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NOTE. THE EFFECT OF COLOUR ON PERCEIVED DISTANCE WITH SPECIAL REFERENCE TO LAYER TINT MAPS

In a layer tint map a series of colours are used to depict heights. Although the map is printed on a flat piece of paper the colours may tend to create an illusion of varying height and it is desirable that this effect should work with the layer tinting, so that higher ground is in a colour that rises from the paper and lower ground sinks into it. This is certainly not the only criterion for choosing colour for layer tint maps but it is sufficiently important to merit investigation. This note describes existing work on colour and depth which is discussed in relation to map design.

If identical red and blue lights are viewed at the same distance, the red is frequently reported as nearer. This is a purely optical effect called the 'colour stereoscopic effect' (Kishto, 1965). According to Vos (1960) the phenomenon is the result of two optical effects in the eye, one due to chromatic dispersion and the other related to the pupil. There are large individual differences in the effect and it is not uncommon for people to report the blue light nearer than the red, which is almost certainly due to variations in the optics of the eye. The effect is not a particularly strong one, it is directly related to the wavelength of the light, and operates best with lights or with bright, saturated colours of a kind not usually found on maps.

In complete contrast to this effect, our experience and culture have taught us to associate certain colours with depth. One example is the artist's use of blue to represent distance. On misty days distant objects have a bluish appearance and this is sometimes used by painters in a slightly exaggerated way to depict distance. (It is usually combined with a decrease in chroma, an increase in value and a slight blurring which together are sometimes called 'aerial perspective'). There is no evidence that this kind of colour association leads to strong impressions of depth, and it appears to be easy to ignore if it conflicts with other information.

In what other ways does colour effect the perception of depth? There are almost certainly other effects in operation but they have not been isolated. Several experiments have been carried out to compare the distance of a coloured object with the distance of a standard coloured black, white or gray. Unfortunately the literature is far from clear. Wallis (1935) found that subjects saw yellow objects as nearest, then white, red, green, black, and blue furthest away. There was no attempt to standardise the value or chroma of these colours so this order of hues may be misleading. A similar result was found by Taylor and Sumner (1945) and by Johns and Sumner (1948) who suggested that the value (brightness) might be the main factor which affected depth. Mount, Case, Sanderson and Brenner (1956) obtained judgements on the apparent distance of red, yellow, blue and green coloured objects, and gray objects of similar reflectance, all of which were viewed at a distance of 200 feet. With the grays, apparent distance was a U-shaped function of luminance, with white and black being seen as closer than middle grays. With the coloured objects there was a similar U-shaped function, but with colours seen as

By comparing times a 'relative dominance' score can be calculated for the tints. Oyama claimed that red tints dominate more than blue tints, but he did not hold chroma constant so this could be a confounding factor.

A simpler method has been used by Dent (1970, 1972) who was working with textures rather than tints. He placed two square areas of texture next to each other and simply asked the subject which was the 'figure'. Subjects showed a fair degree of consistency and, within certain limits, chose the coarser of two textures as the 'figure'. It is unfortunate that Dent did not alter his variables in a systematic way and so his data are difficult to interpret. Another criticism is one which also applies to Oyama's method: the background may be very important. Dent's squares may not have been compared with each other, but each separately compared against the background on which they were lying. It is possible that if Dent's squares were seen against a very coarse background, he would have found the reverse result: the less coarse texture is seen as the figure.

From this brief review of the literature, it would appear that both the colour distance effects and the related figure/ground effects are strongly affected by the conditions under which they are tested. The picture is a confused one and it is impossible to make any clear statement about the effect of coloured tints on the figure/ground organization of a map.

REFERENCES

- DENT, B. D. (1970). Perceptual organization and thematic map communication. Place perception research report No.5. Cartographic Laboratory, Clark University.
- DENT, B. D. (1972). Visual organization and thematic map communication. An. Ass. Amer. Geog., 62, 79-93.
- EDWARDS, A. S. (1955) Effect of colour on visual depth perception. J. Gen. Psychol., 52, 331-333.
- JOHNS, E. H. & SUMNER, F. C. (1948). Relation of brightness differences of colours to their apparent distances. J. Psychol., 26, 25-29.
- KISHTO, B. N. (1965). The colour stereoscopic effect. Vision Research, 5, 313-329.
- MOUNT, G. E., CASE, H. W., SANDERSON, J. W. & BRENNER, R. (1956). Distance judgment of coloured objects. J. Gen. Psychol., 55, 207-214.
- OYAMA, T. (1960). Figure-ground dominance as a function of sector angle, brightness, hue and orientation. J. Exp. Psychol., 60, 299-305.
- OYAMA, T. & YAMAMURA, T. (1960). The effect of hue and brightness on the depth perception in normal and color-blind subjects. Psychologia, 3, 191-194.
- TAYLOR, J. L. & SUMNER, F. C. (1945). Actual brightness and distances of individual colors when their apparent distance is held constant. J. Psychol., 19, 79-85.
- WALLIS, W. A. (1935). The influence of colour on apparent size. J. Gen. Psychol., 13, 193-199.
- VOSS, J. J. (1960). Some new aspects of colour stereoscopy. J. Opt. Soc. Amer., 50, 785-790.