



INCREASING THE SENSITIVITY OF A NEW, WEB-BASED AMBLYOPIA SCREENING APPLICATION



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Introduction:

Stereopsis is absent in amblyopia, therefore lack of stereopsis in childhood requires medical attention. Evusion® screening system is a tool especially designed for children to assess stereopsis. The test can be performed at home, on any computer or mobile device and requires no assistance of healthcare professionals. Since it is based on anaglyphic technique, red-cyan/red-green filter-glasses are needed for channel separation. The aim of our present study was to minimize the false negative rate to increase the sensitivity of our test in detecting lack of stereopsis. According to our previous findings, false negative measurements mostly arise from the monocularly detectable visual cues (i.e., artifacts) that may be present in the stimulus set, due to variations in display characteristics or individual biases in the color vision of the patient.

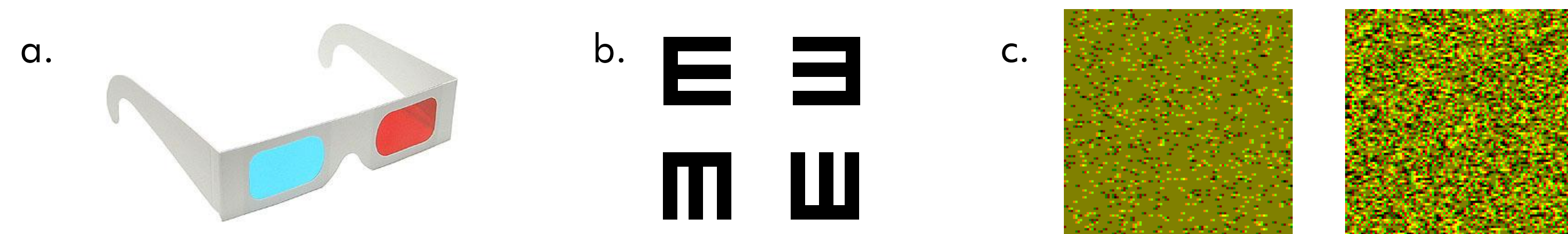


Figure 1. a.) Red-green filters used in the study; b.) The four orientations of Snellen E; c.) Evusion® test at dot densities of 10 and 50%

Methods:

In order to detect the presence of these monocular artifacts in the static and dynamically updated random dot stimuli we recruited young, healthy individuals (n=48). Subjects performed the Evusion® test in different conditions presented in Table 1. Participants had to identify the orientation of 10 stereo Snellen E optotypes for each condition. The proportion of correctly identified directions (i.e. hit ratio) was registered by the system. The pass-level of the tests was based on Bernoulli probability ratio and it was set at $p=0.001$ or 8/10. The number of correct hits at each condition were statistically compared to random hits calculated by the mathematical model of Bernoulli distribution, where r: No. of repetitions, c: No. of correct hits, n: No. of possible answers) using chi square distribution test.

$$p = \frac{(n-1)^{r-c} r!}{(r-c)! c! n^r}$$

Table 1.

Stimulus parameters	Settings
Presentation of the correlogram	Static/ dynamically updated
Viewing condition	Binocular/monocular; with/ without filter
Dot density of red/ green dots in the background	2, 10, 50%
Disparity	Depends on screen size and viewing distance

Results:

Based on the result of binocularly performed tests using red-green filter at dot densities of 10 and 50%, the subjects were divided into stereonormal (hit ratio > 8/10; n=41) and stereoblind (hit ratio < 8/10; n=7) groups. Even the participants with intact stereovision had controversial results at a dot density of 2. All but one participant failed the test when the images were viewed monocularly either with filter-glasses on or off, regardless of the dynamic property of the images. In binocular viewing conditions without filter-glasses, 3 and 4 participants passed the tests in the static and dynamic conditions, respectively. No subjects in the stereoblind group passed the test in any of the conditions.

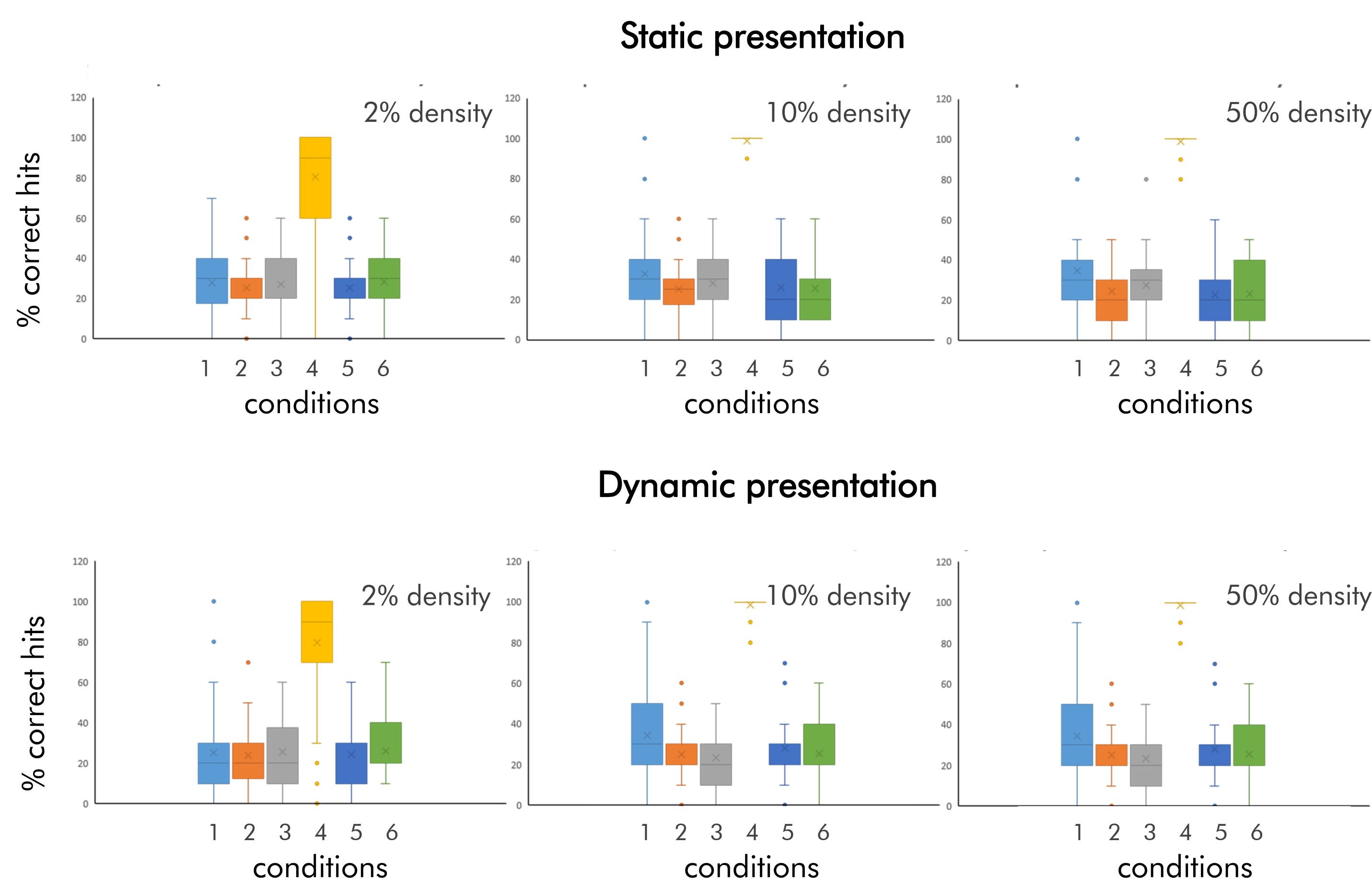


Figure 2. Percentage distribution of correct hits at 6 different viewing condition: 1. with two eyes 2. with right eye 3. with left eye; wearing filter-glasses: 4. with two eyes (red-green) 5. with right eye (green) 6. with left eye (red).

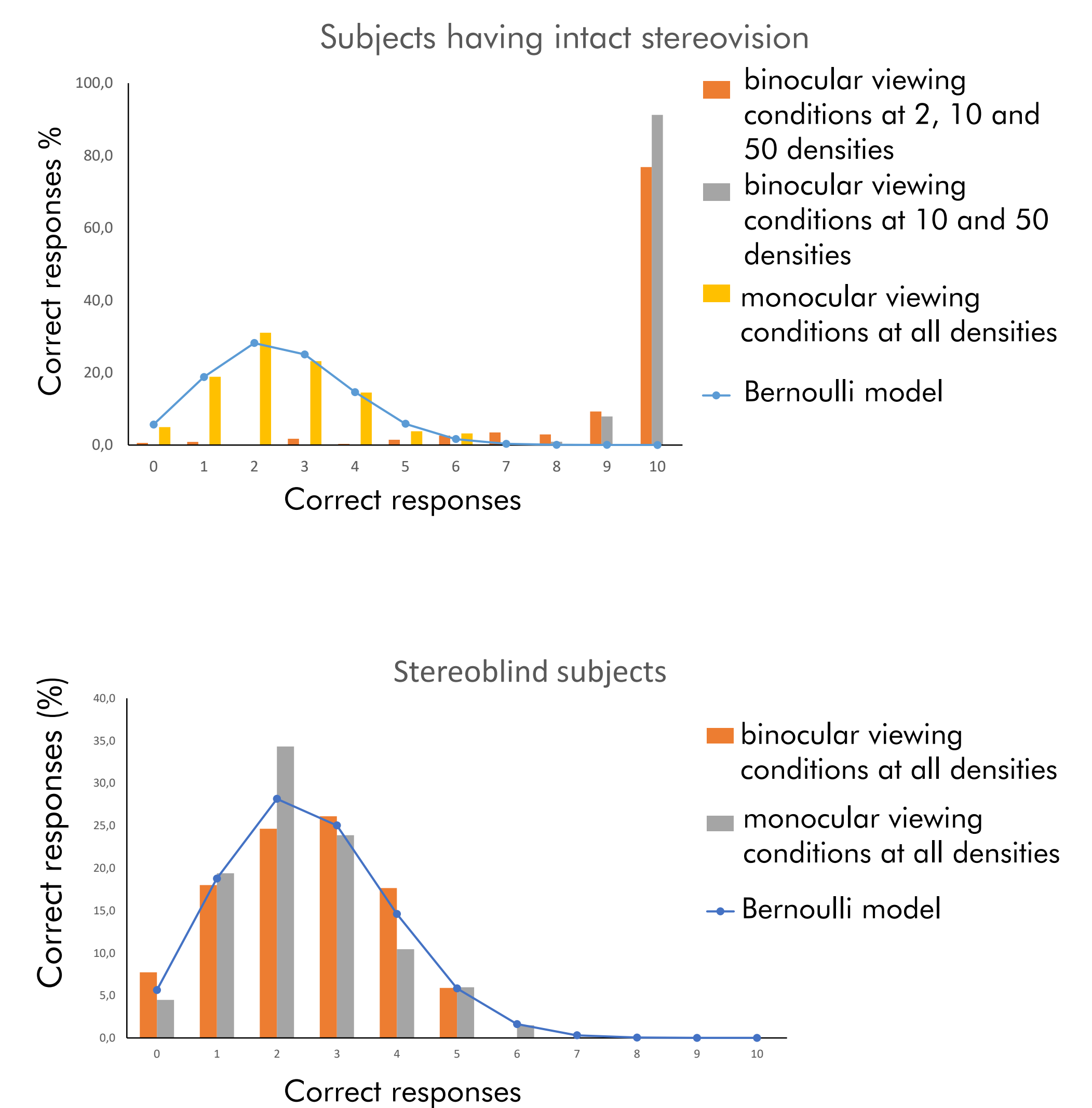


Figure 3. Proportion of different response rates at test conditions (orange; red-green filter, binocularly) and monocular conditions. χ^2 -test revealed no significant difference in comparison with the random Bernoulli distribution in any of the conditions except for the binocular viewing conditions in stereonormal subjects ($p < 0.001$).

Conclusion:

In conclusion, presence of monocular artifacts can be clearly excluded. Passing the test in the binocular condition without filter-glasses may arise from three possible reasons: 1) individual differences of the red-green isoluminance properties for the two eyes; 2) the different color filtering properties of LCD monitors from different viewing angles or 3) slightly different color filtering properties of the two corrective eye glasses (e.g. photo grey lenses). These binocular artifacts will not influence the false negativity, therefore they will not affect sensitivity, and they are never present at amblyops, since they are only detected binocularly with intact stereovision. When the Evusion® test is presented at 2% dot density, even the subjects with intact stereovision tend to fail, therefore this condition will be removed from the further testing.

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