Color-check in stroke rehabilitation games

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ABSTRACT

The article presents the colorimetric testing of rehabilitation games designed for the StrokeBack project. In this testing the main subject of the investigation was how the people with different colour-blindness types can percept the games. Many of the programmers and game designers do not pay attention to the aspect that the games should be accessible. This accessibility implies that the colour-blind users should be able to use the games the same way as the people with no vision problems.

1. INTRODUCTION

The purpose of the research showed in this article is to investigate the colours of the Virtual Reality (VR) based rehabilitation games (Sik Lányi, 2012a) designed for the StrokeBack (StrokeBack) project. The goal of the 'StrokeBack' project is to improve the speed and quality of stroke recovery by the development of a telemedicine system which supports ambulant rehabilitation at home settings for stroke patients with minimal human intervention. During our investigation we designed our VR based rehabilitation games in such a way that they would be enjoyable for colour-blind people as well.

The disorders in colour vision can be inherited and acquired. The cones' red and green colour specific paint cell's genes are linked to the X chromosome. Because of the sex-linked inheritance, there are 20 times more men involved. About 8% of Caucasian males and 0,4-0,5% of females are "red-green" colour-blind. The inherited blue-blindness (tritanopia) is much rarer, at only about 0,05% from the population can be detected. A part of the disorders of colour vision are not inherited, they are so called "acquired": several ophthalmological diseases can be followed by colour perception disorders (e.g. retinal diseases, glaucoma, cataracts, etc.) (Colour-blindness).

Stroke is a leading cause of death in the United States, killing nearly 130,000 Americans each year—that's 1 of every 19 deaths. Every year, about 95,000 people in the United States have a stroke. About 610,000 of these are first or new strokes; 185,000 are recurrent strokes.

Evidence from opticians is that about 10% of the male population are colour-blind. This together with stroke incidence rate refers to a statistically important problem.

2. THE STATE OF THE ART

The harmony of colours and proportions play an essential role in the appearance. Although many tend to neglect these issues, much scientific research is being conducted within this field. All this is based on the colour perception of the eye, which, however unconsciously, may have an influence on patients' decisions.

Scientists and artists of the last centuries (Itten, 1961), (Munsell, 1969), (Ostwald, 1969) and nowadays (Nemcsics, 1993), (Nemcsics, 2007) developed colour order systems where they defined rules to establish harmonic sets of colours. These colour harmony studies were based on the orderly arrangement of colours in the colour order system. The second group of authors (Goethe, 1810), (Chevreul, 1854) defined colour harmony as an interrelationship of colours. The main principles of these studies are "complementary" and "analogous" but these concepts are not consistent among the studies. Also, the colour wheel was often adopted as a tool to define these basic relationships. Other authors (Judd and Wyszecki, 1975) define colour harmony as a more universal concept: "when two or more colours seen in neighbouring areas produce a pleasing effect, they are said to produce colour harmony". Also, there is no consistency among the principles and the keywords of colour harmony: It is *completeness* according to Goethe (Goethe, 1810), *order* according to (Nemcsics, 2007) and (Chevreul, 1854), and *balance* according to (Munsell, 1969). A quantitative model for two-colour combinations based on the CIECAM02 colour appearance model was developed by Szabó et al. (2010). Many other effects (i.e. age, cultural background) of colour harmony feeling has to be investigated in the future.

In visual experiences, harmony is something that is pleasing to the eye. It engages the viewer and it creates an inner sense of order, a balance in the visual experience. When something is not harmonious, it's chaotic. At one extreme is a visual experience that is so bland that the viewer is not engaged. The human brain will reject under-stimulating information. The human brain rejects what it cannot organize, what it cannot understand. The visual task requires that we present a logical structure. Colour harmony delivers visual interest and a sense of order. Extreme unity leads to under-stimulation, extreme complexity leads to over-stimulation. Harmony is a dynamic equilibrium (Sik Lányi, 2012b).

Colour deficiency is often neglected, as most people do not consider colour deficiency as a serious problem. Up to 15% of the population being affected by one form or another of colour deficiency (Sik Lányi, 2012b).

It is quite common to see combinations of background and foreground colours that make web-pages, software, games etc. virtually unreadable for colour deficient users. Background, text, and graphics colours should be carefully chosen to allow understanding for people with colour deficiency. Designing for colour deficient people is complicated. It's not a matter of green/red or yellow/blue combinations (Sik Lányi, 2012b).

The most important issue in designing for colour deficient users is not to rely on colour alone to convey information and not to use colour as a primary means to impart information (Karagol-Ayan, 2001).

3. THE METHODOLOGY USED

Currently 3 games are built in the StrokeBack project:

- Break the Bricks game: practices horizontal (right-left) wrist movements, (the player's task is to control the object at the bottom of the monitor with this wrist movement)
- Birdie game: practices vertical (up-down) wrist movements, (the player's task is to make a little bird fly and do not let it fall with this wrist movement)
- Gardener game: practices finger extension movements, (the player's task is to pump a virtual sprinkler to make the plants grow by watering them)

These games can be used during the home rehabilitation process by the patients or replacing clinical rehabilitation and speeding up the process of recovery. These games are single player games, which the patient can play by himself/herself. It is expected that the patients will play more with the games, than they would do exercises.

To these games several 'locations' were developed:

- Break the Bricks: default bricks, car, cake, duck, ship, train
- Birdie: default meadow, cave (played with a bat), circus, forest, jungle, mountain, sea, town, winter
- Gardener: bluebell, carrot, currant, geranium, grape, pepper, rose, strawberry, tomato, tulip

Besides the 24 backgrounds for the 24 themes, more than 170 different objects had to be inserted, which had to be clearly visible. These were tested by different colour-blindness simulators and automatic testers.

Figure 1. shows two themes of Gardener as seen by a person with a good vision.

Figure 1. *Gardener's "Bluebell" and "Grapes" themes as seen by a person with good vision*.

Figure 2 presents the jungle theme of game Birdie and the objects that can be inserted as obstacles in the theme.

Figure 2. *Jungle theme of "Birdie" game and the objects that can be inserted.*

4. THE RESEARCH & DEVELOPMENT WORK AND RESULTS

For the investigation 4 different colour-blindness simulators were used, which are accessible on the Internet and where pictures can be uploaded (ASP.NET), (ETRE), (Coblis) and a downloadable software, ColorOracle (ColorOracle), with which we could test the pictures appearing on the screen on the developer computer, to find out how the users of different types of colour-blindness: deuteranopia, protanopis, tritanopia; see the colours.

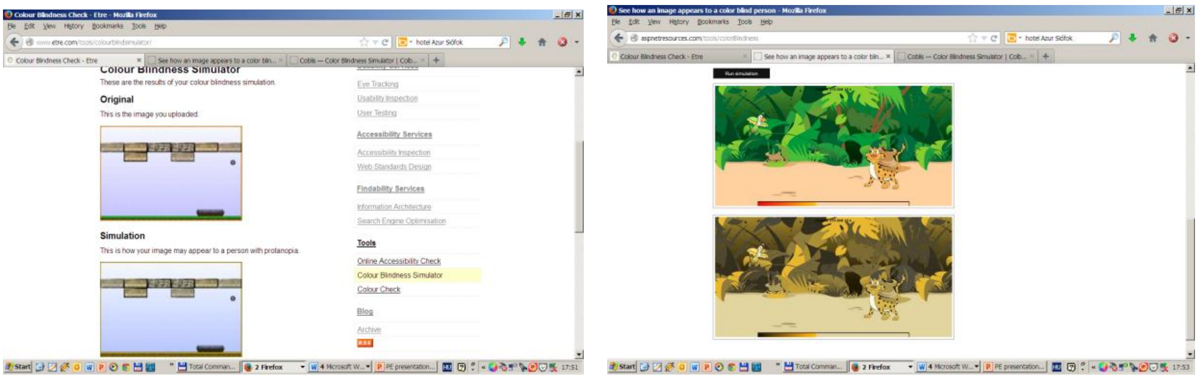

Figure 3. *Testing of "BTB basic brick" theme with ETRE simulator (left) and "Birdie jungle" theme with ASP.NET simulator (right).*

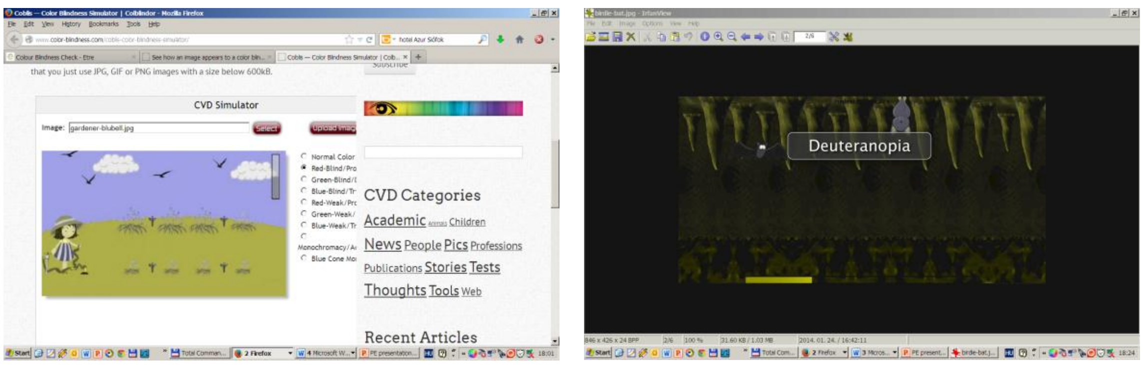

Figure 4. *Testing of "Gardener" with Coblis simulator (left) and "Birdie cave" theme with ColorOracle tester.*

4.1 Test and the contribution to the field

Testing has been completed not only with the *ETRE-*, *ASP.NET -*, *Coblis* – simulators and *ColorOracle* tester, but with Variantor's special glasses (variantor) with two individuals with good vision, and two colour-blind persons. Testing is really important because developers usually do not pay respect to colour-blind people.

We did not find any publications that would deal with the testing of colours of rehabilitation games. Unfortunately, the developers do not think about the colour-blind people. Thus, our case-study is of great importance.

5. CONCLUSION AND PLANNED ACTIVITES

As a result of our testing we reached to the conclusion that the objects are clearly visible, so the colour-blind patients can practice in the same way as the normal sighted. In the future the games will not only be tested with the software, but also with other simulation goggles (tunnel-vision, macula or lens degeneration). The clinical tests of efficiency (these refer to the colour test and efficiency of the rehabilitation too) are going to be from June, 2014. Our future plan is to test the games with more colour-blind patients as well.

At the conference the detailed results of testing – including the testing with simulation goggles – will be presented.

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