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Optimization of Computer presented Information for left-handed Observer

Cecília Sikné Lányi♣

Laboratory of Colour and Multimedia, Department of Image Processing and Neurocomputing, University of Veszprem, H-8200 Veszprem, Hungary

ABSTRACT

An experiment was conducted to test the hypothesis that left- and right-handed people – due to differences in the cortical processing of the perceived information — will respond differently if a signal is presented in the left or right peripheral visual zone. Experiments showed small differences between left- and right-handed people that could be partially traced back to differences between their motoric skills.
Differences could be observed depending on the task (identification of letters, numbers, seeing pictograms).
For the lay-out of a display window, however, the differences seem to be too small to justify developing separate screen lay-outs designed for the use of left-handed or right-handed people.

Keywords: *right and left handed, stimuli presentation, software design*

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1. Introduction

It is well known that the two halves of the human brain are differentiating among the tasks they have: in an oversimplified form one might state that the processing of verbal information is done in the left side of our brain. This half-brain leads the right-hand in writing the information. On the other hand the right hemisphere of our brain is normally responsible for perceiving pictorial information. It is usually better in processing images and is responsible for the left hand motoric skills. [1, 5]

Most people are right-handed. About 10 per cent of us are, however, left handed, but we are living in a right-handed world. For this reason some utensils are

♣ Corresponding Author:
Cecília Sik Lányi,
Laboratory of Colour and Multimedia, Department of Image Processing and Neurocomputing, University of Veszprem,
H-8200 Veszprem, Hungary.
Tel.: +36-88-422022
Fax: +36-88-423466
Email: lanyi@almos.vein.hu

less suited for the left-handed people. Now-a-days, one can get e.g. a pair of scissors designed specially for left-handed users. But what is the situation if cognitive effects play a role, as well? Is the ergonomic design of a computer screen, optimised for the general population, also optimal for the left-handed user, or not. Should the design of a computer display reflect the differences between users, or can we live with a single – right-handed design of the computer screen.

This question might be even more important in educational multimedia applications, as modern pedagogic theory favours to permit left-handed children to stay left-handed and tries to provide them with utensils optimised for their use.

2. Description of the experiments

The fundamental idea we wanted to test was the following: is there any difference in cognitive reactions between left- and right-handed observers if, after working with a normal visual task in the middle of the computer screen, a special task pops up on the left side or the right side of the screen. Is there any difference in experiencing this special task by right- and by left-handed people? We tried to differentiate between tasks

- where the meaning of a sign had to be recognised (identification of letters, such identification work should be performed by the left hemisphere of the brain), and
- where pictorial information was used (perhaps processed primarily by the right hemisphere of the brain).

The experiments were conducted using a PC, with a 19” screen diameter monitor. The angular distance between the task seen in the middle of the screen and on the right or left side was approximately 18°.

Three independent experiments were performed. In all three experiments the observer had first a search task to keep him occupied. Two of these were designed to show different mental loads, one was a letter search task. In the other task, the observer had to make a mental decision. The third experiment was designed to test the image perception of the observer.

The first task was a search task: A printed text was displayed in the middle of the screen and the observer had to search for a particular character in this text, and had to hit the space bar when he/she found the character (see Figure 1.).

After a random time-lapse (this has been recorded together with the number of hitting the space bar) the text disappeared in the middle of the screen and reappeared either on the left or the right side of the screen. The observer had to continue to search for the particular letter from the third paragraph on, and signalled every finding of the letter by hitting the space bar.

The idea behind this experiment was that if there is any difference in processing printed text information by the two halves of the brain, [2] this would manifest itself in the speed of finding the particular letter in the reappeared text. One could speculate that depending on the handedness some differences might occur if a right- or left-handed person performed the experiment.

In the second experiment the primary task was a mental task: In the middle of the screen three digit numbers appeared randomly and the observer had to respond whether the number was even or odd. [3, 4] At the same time, on the two sides of the screen the same picture (photorealistic image) was displayed, as seen in Figure 2. After the elapse of a random amount of time a small part of the image either on the left or on the right side of the picture changed and the observer had to respond when he/she realised the change and on which side he/she realised it. (see e.g. Figure 3.).

The third experiment was quite similar to experiment No. 2, but here the same picture was used on both sides of the screen as the mirror image of one another. In this experiment, the task in the middle of the screen was the realisation of a simple geometric shape. Thus the question was, comparing experiments 2 and 3: is there any difference in the reaction time if the task is a mathematical one (processed primarily by the left side of the brain), or a pictorial one (where the primary processing might be done by the right side of the brain. Figures 4 and 5 show the computer screen image before and after the change occurring on the screen.

3. Subjects

Results of 18 subjects will be analysed in this paper. We selected six absolutely left-handed and six absolutely right-handed subjects and six who can be termed as ambidexter (two-handed). All subjects were young university students. [6]

4. Results of the experiments

In case of all three programmes we collected 20 individual results for each subject, see Tables 1. to 3.

Comparing the averages of all the left-handed subjects with the averages of all the right-handed subjects first a t test was performed (see Table 4. line 4.), followed by a multiple analysis of variance (see Table 5.). The averages were regarded not to be different if, for a significance level of $\alpha = 0.05$, the two averages could not be regarded as different. We found that differences between the responses given by left- and right-handed subjects could be found only if the answer had to be given with the right hand and the task was finding numbers (see t-test, Table 4). In both groups, differences

could be found depending on what had to be searched for (text, numbers or figure, see multiple analysis of variance, Table 5.).

Analysing 1,000 individual results, there seems to be indication that right-handed subjects signal earlier for the text search task if it appears on the right side than the left-handed subjects (see Table 2.). Left-handed subjects signal in average earlier if the change appears on the left-side (see Table 1.). A possible explanation could be that the right-handed person is not so quick using his left-hand than the left-handed person using his right-hand (the programme lay-out was such that if the change appeared on the left side of the screen, one had to signal with the left hand).

The experiment, where odd and even numbers had to be distinguished, contradicts this assumption: for realising that a change occurred in the pictures, right-handed subjects signalled earlier if the change occurred on the left side than when it occurred on the right side (see Table 2.).

According to Table 1, left-handed subjects realise the change on the right side of the screen faster than the change on the left side of the screen if the task is number checking. A possible explanation could be that left-handed people are apt to mix up numbers. It is well known that they easily mix signs being mirror images for each other. Thus it might be necessary for them to take more attention to the number-task, a task occurring in the left side of the brain. Differences could be found only when the task was number identification and answer was given by the right-hand, see t-test, Table 4.

The results for ambidexter (two-handed) subjects resembled sometime that of the left-handed, and some time that of the right-handed subjects (see Table 3.).

Comparing the real left- and right-handed subjects' results (see Table 4.), we can state that at the significance level of $\alpha = 0.05$ the results of the two groups are not different (with one exception). The multiple analysis of variance has shown differences depending on the task (see Table 5 line 4)

The statistical analysis was performed using the SPSS statistics program.

Table 4. shows that the left-handed subjects are slightly faster than the right-handed ones. For all three groups it is common that the longest time is required to search the text task. Identification of the change in the picture needs the shortest time. Thus, as a subsidiary result, we can state that, the use of a pictogram is the best choice to direct the attention of an observer to something on the computer screen. It should be placed on the left side of the screen and should not be mixed with other tasks (texts, numbers, etc.).

5. Conclusions

Experiments conducted up to now show that there is difference between observing different types of information. Both right- and left-handed observers have the shortest reaction time for pictogram observation and the longest for text identification.

Differences between processing of information presented on the left or on the rightside of a screen seems to be smaller than other motoric skill differences. If one is accustomed to observe at a given location one type of information, it is more important to keep that location constant then to adjust it to different observers.

References

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Table 1 Average results of left-handed subjects in sec/60

left-handed	1	2	3	4	5	6	average
lh-l-text	97,5	63,5	45,6	47,9	64,2	57,88	62,763
lh-r-text	100,8	59,2	48,1	39,1	56,4	60	60,6
lh-l-numb	47	33,11	39,22	42	55	50	44,388
lh-r-numb	42,7	37,5	41	38	47,5	43,75	41,742
lh-l-figure	38,25	34,4	40,88	35,5	41	40	38,338
lh-r-figure	40,77	32,3	39	34,6	41,75	41,1	38,253

Designations:

lh-l-text: lefthanded observer with his/her lefthand answers to the text changing,

lh-r-text: lefthanded observer with his/her righthand answers to the text changing,

lh-l-numb: lefthanded observer with his/her lefthand answers to the number changing,

lh-r-numb: lefthanded observer with his/her righthand answers to the number changing,

lh-l-figure: lefthanded observer with his/her lefthand answers to the figure changing,

lh-r-figure: lefthanded observer with his/her righthand answers to the figure changing,

Table 2 Average results of right-handed subjects in sec/60

right-handed	1	2	3	4	5	6	average
rh-l-text	105,7	56,4	53,8	83,11	48,1	69,9	69,502
rh-r-text	101,5	53	48,1	76,77	57,5	59,9	66,128
rh-l-numb	45,3	37,66	49,33	44,625	50,83	39,8	44,591
rh-r-numb	50,1	43,75	50,25	45,55	61,857	41,25	48,793
rh-l-figure	38,25	32,55	43,125	41	46,77	34,4	39,349
rh-r-figure	41,7	34	49,33	48,33	47,8	37,11	43,045

Designations:

rh-l-text: righthanded observer with his/her lefthand answers to the text changing,

rh-r-text: righthanded observer with his/her righthand answers to the text changing,

rh-l-numb: righthanded observer with his/her lefthand answers to the number changing,

rh-r-numb righthanded observer with his/her righthand answers to the number changing,

rh-l-figure: righthanded observer with his/her lefthand answers to the figure changing,

rh-r-figure: righthanded observer with his/her righthand answers to the figure changing.

Table 3 Average results of two-handed subjects in sec/60

ambidexter	1	2	3	4	5	6	average
a-l-text	95,6	46,8	82,2	58,7	65,6	53	66,983
a-r-text	95,5	46,4	80,3	52,2	63,4	49,7	64,583
a-l-numb	47	39,75	39,4	43,2	41,88	39,5	41,788
a-r-numb	44,62	40,5	37,77	45,33	42,42	42,55	42,198
a-l-figure	34,3	36,11	35,2	40,375	37	37	36,664
a-r-figure	40,2	38,77	37,9	43,77	41	40,1	40,29

Designations:

a-l-text: ambidexter observer with his/her lefthand answers to the text changing,

a-r-text: ambidexter observer with his/her righthand answers to the text changing,

a-l-numb: ambidexter observer with his/her lefthand answers to the number changing,

a-r-numb: ambidexter observer with his/her righthand answers to the number changing,

a-l-figure: ambidexter observer with his/her lefthand answers to the figure changing,

a-r-figure: ambidexter observer with his/her righthand answers to the figure changing.

Table 4 Comparison of results (t-test)

left-handed	average	right-handed	average	significance level
lh-l-text	62,763	rh-l-text	69,501	0,392
lh-r-text	60,6	rh-r-text	66,128	0,435
lh-l-numb	44,388	rh-l-numb	44,591	0,947
lh-r-numb	41,742	rh-r-numb	48,793	0,025
lh-l-figure	38,338	rh-l-figure	39,349	0,599
lh-r-figure	38,253	rh-r-figure	43,045	0,133

Designations:

lh-l-text: lefthanded observer with his/her lefthand answers to the text changing,

rh-l-text: righthanded observer with his/her lefthand answers to the text changing,

lh-r-text: lefthanded observer with his/her righthand answers to the text changing,

rh-r-text: righthanded observer with his/her righthand answers to the text changing,

lh-l-numb: lefthanded observer with his/her lefthand answers to the number changing,

rh-l-numb: righthanded observer with his/her lefthand answers to the number changing,

lh-r-numb: lefthanded observer with his/her righthand answers to the number changing,

rh-r-numb righthanded observer with his/her righthand answers to the number changing,

lh-l-figure: lefthanded observer with his/her lefthand answers to the figure changing,

rh-l-figure: righthanded observer with his/her lefthand answers to the figure changing,

lh-r-figure: lefthanded observer with his/her righthand answers to the figure changing,

rh-r-figure: righthanded observer with his/her righthand answers to the figure changing.

Table 5 Results of the multiple analysis of variance

Dependent Variable: time

Source	df	Mean Square	F	significance level
HANDED*WHAT	2	17.255	0.115	0.892
HANDED (left, right)	1	320.623	2.135	0.149
HAND OF ANSWER	1	0.864E-02	0.000	0.983
WHAT IS FINDING (text, number, figure)	2	4184.977	27.862	0.000
Error	65	150.204		

Captions to illustrations

Figure 1: Experiment No. 1. before the change.

Figure 2: Experiment No. 2. before the change.

Figure 3: Experiment No. 2. after the change.

Figure 4: Experiment No. 3. before the change.

Figure 5: Experiment No. 3. after the change.

Figure 1

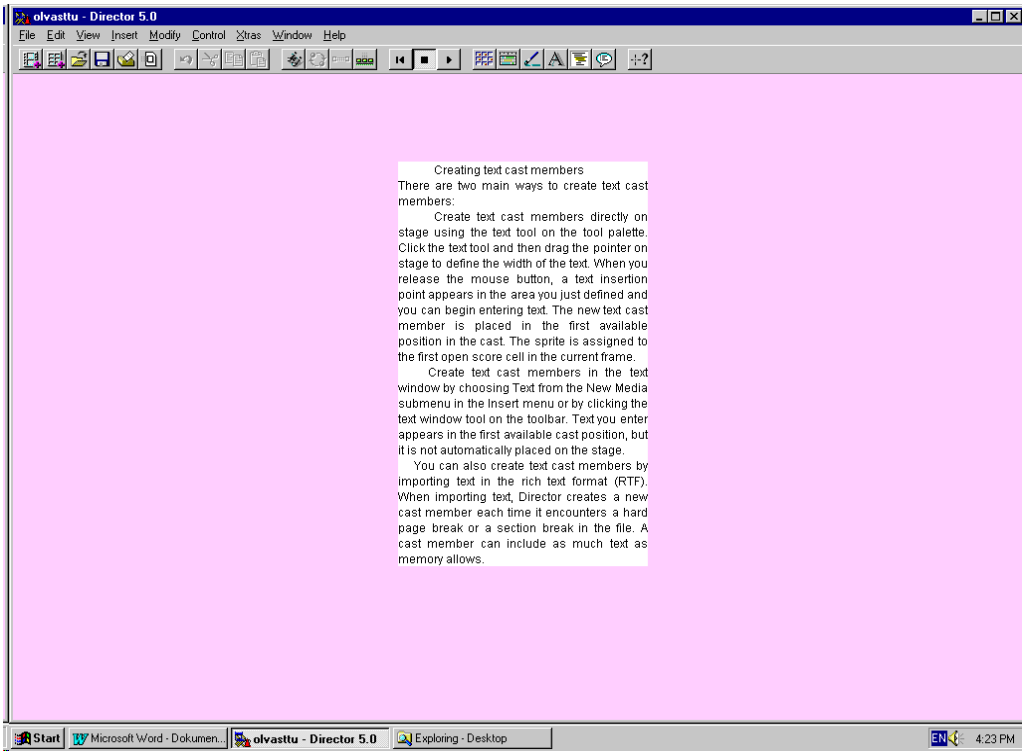

Figure 2

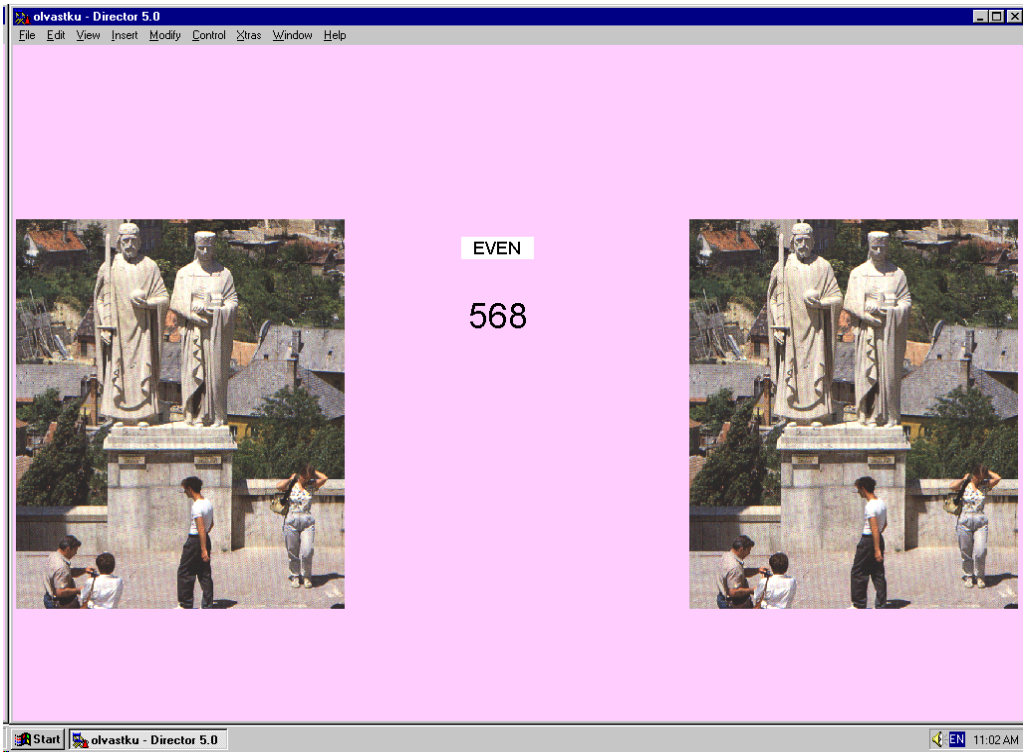

Figure 3

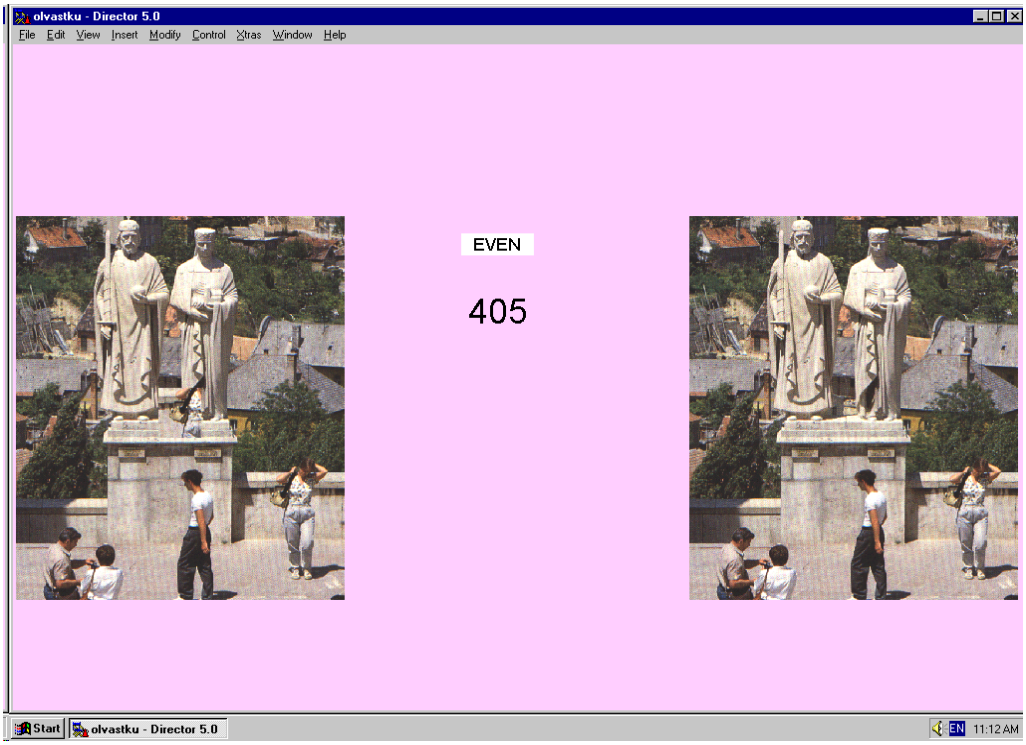

Figure 4

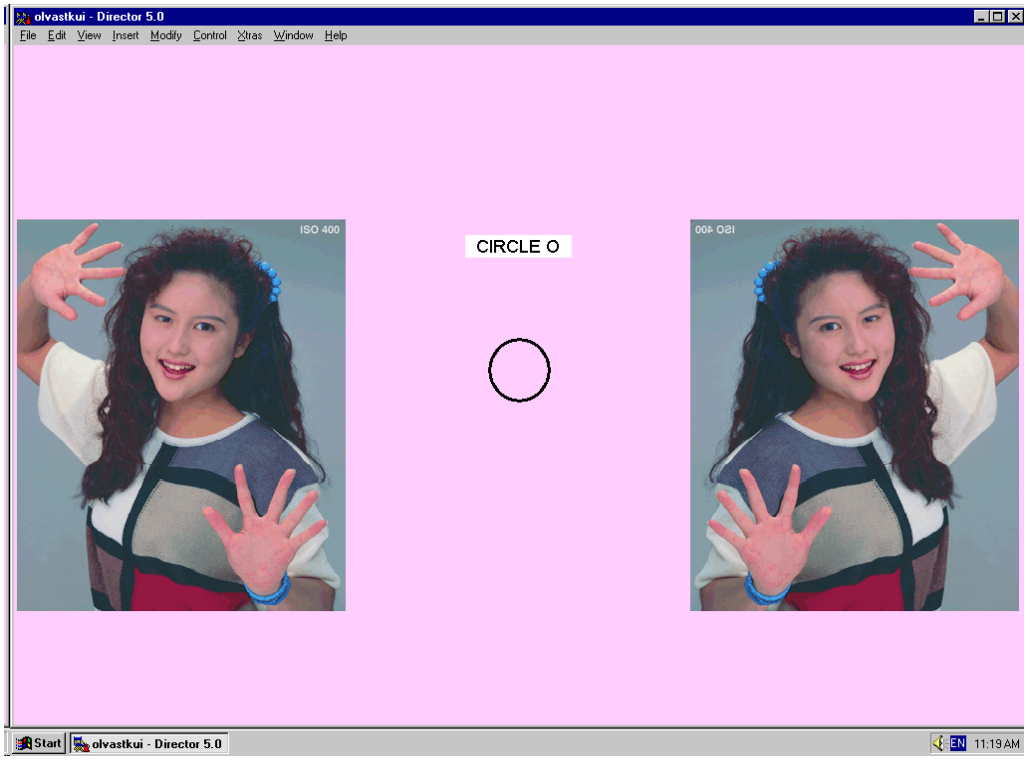

Figure 5