Useful field of view for older people

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Abstract: **The aim of this research was to investigate age-related changes in useful field of view (UFOV) for targets of different luminance, color, and background. Target properties were manipulated in four experiments: luminance only (Exp. 1), color only (Exp. 2), color and luminance (Exp. 3), and color and background (Exp. 4). In all experiments, older subjects showed smaller UFOV compared to younger subjects. The results contain important design implications for the presentation of visual information frequently accessed by older adults (e.g., road signs).**

I. Introduction

MOST public visual information (e.g., signs), both indoor and outdoor, often appears in our peripheral visual field and is not always easy to detect or notice. For example, some traffic signs appear in the extreme periphery of our visual field, and vehicle drivers often have difficulty seeing them while driving. This problem is likely to be more severe for older adults, as the size of the visual field shrinks with age.

Previous studies have reported that distracters and visual clutter affect search efficiency for older adults[1-3]. However, there have been no reports concerning the effects of target luminance, target color, and background scenery on detection rates. In this study, the effects of these target factors on detection were investigated by measuring the useful field of view (UFOV) for older and younger adults under four different target visibility conditions.

The purpose of this study was to develop a method for evaluating the detectability of visual information and signs for the older adult, and to derive relevant design principles. The target variables (luminance, color, and background scenery) were examined separately and in combination in order to understand the interaction between the variables.

II. Method

A. *Experiment set up*

A large white uniform screen was illuminated by rear projection. The projected image consisted of a background field and a circular target of variable luminance, color, and size. Participants were required to detect a single test target presented along eight different axes and at different eccentricities (0-60 degrees with 10 degree increments) (see Figure 1). Targets were randomly presented multiple times at each of 46 locations, and the criterion for target detection at each location was set to 50%. To avoid the effects of sudden target onset, a change blindness[4] paradigm was adopted (see Figure 2).

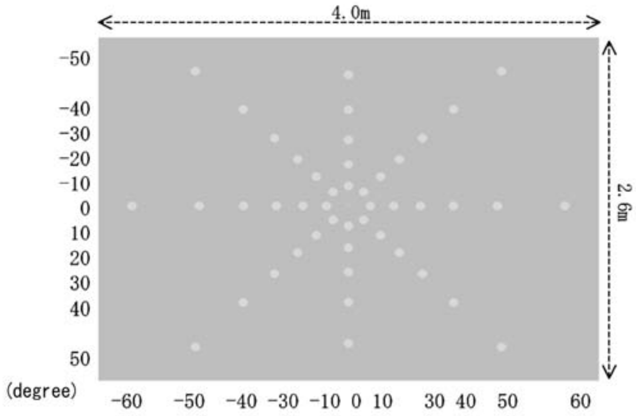

Figure 1. Screen size is 4 m (width) by 2.6 m (height), corresponding to visual angles of 120 degrees and 100 degrees respectively. Target size is 2, 4, or 8 degrees. All participants wore corrective lenses to attain maximum visual acuity, and viewed the screen with their right eye only in a dark room at a distance of 1 m.

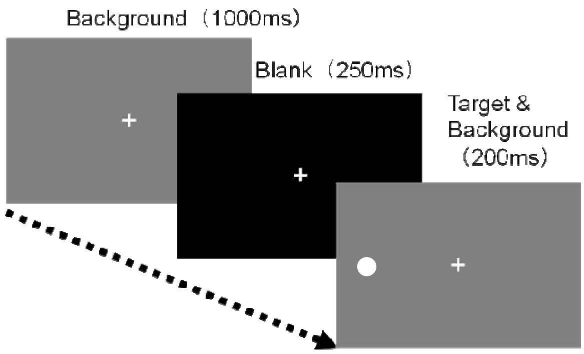

Figure 2. Projection sequence of background, blank, and target and background screens. Projection times are shown in parentheses. The blank screen serves to mask the sudden appearance of the target.

B. *Stimuli*

Experiment 1: The effect of target luminance.

Targets were solid white circles of 24, 28, or 36 cd/m^2 and the background was 20 cd/m^2 white (gray).

Luminance contrast differences were 20, 40 and 80% as **(Lt-Lb)/Lb**, where Lt is the target luminance and Lb is the background luminance.

Experiment 2: The effect of target color.

Targets were solid red, green, or blue circles with a luminance of 10 cd/m^2, and the background was 10 cd/m^2 white (gray). Three versions of each color were used (see Figure 3).

Experiment 3: The effect of luminance and color.

Targets were solid 12 or 14 cd/m^2 red, green, or blue circles (same as Experiment 2), and the background was 10 cd/m^2 white (gray).

Experiment 4: The effect of target color and background. Targets were solid 12 or 14 cd/m^2 red, green, or blue circles (colors R3, G3, B3 from experiment 2) and the background was 10 cd/m^2 white (gray). Background scenery consisted of rural, suburban or urban images (see Figure 4).

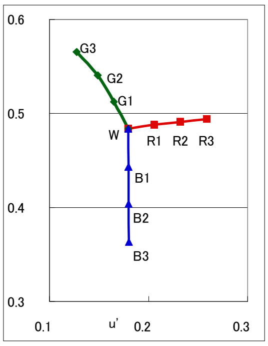

Figure 3. Target colors used in Experiments 1-4 plotted on 1978 CIE LUV Color Space. To examine the effects of the colors, chromatic differences in each type of color were set to the same level.

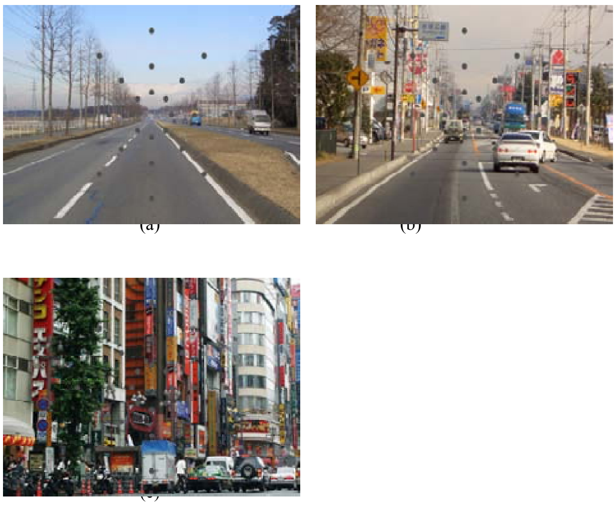

Figure 4. The position of the targets in three types of background scenery: (a) rural, (b) suburban, and (c) urban.

C. *Subjects*

Participants were 52 older (60-83 yr.) and 46 younger (20-27 yr.) for Experiment 1, 2 and 3, 32 older (62-82yr.) and 29 (20-26yr.) younger for Experiment 4 adults without eye disease. Prior to starting the experiment, each participant's visual acuity was adjusted to their respective maximum attainable level using corrective lenses. Participants viewed the screen with their right eye only while seated in a dark room at a distance of 1m from the screen, and responded to each trial by using a keypad to indicate the axis on which the target appeared.

III. Results and Discussions

Figures 5a and 5b show the relative sizes of the UFOV for targets of different luminance (Experiment 1) and color (Experiment 2). The left side of both figures shows the data for younger participants, and the right side shows the data for older participants.

Age effects are observed for both luminance and color. Figure 5a shows that the difference between older and younger participants increased as target luminance decreased. In Figure 5b, blue targets were detected at greater eccentricities along all axes, when compared to red and green targets. These results are similar to a previous study of color vision in the peripheral visual field, which found that blue had the broadest zone of detectability and green the narrowest[5]. Note that the difference in UFOV for red and green targets in older participants is greater than the difference observed in the younger participants.

Figure 6 shows the results of Experiment 4, in which the background scenery was varied. The size of the UFOV for older participants was smaller than that of younger participants across all three types of natural background scenery. As shown in Experiment 2, blue targets were more detectable than red and green targets, especially in the far periphery, for both younger and older participants. In comparison to the rural background, participants in both age groups found it more difficult to detect targets that appeared against suburban and urban background scenery. In general, differences in detection performance across the three background scenery conditions were more evident in the middle periphery for older participants, and in the far periphery for younger participants. Therefore, in addition to changes in the size of the UFOV, it was found that decreases in detection performance at greater eccentricities were different for young and older subjects when the target was observed in complex scenery.

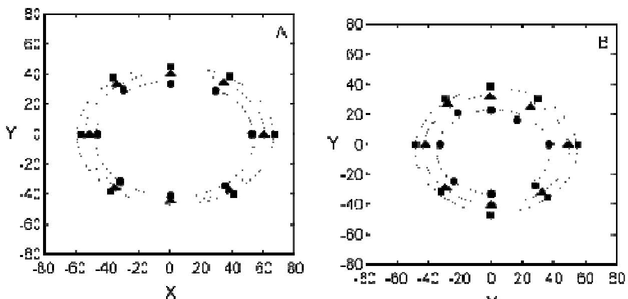

Figure 5a. UFOV dependence on luminance. A: Younger participants. B: Older Participants. ● 20%, ▲ 40%, ■ 80% ((Lt-Lb)/Lb).

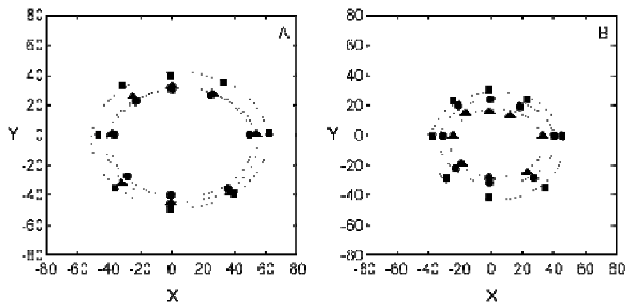

Figure 5b. UFOV dependence on color. A: Younger participants. B: Older Participants. ● Red, ▲ Green, ■ Blue.

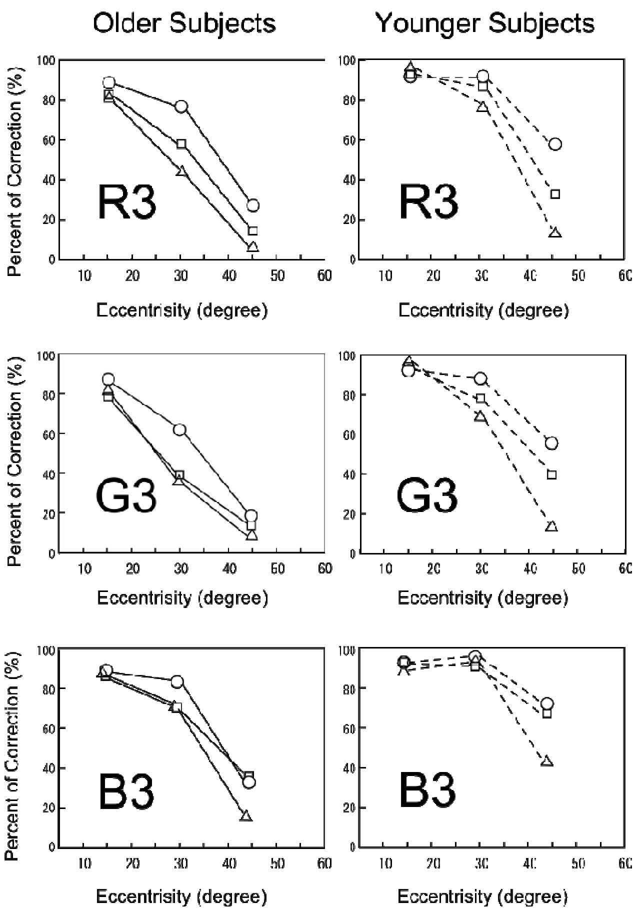

Figure 6. Changes in UFOV as a factor of target color and background scenery for younger and older participants. Target color: R3 red (top panel), G3 green (middle panel), B3 blue (bottom panel). Background scenery: ○ Rural, □ Suburban, □ Urban.

IV. Conclusion

When designing visual information and positioning visual signs in public spaces, the effects of target color and background scenery on UFOV should be taken into account. Consideration of these factors will aid in maximizing the detectability and visibility of visual information, especially for older adults.

V. Future works

A. *Utilization of the experimental data*

From this study, age-related differences in detectability were found to depend on the size, color, and luminance of the target. A separate study found that detectability also depends on the complexity and colorfulness of the background[6].

To maximize the detectability and visibility of visual information, especially for older adults, it is necessary to consider all these factors. We are currently working on a model (see Figure 7) which would enable designers to estimate ideal target variables based on the characteristics of the intended viewer and the environmental viewing conditions.

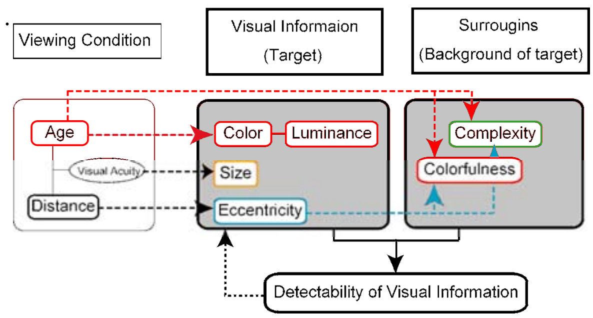

Figure 7. Model for the design of visual information. If viewing conditions (e.g., age of the viewer, viewing distance, eccentricities) are known, ideal target variables including color, size, and position or layout of the visual information can be estimated based on quantitative experimental data.

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