A Model for Implementing Color Contrast in the Environment Of the Elderly

(function, occupational therapy, theoretical, visual clarity)

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Much has been written on the use of color as a functional facilitator in the environment of the elderly, but little information is available on how to implement it. This paper a) re-states the main age-acquired visual defects, b) critically examines the literature on the use of environmental color, and then c) proposes a model which incorporates the factors that enhance visual clarity and Johannes Itten’s rules of color contrast. Implicit in the application of color to enhance vision is a clear understanding of the main functional purpose of the area to be heightened.

The effects of aging on the visual system and the subsequent negative impingement on function have been well documented (1, 2). Many authors (3–8) cite the use of color contrast as a means of enhancing existing visual ability, but they usually leave the implementation of this process open to the interpretation and devices of the readers. This paper, therefore, reviews the literature and suggests a theoretical model for pragmatic use based on the rules of color contrast as established for artists by Itten (9) of the Bauhaus. For a comprehensive review of the effects of aging on vision, the reader is referred to authors such as Cristarella (1) and Pokorny et al. (2).

Effects of Normal Aging on Vision

Normal aging diminishes acuity (the capacity to see detail) and the ability to focus on objects at varying distances. Visual fields shrink. The ability to adapt to varying degrees of light and to discriminate contrast and differentiate color is affected. A variety of perceptual changes occur, such as increased visual ambiguity, the maintenance of figural aftereffects, and diminished depth perception, decreased visual memory, and the ability to establish closure. These changes appear to be related to normal degeneration of both central and peripheral mechanisms and are compounded by pathology, most commonly macular degeneration, cataracts, and glaucoma. The end result is information loss and increased misinformation about the environment, which interferes with function (1, 2). To minimize this, we suggest using color contrast to clarify key components of the environment.

Literature Review

Environmental Color

The literature on the appropriate use of environmental color for the elderly is primarily descriptive (3–8). In general, this literature advocates the selective use of environmental color to a) prevent the adverse effect of sensory deprivation (5), b) promote mood enhancement (4, 6, 7), and c) serve as a means of cueing and coding for function (6, 7).

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Factors Influencing Visual Clarity

Of these results to the population of interest here is questionable (12,13). Thus, extrapolation to the retarded or learning dis­abled becomes difficult or impossible to make. Thus, the chain of action that permits people to function in their environment may be blocked. However, there is not much literature on the use of color cueing that relates specifically to the elderly. Most research has concentrated on aspects of cognitive learning (usually reading), and thus subjects are usually young school children or university students. The role of color in learning has been reviewed by Otto and Askov (11), who state that the use of color as a cueing agent is not conclusive, but that on the whole it seems to enhance learning, especially if it is teamed with other cues or if other cues are absent.

Many activities of daily living can be classified as psychomotor skills, most of which have already been learned by the population in question and have become semiautomatic acts. Color-cueing studies in this area primarily deal with the teaching of new psychomotor skills to the retarded or learning dis­abled (12,13). Thus, extrapolation of these results to the population of interest here is questionable (13).

Factors Influencing Visual Clarity

Color is a complex, subjective phenomenon that, in simplest psychological terms, may be said to have three attributes: hue, brightness, and saturation (14–16). In psychometric terms, these may be approximated to dominant wave length, luminance, and purity, respec­tively. Pease (14) points out that changes in one (psychometric) variable may affect all three psychological attributes of color (p 739) and further emphasizes the complexity of the subject. Color contrast can be defined as perceived differences of juxtaposed edges and can be produced by varying one or more of the three above-mentioned attributes of an object in relation to its surroundings or ground (17,18). Physiologically, the reception of color is processed by three kinds of cones: red (R), green (G), and blue (B). Evidence indicates that it is only the R (long wave length receptors) and G (middle wave length receptors) cones, not the B (short wave length receptors) cones, that mediate the perception of chromatic borders (17,19,20). In the absence of color, luminance alone can create contrast (18). However, “when borders are formed by the combination of chromatic differences and luminance contrasts, they are more visible than borders that have only the same chromatic or luminance contrast alone” (17, p 148). High luminance creates more con­trast than low (17); peak wave length sensitivities for color vision have been found to be at 550 nm (yellow) (21). While the ability to discriminate short wave lengths (blue) (1,2, pp 243,244) diminishes with age, the ability to dis­tinguish between red and green increases (14).

The perception of area color is also affected by the color of its surroundings, precipitating a phe­nomenon known as simultaneous contrast (22,23). Simply stated, this is the enhancement of salient features of the colors in question (e.g., a light color appears lighter if surrounded by a dark color and vice versa; a red surrounded by its complementary, green, seems “redder,” the green, “greener”). Perception is also affected by the quantity of small area colors im­mediately surrounding the focal stimulus. As these increase, the ability to identify the focus in­creases (1,16). This is known as “figure-ground confusion.” Size also affects the ease of identification of the focal stimulus. Finally, adequate area lighting is essential for clarity of vision in the environ­ment (2, p 243,24). Also, glare should be avoided (1,2,p 23).

Visual clarity, therefore, is posi­tively influenced by a number of factors: a) contrast as established by both chromatic and luminance differences, b) high luminance as opposed to low, c) minimal figure­ground confusion, d) adequate stimulus size, e) color surrounding of the stimulus focal, f) matte surfaces to minimize glare, and g) ad­equate lighting.

To summarize, the literature, while weak in the area of general environmental influence, cueing, and coding, does strongly support the argument that color contrast can be used to promote visual clarity. Thus, on the basis of this and in the absence of other guidelines, the work of Itten (9) may be ex­amined as a pragmatic guide for developing and applying color con­trast to the environment.

Itten’s Rules of Contrast

Artists have long used the seven rules of contrast established by It­ten (9) of the Bauhaus. It is of interest to note that these rules have subsequently been upheld by scientific research (23). Itten (9,p 32) states that contrast can be achieved in the following ways: a) contrast of hue, b) light/dark con­trast, c) warm/cool contrast, d)
complementary contrast, c) simultaneous contrast, f) contrast of saturation, and g) contrast of extension.

- **Contrast of hue**—Hue is the term used to differentiate the various identifiable wave length components of the visible spectrum (e.g., blue, green, yellow, orange, and red). Contrast by hue, therefore, compares two or more of these elements.

- **Light/dark contrast**—Hues may be compared to white or black, with the lighter colors (e.g., yellow) being more analogous to white, and the darker colors (e.g., navy blue) being closer to black. Brightness, saturation, and hue all affect this dimension.

- **Warm/cool contrast**—Artists define warm colors as those closest to the red end of the spectrum (e.g., yellow, orange, and red). Conversely, colors farther from that end are considered to be cool colors (e.g., green, blue, and violet). However, each of these hues has a warm/cool component within itself, and subtle contrast could be achieved, for example, by contrasting a warm red with a cool red. Itten (9, p 46) cites the strongest warm/cool contrast as red/orange against blue/green.

- **Complementary contrast**—Artists define complementary colors as those colors that combine (when in pigment form) to produce brown/black. Complementary colors are located opposite each other on the color wheel (see Figure 1) and when juxtaposed in varying proportions, accentuate each other. Goethe's (9, p 59) area proportionalities for harmony of complementary pairs are:

  - yellow:violet = 3:1
  - orange:blue = 2:1
  - red:green = 1:1

- **Simultaneous contrast**—Juxtaposed colors affect each other in a manner that tends to generate the complementary of each. For example, a red and green will interplay so that the red looks "redder" and the green looks "greener." This can become highly complex and is a major factor affecting the perception of multiple colors.

- **Contrast of saturation**—This category refers to the amount of characteristic wave lengths or pigment each color contains. It therefore is a quantifiable contrast, which states that pale or diluted colors are more noticeable when placed next to colors containing a greater amount of pigment.

- **Contrast of extension**—This final category is also quantifiable and refers to the size of the contrasting areas. It should be noted that light colors on a dark ground are more visible than equal-sized dark areas on a light ground.

**A Model of Environmental Color Contrast**

This model, of necessity, is a dynamic one, because visual environments vary continually in lighting, distance, and component objects. The model incorporates the visual enhancement factors as delineated in the literature review along with Itten's (9) rules. Overriding and implicit in color intervention is the need to clearly define the purpose of the area and the function expected with or without it. The model also allows for the expression of cultural and personal tastes (see Figure 2). The priorities of safety and function must be established because the enhancement of too many environmental features creates figure-ground confusion.

**Applying the Model**

To apply the model, a series of organizational steps may be taken. We suggest the following.
**Organization**
- Identify the purpose(s) of the color intervention.
- Identify general limitations to implementing the intervention, such as structure, budget, or time.
- Establish and rank specific objectives (priorities).

**Application**
- Identify items that will receive the color intervention.
- State present color of these items.
- Identify the usual background of use.
- State background color.
- On the basis of the above information, make an ideal color decision. (Use as many of the model’s contrast and visual enhancement factors as possible.)
- Note specific limitations, including personal and cultural factors.
- Make final modified color intervention decision.
- Decide on method of color application.

Tables 1 and 2 illustrate this further. In the interest of brevity, the list of items is not exhaustive and has been developed only sufficiently to make the point.

We should mention that the issue of minimizing figure-ground confusion is often difficult to deal with because too strict of an adherence to this principle can produce a rigid, sterile environment. A rule of thumb is to relate, clump, and distance objects not in constant use and to separate the more useful articles, such as glasses, into easily accessible, visible compartments. Personal and cultural tastes also influence the degree of figure-ground confusion to be found, and care must be taken to promote the visual clarity factors without precipitating negative emotional reactions to the environmental changes.

**Conclusion**

On the basis of a review of the literature, a theoretical model that applies Itten’s (9) rules of contrast and other visual enhancement factors has been proposed as a guide for applying color contrast to the environment. While the model is suggested primarily for the elderly to counteract the negative effects of aging on vision, it can be specifically used for any population that has visual problems or for the interactions of any population with distance objects.
<table>
<thead>
<tr>
<th>Objective</th>
<th>Item</th>
<th>Existing Color</th>
<th>Background</th>
<th>Ideal Contrast</th>
<th>Limitations</th>
<th>Final Color</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeding</td>
<td>Cutlery handles</td>
<td>Silver</td>
<td>Cream colored trays</td>
<td>Choice of black or any saturated primary or secondary color</td>
<td>Dish washing procedures in institution prevent making any changes Nurses to monitor and keep on ward</td>
<td>No change</td>
<td>No change</td>
</tr>
<tr>
<td></td>
<td>Trays*</td>
<td>Light cream</td>
<td>Light cream tables</td>
<td>Choice of saturated primary and secondary colors</td>
<td></td>
<td>Any saturated primary or secondary color</td>
<td>Purchase</td>
</tr>
<tr>
<td>Toileting</td>
<td>Toilet seat</td>
<td>Black</td>
<td>White toilet</td>
<td>Good contrast Colored graphic to unite elements in orange, yellow, red range</td>
<td>No change</td>
<td>Colored graphic: yellow, orange, red range</td>
<td>Paint</td>
</tr>
<tr>
<td></td>
<td>Toilet unit, grab bars, and paper dispenser (housed in small room off bedroom)</td>
<td>White, black, and silver</td>
<td>White painted walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>Wheel chair: brakes and foot rests</td>
<td>Silver</td>
<td>Grey terrazzo floor</td>
<td>Saturated yellow Glare of metal and floor cannot be modified</td>
<td>Brillant saturated yellow</td>
<td>Safety tape</td>
<td></td>
</tr>
<tr>
<td>Batting</td>
<td>Bathtub</td>
<td>White</td>
<td>White tile walls and grey terrazzo floors</td>
<td>Choice of saturated red or orange</td>
<td>Saturated orange or red</td>
<td>Saturated orange or red</td>
<td>Nonskid tape to grab bars, edges, and bottom of tub</td>
</tr>
<tr>
<td>Grooming*</td>
<td>Comb</td>
<td>Black</td>
<td>Bedside table: pale grey</td>
<td>Red</td>
<td>Increase size, red</td>
<td>Saturated yellow</td>
<td>Paint</td>
</tr>
<tr>
<td>Dressing*</td>
<td>Closet</td>
<td>Cream</td>
<td>Cream walls, grey terrazzo floors</td>
<td>Saturated yellow Four-bed unit: one color assigned to each unit of red, green, yellow, royal blue</td>
<td></td>
<td>Saturated yellow</td>
<td>Paint</td>
</tr>
<tr>
<td>Leisure*</td>
<td>Glasses</td>
<td>Metal</td>
<td>Varied: usually top of bedside table or drawer</td>
<td>Brilliant yellow Patient does not want glasses altered</td>
<td></td>
<td>Brilliant yellow</td>
<td>Apply to case (tape or purchase new case); add yellow neck cord; designate specific storage spot on bedside table and paint or tape this yellow</td>
</tr>
<tr>
<td>General environmental</td>
<td>Bell pull for nurses</td>
<td>White</td>
<td>Light cream walls</td>
<td>Saturated red Small size Increase size, saturated red</td>
<td></td>
<td>Purchased wooden drawer knob painted and attached to pull</td>
<td></td>
</tr>
</tbody>
</table>

* Color contrast choice used will vary for each resident in these sections when individuality takes priority.
the environment. Adding color to surroundings to promote visual clarity may also possibly influence mood and clearly provides the means for cueing and coding. However, because these factors cannot be isolated and their effects have not been substantiated in the literature, their independent or interdependent contributions to function cannot be addressed at this time. Finally, the model lends itself to future testing because desired outcomes can be identified and quantified. For example, the proposed study used to illustrate the application section will measure activities of daily living function; a control group who will receive the same occupational therapy treatment with no color intervention will provide comparative outcome measures. Thus, on the basis of these findings, modifications can be made to the model and to its future application.

ACKNOWLEDGMENTS

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REFERENCES

19. Tansley B: A line, not a space, represents visual distinctness of borders formed by different colors. Science 19:934–937, 1976