



Design for Improving Visual Accessibility:
Appropriate Contrast for Older People and
People with Low Vision

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Design For Improving Visual Accessibility: Appropriate Contrast For Older People And People With Low Vision

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Abstract. Contrast is a very important factor when improving visibility, especially for older adults and people with low vision.

An experimental study was conducted to clarify how much luminance contrast is necessary in visual signs for older people and people with low vision, using pattern displays with a simple border, squares and stripes consisting of square wave patterns.

A total of 80 people, including older people, people with low vision and, as comparison, younger people without any vision impairments, participated in the experiment.

Older people and people with low vision generally need a higher contrast than younger people do. In particular, some patterns with high spatial frequencies were found to be less visible to older people and people with low vision than to younger people.

It was also found that people with low vision prefer to see in negative contrast than in positive contrast.

The results of this study can be used for designing buildings, signs, and the outside environment with the goal of increasing visibility for older people and people with low vision.

Keywords: Contrast, Older people, Low vision, Standards, Accessible design.

1 Introduction

In building and outside walking environments, contrast is important for older people and people with low vision. For example, the edge of a staircase, a handrail, the difference between the floor and a wall, or a line drawn on the floor are very good cues when walking.

If these elements are designed in a way that provides a clear contrast, then they are more visible to low-vision and elderly people. However, not all such cues have a fixed width and size, such as induction blocks.

The combined effects of size and contrast must be investigated because the apparent size, the visual field angle, has a significant effect on visibility.

Various measurements of contrast sensitivity have been made using sine waveforms as visual characteristics¹⁾.

Although these are effective for evaluating the degree of a person's visual function, they are based on sine waveforms with a gradation of edges, and do not show the clear edge patterns common in our environment.

Therefore, it is difficult to design visual displays with good visibility based on contrast sensitivity functions.

The purpose of this study is to clarify how much luminance contrast is necessary in visual signs for older people and people with low vision using display patterns with a simple border, squares and stripes consisting of clear edge patterns.

2 Method

In total, 30 older people (average 71.8 ± 3.5 yr), 20 people with low vision (average 56.0 ± 17.5 yr) and, as comparison, 30 younger people (average 22.2 ± 2.5 yr) without any vision impairments participated in the experiment. All participants had optically corrected visual acuity with glasses to minimize subjective variations.

Ten achromatic test patterns were used and presented on a display (Fig. 1).

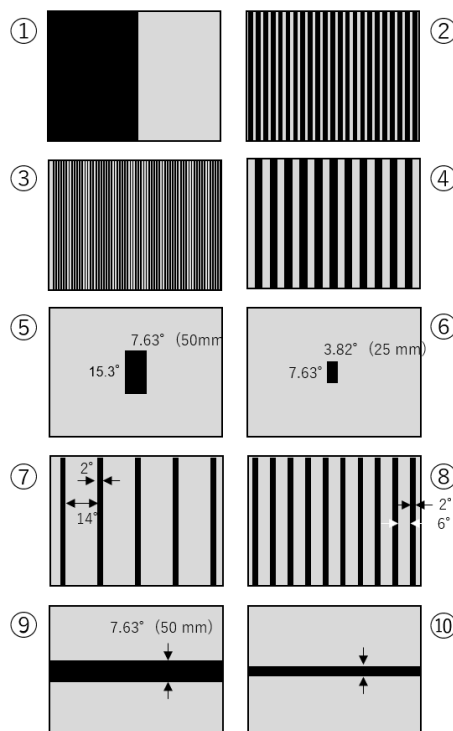


Fig.1

Fig. 1. Ten achromatic test patterns used in the experiment. 1. Outline, 2. Vertical stripes: 1 cpd (cycle per degree). 3. Vertical stripes: 3 cpd. 4. Vertical stripes: 1/3

cpd. 5. Rectangular shape: large, 6. Rectangular shape: Small, 7. Wide stripes, 8. Narrow stripes, 9. Horizontal thick line, 10. Horizontal thin line.

A total of 14 different contrast conditions, including positive and negative contrast, were set up for each pattern, whereby the background was fixed at 60 cd/m^2 (for positive contrast) and the luminance of the stripe or square was changed (Fig. 2). For negative contrast, the luminance of the background was also changed. In both cases, i.e., positive (darker patterns on a lighter background) and negative (lighter patterns on a darker background) contrast conditions, almost the same luminance ratios were chosen. The ratios ranged from 0.05 to 0.99 in Michelson contrast.

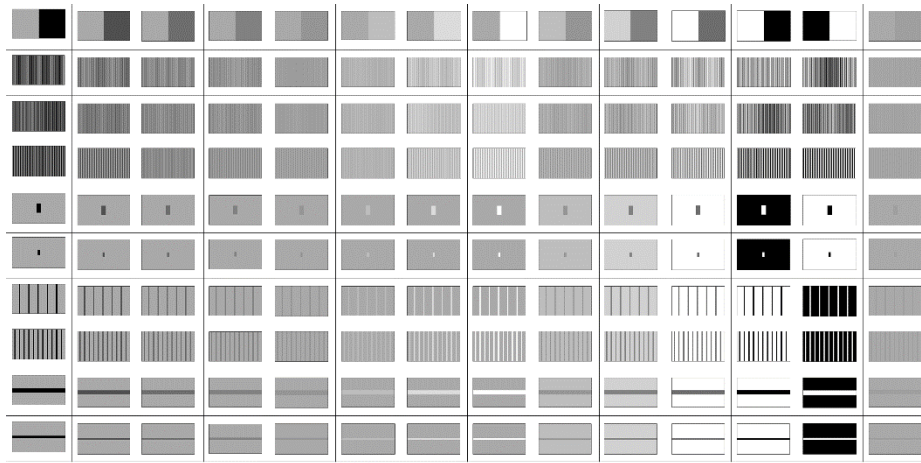


Fig. 2. 14 contrast conditions used in the experiment. Michelson contrast from left to right: 0.98, 0.52, 0.33, 0.21, 0.10, 0.09, 0.21, 0.33, 0.19, 0.41, 0.60, 0.99, 0.99, 0.05.

A total of 28 random trials were carried out for one test pattern and this was repeated for 10 different test patterns to obtain a total of 280 trials for one participant in the experiment. First all patterns were presented with a time limit of 1 s. Then, the participants were allowed to respond to two patterns with no time limit.

3 For each trial, participants reported on the visibility of the patterns (degree of visibility based on subjective sharpness and clarity) using a 5-point scale; 5: Very easy to see, 4: Slightly easy to see, 3: Normal (Cannot say either), 2: Slightly difficult to see, 1: Very difficult to see. In addition, if no pattern was seen, the answer was “0: not seen”.Results

The differences in appropriate contrasts for older people, younger people, and people with low vision were clarified using 10 patterns. In Fig. 3A-D, black circles indicate

older people, white circles younger people, and gray circles indicate people with low vision.

Older people and people with low vision generally needed a higher contrast than younger people. For simple patterns, such as a simple border, the differences between younger and older people were not so large (Fig. 3A). However, when viewing the detailed patterns (e.g., stripes with a high spatial frequency), the differences were quite significant (Fig 3B.). People with low vision had significant difficulties in seeing fine stripe patterns, and especially when the contrast was low (e.g., 0.05, and 0.1 of Michelson contrast), most people with low vision reported "0: not seen" (Fig. 3A-C). In addition, for patterns with a low spatial frequency or simple patterns, such as wide stripes, a negative contrast made the pattern more visible than a positive one for people with low vision, even when the contrast ratio was the same (Fig. 3C and 3D).

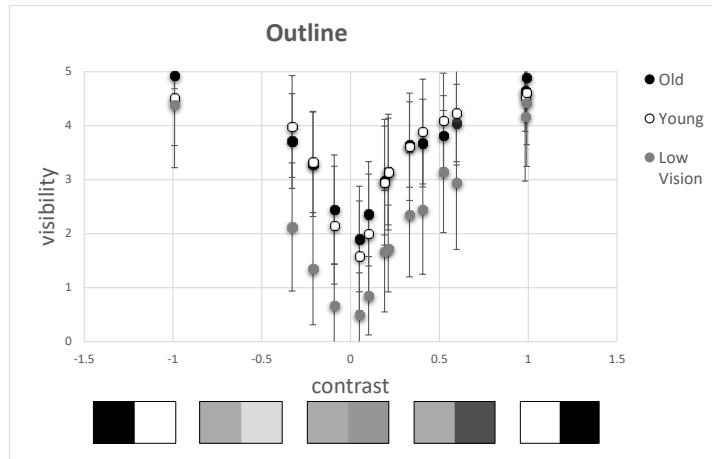


Fig. 3A. Comparison of visibility: Outline

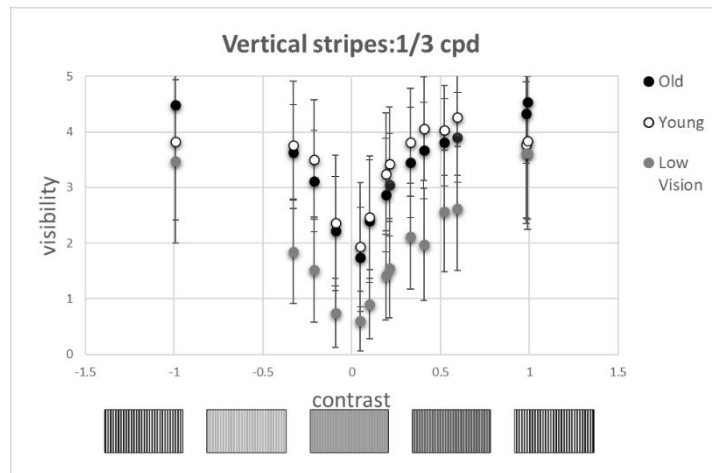


Fig. 3B. Comparison of visibility: Vertical stripes: 1 cpd.

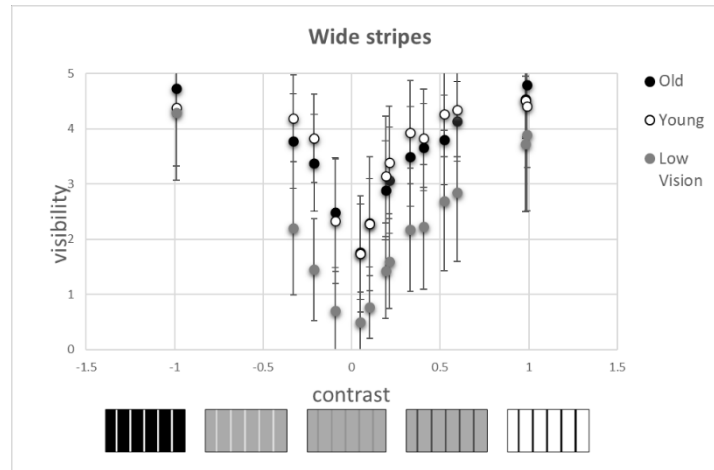


Fig. 3C. Comparison of visibility: Wide strips

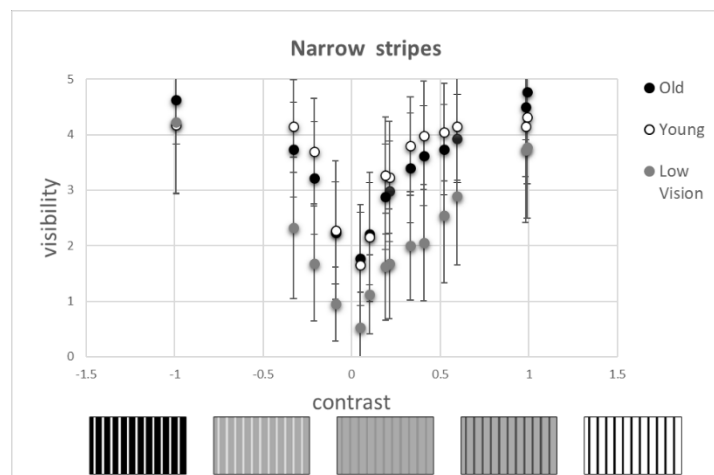


Fig. 3D. Comparison of visibility: Narrow strips

Comparing the results from with and without time limits, it was found that people with low vision reported better visibility of the contrasts when there were no time limits (Fig. 3B and 3E). The difference is significant when compared to older and younger people, which indicates that the effect of time restriction on visibility is a characteristic of low vision.

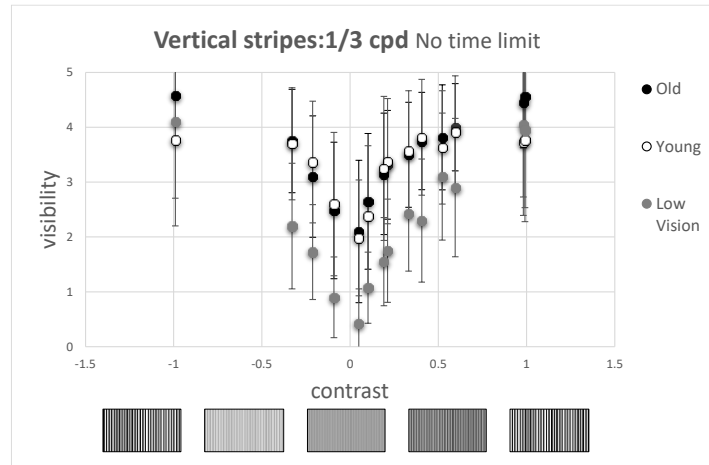


Fig. 3E. Comparison of visibility: 1/3 cpd with no time limit.

4 Conclusion

The differences in appropriate contrast between older people, younger people, and people with low vision were revealed using 10 different patterns. Further analysis is needed to determine the appropriate contrast values for each participant group: older people, younger people, and people with low vision. The conclusions of this experiment are as follows:

- In general, younger people, older people, and people with low vision need higher contrast images, in that order.
- In particular, older people and people with low vision need a high contrast when the patterns are detailed. However, the appropriate contrast depends on the pattern.
- Regarding images with the same contrast, people with low vision tend to see patterns with a negative contrast better, but there is not much difference between older people and younger people in this regard.
- The visibility of people with low vision is improved when there is no time limit.

This data will be used for designing visual signs and markings of products and surroundings. Furthermore, it will be used for the formulation of accessible design standards in the ISO/TC159 (ergonomics) field in the future.

References

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