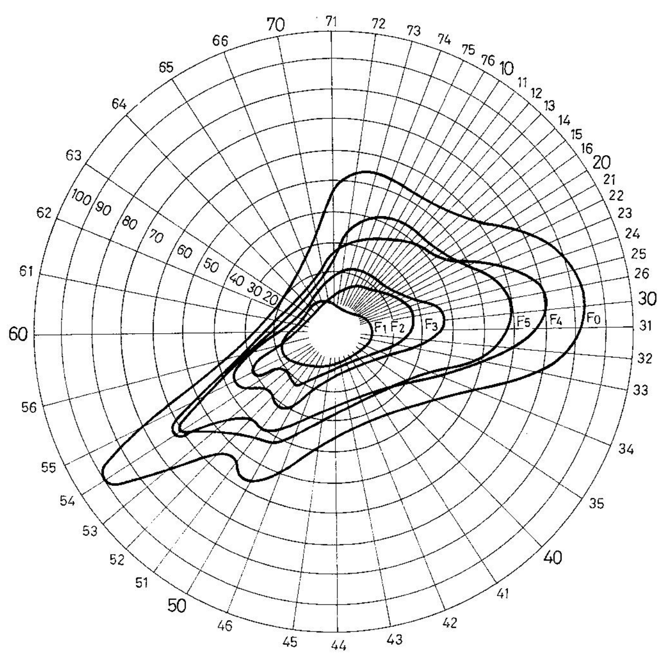
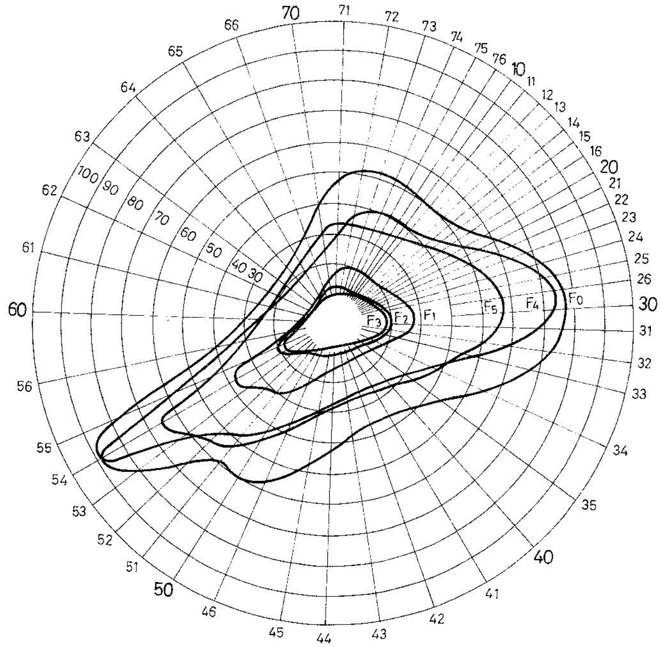
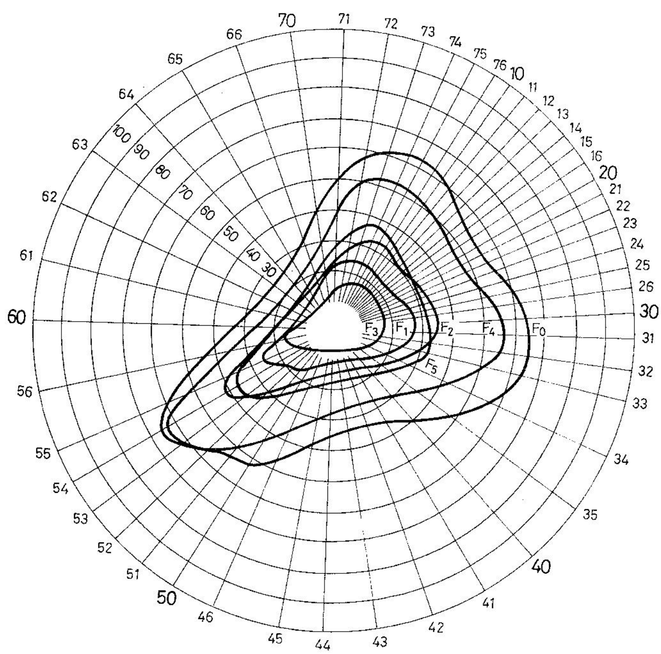


Fig. 4.79. Preferences by girls aged 13 to 14 for 291 colours uniformly distributed in the colour space



4.30. Preferences by girls aged 15 to 16 for 291 colours uniformly distributed in the colour space



Preferences by girls aged 17 to 19 for 291 colours uniformly distributed in the colour space

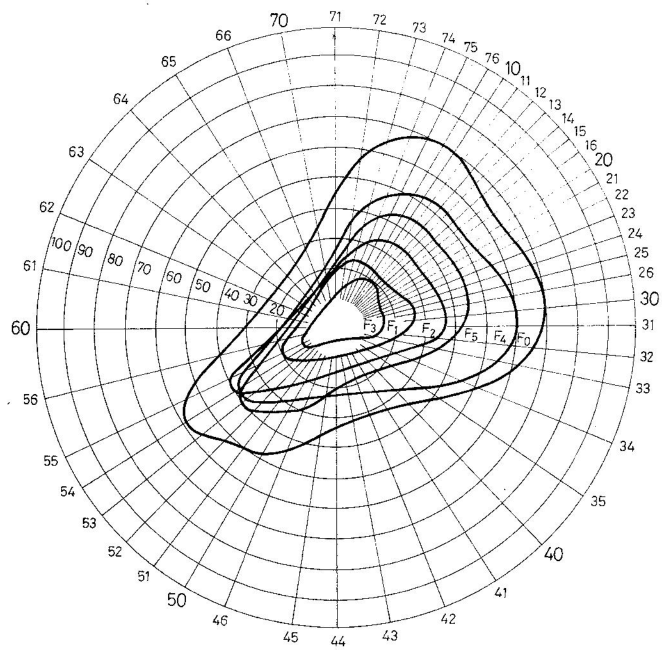


Fig. 4.82. Preferences by women aged 20 to 30 for 291 colours uniformly distributed in the colour space

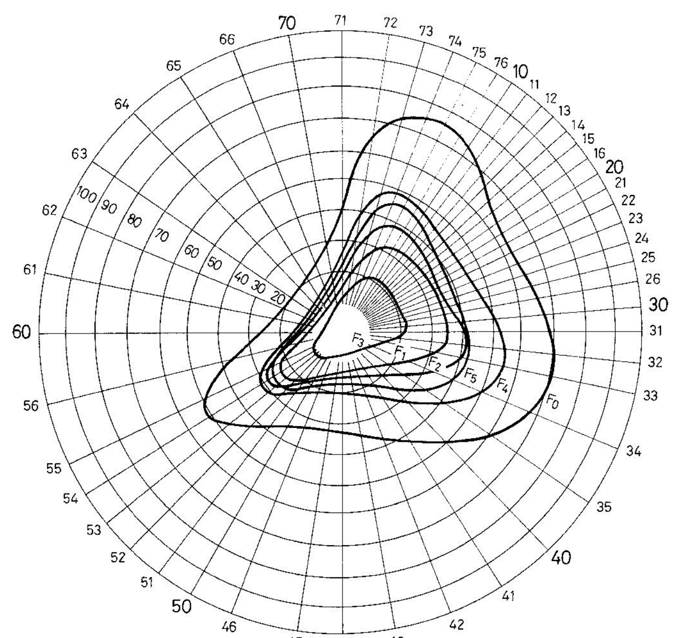
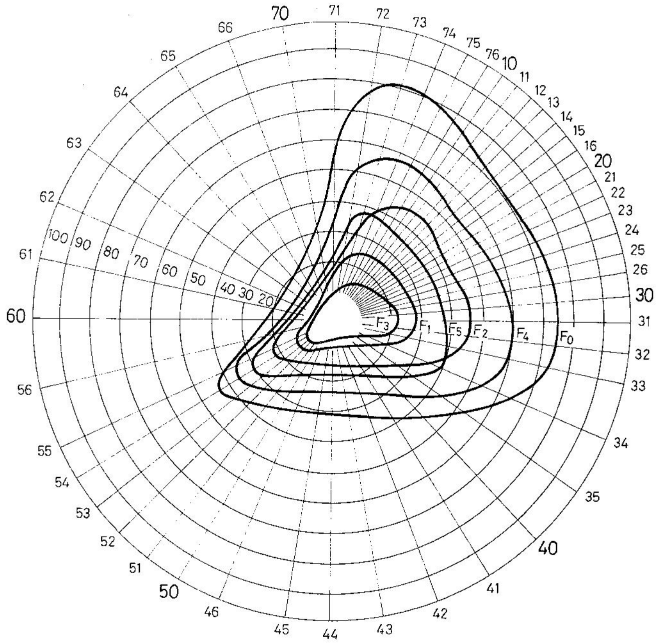
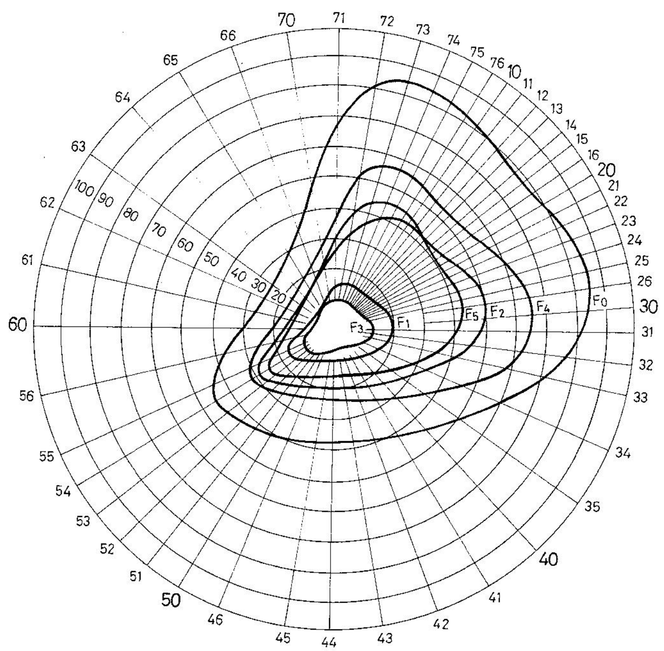


Fig. 4.83. Preferences by women aged 31 to 40 for 291 colours uniformly distributed in the colour space



- 14 Preferences by women aged 41 to 50 for 291 colours uniformly distributed in the colour space



- 15 Preferences by women over 51 years for 291 colours uniformly distributed in the colour space saturated dark colours in any colour domain, while girls prefer medium saturated dark colours to light ones in colour domains red and green. Over 20 years of age, less saturated shades are ever more preferred, mainly by women. Beginning with 30 years, warm green, red and blue prevail in colour selection. When women choose green it is a more yellowish, red more purplish, and blue colder.

Preference values for every colour in colour planes corresponding to 48 Coloroid basic hues are obtained from:

$$P = AT^2 + BTV + CV^2 + DT + EV + F, \tag{120}$$

written for nine data in every colour plane, where P stands for preference, T for saturation, and V for lightness. Coefficients A, B, C, D, E, F have been selected so that section $T=0$ corresponding to the achromatic scale should be equal for every age group. So first coefficients C, E, F have been determined from data for points of white, gray and black, followed by other equations written by means of other points. Coefficients A, B, D have been determined from this redundant system of six equations with three unknowns, on the basis of the condition of least error square sum. It has to be noted that the equation for the most saturated surface colour has been accounted for with a weight factor ten. Interpolation between corresponding colour points of adjacent sections permits us to assign a preference value to every point ot the colour space.

For use in practical colour design, colour preference of a discrete colour for every ten Coloroid lightness units, and every four Coloroid saturation units in every colour plane have been computed, totalling for all the age groups 2248 preference values in each colour plane. Our preference tables contain a total of 107 904 index numbers, of them a set is presented in Appendix. These tables are useful in practical colour design, in particular, in the stage of colour delimitation (see Chapter 7). Adequate information on preferences for various domains of the colour space can be found in the circular diagrams above, which in the absence of tables can fulfil moderate demands. The entire set of tables will be issued as a separate publication.

4.2.13. Colour Preferences in History

Nowadays, there is an increasing tendency to clad historical towns in colours reflecting or expressing the age and original architectural style of buildings. In this case among the aspects of colour dynamics to be considered in colour choice, the historic points of view should prevail. In other words, instead of present day colour preferences, colours expressing the building age have to be selected. Historical ages can be impressively characterized by their colour preferences which originated by interaction between several factors.

Human colour preferences have always had physiological fundamentals. A sufficiently broad selection underlying appreciation of colour perceptions could only be provided by an adequately developed visual organ. Our relation to colours has, however, always been determined by the mentality of the given age, shaping and modulating ancient messages associated with colours. Means permitting the coloration of human environment, that is, paints and natural or artificially coloured materials have been the objective conditions and at the same time, proofs of colour preference, materializing the human desire to rejoice in colours.

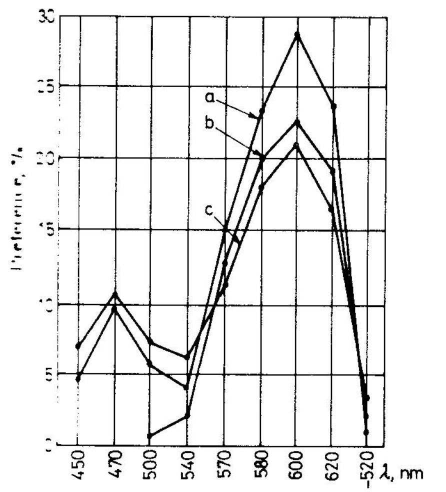
...s a proven fact that colour distinction ability of the human eye is in continuous, and ... development. The number of shades distinguishable to an average present day ... much exceeds that of some hundred years ago. The sensitivity of vision can be ...ped, sensitivity of a painter's eye may be the multiple of that of a non-professional. ...erall definition of an age, the spirit of that age primarily reflects actual social ...ions, relation of people to nature, to the world, knowledge and faith, ambitions ... desires. An interplay of all these factors shaped relation to, and preference for ...rs by mankind in historical ages.

...ssibilities to express relations to colours have always been delimited by known, ...able pigments, making them the decisive, objective conditions of colour preference. ...ally, coloured minerals and plant juices have been used as pigments for decorating ... surroundings. Semantic messages have also been associated with colours. The ...ng for self-expression or to rejoice in colours urged man to extend his palette, and ... ever more colours and shades both to his environment and vocabulary.

... ancestors were willing to bring great sacrifices to take possession of new, beautiful ... Pigment mines of renown for some attractive pigments were goals of pilgrimage ... the remotest points of the known world. Man in antiquity invested perhaps more ... to create a new shade, than the alchemist in making gold, and some pigments were ... higher than gold.

...our preference in ancient Egypt is presented in Fig. 4.86, Greek, Roman, Mediae-... Renaissance colour preferences in Fig. 4.87, while those in Baroque, Rococo, ...ttocento periods are seen in Fig. 4.88. It appears that originally, colours of the red ... prevailed, then gradually gave way to blue. Against an increasing preference for ... and violet, yellow and orange gradually lost ground.

... the same time, however, variability, that is, the number of shades differing in ...ation and lightness increased within the decreasingly preferred colour domains of ... orange, and yellow. For instance, within the red domain, Egyptian Memphis and



... Colour preferences in % in ancient Egypt ... wavelengths of hues, a) ancient empire, ... empire, c) new empire

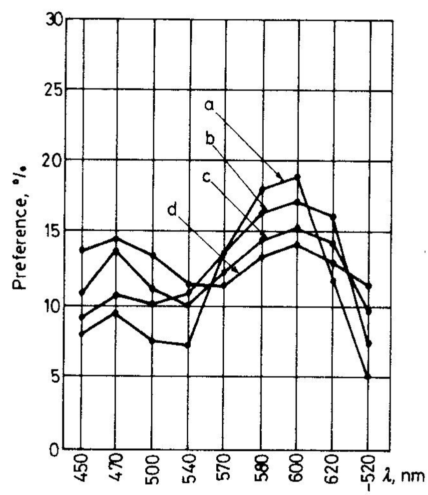


Fig. 4.87. Colour preferences in a) Hellenism, b) Roman age, c) Middle Ages and d) Renaissance. Notations as in Fig. 4.86

henna reds were similar by hue and saturation, as compared to minium, cinnabar and Pontian reds applied in Hellas, let alone the reds used in the Middle Ages, i.e. membrana, minium, cenobrium, carminium, terra rossa, vermiculum, sinopis, which were rather different not only by hue but also by saturation and lightness.

Colour preferences in Classicism and in Romanticism are given in Fig. 4.89. Change of preferences for yellow, red, and blue from ancient Egypt to the twentieth century appear in Fig. 4.90. Whilst preferences for red and blue thoroughly changed through the ages, that for yellow hardly did so. In the course of history, however, it was not only human relation to hues that underwent changes. In the Middle Ages intensive, saturated shades were liked, and so were contrasts, including lightness contrasts. In the Renais-

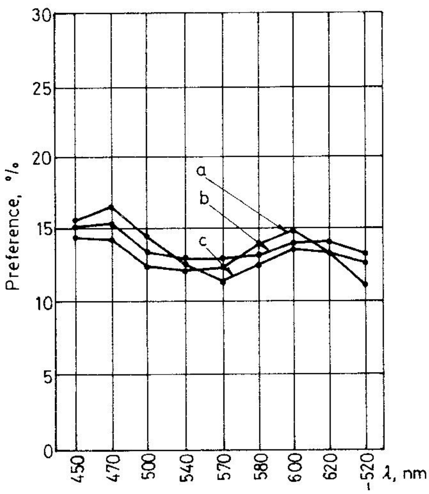


Fig. 4.88. Colour preferences in a) Baroque age, b) Rococo age and c) Ottocento. Notations as in Fig. 4.86

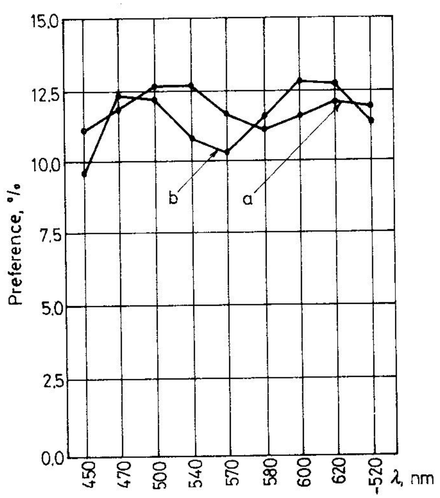


Fig. 4.89. Colour preferences in a) Classicism and b) Romanticism. Notations as in Fig. 4.86

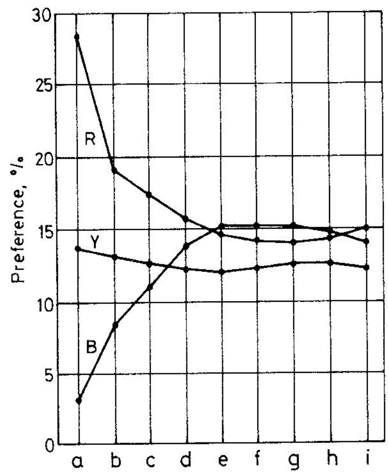
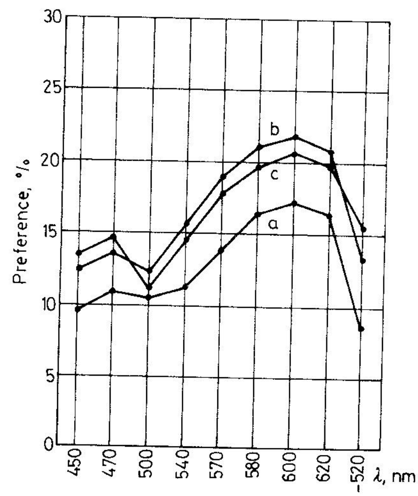
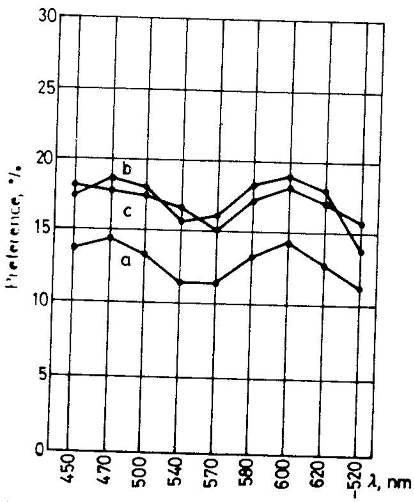


Fig. 4.90. Variation of preferences in % for red (R), yellow (Y), and blue (B) in the European culture complex. Notations along the horizontal axis: a) Egyptian, b) Hellenism, c) Roman, d) Middle Ages, e) Renaissance, f) Baroque, g) Rococo, h) 19th century, i) 20th century



4.91. Comparison of colour preferences in % vs. domi- wavelengths of hues in a) the Roman age, b) by present- boys and c) girls aged 11–12 years



Comparison of colour preferences in a) Re- b) by present-day boys and c) girls aged Notations as in Fig. 4.91

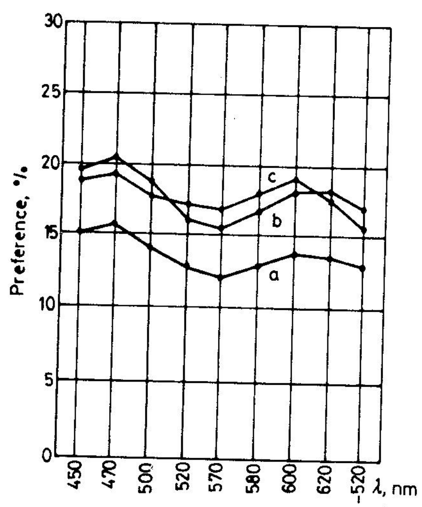


Fig. 4.93. Comparison of colour preferences in a) early 20th century to that b) by present-day men aged 20 to 30 and c) women aged 20 to 30. Notations as in Fig. 4.91

intensive shades gave way to dull shades, and saturation contrast came to ence. In the Baroque age, the scales of both saturations and lightnesses were and there was a tendency to highlight architectural elements, such as piers, courses, and capitals by shades lighter than those of the walls. In Classicism, urated tones retreated, while variation of the less saturated colours increased general, colours became lighter. In Romantic and Eclectic architecture, even saturated colours were banished, the number of colour varieties abruptly sed. architectural elements were not distinguished any more by colours, and Finally by the turn of the 20th century, almost complete greyness became If colours were used at all, their saturation was nearly zero. Since the mid-20th century, buildings became again more coloured, but the wide choice offered by the paint industry is seldom fully exploited by architects. However, in the colour design of historical town centres, colour preferences in the period of construction have to be taken into consideration.

Comparison between historical and actual colour preferences leads to interesting conclusions. Historical variation of preferences follows the pattern of colour preferences of the individual from childhood to adult age. Figure 4.91 compares preferences by boys and girls aged 11 and 12, to those realized in monuments of the Roman age. Respective Figures 4.92 and 4.93 are compared with colour preferences of boys and girls aged 17 to 19, to those in the Renaissance, and of men and women aged 20 to 30 to those of the early 20th century.