

# **Accuracy of Eye-tracking measurements of a human fixation on the screen**

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<p><b>Abstract:</b>  A particular study is a part of the project “Visual Impact” held at Arcada UAS. The eye-tracking technology is used to track the eye movements by recording fixations and saccades within the time of the test. The eye-tracker records and saves the information that can be presented with heat map, cluster and gaze plots. As all these methods are visual representations of data and don't show the exact coordinates of the gaze point, this particular work is based on processing the raw statistical data that contains the exact location of each eye at each millisecond of the recording time. A particular research is an exploratory study using raw from the Eye Tracker for the first time. The following questions are addressed: how accurate the measurements of the Eye Tracker are, how accurate the human fixation on the screen with stimulus is and if there're any differences of human perception within different racial groups. For this investigation fifteen students of Arcada were tested with a test including three parts with different time duration of 5, 7, 9 seconds containing five images created by the researcher for this particular experiment with a figure set in different corners of the screen. All raw data obtained were processed considering the mean coordinates of the gaze points of each particular group of European, African and Asian participants. All data were processed in Excel using Excel formulas and metrics. Thus, we found that the eye-tracker provides very accurate measurements of human fixation on the screen; during the time the human fixation has a bigger deviation explained by the eye tiredness; there're differences of perception among racial groups. The most complete information about the Eye tracking technology is provided by the book of Holmqvist Eye tracking. A comprehensive Guide to methods and Measures, 2011. Technological issues of creation the experiment was mostly based on the instruction provided by Tobii company An instruction to eye tracking and Tobii Eye Trackers. As it's a study in process for a further research of the Eye Tracker T120 it's proposed to test the accuracy of the Eye Tracker using an artificial eye.</p>	
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# 1 INTRODUCTION

## 1.1 Background of research study

Eye movement is a necessary component of the visual analyzing of a human being. Eye movements reflect human emotions and cannot be hidden unlike other emotional demonstrations such as hand movements or voice changes. Thus, by observing and studying the eye movements it's possible to determine the real preferences of a person related to a web design or choice of goods and services via internet which can be used in studying customer's behavior in e-commerce.

Eye-tracking is the process of determining the coordinates of a human gaze. The gaze is the point of intersection of the optical axis of the eyeball and the plane and the object of observation with some stimulus. Eye-tracker is a device that determines the location of the axis of eyeball at the plane, records it and saves data. Consideration the points of fixation at the scan path allows determine the area of interest of a respondent during the experiment. The eye-tracker doesn't determine the exact point attracted the interest of the respondent but it's able to determine the approximate sequence of points attracted the interest. Thus, with eye-tracking research it's possible to get a full information about the usability of any stimulus and a human perception of this stimulus.

The technology of Eye-tracking is used in many scientific studies (for example, cognitive science, psychology, medical research, study of human behavior in vehicles, technology of virtual reality) and also in marketing and e-commerce research.

In e-commerce the use of Eye-tracking includes web-usability studies, evaluation of the effectiveness of advertisement of different media resources-on TV, internet, evaluation of the brand, online-research, effectiveness of the web design, comparing the sites of competitors. The most popular and efficient area of research in commercial eye-tracking is a web-usability. A traditional way of measuring the usability of the web-site is usually connected to the frequency of mouse clicks and rolling in a time and provide quite accurate data but with eye-tracking it's also possible to analyze the dependence between the customer's behavior and clicking. It leads to the conclusions what parts of the web-site are more attractive for the customer and which parts are not noticed.

The tests with the Eye Tracking in a commercial sphere usually include several respondents of the final customers testing the same stimulus, for example, a design of a new product, web-page, video, commercials, newspapers and etc. The obtained results can be processed statistically and presented graphically for evaluation of the usability or success of the stimulus. Thus, the research in the field of the Eye-tracking is significant.

A particular research study and experiment is a part of a project “Visual Impact” held at Arcada UAS. The main aim of our study is to evaluate the accuracy of measurements of the Eye Tracker by obtaining and processing numerical data of a human perception of a stimulus on the screen. We consider two factors influencing on the accuracy of measurements of the Eye Tracker and as it was mentioned by Tobii company (An introduction to eye tracking and Tobii Eye Trackers 2010:9) they are the error in work of the Eye Tracker and the error of observations of participants (voluntary and involuntary eye-movements, permanent micro-movements of the eye, calibration procedure, drifts, light, noise, concentration of a participant, changing conditions of an experiment, etc.)

In earlier studies the research process was mainly concentrated on visual representations of data and results of an experiment recorded by Eye-tracker-Heat Maps and Gaze Plots. But these methods of study don't provide the exact information about the coordinates of the gaze point, deviation from the set area or the exact changes of the mean coordinates within the time, just the concentration of a human attention and eye movement on the screen.

In our research we decide to work with statistical raw data collected from the Eye Tracker as raw data provide more accurate data about the exact coordinates of the gaze point at each millisecond of the test. Compared with a traditional way of working with data already processed by the Eye-tracker, we're planning to obtain the Mean of the coordinates of the gaze of each participant while the statistical Metrics of the Eye-Tracker don't measure the Mean coordinates of the gaze and therefore don't give the opportunity to compare these indexes of different participants' groups (the Statistical Metrics provided by the Eye Tracker see in the Appendix 1).

) So, in this way we are able to determine the mean gaze coordinates and knowing the exact coordinates of the location of the set area we can determine the accuracy of the gaze measured by the Eye tracker and changes in human perception within each particu-

lar group of participants. A particular research is an exploratory study when we obtain and process the raw data recorded by the Eye Tracker for the first time.

Under the main research question we also pose sub-questions such as: does the accuracy of a human perception changes within the time of observations and if the perception of a stimulus is different depending on the race of a participant?

As it's in process study we don't pose the problem of confirming any hypothesis and we're not able to predict any results of an experiment. We just want to observe the experiment, measure the accuracy of the Eye tracker by processing raw data provided by the Eye tracker and try to find the explanations of possible deviation of accuracy based on the previous studies.

The most complete information about the Eye tracking technology is provided by the book of Holmqvist, Eye tracking. A comprehensive Guide to Methods and Measures, 2011. Technological issues of creation the experiment was mostly based on the instruction provided by Tobii company An instruction to eye tracking and Tobii Eye Trackers. As a particular manual describes general characteristics of all types of Eye Trackers and the researcher works with Tobii Eye Tracker T120 at Arcada, the manual Eye Tracking Research and Arcada Eye tracking guide by Lehmuskallio, 2011 were used for studying technical issues of the Eye Tracker T120.

## 1.2 Theoretical background

As in our study we consider the interaction of an Eye-tracker and human eyes' movements so the theoretical background of a nature of human eyes' movements and technical characteristics of an Eye-Tracker are studied in details.

A human eye has a complex structure and its features of work. The eye movements are all various and almost not limited but based on close interaction between all parts of the eye and the muscles.

For better understanding the technology of Eye-tracking the author considers the main principles of work of the device, the types of the device, equipment and other technological issues.

### 1.2.1 Nature of eye movements

A human eye is a complex optical system and its main function is to make the most accurate perception, initial processing and transfer of the information that a person gets from outside world with reflection of visible light. All different parts of the eye are important components of this process.

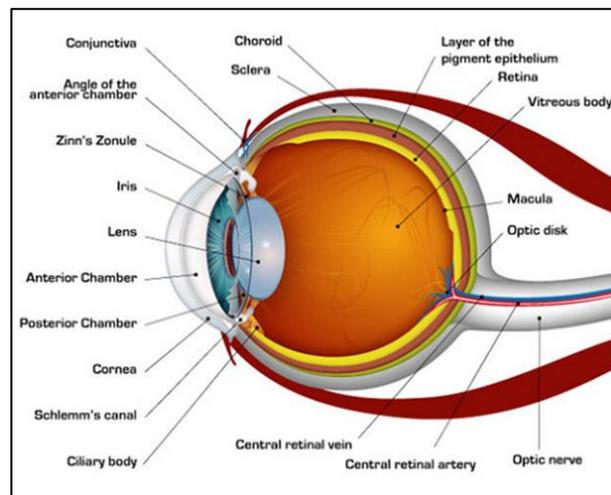


Figure 1. The structure of a human eye. (Eye Anatomy Science. Daily Pages, 2013)

Figure 1 represents the structure of a human eye. According to Tobii manual explanations a human eye includes the eyeball, cornea, ciliary body, Schlemm's canal, posterior chamber, anterior chamber, lens, iris, Zinn's zonule, angle of the anterior chamber, sclera, layer of the pigment epithelium, retina, vitreous body, macula, optic nerve, central

retina artery, central retina vein, subsidiary bodies-the eyelids, lacrimal apparatus, muscles of the eyeball (An introduction to eye tracking and Tobii Eye Trackers 2010:5)

The main principles of work of a human eye are also explained in Tobii Manual (An introduction to Eye tracking and Tobii Eye Trackers. Tobii Technology AB p.3-5). The eyeball is a spherical body that has several axes of rotation. Its position is almost not limited. All axes intersect at one point of rotation, at 13.5 mm behind the cornea. The light rays reflect from surrounding objects and go to the cornea. The cornea works as a strong collecting lens that focuses the light rays going to different directions all together. Then the light rays refracted by the cornea pass through the anterior chamber with a clear liquid to the eye iris. In the iris there's a pupil, an opening round shape. Through the pupil only the central rays of the light flux go to the eye when other peripheral rays are filtered. Thus, the pupil eliminates all possible different distortions caused by lateral light rays and at the same time the pupil is also responsible for adaptability of the eye to different intensity of the light. Later, already filtered light rays go to lens, vitreous body and to retina. The retina is a peculiar screen where a final image is projected upside down. And the object that a person is looking at is reflected.

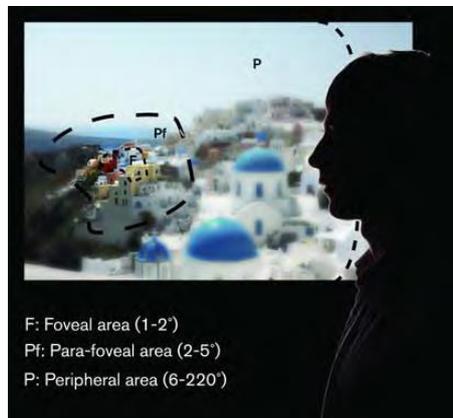


Figure 2. The human visual field. (An introduction to eye tracking and Tobii Eye Trackers, 2010)

The human eye perceives the surrounding world both in light and dark conditions but doesn't perceive all objects in the same way. For example in a really limited area which is called the foveal area people see all objects clearly with details but by the peripheral area of the eye people can better see darker areas, movements and light contrasts of objects but the image in this area is less sharp and colorful. There's also a parafoveal area between foveal and peripheral area when the image becomes less and less sharp when moving from one area to another. Figure 2 represents a human visual field.

As it was already discussed in previous research studies ( Lehmuskallio 2011p.5-6) the eye movements can be voluntary and involuntary, normal and pathological and are coordinated by six muscles- the lateral, medial, inferior and superior rectus muscles, and the inferior and superior oblique muscles. Involuntary eye-movements reflect an internal psychological state of a person.

The eye movement happens due to simultaneous contraction of some muscles and relaxation of other muscles. Figure 3 represents the eyeball surrounded by three pairs of muscles which are run by the signals of the nerves from the brain.

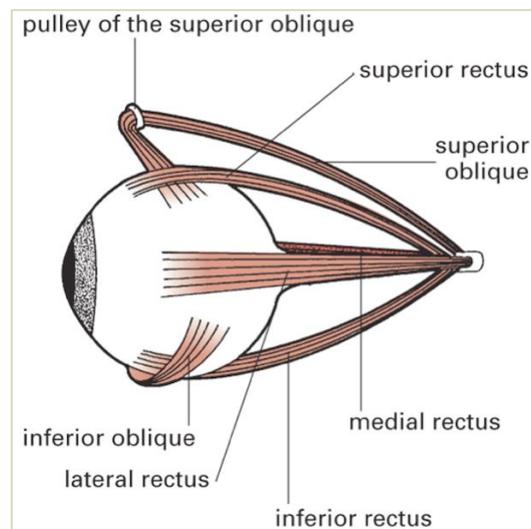


Figure 3. The eye muscles. (User Manual. Tobii Studio. Tobii Technology AB, 2010)

According to Tobii company (An introduction to eye tracking and Tobii Eye Trackers p.6) eye movements are usually divided into fixation and saccades when an eye is fixated at some point and then moves fast to another point. The most information that a man gets from visual perception he/she gets through fixations. A human eye places the object on the foveal with fixations, when the gaze is concentrated on the object. In the case of a moving object or movements of the head, a human eye makes saccades, which are rapid movements between fixations, and keeps the object on the retina. Even during a permanent fixation on the object a human eye is permanently moving to prevent perceptual fading when light receptors make the neurons to stop to react on the stimulus.

Thus, even when a man is focusing on a special object his/her eyes are actually moving between different spots in the area around the object. The set of saccades and fixations is called a scanpath. As it was mentioned by Holmqvist (Holmqvist 2011:33) the aver-

age duration of the fixation is 200-350 ms when reading. The duration of saccade is up to 200 ms.

According to Tobii research (An introduction to eye tracking and Tobii Eye Trackers p.10) Eye movements can be classified depending on their functions: rapid and slow eye movements (rapid-saccades, tremor and drifts, slow-slow tracking). These movements can be also determined as coordinated (saccades) and uncoordinated (tremor and drift). Figure 4 represents a scene of a human perception.

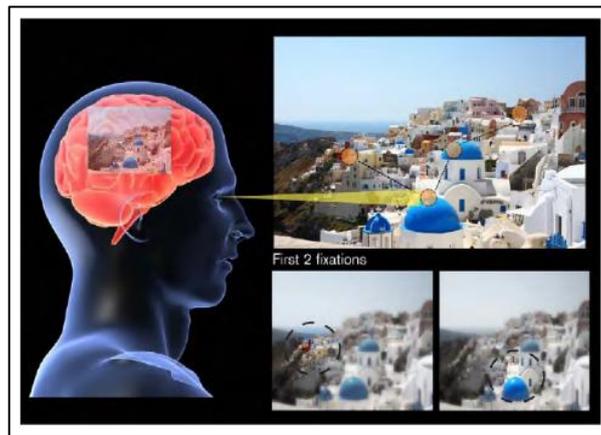


Figure 4. Human perception. (An introduction to eye tracking and Tobii Eye Trackers. Tobii Technology AB, 2010)

Tremor is a quick, rhythmic movement of eyes. Drift is the gradual decrease in accuracy of the eye tracking data compared to the true eye position. Or, in other words, it's a decrease in the attention of a person when focusing on the screen depending on the changes in the environment (such as changes in the lighting) or changes in the condition of a human eye (wetness, tears) or also the duration of the test (the most significant affect in the particular test). To prevent fading perceptually when focusing on one object for long time the eye makes microsaccades. Microsaccades are small version of saccades occurring during long fixation on the object. The purpose of microsaccades is to prevent fading of the image and compensate the displacement of the gaze occurred because of a drift.

With a purpose of a visual representation of a human gaze and the set of saccades and fixations we present the graph of a scanpath of the participant 8 of EU group at the Image 5 (central location of the Cross) during 5, 7 and 9 seconds. Figures 5, 6 and 7 show changing X (red) and Y (blue) coordinates of the gaze track of both eyes of the participant. The measurement of the gaze is not a straight line but a graph with small variances meaning that there're fluctuations during the recording time as a human eye is constantly moving during the fixation. At the graph it's seen that fluctuations get a bigger amplitude during the increasing viewing time, especially during the part of the experiment of 9 seconds. Figure 7 also represents a big gap in recording of the X coordinates. Usually such deviation of the graph can be explained with blinking or if a respondent looked away from the screen of the Eye-Tracker but as at this particular graph we observe the gap of one axis X only but not the axis Y, this fact can be explained with the error of recording of the Eye-tracker.

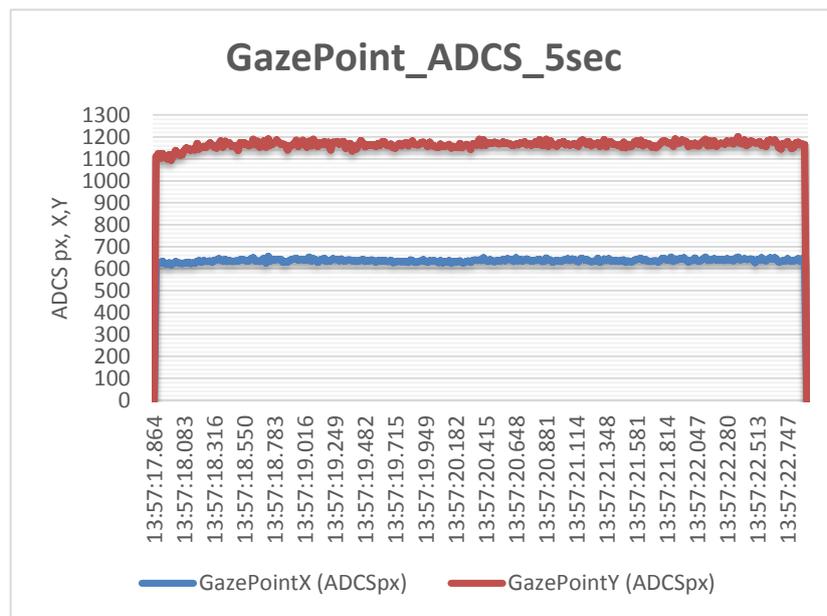


Figure 5. Graph of the mean coordinates of a gaze point. Participant 8. Image 5. Time-5 sec. Both eyes

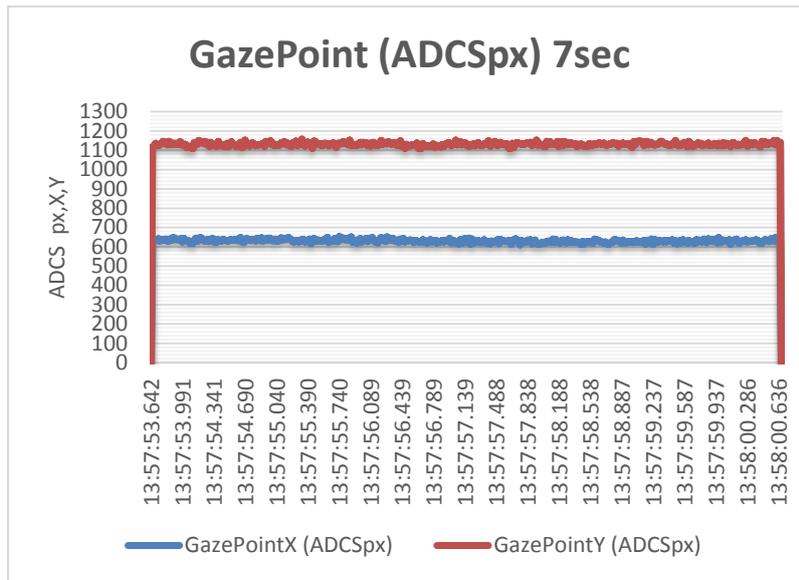


Figure 6. Graph of the mean coordinates of a gaze point. Participant 8. Image 5. Time-7 sec. Both eyes

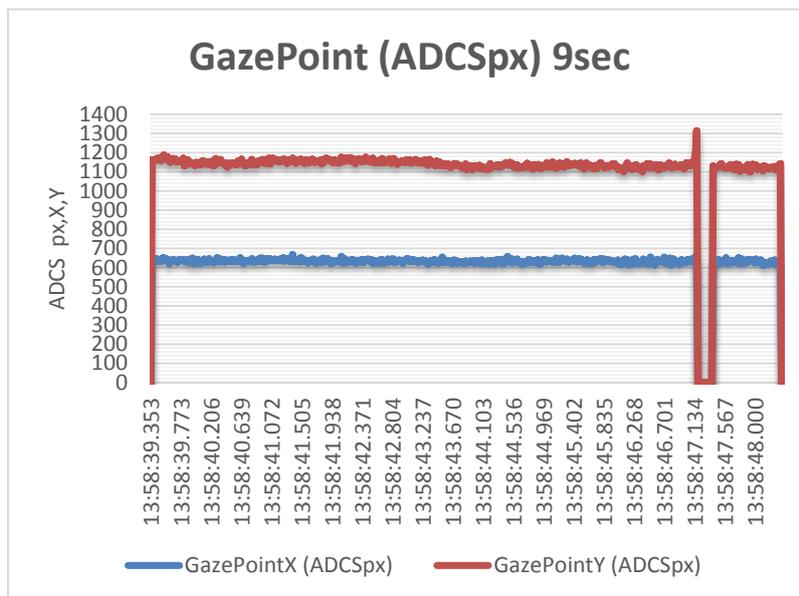


Figure 7. Graph of the mean coordinates of a gaze point. Participant 8. Image 5. Time-9sec. Both eyes

## 1.2.2 Eye-tracking technology

The Eye-tracker works based on flipping recording and analysis of the eye track. The camera is recording the track of each or both eyes and saves data when a respondent is concentrated on the object with a visual stimulus. The most of eye-trackers use the contrast between the pupil and the iris when infrared light. The orientation of the optical axis is determined by the path of reflected infrared light. Consideration of the points of

fixation at the scan path allows determine the area of interest of a respondent during the experiment.

According to Tobii manual (An introduction to eye tracking and Tobii Eye Trackers, 2010:9) there're three types of eye-trackers. The first is an Eye-tracker using a mechanical contact with an eye, for example contact lens. Measurements of this type of Eye-trackers are very sensitive to eye movements. The second- Eye-tracker using electric potential measured by electrodes placed around the eyes. The work of this type of Eye-trackers is based on the fact that each eye emits a stable electrical field which can be measured in the darkness or with closed eyes of a respondent. The electrical signal may be obtained by two pairs of electrodes placed around the eyes.

And the third type of Eye-tracker is the Eye-tracker using a non-contact optical methods for tracking the eye movements. The eye-tracker uses the infrared light which is reflected by an eyeball and is recorded by a camera. In the process of recording the information about the orientation of the eyeball in the space and the dynamics of its movement during the time is obtained.

According to Arcada manual (Eye Tracking research manual at Arcada. 2011 p.8-10) the Eye tracker Tobii T120 studied at Arcada and used in a particular experiment is the third type of Eye-Tracker. It's a desktop device that uses a non-contact optical methods of an infrared light saving raw data about the gaze movements of an eye for further processing.



Figure 8. The components of Tobii Eye Traker (User Manual. Tobii Studio. Tobii Technology AB, 2010)

Figure 8 represents the main components of the Tobii Eye-tracker at Arcada. It has three main elements: monitor, infrared gun and infrared sensitive camera. Monitor is a TFT screen with a resolution  $1280 \times 1024$  where a respondent can see a test image. The pupil of a respondent is illuminated by infrared light when several high-precision infrared cameras permanently record the pupil (Lehmuskallio 2011:10). High accuracy allows cameras to recognize the position of the pupil on the screen. The Tobii Studio Software is needed for further processing of obtained data. A good quality of recognition of a pupil and powerful software allows to carry out an experiment and collect almost any data that are needed to be studied.

During a recording the Tobii T120 desktop Eye tracker collects raw eye movement data points every 8.3 ms with its coordinates X and Y and saves it at the application Tobii Studio at the additional computer connected to the Eye tracker (An introduction to eye tracking and Tobii Eye Trackers. Tobii Technology AB, 2010:9). In order to visualize the data these coordinates will then be processed further into fixations and overlaid on a video recording of the stimuli used in the test. By aggregating data points into fixations the amount of eye tracking data to process is reduced significantly.

The data collected by the Eye Tracker can be represented in several visual ways. The first one is a Gaze Plot, when long fixations are shown with large dots, smaller fixation with smaller dots and saccades-with lines between the dots. Figure 9 represents an example of a gaze Plot or a Scanpath Image.



Figure 9. Gaze Plot or Scanpath image. (An introduction to eye tracking and Tobii Eye Trackers. Tobii Technology AB, 2010)

The second way is a heat map, when the amount of participants and the fixation duration are shown by different colors on the image. The red color usually means a high number of fixations at the same point and a longer fixation duration and the green color changing from the red through orange and yellow means the least number of fixations and fixation duration with various levels in between. The parts of the media without any colored areas mean that either the participants have not paid attention on them or have seen them with a more blurred peripheral vision. Figure 10 represents an example of a Heatmap.

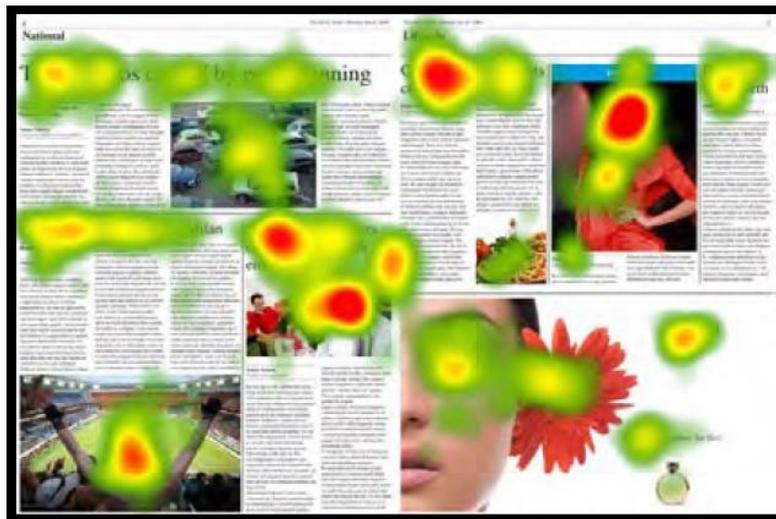


Figure 10. The Heatmap. (An introduction to eye tracking and Tobii Eye Trackers. Tobii Technology AB, 2010)

## 2 METHODS

### 2.1 Methods of experiment

Considering that a human pupil moves with saccades, one of the main goal of the experiment is to determine how well the respondents can focus on a special point on the screen and how accurate the Eye-tracker records these fixations and eye movements.

The participants were randomly chosen within Arcada students for five representatives of each race-European, African, Asian. The total number of participants tested is 15. The particular number of respondents of 15 people were chosen based on the article of Jakob Nielsen (Nielsen, J. 2009:61) where the author assumes that “as you add more and more users, you learn less and less because you will keep seeing the same things again and again”. Thus, Jakob Nielsen offers to test fifteen users for one test each or five users for three short tests. As one of the tasks of our test is to determine if the accuracy of the Mean gaze coordinates depends on the duration of the test, 15 chosen respondents were tested for 5,7, 9 seconds in one test. Table 1 represents the list of participants of all three groups and their percentage of recording.

*Table 1. The list of participant. Percentage of recording*

<b>Group:</b>	<b>%</b>	<b>Group:</b>	<b>%</b>	<b>Group:</b>	<b>%</b>
<b>EU</b>		<b>Africa</b>		<b>Asia</b>	
<b>P1</b>	<b>94%</b>	<b>P6</b>	<b>85%</b>	<b>P11</b>	<b>88%</b>
<b>P2</b>	<b>95%</b>	<b>P7</b>	<b>98%</b>	<b>P12</b>	<b>74%</b>
<b>P3</b>	<b>90%</b>	<b>P8</b>	<b>96%</b>	<b>P13</b>	<b>83%</b>
<b>P4</b>	<b>99%</b>	<b>P9</b>	<b>94%</b>	<b>P14</b>	<b>94%</b>
<b>P5</b>	<b>100%</b>	<b>P10</b>	<b>98%</b>	<b>P15</b>	<b>48%</b>

The test includes three parts with five Images in each with a black cross in each corner of the Image. All pictures are placed in a certain order following each other first for 5 seconds each, then for 7 seconds each and finally for 9 seconds each. Figure 11 represents a visual technical part of a test.

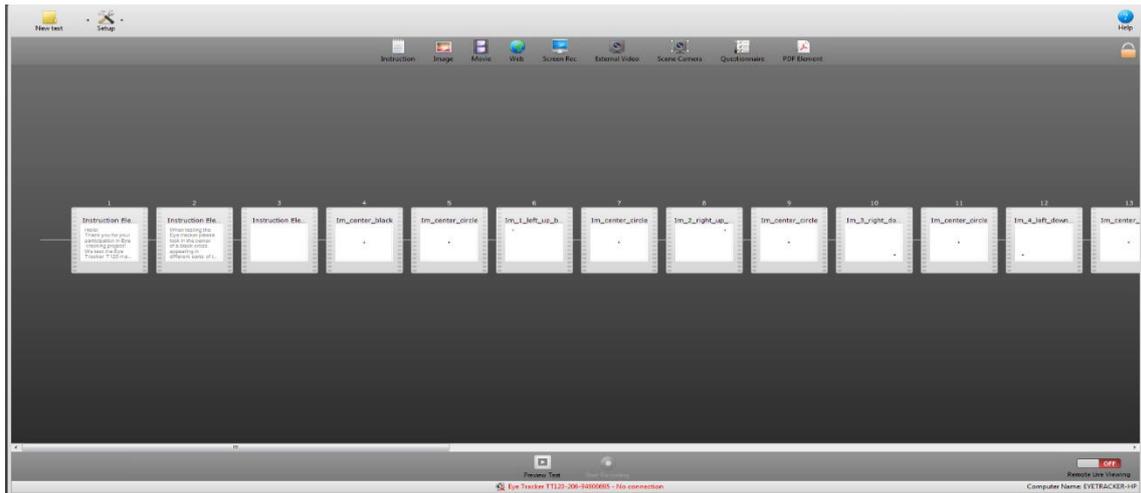


Figure 11. Test in Eye Tracker

Five pictures are made in Photoshop CS6 by the researcher with crosses in different corners of an Image. All pictures are called based on the location of the crosses in different corners: “Image\_Left\_Up”-location of the cross is in the upper left corner, “Image\_Right\_Up” –upper right corner, “Image\_Right\_Down”- lower right corner, “Image\_Left\_Down”- lower down corner and “Image\_Center”- the cross is in the center of the Media. One picture with a circle in the center was set between the parts of the test with different duration with a purpose to avoid the defocusing of the gaze between the parts of the test. Figure 12 represents the location of a set figure Cross on the screen.

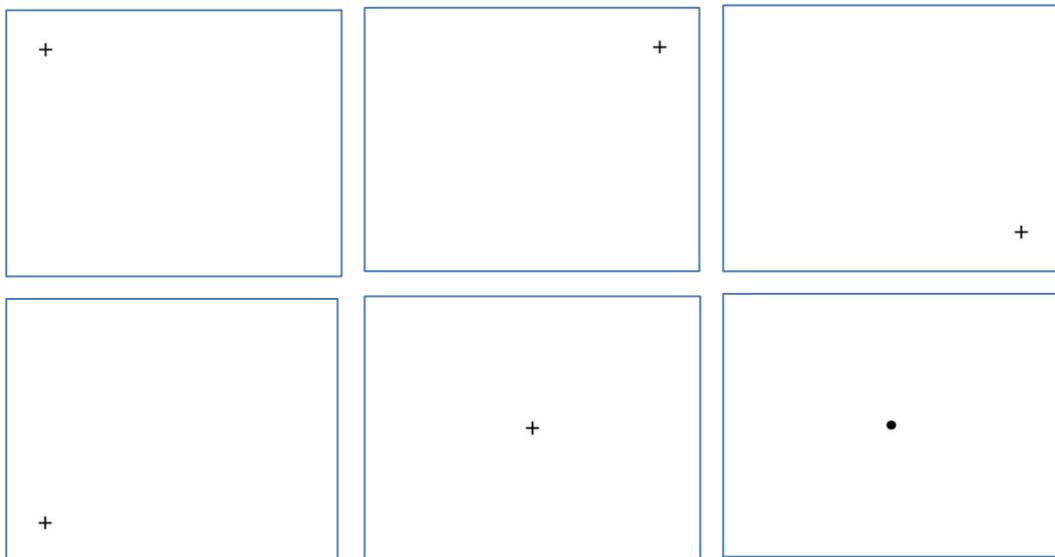


Figure 12. Location of set Crosses on the screen

As one of our main goal is to determine the accuracy of participants’ gaze point at each picture in pixels, all respondents were notified before starting the test and also with an

information page at the beginning of the test to look exactly in the center point of each cross trying to concentrate exactly on the cross but not on other parts of the white screen.

Eye-tracking minimizes the link between the respondent and the object of study, thus we also notified all participants that the data of a particular test will be used only as a study research and will not evaluate personal eye characteristics of a participant.

For easier using the particular pictures Image\_Left\_Up, Image\_Right\_Up, Image\_Right\_Down, Image\_Left\_Down and Image\_Center are called Image 1, 2, 3, 4 and 5 respectively. Figure 13 represents the conformity of the picture name and the Cross location and the number of the picture.

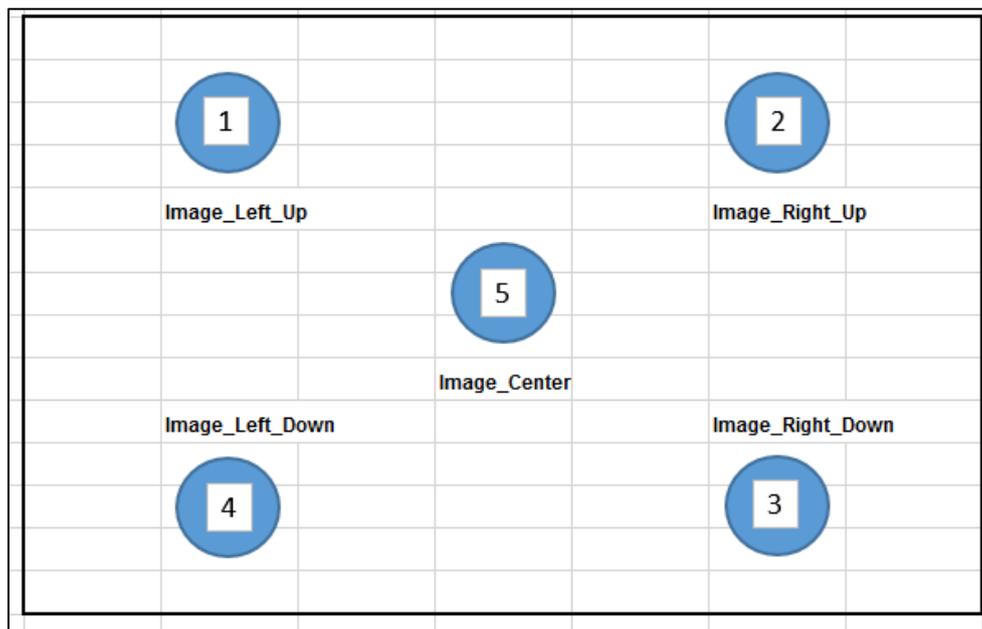


Figure 13. Conformity of the Image name and the Cross location and the number of the Image

As the main goal of the test is to check the accuracy of measurement of Eye-tracking and the ability of participants to concentrate exactly on the set point, so a special attention was paid to exact and accurate coordinates of the Cross at each picture.

Figure 14 represents the exact coordinates of the center of each cross in pixels are: 1. X: 175 px, Y: 175 px, 2. X: 1105 px, Y: 175 px, 3. X: 1105 px, Y: 175 px, 4. X: 175 px, Y: 849 px, 5. X: 640 px, Y: 512 px.

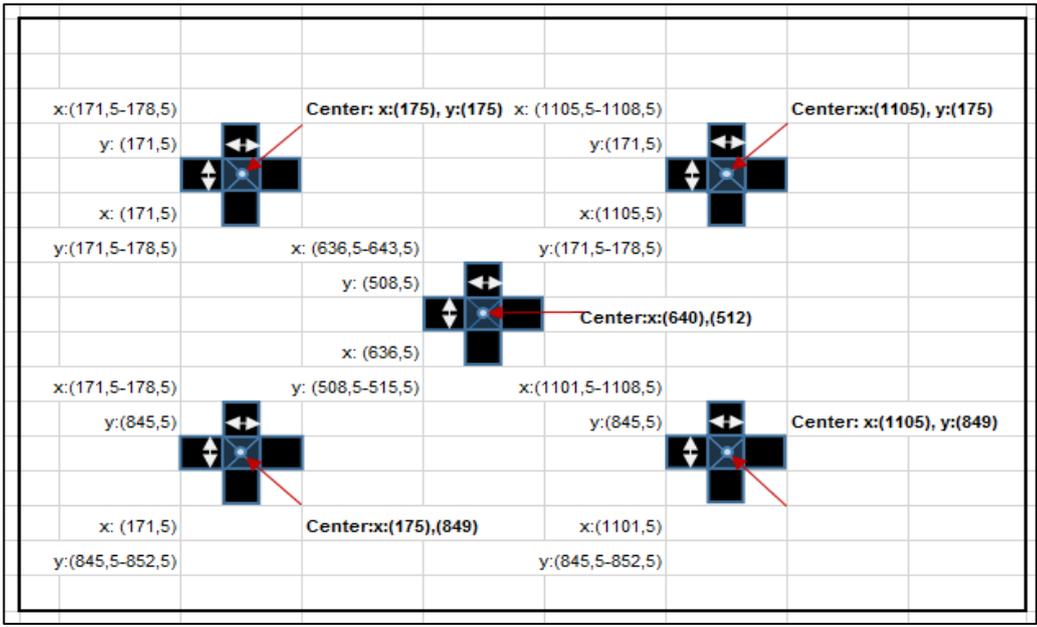


Figure 14. Exact coordinates of location of Crosses on the screen

All crosses have the identical size: the height: 50 px, the length: 50 px, the width: 7 px. The size of the square of the intersection: 7px\*7px. Figure 15 represents the accurate location of the crosses and the distance between them and to the border of the Media.

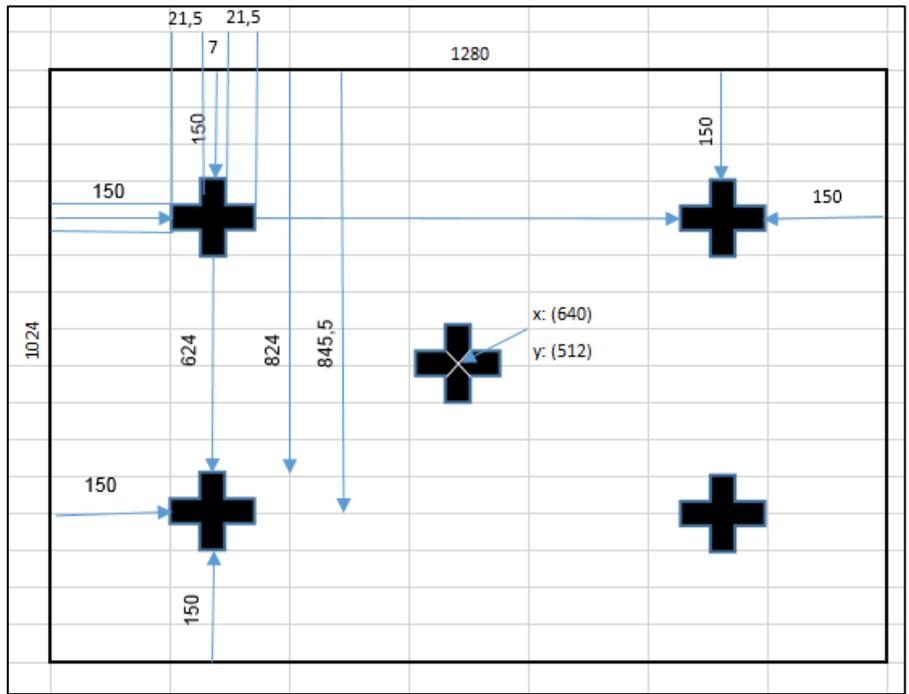


Figure 15. Distance between the set figures and the edge of the screen

As the movements of the head during the experiment can influence on the accuracy of measurements, all participants were notified not to move with their head during the ex-

periment and additionally the neck of the participants were fixed with a neck latch presented at the Figure 16.



Figure 16. Neck latch used in the experiment

The distance between the participant's eyes and the Eye-tracker was established so that the procedure of calibration is possible to set. It varied from 50 to 60 cm. The distance also changes according to the respondent eyesight-in the case of a low eyesight the distance decreased but was enough for the influence of infrared light and camera recording (see Figure 17)

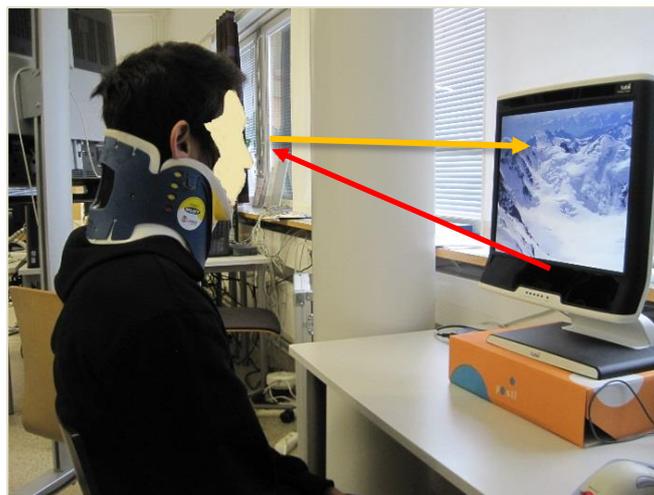


Figure 17. Position of a participant related to the Eye-tracker

As it was previously explained by Tobii company (An introduction to eye tracking and Tobii Eye Trackers2010: 7) the procedure of calibration is the procedure that should be done before the beginning of the experiment so that the Eye-tracker is able to record the coordinates of the pupil of the respondent when he/she is looking at the special markers on the screen appearing consequentially at different corners of the screen. This procedure should be done for each respondent separately and cannot be recorded for all respondents once as the location of vessels on the retina is unique for each person (An introduction to eye tracking and Tobii Eye Trackers2010:14). An accurate and reliable

calibration is a necessary condition for providing the experiment and collecting correct and accurate data. Inaccurate calibration of the system leads to significant errors of the experiment. Figure 18 represents the results of calibration of a participant P08. Longer tails of observations indicate a lower accuracy of calibration procedure. In this case the test still can be recorded but it's better to run a procedure of calibration one more time.

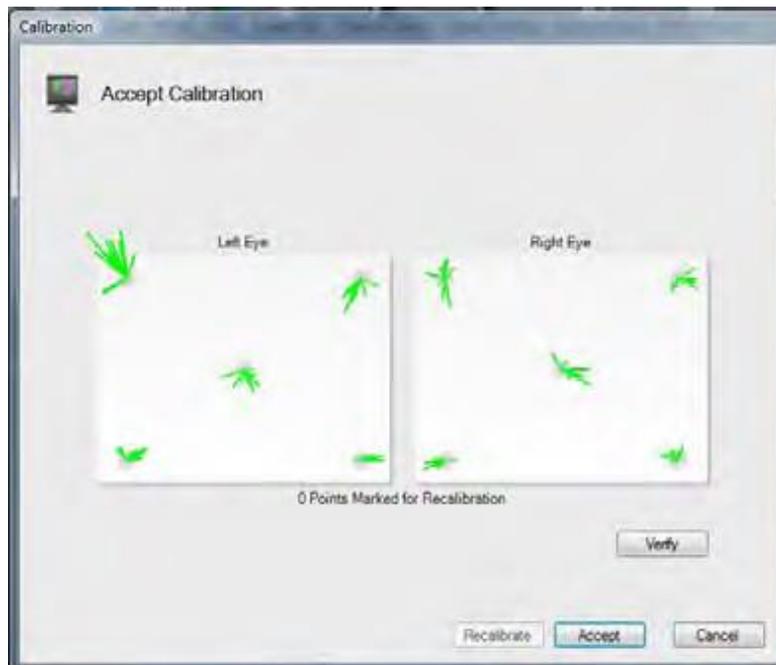


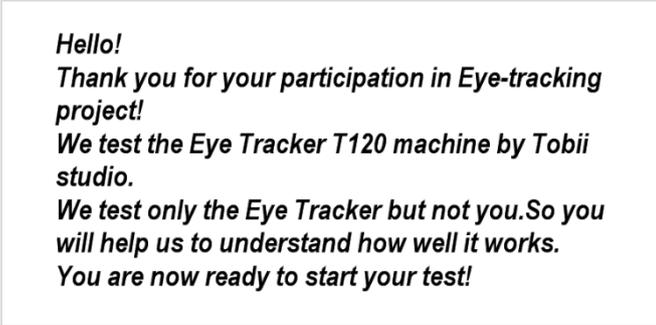
Figure 18. Results of calibration of a participant P08

## 2.2 Ethical issues

According to Holmqvist (2011:115) "Ethics fundamentally means that a participant should have a good feeling about having participated in your studies". Thus, first of all the participation in a particular experiment was voluntary for each respondent and all respondents were informed before the beginning of an experiment that they can quit at any moment of the test in case of feeling uncomfortable.

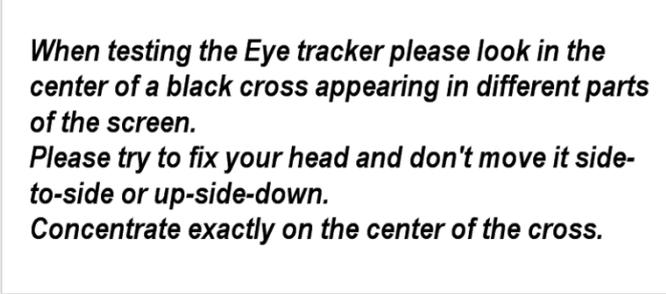
As the main point of a particular study is to test all participants in equal conditions, so it was very important to give clear explanations about the procedure and test's purposes to all participants before the start of the test. It evaluates an unpredictable negative reaction of the participants during the test, makes them feel more relaxed and comfortable in the conditions of a laboratory.

Thus, all respondents were assured orally before the experiment and also after the beginning of an experiment that the participation is anonymous, no personal information about the participant is collected and that only technical characteristics of Eye-Tracker are measured during a test but not personal abilities of respondents. All instructions and explanations are first made orally and then presented written in the instruction on the Eye-tracker screen before starting the test. All questions of each respondent are answered in details such as: what is the purpose of the experiment, what the researcher is going to measure and what data are collected during the experiment, if a respondent may perform poorly in the experiment, if the researcher is evaluating the personal skills and abilities of a participant. Figures 19-20 represent a particular information messages.



**Hello!**  
**Thank you for your participation in Eye-tracking project!**  
**We test the Eye Tracker T120 machine by Tobii studio.**  
**We test only the Eye Tracker but not you. So you will help us to understand how well it works.**  
**You are now ready to start your test!**

Figure 19. Invitation message of Eye tracking experiment



**When testing the Eye tracker please look in the center of a black cross appearing in different parts of the screen.**  
**Please try to fix your head and don't move it side-to-side or up-side-down.**  
**Concentrate exactly on the center of the cross.**

Figure 20. Instructions message of Eye tracking experiment

Only detail of an experiment that could make respondents feel uncomfortable in case of no previous explanations is a neck latch as it makes feel some discomfort during testing. But all participants were asked by a researcher if they are not against of using the neck latch as it helps to prevent undesirable head movements. All participants agreed.

To make participants feel more comfortable, only respondent and a researcher are in the laboratory during the test.

## 2.3 Methods used in Data processing

After recording, all pupil coordinates are saved in the database of a Tobii Studio software from where it's possible to extract them later as raw data and process. A working process with raw data got from the experiment is divided in several stages. All data processing work is made in Excel. All tables must be read from top left corner first to the right, then from the top left corner down. Data processing includes several stages:

1. Division and filtration of all raw data for all participants to check the chosen index separately for each participant from each group at all five pictures for 5,7 and 9 seconds of recording. The division is made according to the algorithm presented at Figure 21.

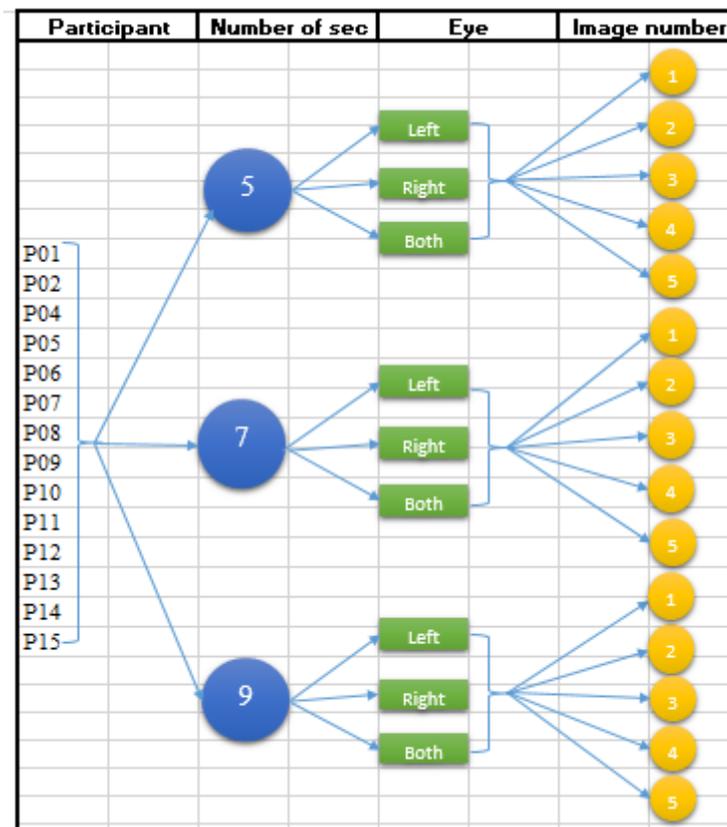


Figure 21. Division of raw data according to the duration of the parts of the experiment, eyes and images

Thus, after the division we got 45 separate tables. Each of them includes such information as Participant name, Media name, Local Time Stamp, Studio Event Index, Studio Event Data, Fixation Index, Saccade Index, Gaze Event Type, Gaze Point Index, Gaze Point Left X, Gaze Point Left Y, Gaze Point Right X, Gaze Point Right Y, Gaze Point X (ADCSpx), Gaze Point Y (ADCSpx).

2. Finding the Mean of fixation of the gaze point coordinates X and Y. All means are entered into a separated table called “Mean”.
3. Comparison of the Mean coordinates with the location coordinates of the Cross at each Media. The calculation were made with a formula “MEADIAN” comparing the chosen index with the chosen range. The indicator “True” means that the mean fits the area of the Cross, if “False”-doesn’t fit.
4. Making charts of the intersection of the Mean and the coordinates of the location of the set Cross and its center using Scatter Chart. The graphs are made for each participant separately and for the groups together, divided according to the images and duration time.

Figures 22-26 represent the Gaze Plot images summarizing the positions of fixations and saccades of all candidates of a particular experiment. The fixations are shown with dots which size means the fixation duration and the number inside means the number of participants concentrated on this point and the saccades are shown with lines in between. The Gaze Plot can show the gaze track of each participant during the time of the whole test or the gaze track of all participants within a short time span. As seen at the figures, the gaze track of every participant starts with a concentration at the Centre of the Image first and then goes to some special corner of the screen. It happens first of all because the center is naturally the most comfortable position for the eyes and secondly because, as it was mentioned above, between each particular Image we placed an additional Media with a dot in the center so that the eyes could relax between the fixations but at the same time the eyes are not completely defocused.

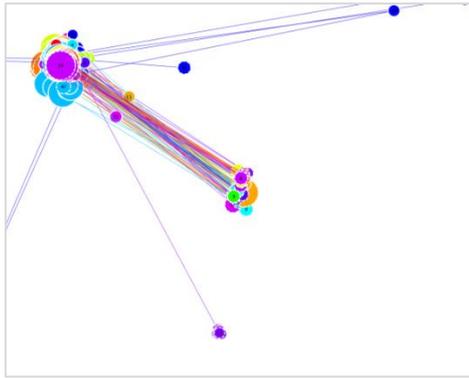


Figure 22. Gaze Plot at Image 1

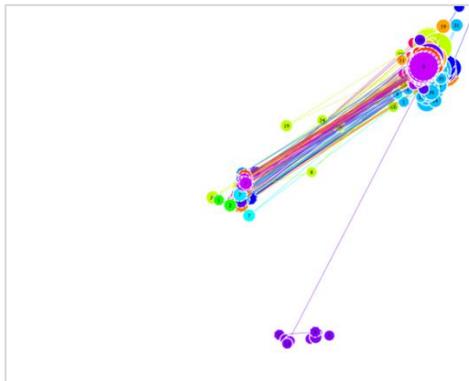


Figure 23. Gaze Plot at Image 2

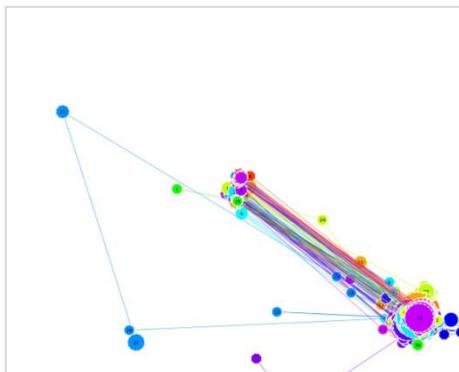


Figure 24. Gaze Plot at Image 3

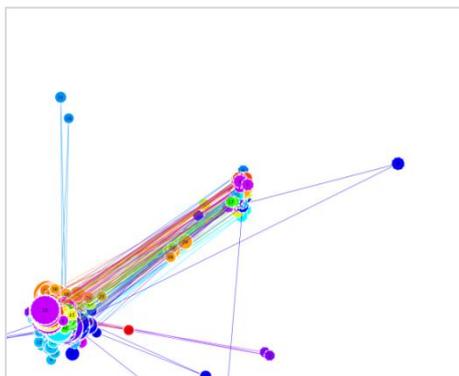


Figure 25. Gaze Plot at Image 4

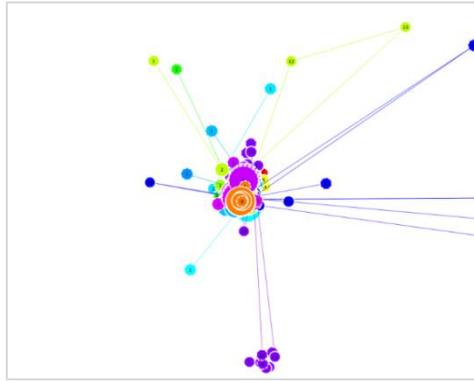


Figure 26. Gaze Plot at Image 5

Figures 27-31 represent the Heat maps indicating the areas of the image with fixations of the participants 1-15 and the duration of fixations at the Images 1,2,3,4 and 5. As seen at the Heatmaps, the concentration also starts from the center of the screen but then moves to a certain corner, where the red color indicates the longest fixation duration.



Figure 27. Heat Map at Image 1



Figure 28. Heat Map at Image 2

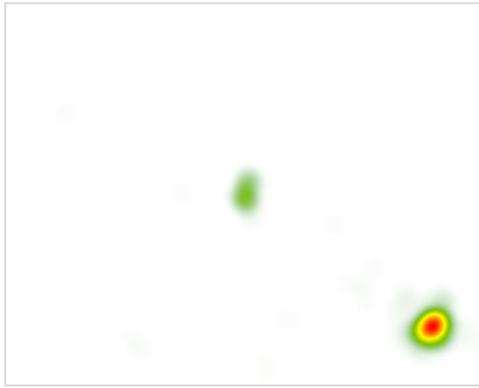


Figure 29. Heat Map at Image 3



Figure 30. Heat map at Image 4



Figure 31. Heat Map at Image 5

Figures 32-36 represent initial raw data exported from Tobii Studio Software to Excel including the following indexes used in the further data processing: Export Date, Studio Version, Studio Project Name, Studio Test Name, Participant Name, Recording Name, Recording Name, Recording Date, Recording Duration, Recording Resolution, Media Name, Media Position X (ADCS px), Media Position Y (ADCS px), Media Width, Media Height, Recording Times Stamp, Local Time Stamp Studio Event Index, Studio vent

Data, Fixation Index, Saccade Index, Gaze Event Type, Gaze Event Duration, Fixation Point X (px), Fixation Point Y (px).

	A	B	C	D	E	F	G	H	I
1	ExportDate	StudioVersion	StudioProjectName	StudioTestName	ParticipantName	RecordingName	RecordingDate	RecordingDuration	RecordingResolution
2	21.3.2014	3.2.1	Elena_Mazurova_2	New test	P08	Rec 08	7.3.2014	193215	1280 x 1024
3	21.3.2014	3.2.1	Elena_Mazurova_2	New test	P08	Rec 08	7.3.2014	193215	1280 x 1024
4	21.3.2014	3.2.1	Elena_Mazurova_2	New test	P08	Rec 08	7.3.2014	193215	1280 x 1024
5	21.3.2014	3.2.1	Elena_Mazurova_2	New test	P08	Rec 08	7.3.2014	193215	1280 x 1024
6	21.3.2014	3.2.1	Elena_Mazurova_2	New test	P08	Rec 08	7.3.2014	193215	1280 x 1024
7	21.3.2014	3.2.1	Elena_Mazurova_2	New test	P08	Rec 08	7.3.2014	193215	1280 x 1024
8	21.3.2014	3.2.1	Elena_Mazurova_2	New test	P08	Rec 08	7.3.2014	193215	1280 x 1024

Figure 32. Raw data. Studio Events

	J	K	L	M	N	O	P	Q	R	S	T
1	MediaName	MediaPosX (ADCSpz)	MediaPosY (ADCSpz)	MediaWidth	MediaHeight	RecordingTimes	LocalTimeSt	EyeTrackerTimestamp	StudioEventIndex	StudioEvent	StudioEventData
2	lm_center_block.jpg	0	0	1280	1024	53630	13:57:17.864		1	ImageStart	lm_center_block.jpg
3	lm_center_block.jpg	0	0	1280	1024	53630	13:57:17.867	1036234234383860			
4	lm_center_block.jpg	0	0	1280	1024	53710	13:57:17.884	1036234234400600			
5	lm_center_block.jpg	0	0	1280	1024	53727	13:57:17.900	1036234234417220			
6	lm_center_block.jpg	0	0	1280	1024	53743	13:57:17.917	1036234234433850			
7	lm_center_block.jpg	0	0	1280	1024	53760	13:57:17.934	1036234234450530			
8	lm_center_block.jpg	0	0	1280	1024	53777	13:57:17.950	1036234234467210			

Figure 33. Raw data. Media data

	U	V	W	X	Y	Z	AA
1	FixationIndex	SaccadeIndex	GazeEvent Type	GazeEventDuration	FixationPointX (MCSpx)	FixationPointY (MCSpx)	AOI(Rectangle 4)Hit
2	1		Fixation	1499	621	481	
3	1		Fixation	1499	621	481	0
4	1		Fixation	1499	621	481	0
5		1	Saccade	17			0
6	2		Fixation	266	625	501	1
7	2		Fixation	266	625	501	1
8	2		Fixation	266	625	501	1

Figure 34. Raw data. Gaze Event

	AB	AC	AD	AE	AF
1	GazePointIndex	GazePointLeftX (ADCSpz)	GazePointLeftY (ADCSpz)	GazePointRightX (ADCSpz)	GazePointRightY (ADCSpz)
2					
3	1	626	495	612	483
4	2	630	516	620	481
5	3	632	468	618	487
6	4	638	491	627	491
7	5	626	494	618	480
8	6	630	490	610	470
9	7	621	507	619	479

Figure 35. Raw data. Gaze Point coordinates. Left and Right eye separately

	AB	AG	AH	AI	AJ
1	GazePointIndex	GazePointX (ADCSpz)	GazePointY (ADCSpz)	GazePointX (MCSpx)	GazePointY (MCSpx)
2					
3	1	619	489	619	489
4	2	625	498	625	498
5	3	625	477	625	477
6	4	632	491	632	491
7	5	622	487	622	487
8	6	620	480	620	480

Figure 36. Raw data. Gaze Point coordinates. ADCS. Both Eyes

The meaning of each index is presented below:

- **ExportDate**-date when the file was exported(date of export),
- **StudioVersionRec**-Tobii Studio release version used to perform the recording,
- **StudioProjectName**-name of the Tobii Studio Project,
- **StudioTestName**-name of the Tobii Studio Test,

- **ParticipantName**-name of the Participant associated with the Tobii Studio recording,
- **RecordingName**-name of the Recording,
- **RecordingDate**-date when the recording was performed,
- **RecordingDuration**-total duration of the recording,
- **RecordingResolution**-the resolution of the screen or video capture device used during the recording,
- **MediaName**-name of the media/stimuli element from the Tobii Studio test timeline,
- **MediaPosX(ADCSpX)**-recording horizontal position of the media on the screen. The value represents the horizontal position of the left edge of the media in relation to the left edge of the screen,
- **MediaPosY(ADCSpY)**- recording vertical position of the media on the screen. The value represents the vertical position of the top edge of the media to the top edge of the screen,
- **MediaWidth**-recorded horizontal size of the media element-width,
- **MediaHeight**-recorded vertical size of the media element-height,
- **RecordingTimestamp**-timestamp counted from the start of the recording (t0=0 ms),
- **LocalTimeStamp**-recording computer local “date time value” timestamp,
- **EyeTrackerTimestamp**-timestamp obtained from the Eye tracker firmware (TET server) clock,
- **StudioEventIndex**-represents the order in which a Tobii Studio recording event was registered. The index is an auto-increment number starting with 1 (first event detected),
- **StudioEvent**-type of media element or manual event (START,END and manual logging description),
- **StudioEventData**-displays the name of the media element, webpage URL or PDF page. For Manual logging it displays the text entered in the log message,
- **FixationIndex**-represents the order in which a fixation (i.e. fixation and saccades). The index is an auto-increment number starting with 1(first fixation detected),
- **SaccadeIndex**-represents the order in which a saccade was recorded. The index is an auto-increment number starting with 1 (first saccade detected),

- **GazeEventType**-type of eye movement event classified by the fixation filter setting applied during the gaze data export: Fixation, Saccade and Unclassified,
- **GazeEventDuration**-duration of an eye movement event,
- **FixationPointX(MCSpx)**-horizontal coordinate of the fixation point on the media. This column is affected by the setting in the Fixation Filter Tab (Global Settings),
- **FixationPointY(MCSpx)**-vertical coordinate of the fixation point in the media. This column is affected by the settings in the Fixation Filter Tab (Global Settings),
- **AOI Hit**-reports whether the AOI is active and whether the first fixation is located inside of the AOI:-1=AOI Not active; 0=AOI active, the fixation is not located in the AOI, 1=AOI active and the fixation is located inside of the AOI. Enabling this column generates one column per AOI,
- **GazePointIndex**-represents the order in which the gaze sample was acquired by Tobii Studio from the Eye tracker. The index is an auto-increment number starting with 1 (first gaze sample),
- **GazePointLeftX(ADCSPx)** - horizontal coordinate of the unprocessed gaze point for the left eye on the screen,
- **GazePointLeftY(ADCSPx)** –vertical coordinate of the unprocessed gaze point for the left eye on the screen,
- **GazePointRightX(ADCSPx)** - horizontal coordinate of the unprocessed gaze point for the right eye on the screen,
- **GazePointRightY(ADCSPx)** - vertical coordinate of the unprocessed gaze point for the right eye on the screen,
- **GazePointX(ADCSPx)** - horizontal coordinate of the averaged left and right eye gaze point on the media element,
- **GazePointY(ADCSPx)** - vertical coordinate of the averaged left and right eye gaze point on the media element.

### 3 RESULTS

Using the methods described above we processed data and got the mean coordinates of the gaze point of each participant during 5,7 and 9 seconds for left, right and both eyes at each of five set media pictures. Considering and comparing the mean coordinates of the gaze point to the X,Y coordinates of the center of the Cross we can determine the deviation of the gaze track and its changes during the experiment and accuracy of measurements. All results are presented below.

The Mean table is divided into several tables. Each table contains the information per one Image divided for 5,7 and 9 seconds, separately for the left and the right eye and for both eyes together considering the results of all participants. Each section contains the results for one of five Images tested in the experiment: Image 1 with a cross position at the upper left corner, Image 2 with a cross position at the upper right corner, Image 3-cross position at the downer right corner, Image 4-cross position at the downer left corner and Image 5-at the center; 3 tables (for 5,7,9 seconds separately) and 9 graphs (for left, right and both eyes for 5,7,9 seconds of recording respectively).

#### 3.1 Mean gaze coordinates of all participants at the Image 1

Cross position-upper left corner (Figure 37).

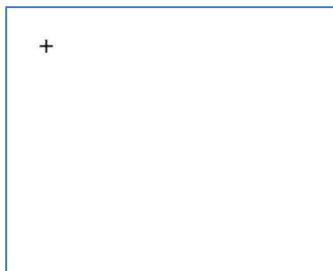


Figure 37. Cross-position-upper left corner

Figure 38 shows the algorithm of presenting the results in the section: Image 1-Cross position-Upper Left corner → for 5,7,9 seconds → for the left, right, both eyes → for group of participants EU (P1-5), Africa (P6-10), Asia (P11-15).

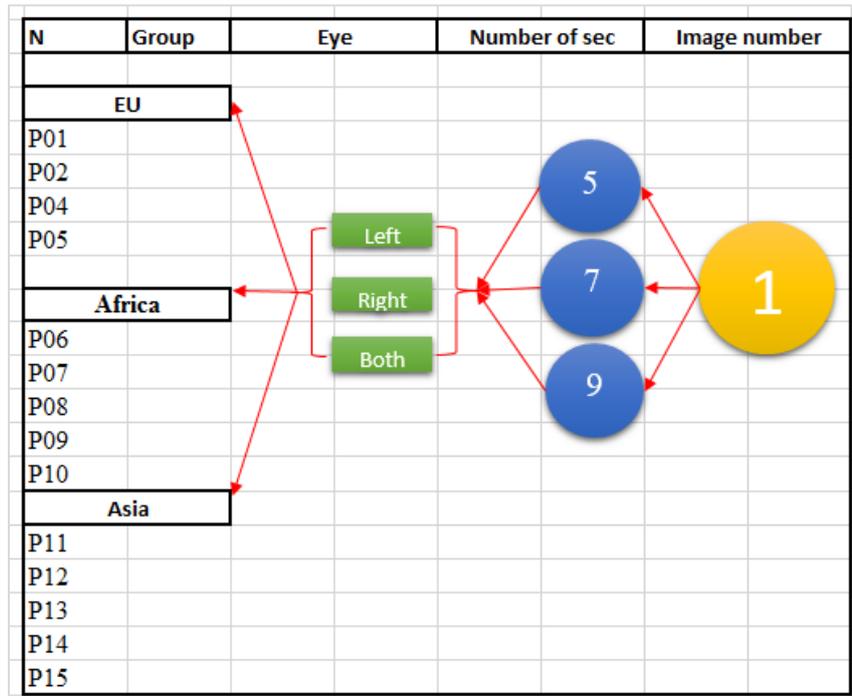


Figure 38. The algorithm of data presentation of the Image 1

Image 1 with a Cross position at the upper left corner is the most comfortable for a participant to observe as according to Outing, S. (*Eye-track III: What News Websites Look Like Through Readers' Eyes*. 2004:3), the upper left corner captures the most attention of the respondents.

Tables 2-16 represent the mean coordinates of the gaze point measurements of all participants divided for groups-European, Asian and African. The coordinates of the center of a set Cross are also shown. All data presented in the tables are shown at the graphs after each table.

Figures 39-91 present the graphical image of the mean coordinates related to the position of the Cross and the axis X and Y which makes the deviation more visible. Each group of participants is shown in different colors.

Table 2. Mean coordinates of the gaze at the Image 1. Recording time-5 sec

Center point			MEAN					
X	175		5 sec					
Y	175		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	213,1	302,8	136,7	179,8	195,9	218,6
	P2	95 %	179,9	154,1	164,3	215,7	171,9	184,7
	P3	90 %	161,5	195,4	185,4	169,4	174,0	182,8
	P4	99 %	192,5	180,5	183,3	182,0	187,6	181,0
	P5	100 %	173,7	153,3	162,7	172,0	168,0	162,5
Africa	P6	85 %	170,8	189,5	169,1	147,6	169,7	168,3
	P7	98 %	290,8	236,6	299,4	242,0	294,8	239,1
	P8	96 %	188,2	181,9	175,0	175,2	181,3	178,3
	P9	94 %	175,9	154,2	160,4	146,9	168,0	150,6
	P10	98 %	181,0	160,9	171,5	167,8	176,0	164,1
Asia	P11	88 %	191,0	177,6	186,9	182,8	188,6	180,1
	P12	74 %	185,3	164,9	216,9	204,6	201,3	185,5
	P13	83 %	177,8	208,2	208,5	176,0	189,7	191,9
	P14	94 %	198,4	171,0	176,3	178,4	187,1	174,5
	P15	48 %	607,0	529,4	625,6	511,3	616,2	520,1

Table 2 shows the Mean X and Y coordinates of the fixation at the Image 1 for left, right and both eyes during the recording time of 5 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

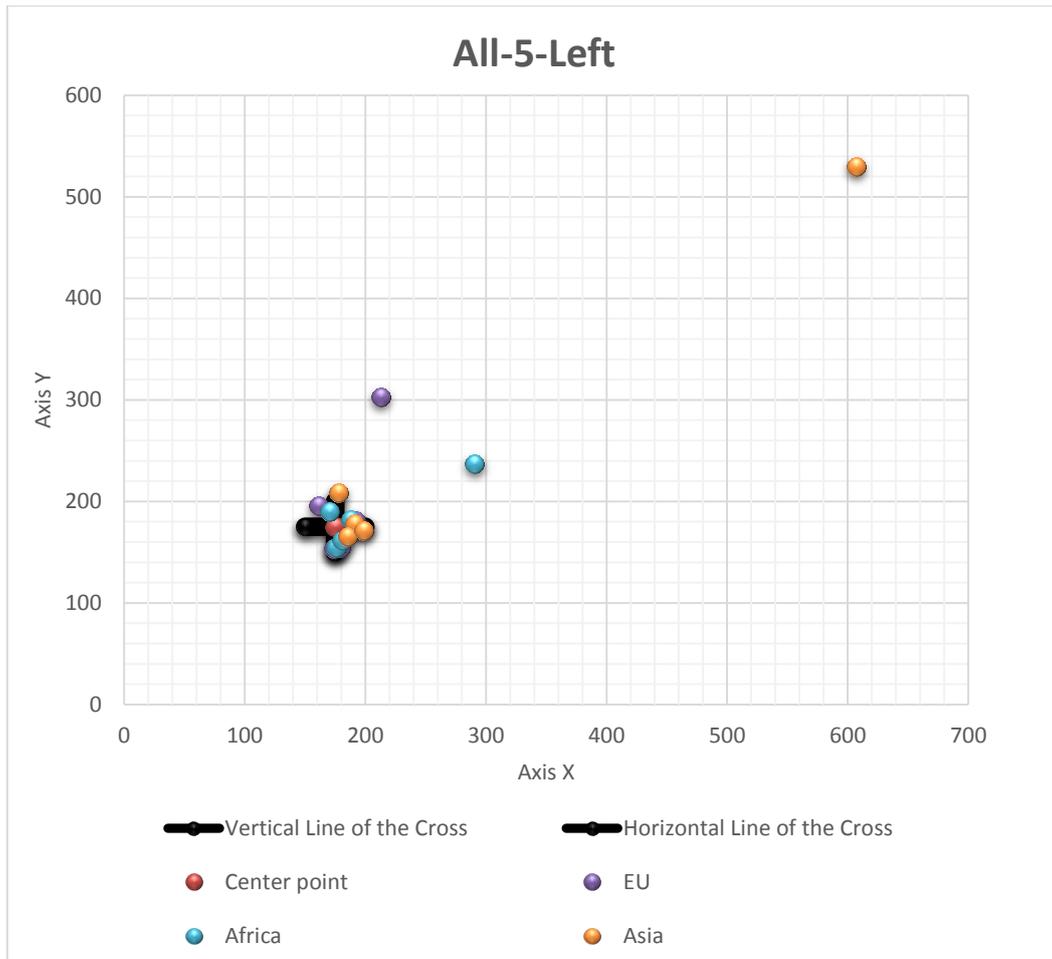


Figure 39. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5seconds. Left Eye

Figure 39 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

At the particular Figure it’s visible that the mean gaze of almost all participants fits the set area of the Cross but no one participant fits the center with a tendency of concentration at the lower right side of the Cross. One participant of each group doesn’t fit the area and one participant of each group has a bigger deviation than others.

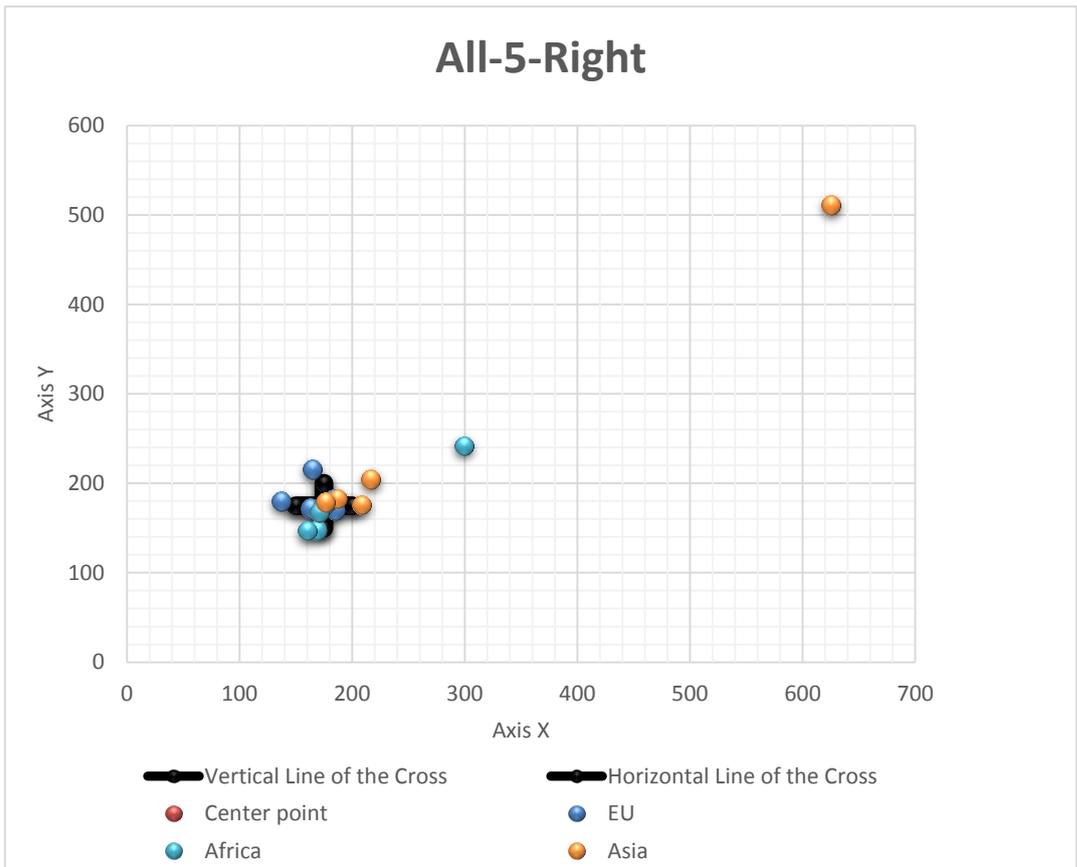


Figure 40. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5seconds. Right Eye

Figure 40 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

At the particular Figure it’s visible that the mean gaze of almost all participants fits the set area of the Cross and have the intersection with the center. The participants of the group EU and Africa have a bigger deviation comparing to the group Asia with shifting to the right side of the Cross.

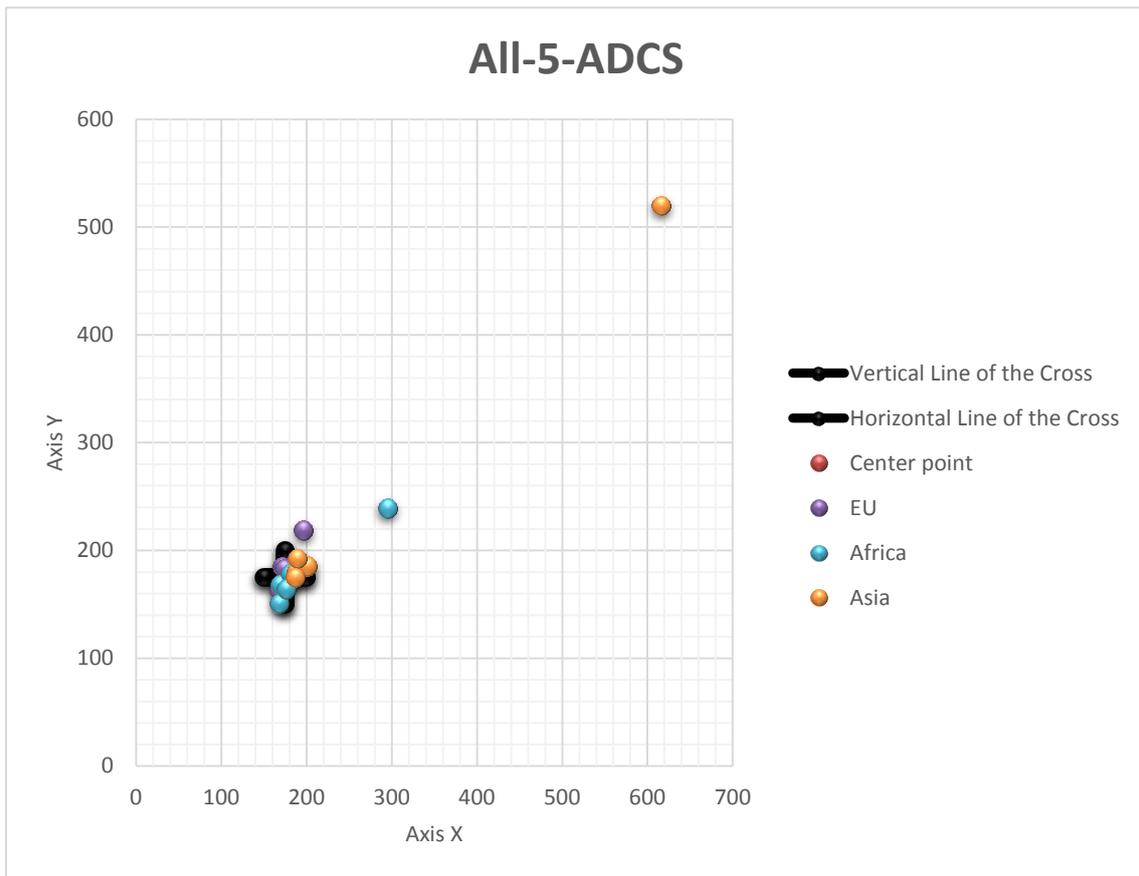


Figure 41. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Both Eyes

Figure 41 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

At the particular Figure it’s visible that the mean gaze of most of all participants fits the set area of the Cross and have the intersection with the center but one participant of each group doesn’t fit the area. The group Asia has a tendency of shifting to the upper right quarter of the Cross.

Table 3. Mean coordinates of the gaze at the Image 1. Recording time-7 sec

Center point			MEAN					
X	175		7 sec					
Y	175		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	180,88	256,81	157,52	137,44	168,83	196,57
	P2	95 %	168,23	149,90	146,03	208,23	156,78	178,87
	P3	90 %	156,21	191,76	173,51	159,73	164,62	175,50
	P4	99 %	191,39	180,01	182,85	182,64	186,87	181,07
	P5	100 %	170,37	134,04	139,23	142,13	154,56	137,86
Africa	P6	85 %	167,81	181,46	168,34	149,99	167,82	165,66
	P7	98 %	187,93	173,25	185,83	167,68	186,66	170,21
	P8	96 %	184,39	169,69	160,30	159,73	172,10	164,47
	P9	94 %	179,60	154,50	152,07	145,23	165,68	149,79
	P10	98 %	162,53	160,30	154,10	168,79	158,00	164,38
Asia	P11	88 %	193,50	182,70	183,62	184,12	188,61	184,01
	P12	74 %	179,05	176,17	216,06	190,81	197,37	182,98
	P13	83 %	183,71	211,32	149,04	216,88	159,41	213,45
	P14	94 %	188,45	164,32	163,81	175,11	175,88	169,46
	P15	48 %	609,58	537,03	628,04	531,54	618,98	533,83

Table 3 shows the Mean X and Y coordinates of the fixation at the Image 1 for left, right and both eyes during the recording time of 7 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

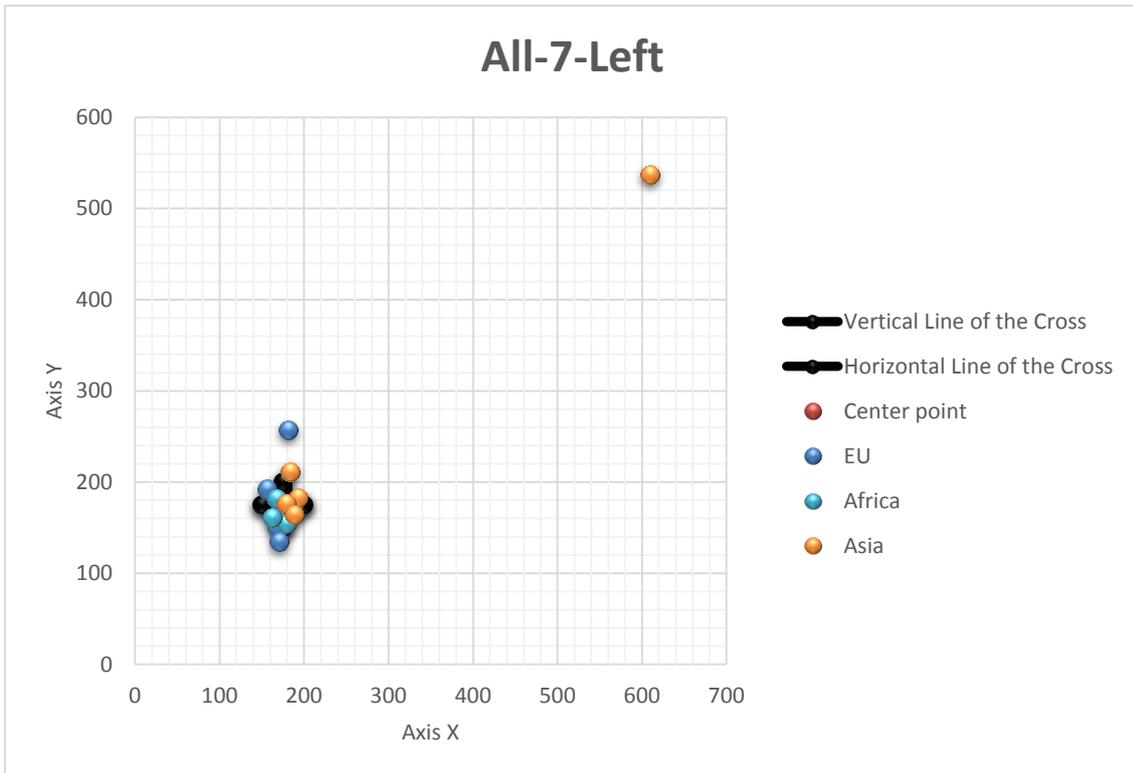


Figure 42. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7seconds.Left Eye

Figure 42 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

The particular Figure shows that the mean gaze of most of all participants fits the set area of the Cross and have the intersection with the center but the mean of one participant of the group EU shifts upper the set area and doesn’t have the intersection with it. The mean gaze point of one participant of the group Asia leis out far away from the set area.

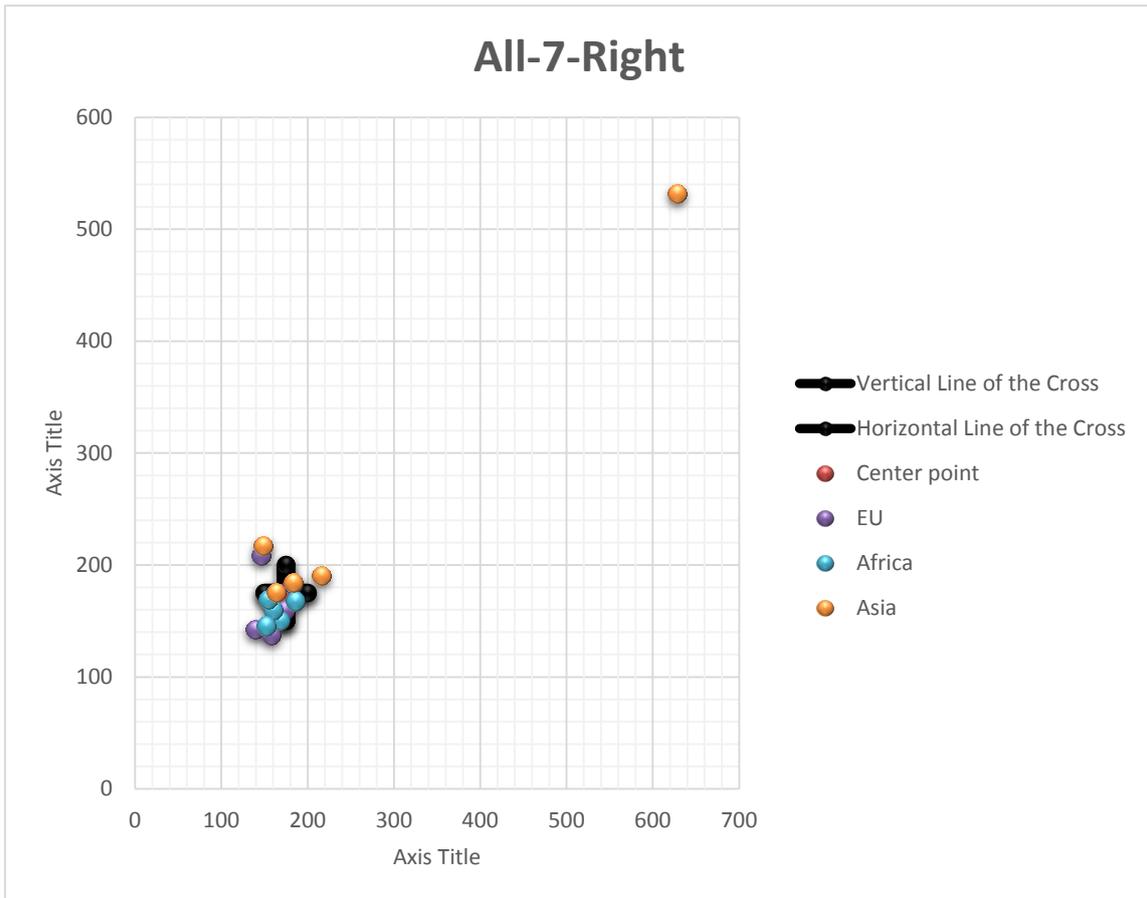


Figure 43. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7seconds. Right Eye

Figure 43 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

At the Figure it’s observed a bigger deviation of the mean with a tendency to shift to the lower left quarter of the Cross for all groups. The respondents of the group EU and Asia have a bigger deviation than the respondents of the group Africa. The mean gaze point of one participant of the group Asia leis out far away from the set area.

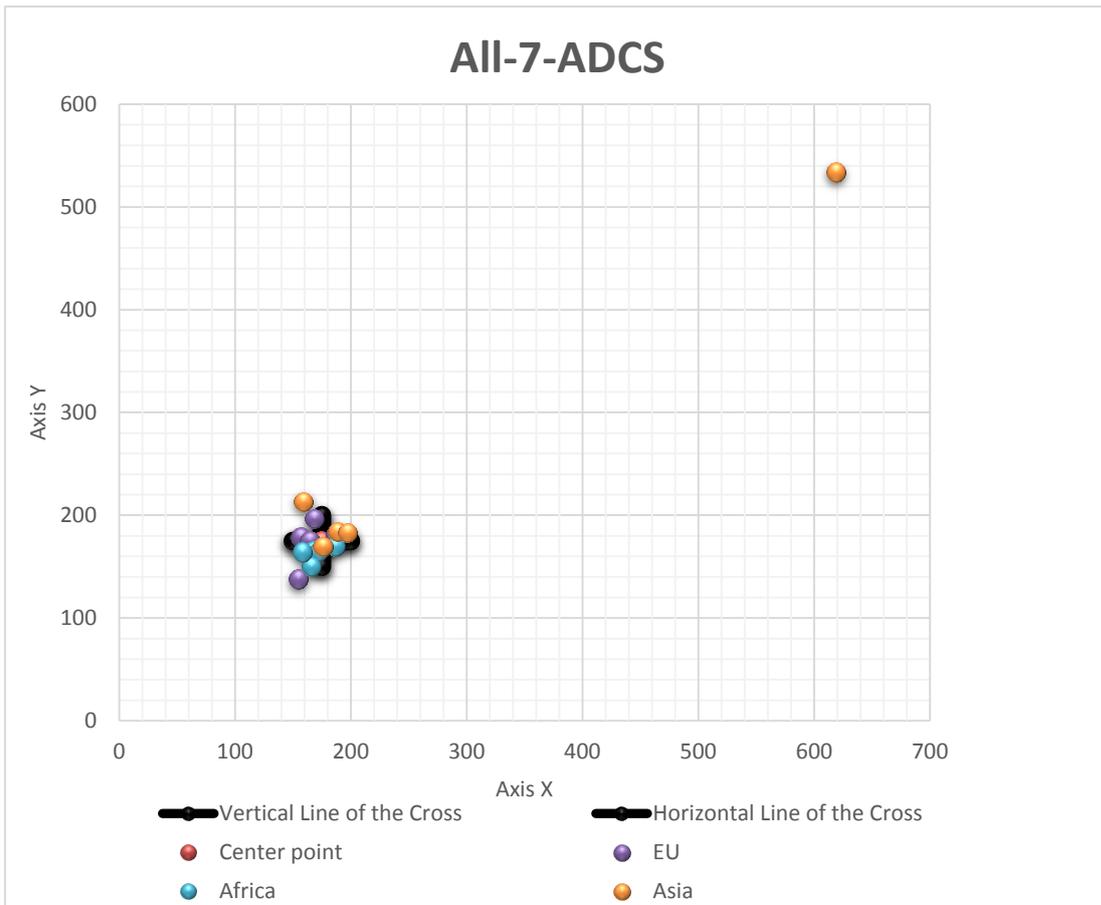


Figure 44. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7seconds. Both eyes

Figure 44 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

At the Figure for both eye the deviation for 7 seconds of the mean is bigger than for 5 seconds but it’s still observed a pretty well accuracy of the mean gaze fitting the set area of the Cross and its center point. The mean gaze point of one participant of the group Asia leis out far away from the set area.

Table 4. Mean coordinates of the gaze at the Image 1. Recording time-9 sec

Center point			MEAN					
X	175		9 sec					
Y	175		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	126,7173	220,5808	168,1508	160,9695	147,32	190,4514
	P2	95 %	158,5166	93,07565	140,5295	208,2122	149,2657	150,3985
	P3	90 %	157,2537	195,9426	176,1481	152,2833	166,3764	173,7952
	P4	99 %	172,9797	166,3985	164,8838	167,9354	168,69	166,9299
	P5	100 %	163,9613	136,8801	127,1181	142,2897	145,2989	139,3192
Africa	P6	85 %	169,0455	189,0139	167,7171	159,1366	167,6715	173,8273
	P7	98 %	171,7387	150,5226	168,9925	129,7411	170,152	139,8912
	P8	96 %	180,2627	168,0333	157,2903	162,1765	167,9298	165,1765
	P9	94 %	180,5667	155,8608	149,3086	149,5859	164,7715	153,0059
	P10	98 %	159,4214	158,7837	154,0018	161,6784	156,4362	159,9815
Asia	P11	88 %	185,5711	184,0741	177,8531	187,2716	181,8878	185,8778
	P12	74 %	310,7984	145,1835	346,4235	155,9668	326,3477	151,4898
	P13	83 %	146,4981	250,1944	198,2778	246,1352	172,1238	247,8835
	P14	94 %	174,8558	138,7412	141,8355	152,6266	158,085	145,4288
	P15	48 %	572,5855	529,9054	633,3852	520,8279	600,2838	524,8362

Table 4 shows the Mean X and Y coordinates of the fixation at the Image 1 for left, right and both eyes during the recording time of 9 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

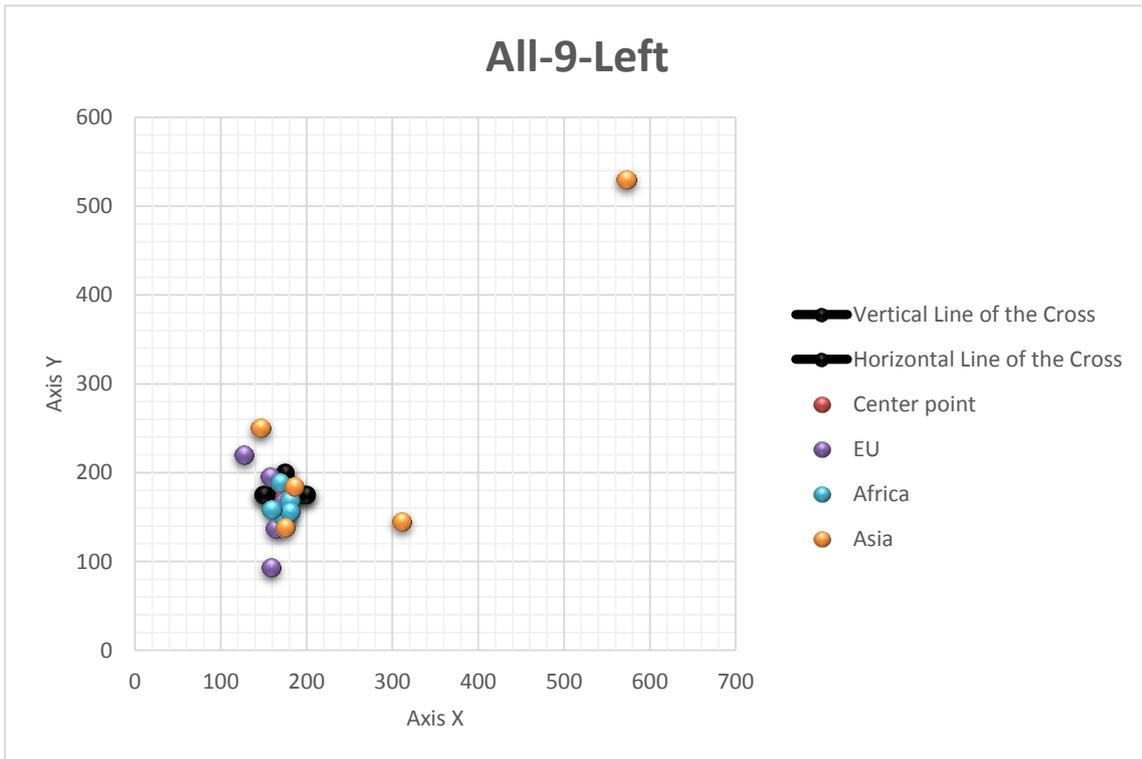


Figure 45. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Left Eye

Figure 45 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

The Figure shows that at the last part of the test the indexes of the mean has a bigger deviation comparing to the set area and more participant of each group don't fit the set area.

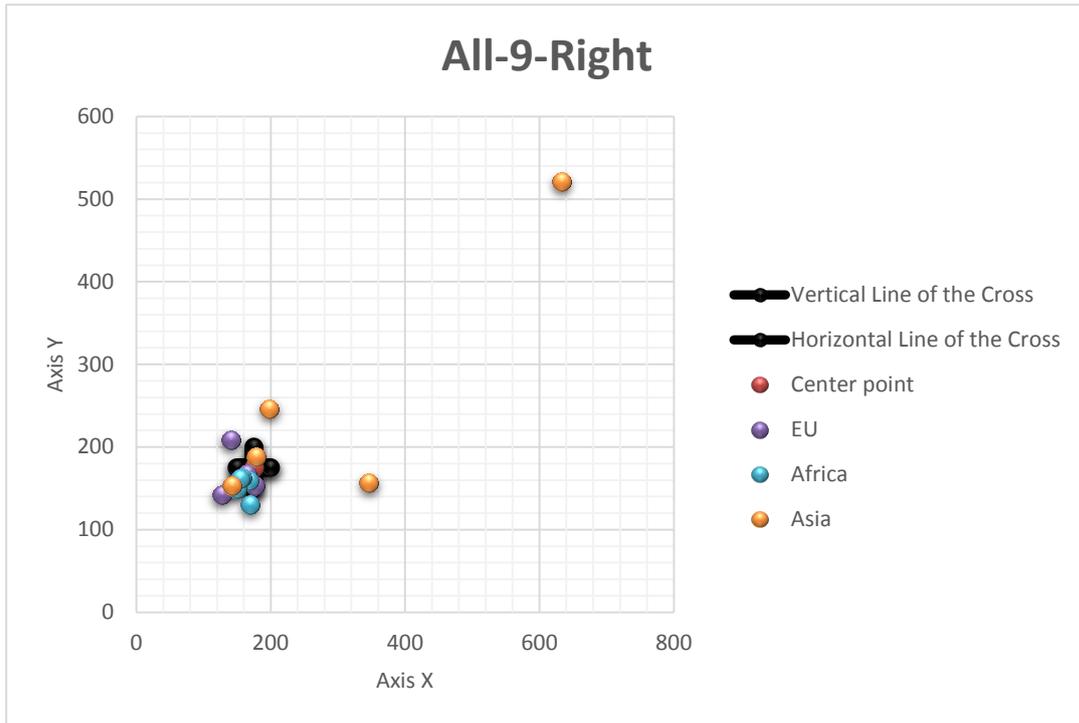


Figure 46. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Right Eye

Figure 46 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 1.

The figure of the mean for 9 seconds recording shows a similar tendency as a previous figure. The mean coordinates of the participants’ gaze shift to the lower left quarter of the area. The worst result are presented here by Asian respondents whose three of five participant’s mean gaze lie far away from the Cross. The best results are presented by the EU respondents having the intersections with the center.

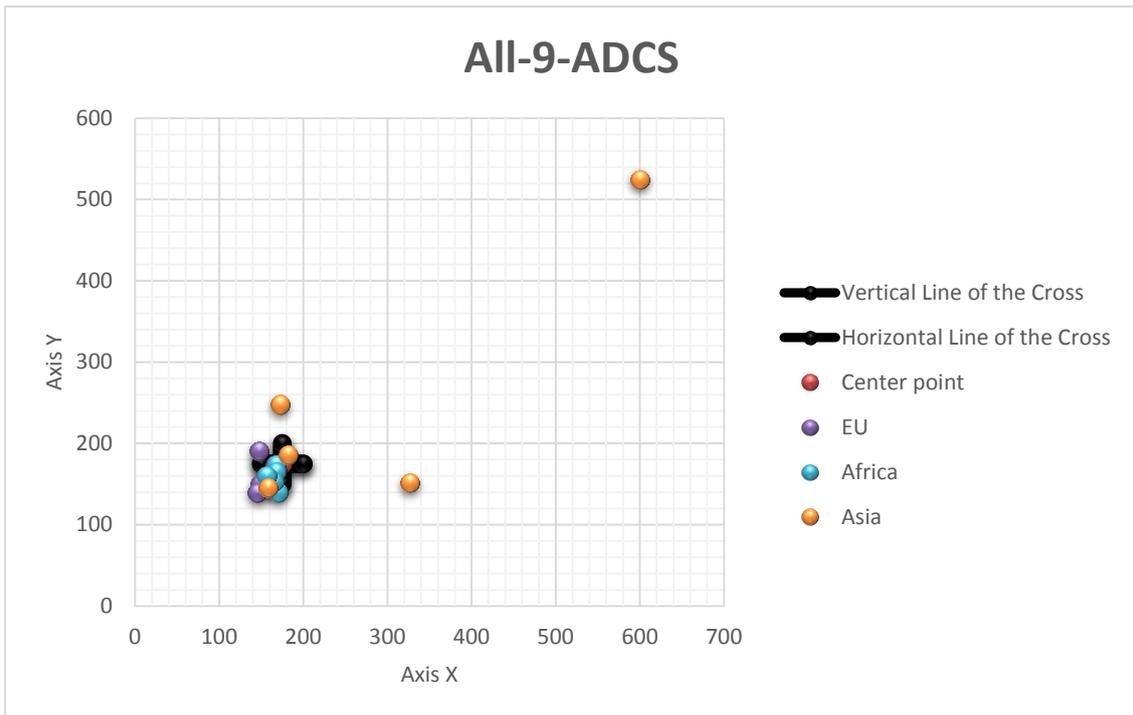


Figure 47. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Both eyes

Figure 47 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image1.

Summarizing the result of two previous Figures for separated left and right eyes the Figure 47 shows a visible shifting of the mean to the lower left quarter of the Cross even most of respondents’ mean fit the set area. The worst results are presented by the Asian group.

### 3.2 Mean gaze coordinates of all participants at the Image 2

Cross position-upper right corner (Figure 48).

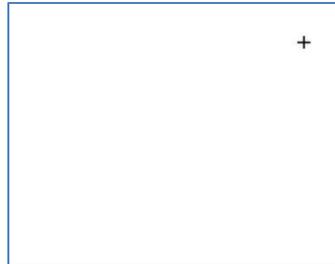


Figure 48. Cross-position-upper right corner

Figure 49 shows the algorithm of presenting the results in the section: Image 2-Cross position-Upper Right corner → for 5,7,9 seconds → for the left, right, both eyes → for group of participants EU (P1-5), Africa (P6-10), Asia (P11-15).

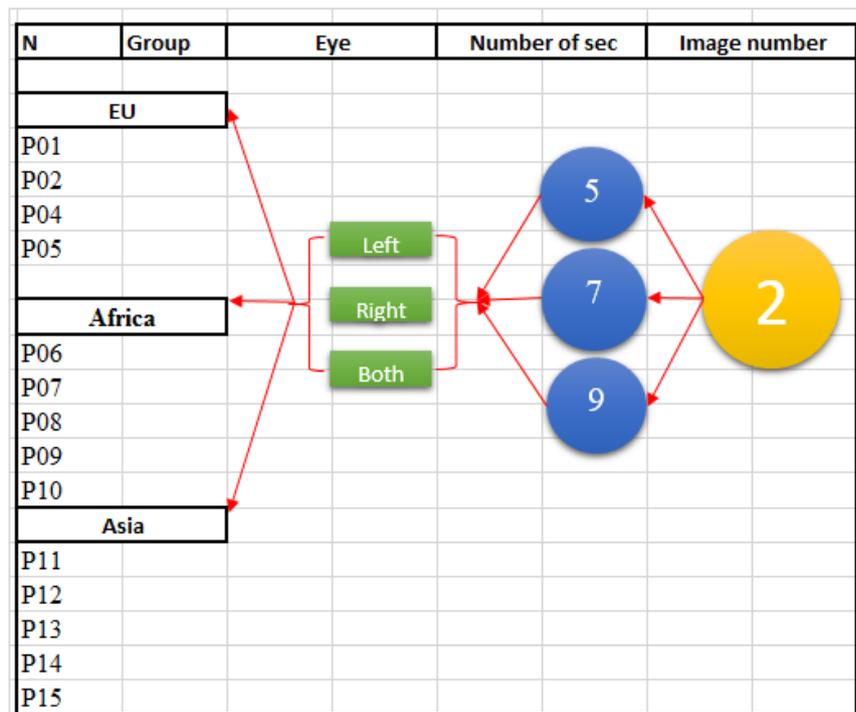


Figure 49. The algorithm of data presentation of the Image 2

Table 5. Mean coordinates of the gaze at the Image 2. Recording time-5 sec

Center point			MEAN					
X	1105		5 sec					
Y	175		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	1098,8	218,3	1125,7	183,3	1112,0	200,5
	P2	95 %	1128,7	1128,7	1130,8	190,7	1129,6	192,8
	P3	90 %	1101,0	179,6	1110,9	187,9	1105,8	183,6
	P4	99 %	1123,8	169,0	1119,6	1119,6	1121,4	176,6
	P5	100 %	1125,1	130,4	1106,6	137,1	1115,6	133,5
Africa	P6	85 %	1117,3	166,8	1122,0	194,6	1119,4	180,4
	P7	98 %	1116,9	178,8	1109,6	175,3	1113,0	176,8
	P8	96 %	1113,0	166,4	1109,1	182,8	1110,8	174,4
	P9	94 %	1122,2	167,8	1112,4	175,3	1117,1	171,9
	P10	98 %	1112,9	177,2	1105,8	181,5	1109,1	179,1
Asia	P11	88 %	1121,1	147,8	1113,3	172,5	1116,4	161,9
	P12	74 %	1155,8	179,4	1117,6	232,0	1136,6	205,8
	P13	83 %	1133,5	210,2	1091,9	222,8	1112,4	216,3
	P14	94 %	1118,7	155,0	1121,3	163,8	1119,8	159,2
	P15	48 %	780,9	414,2	735,1	735,1	813,7	390,9

Table 5 shows the Mean X and Y coordinates of the fixation at the Image 2 for left, right and both eyes during the recording time of 5 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

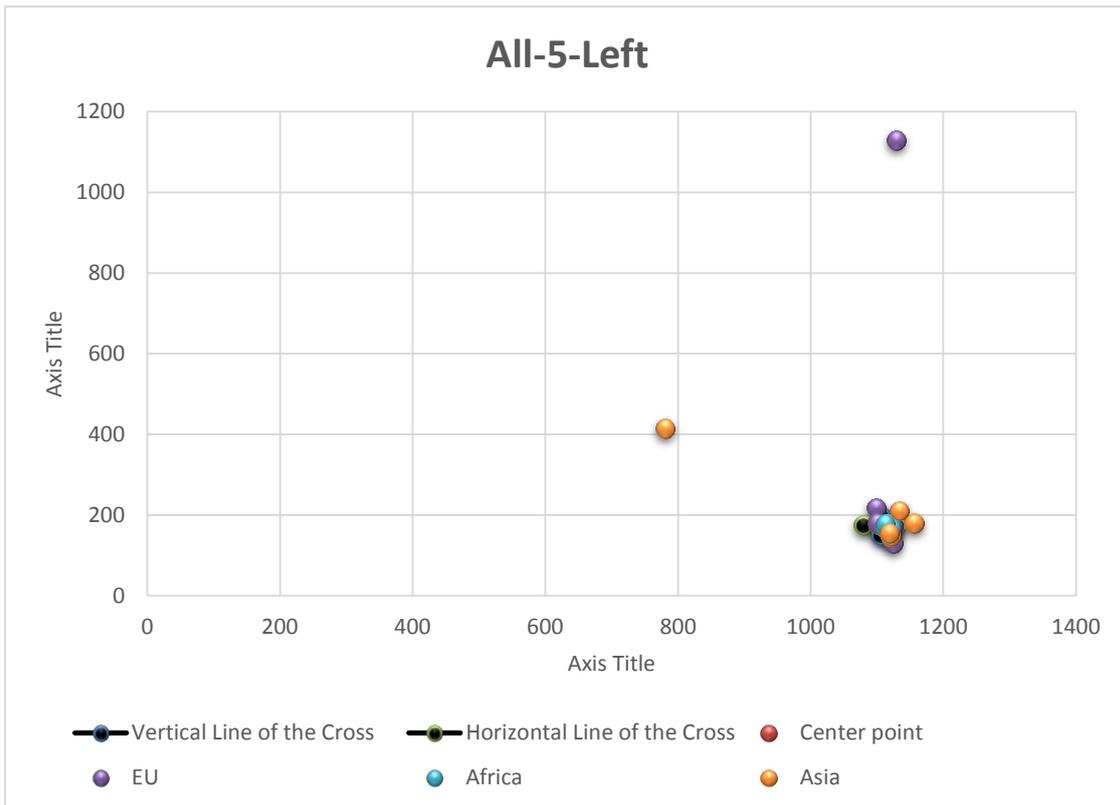


Figure 50. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Left Eye

Figure 50 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-presents for most of participants. The number of participants whose mean gaze point is out of the set area-2 participants from the groups-EU and Asia.

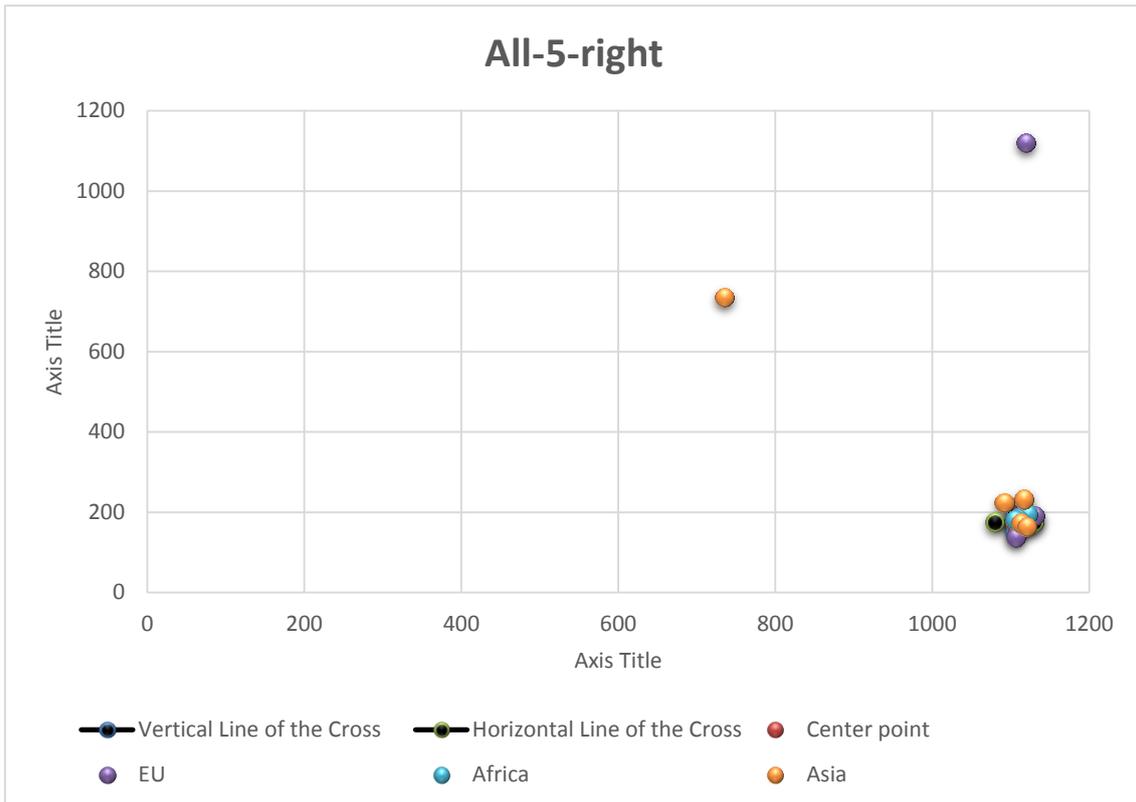


Figure 51. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5seconds. Right Eye

Figure 51 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-presents for most of participants. The number of participants whose mean gaze point is out of the set area-2 participants from the groups-EU and Asia.

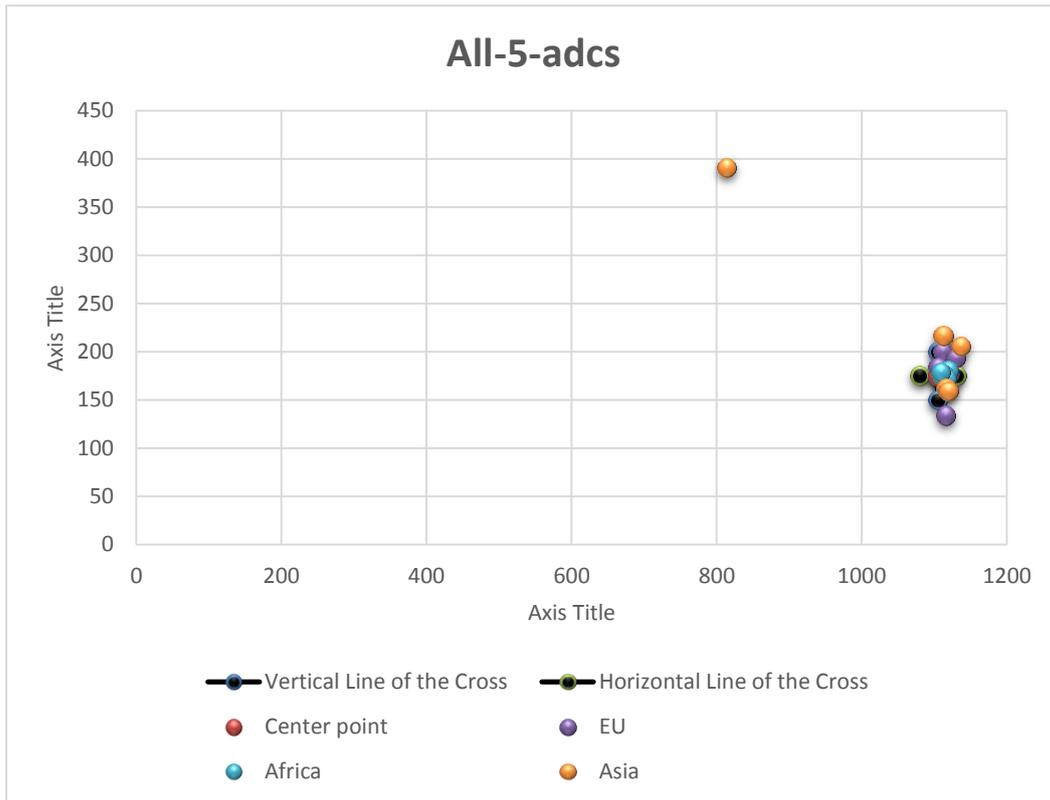


Figure 52. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5seconds. Both eyes

Figure 52 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-presents for most of participants. The number of participants whose mean gaze point is out of the set area-1 participant P15 from the group Asia.

Table 6. Mean coordinates of the gaze at the Image 2. Recording time-7 sec

Center point			MEAN					
X	1105		7 sec					
Y	175		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	1134,8	139,3	1127,0	192,1	1130,6	165,5
	P2	95 %	1138,0	196,5	1138,9	183,4	1138,4	189,5
	P3	90 %	1110,2	165,5	1115,4	185,6	1112,5	175,3
	P4	99 %	1122,6	164,5	1117,4	178,7	1119,7	171,3
	P5	100 %	1133,6	137,0	1106,8	147,4	1119,9	142,0
Africa	P6	85 %	1121,8	160,0	1128,8	191,2	1125,2	175,5
	P7	98 %	1129,0	171,9	1128,2	156,3	1128,4	163,9
	P8	96 %	1131,2	162,5	1108,1	181,3	1119,4	171,6
	P9	94 %	1134,2	161,6	1127,4	160,5	1130,8	161,2
	P10	98 %	1123,2	170,6	1116,1	180,0	1119,4	175,0
Asia	P11	88 %	1118,8	157,9	1110,7	177,6	1114,0	167,9
	P12	74 %	1159,4	146,7	1120,5	194,1	1140,1	169,6
	P13	83 %	1148,3	181,5	1137,2	201,8	1142,6	191,5
	P14	94 %	1129,9	150,7	1133,0	170,4	1131,2	160,3
	P15	48 %	707,7	458,9	643,9	532,8	719,0	466,9

Table 6 shows the Mean X and Y coordinates of the fixation at the Image 2 for left, right and both eyes during the recording time of 7 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

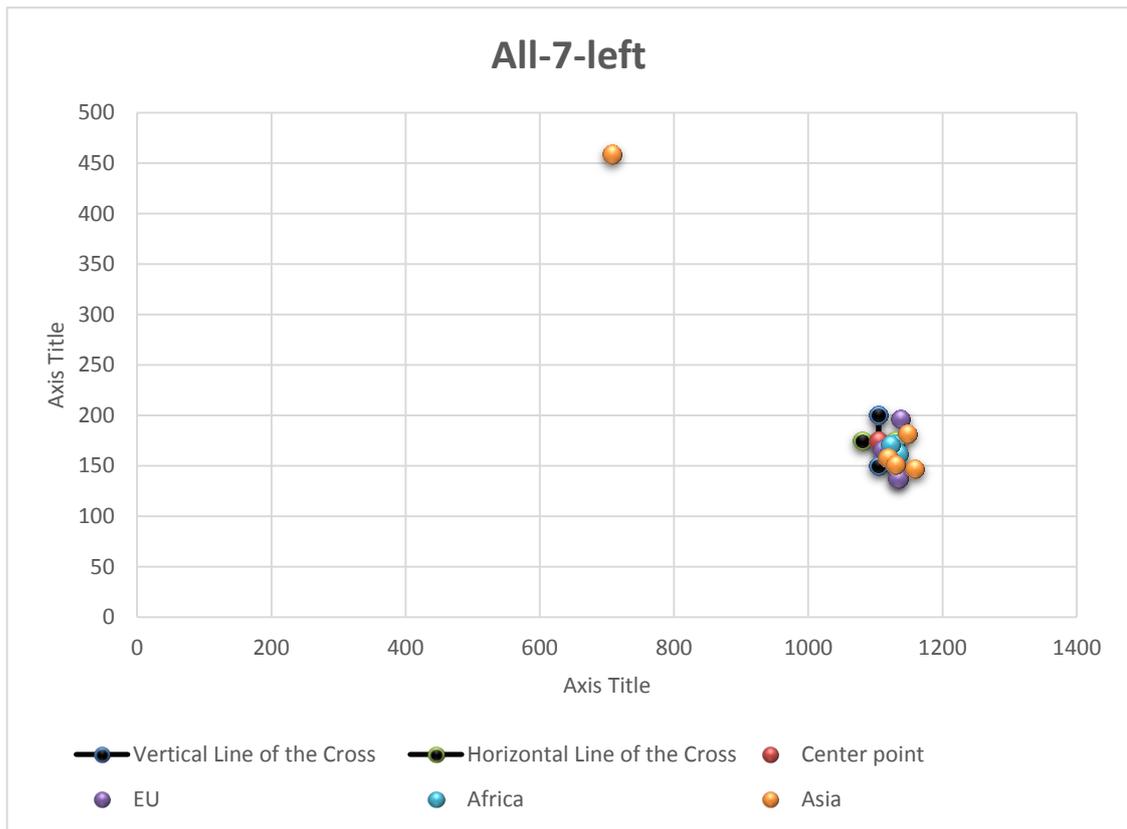


Figure 53. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7seconds. Left eye

Figure 53 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-presents for most of participants. Deviation-to the right part of the Cross. The number of participants whose mean gaze point is out of the set area-1 participant P15 from the groups Asia.

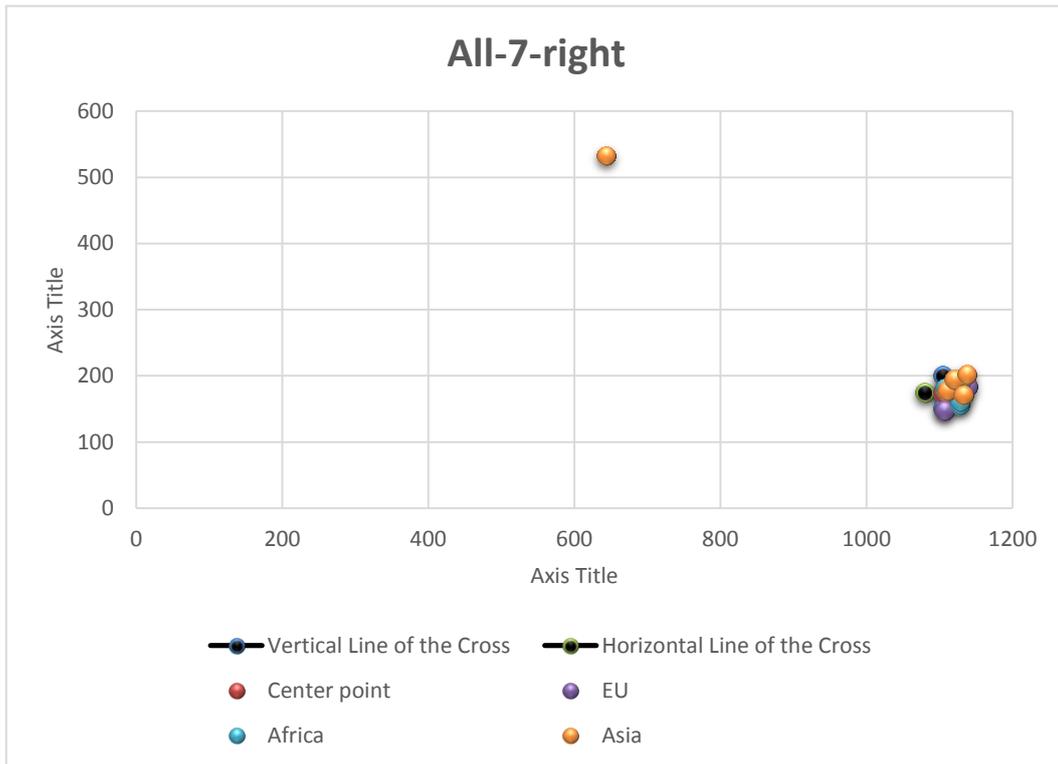


Figure 54. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7seconds. Right eye

Figure 54 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-presents for most of participants. Deviation-to the right part of the Cross. The number of participants whose mean gaze point is out of the set area-1 participant P15 from the groups Asia.

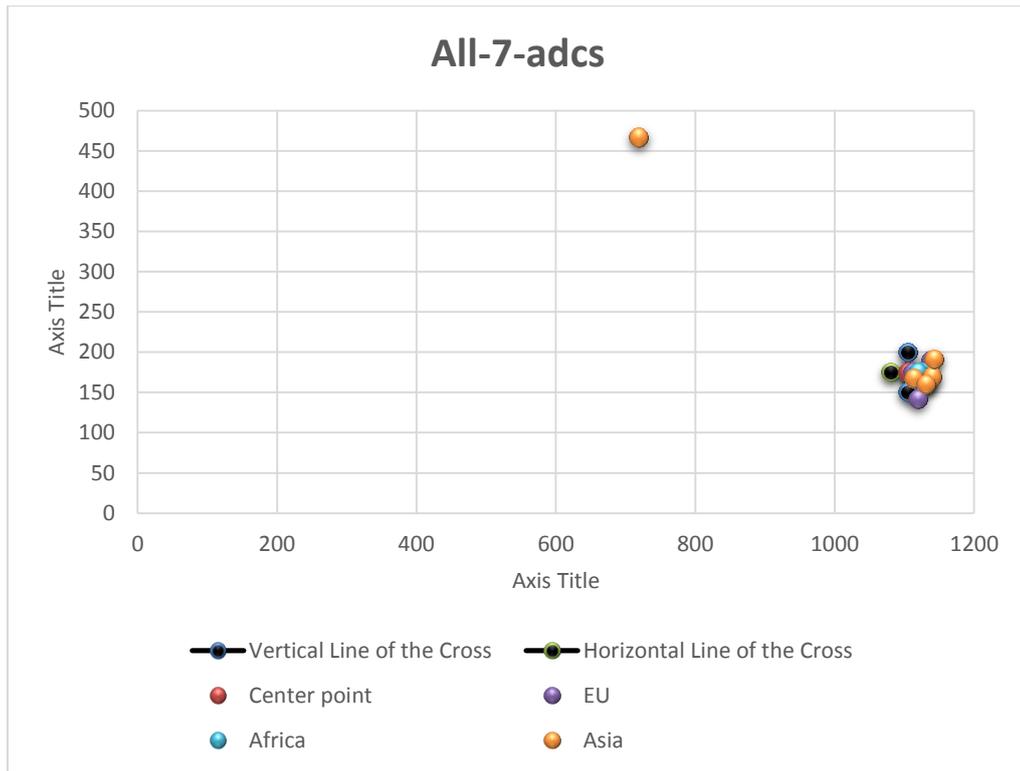


Figure 55. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7seconds. Both eyes

Figure 55 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-presents for most of participants. Deviation-to the right part of the Cross. The number of participants whose mean gaze point is out of the set area-1 participant P15 from the groups Asia.

Table 7. Mean coordinates of the gaze at the Image 2. Recording time-9 sec

Center point			MEAN					
X	1105		9 sec					
Y	175		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	1145,4	191,3	1133,0	232,1	1139,1	211,7
	P2	95 %	1141,0	198,8	1144,0	186,8	1142,3	192,6
	P3	90 %	1112,6	173,8	1124,9	179,8	1118,5	176,7
	P4	99 %	1134,8	166,2	1131,9	181,5	1133,1	173,6
	P5	100 %	1132,8	144,9	1106,8	147,4	1119,9	142,0
Africa	P6	85 %	1131,8	153,6	1131,8	195,9	1131,5	174,4
	P7	98 %	1128,7	156,1	1127,2	163,9	1127,7	159,9
	P8	96 %	1135,8	159,8	1104,9	188,5	1120,0	173,9
	P9	94 %	1126,2	165,3	1122,3	169,4	1123,9	167,4
	P10	98 %	1126,5	181,2	1110,3	181,7	1118,1	181,2
Asia	P11	88 %	1128,0	154,8	1119,4	179,1	1123,4	166,7
	P12	74 %	1177,5	161,6	1149,3	216,1	1163,0	189,6
	P13	83 %	1141,9	177,6	1139,0	277,1	1138,9	226,5
	P14	94 %	1094,6	168,7	1078,9	180,5	1086,6	174,3
	P15	48 %	1145,8	206,0	1155,0	156,8	1150,0	181,0

Table 7 shows the Mean X and Y coordinates of the fixation at the Image 2 for left, right and both eyes during the recording time of 9 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

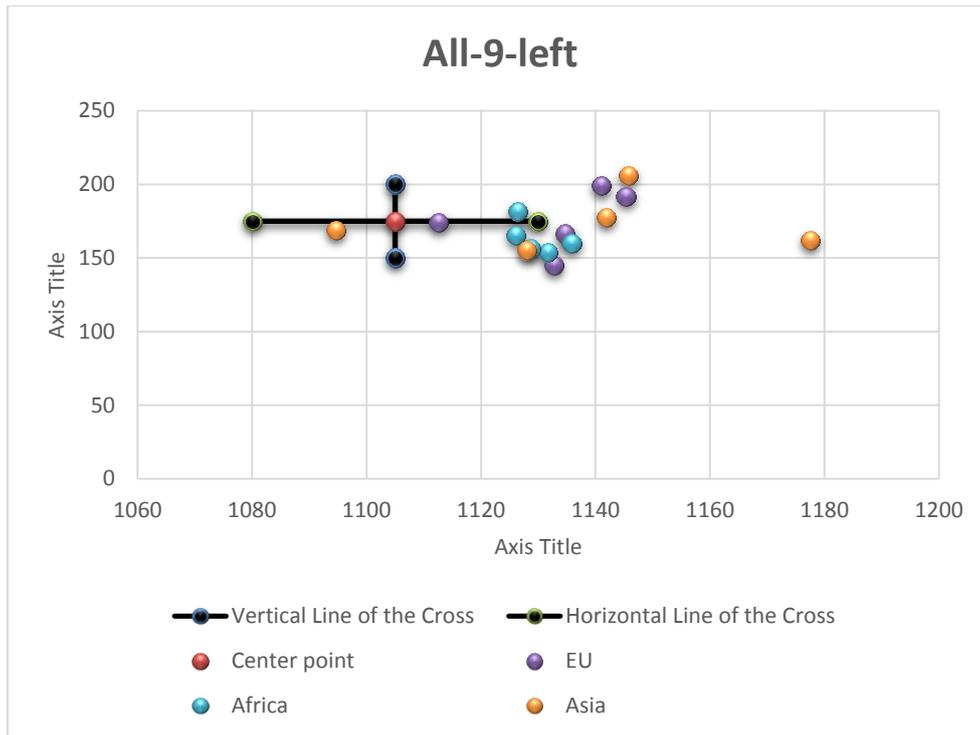


Figure 56. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Left eye

Figure 56 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-presents for most of participants. Deviation-significant along axis X. The number of participants whose mean gaze point is out of the set area-10 participants in total from all groups.

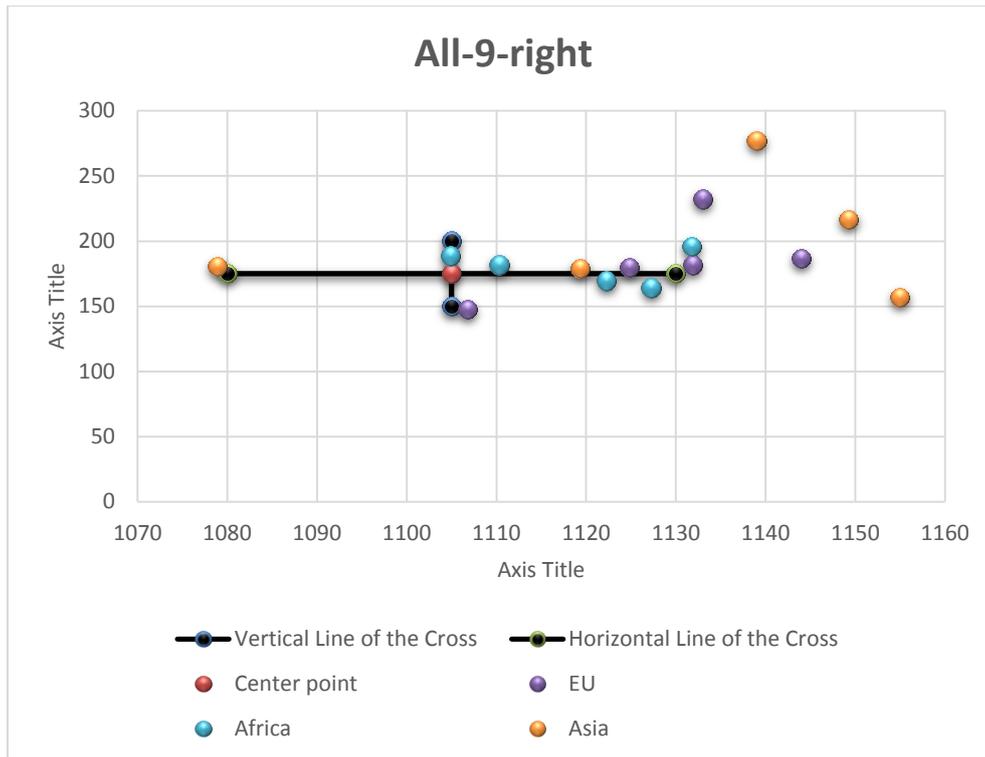


Figure 57. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Right eye

Figure 57 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation-significant along the axis X of the Cross and for all participants to the right side out of the Cross. The number of participants whose mean gaze point is out of the set area-8 participants in total from all groups.

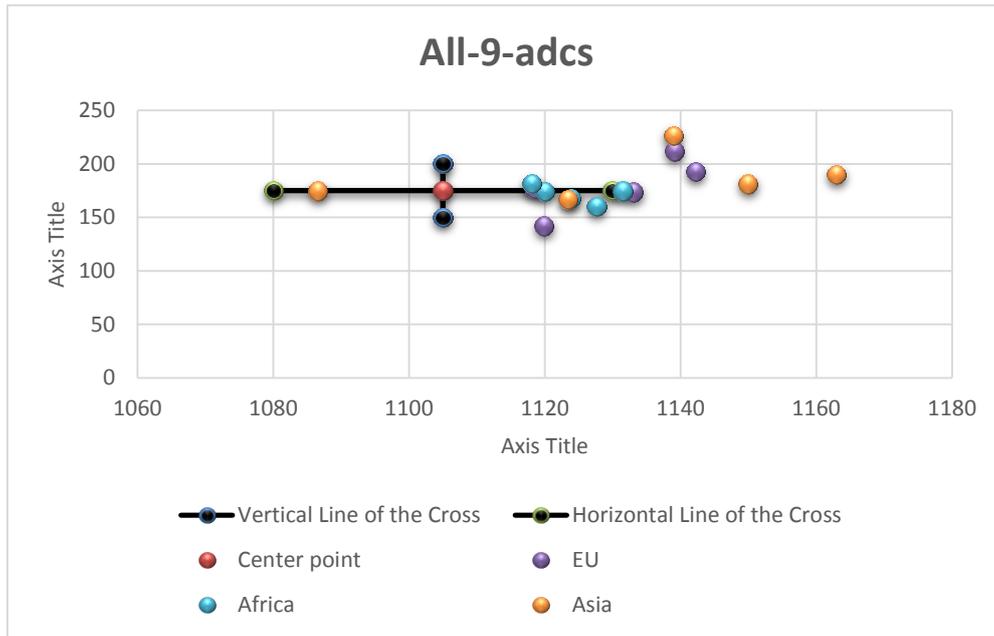


Figure 58. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Both eyes

Figure 58 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 2.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation-significant for all participants to the right side out of the Cross. The number of participants whose mean gaze point is out of the set area-11 participants in total from all groups.

### 3.3 Mean gaze coordinates of all participants at the Image 3

Cross position-downner right corner (Figure 59).

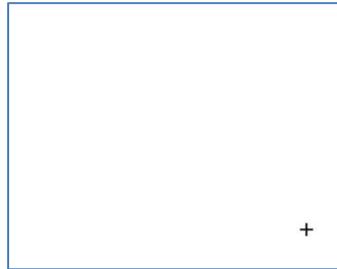


Figure 59. Cross-position-downner right corner

Figure 60 shows the algorithm of presenting the results in the section: Image 3-Cross position-Downner Right corner → for 5,7,9 seconds → for the left, right, both eyes → for group of participants EU (P1-5), Africa (P6-10), Asia (P11-15).

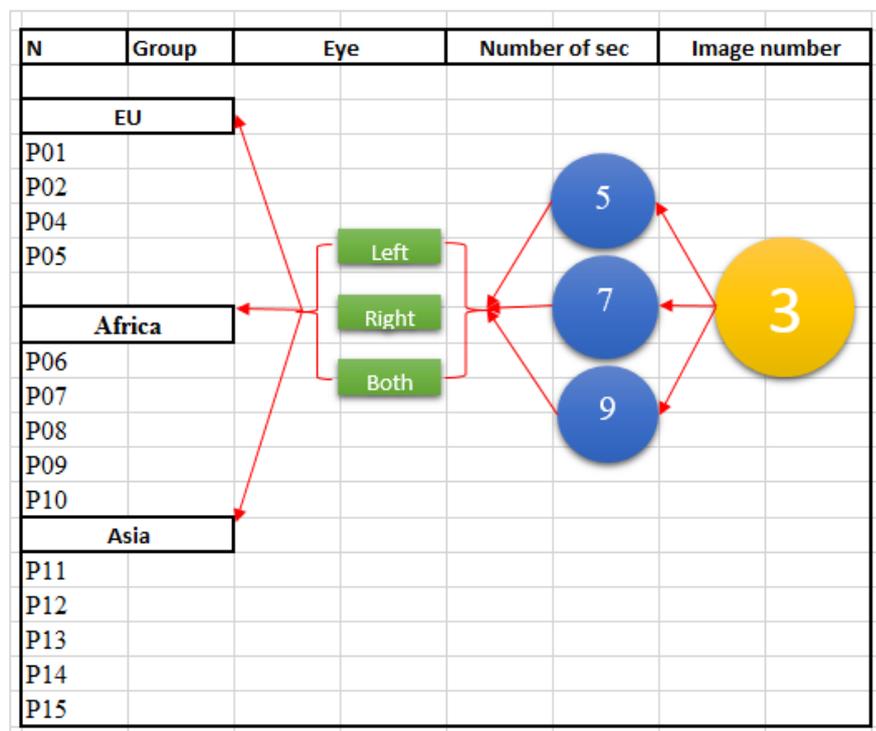


Figure 60. The algorithm of data presentation of the Image 3

Table 8. Mean coordinates of the gaze at the Image 3. Recording time-5 sec

Center point			MEAN					
X	1105		5 sec					
Y	849		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	1107,0	876,1	1087,1	857,7	1096,8	866,7
	P2	95 %	1128,4	842,9	1102,4	849,5	1114,4	845,3
	P3	90 %	1090,8	852,8	1079,2	852,3	1085,2	852,6
	P4	99 %	1098,8	845,3	1080,6	837,0	1089,5	840,9
	P5	100 %	1124,3	829,9	1105,9	820,2	1114,9	824,8
Africa	P6	85 %	1111,4	851,7	1103,5	855,7	1107,6	854,2
	P7	98 %	1115,4	790,1	1081,0	854,1	1097,9	821,8
	P8	96 %	1105,9	824,8	1074,6	852,2	1090,0	838,2
	P9	94 %	1098,2	873,6	1088,5	877,5	1093,4	875,9
	P10	98 %	1084,1	829,2	1088,6	849,0	1086,1	838,8
Asia	P11	88 %	1077,3	859,0	1084,0	863,4	1080,4	861,1
	P12	74 %	1151,7	885,3	1109,4	863,2	1130,3	874,3
	P13	83 %	1143,9	855,2	1112,0	875,8	1135,8	861,5
	P14	94 %	1126,8	841,6	1114,8	818,1	1120,5	829,6
	P15	48 %	780,9	414,2	735,1	446,7	813,7	390,9

The table shows the Mean X and Y coordinates of the fixation at the Image 3 for left, right and both eyes during the recording time of 5 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented

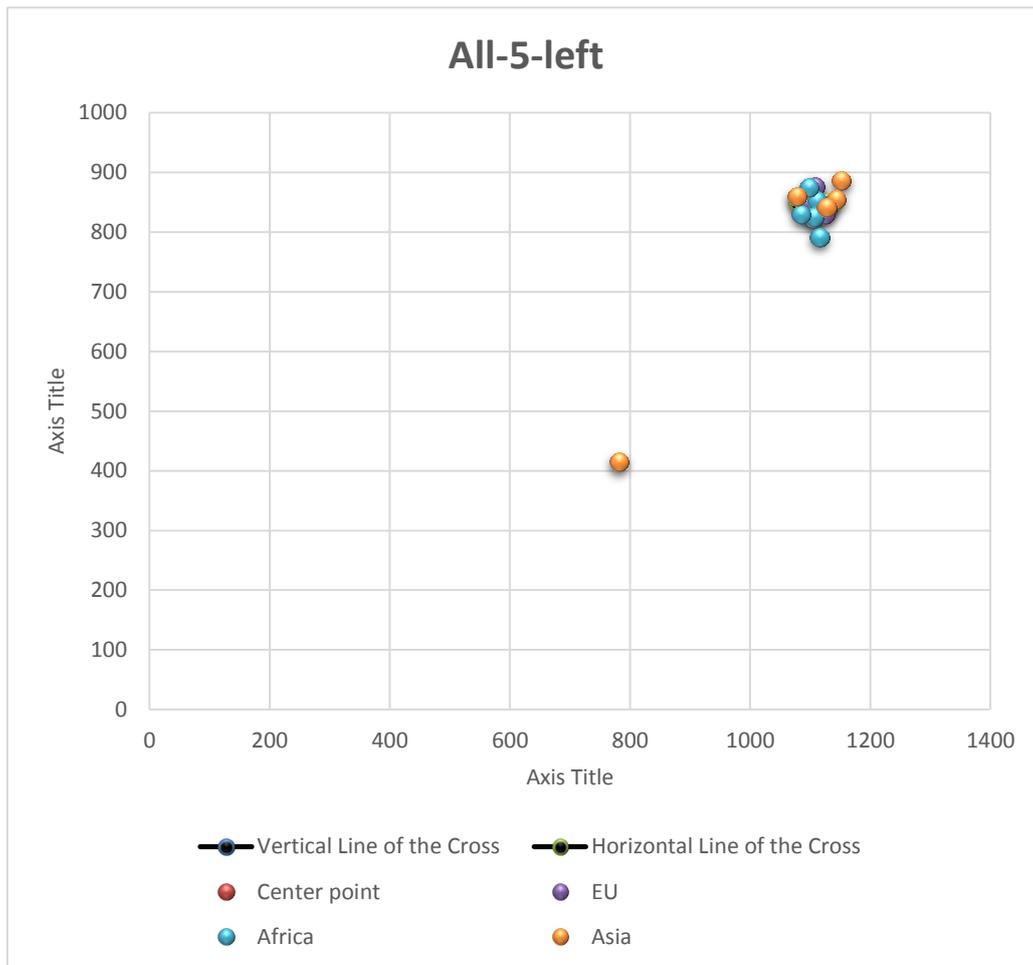


Figure 61. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Left eye

Figure 61 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of participants. Deviation- insignificant. The number of participants whose mean gaze point is out of the set area-1 participant P15 front the group Asia.

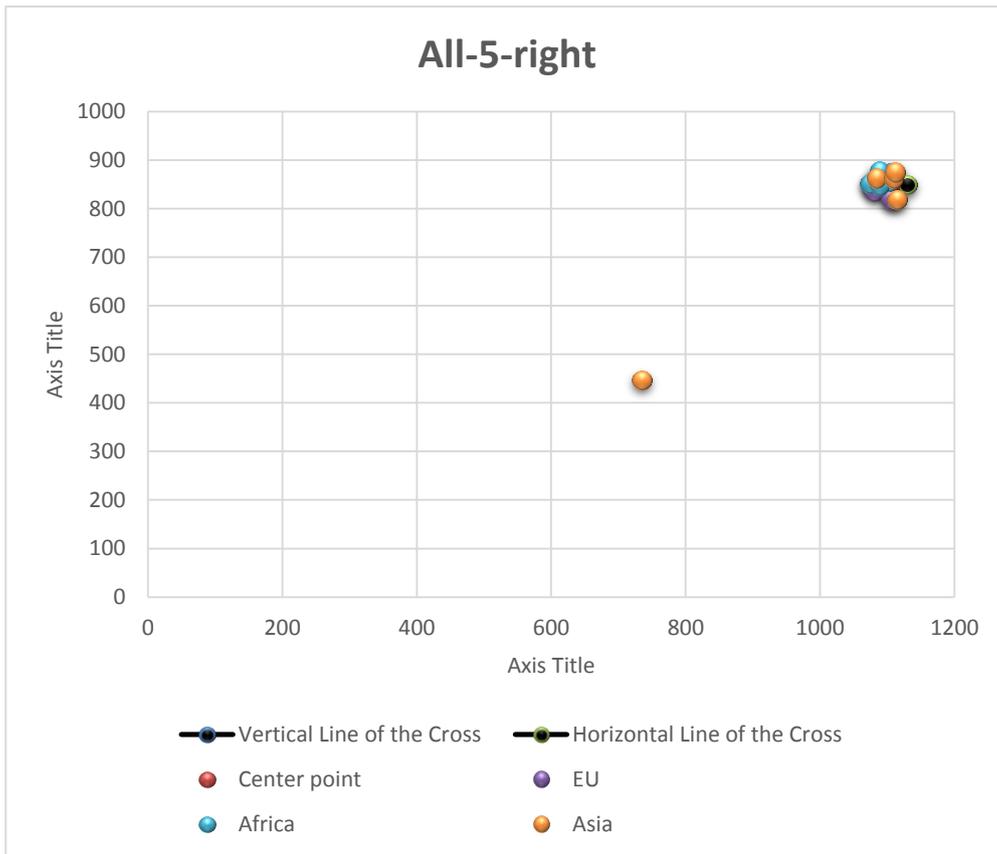


Figure 62. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Right eye

Figure 62 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of participants. Deviation- insignificant. The number of participants whose mean gaze point is out of the set area-1 participant P15 front the group Asia.

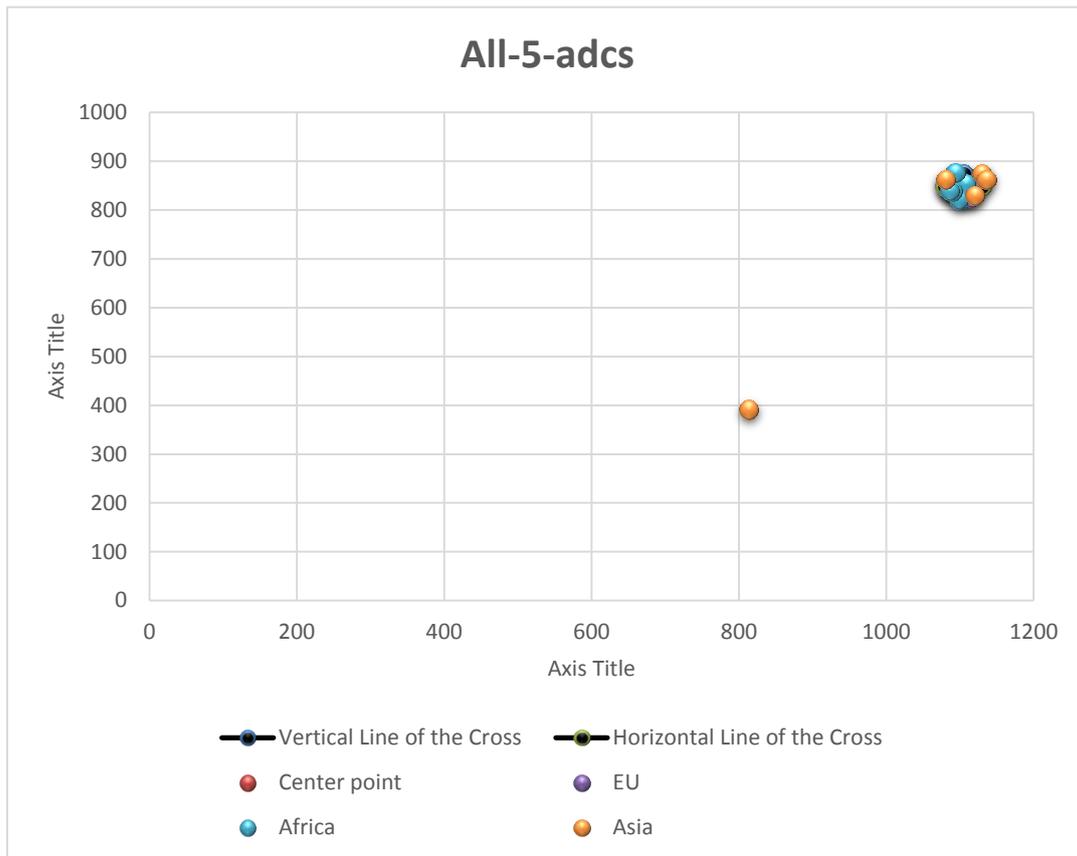


Figure 63. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Both eyes

Figure 63 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of participants. Deviation- insignificant. The number of participants whose mean gaze point is out of the set area-1 participant P15 front the group Asia.

Table 9. Mean coordinates of the gaze at the Image 3. Recording time-7 sec

Center point			MEAN					
X	1105		7 sec					
Y	849		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	1118,4	900,2	1092,6	868,5	1105,2	884,1
	P2	95 %	1139,8	835,8	1100,4	847,8	1119,9	841,5
	P3	90 %	1104,3	862,9	1092,4	860,8	1098,1	861,6
	P4	99 %	1114,4	855,0	1097,5	853,2	1105,7	853,8
	P5	100 %	1125,1	830,2	1102,3	820,4	1113,5	825,1
Africa	P6	85 %	1004,0	861,5	999,1	867,7	1001,3	864,3
	P7	98 %	1081,1	833,8	1078,0	842,4	1079,3	837,9
	P8	96 %	1127,4	843,5	1089,8	868,3	1108,4	855,7
	P9	94 %	1098,4	876,2	1081,3	872,2	1089,6	873,9
	P10	98 %	1100,1	846,6	1103,3	864,4	1101,7	855,6
Asia	P11	88 %	1066,4	860,3	1082,6	864,8	1074,4	862,3
	P12	74 %	1313,5	868,7	1284,7	871,9	1301,1	869,9
	P13	83 %	1138,5	853,1	1110,3	879,2	1133,8	864,5
	P14	94 %	1135,3	853,6	1112,0	830,8	1123,4	842,0
	P15	48 %	707,7	458,9	643,9	532,8	719,0	466,9

Table 9 shows the Mean X and Y coordinates of the fixation at the Image 3 for left, right and both eyes during the recording time of 7 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented

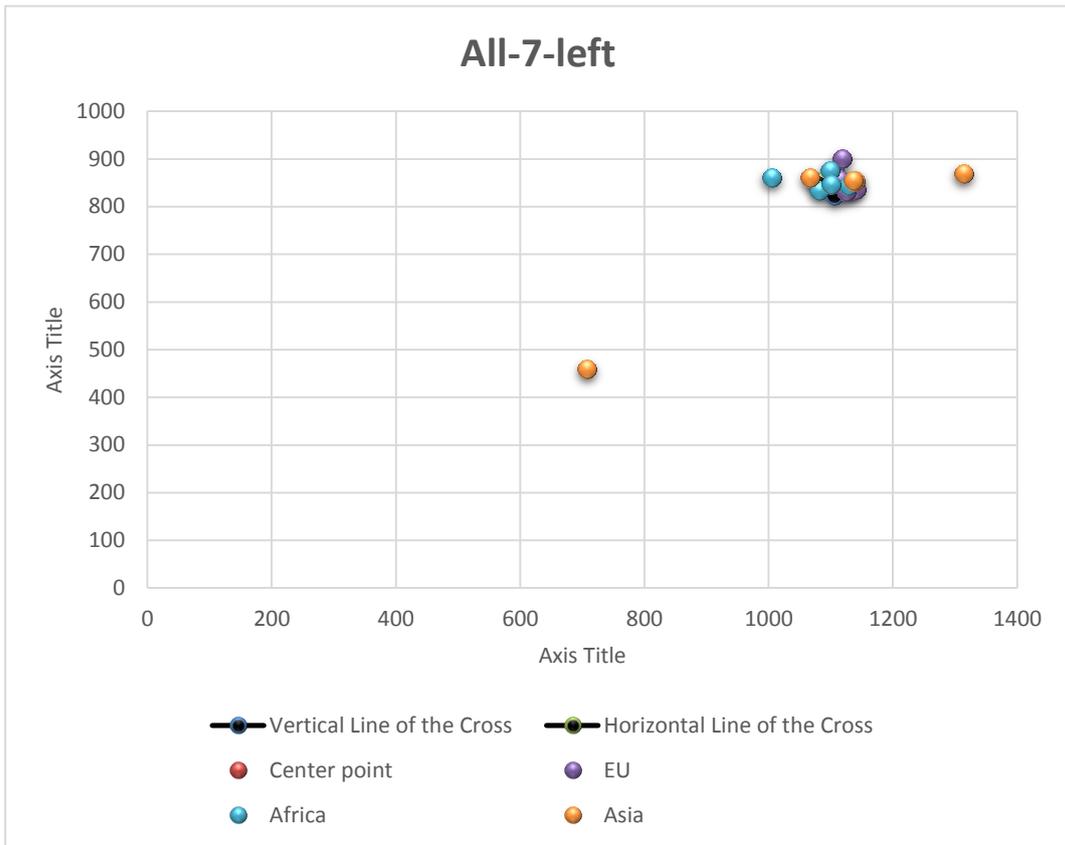
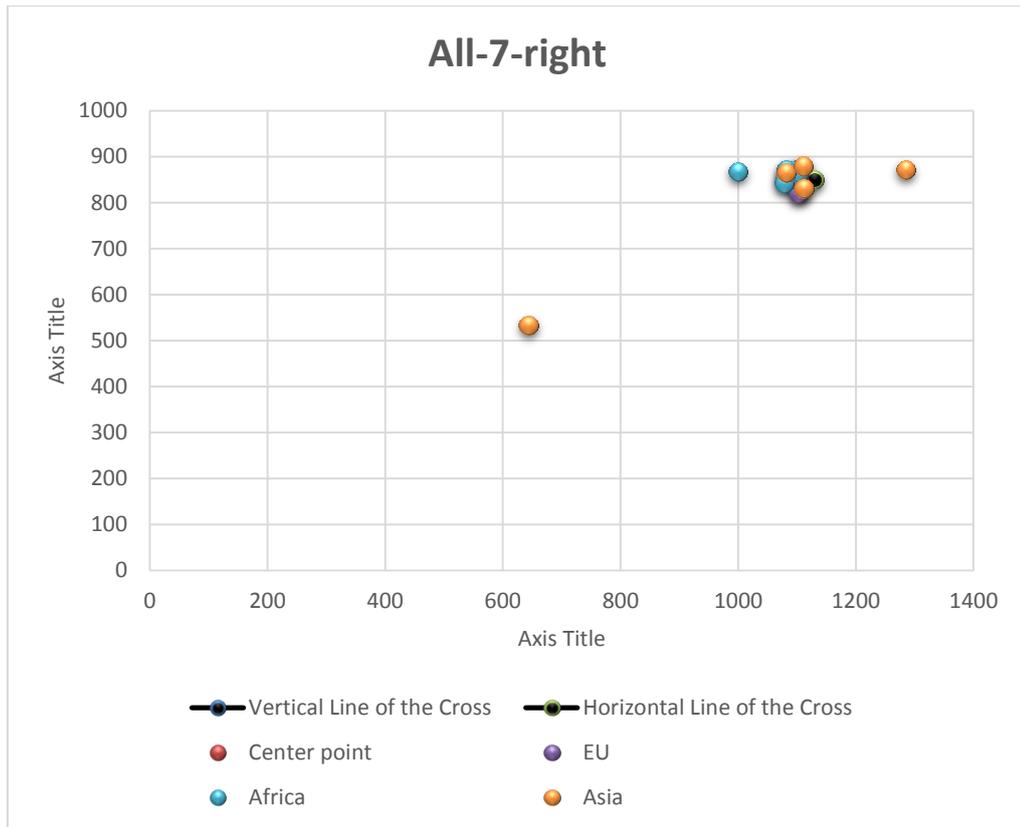


Figure 64. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7 seconds. Left eye

Figure 64 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of participants. Deviation- insignificant. The number of participants whose mean gaze point is out of the set area-3 participant from the groups Asia and Africa.



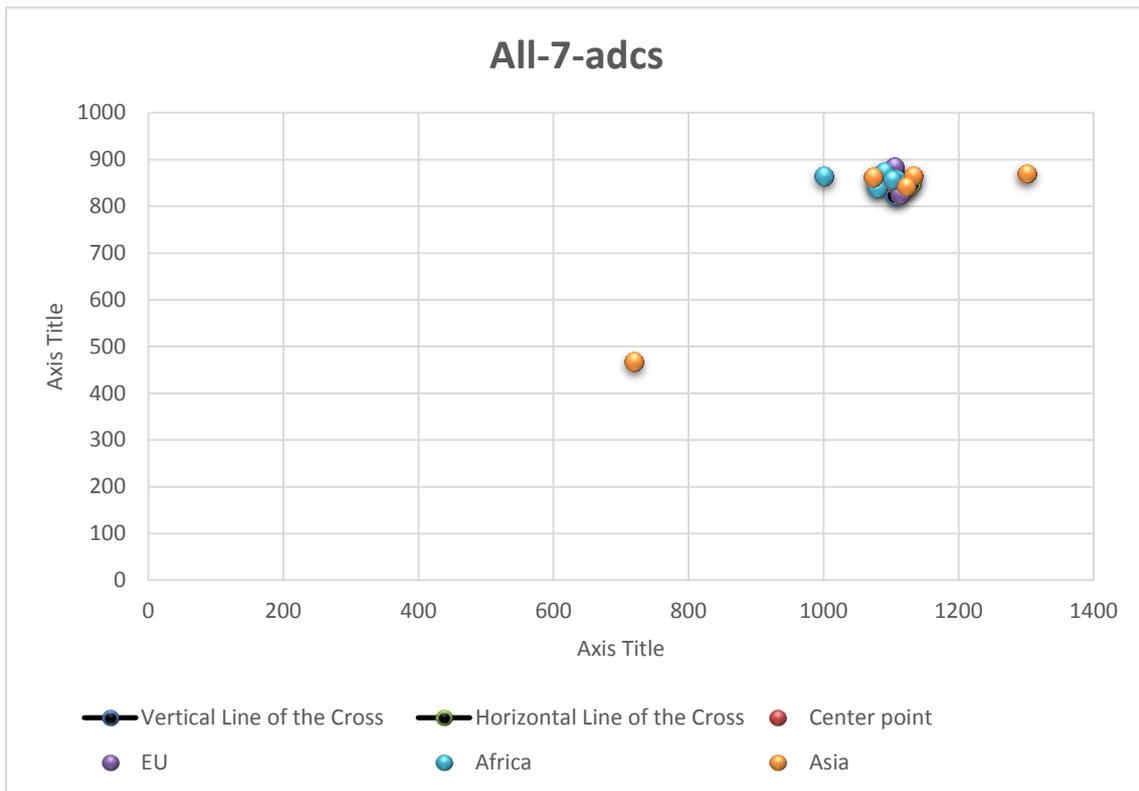


Figure 66. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7 seconds. Both eyes

Figure 66 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of participants. Deviation- insignificant. The number of participants whose mean gaze point is out of the set area-4 participant from the groups Asia and Africa.

Table 10. Mean coordinates of the gaze at the Image 3. Recording time-9 sec

Center point			MEAN					
X	1105		9 sec					
Y	849		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	1112,6	904,4	1096,2	868,8	1104,6	887,6
	P2	95 %	1148,0	832,8	1102,0	851,9	1124,6	842,2
	P3	90 %	1108,2	877,5	1102,9	874,9	1103,0	876,3
	P4	99 %	1118,3	865,9	1098,4	865,3	1108,1	865,4
	P5	100 %	1106,5	861,8	1120,6	842,9	1113,3	852,1
Africa	P6	85 %	1089,0	840,0	1081,1	844,7	1085,7	842,9
	P7	98 %	1102,8	851,2	1095,7	863,1	1099,0	856,9
	P8	96 %	1131,0	848,1	1084,8	864,2	1107,6	855,9
	P9	94 %	1103,4	878,3	1084,3	877,0	1093,8	877,7
	P10	98 %	1102,4	842,5	1103,2	863,9	1102,5	852,9
Asia	P11	88 %	1084,7	873,3	1098,6	878,4	1091,2	875,9
	P12	74 %	1162,8	882,4	1119,7	862,0	1140,7	873,1
	P13	83 %	1150,2	852,2	1116,3	880,4	1142,7	864,9
	P14	94 %	1152,2	849,1	1123,9	825,5	1137,8	837,1
	P15	48 %	1145,8	206,0	1155,0	156,8	1150,0	181,0

Table 10 shows the Mean X and Y coordinates of the fixation at the Image 3 for left, right and both eyes during the recording time of 9 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented

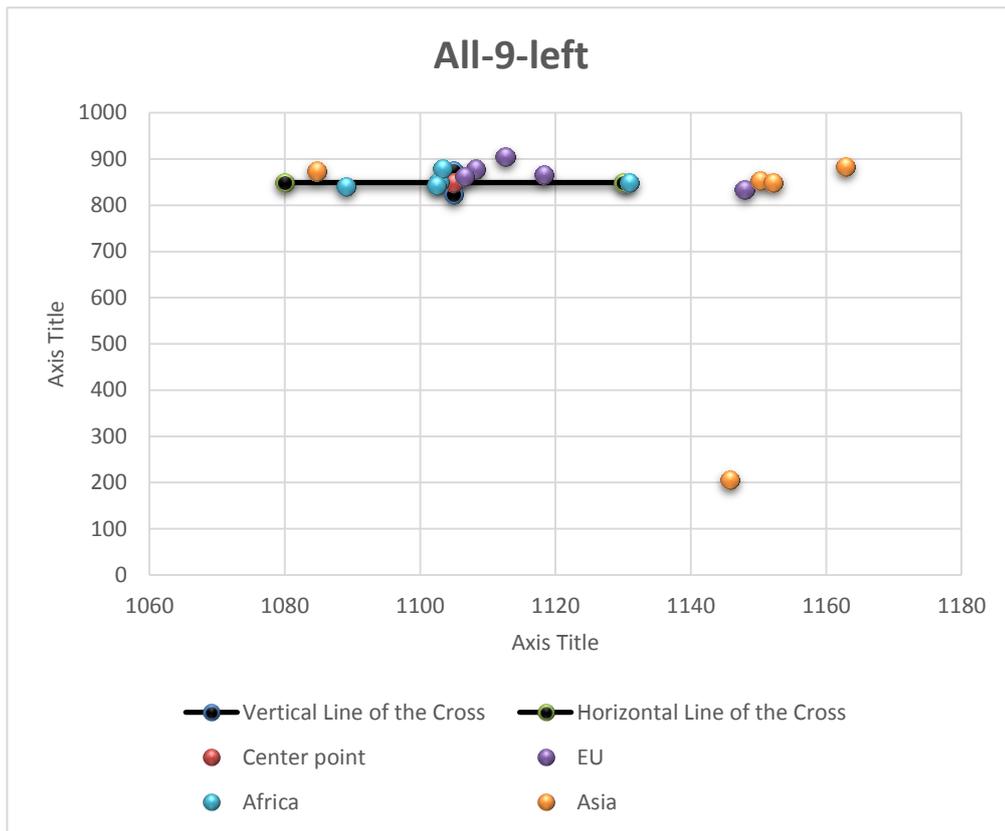


Figure 67. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Left eye

Figure 67 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-few participants. Deviation- significant for all groups along the axis X. The number of participants whose mean gaze point is out of the set area-6 participant from the groups Asia and Africa.

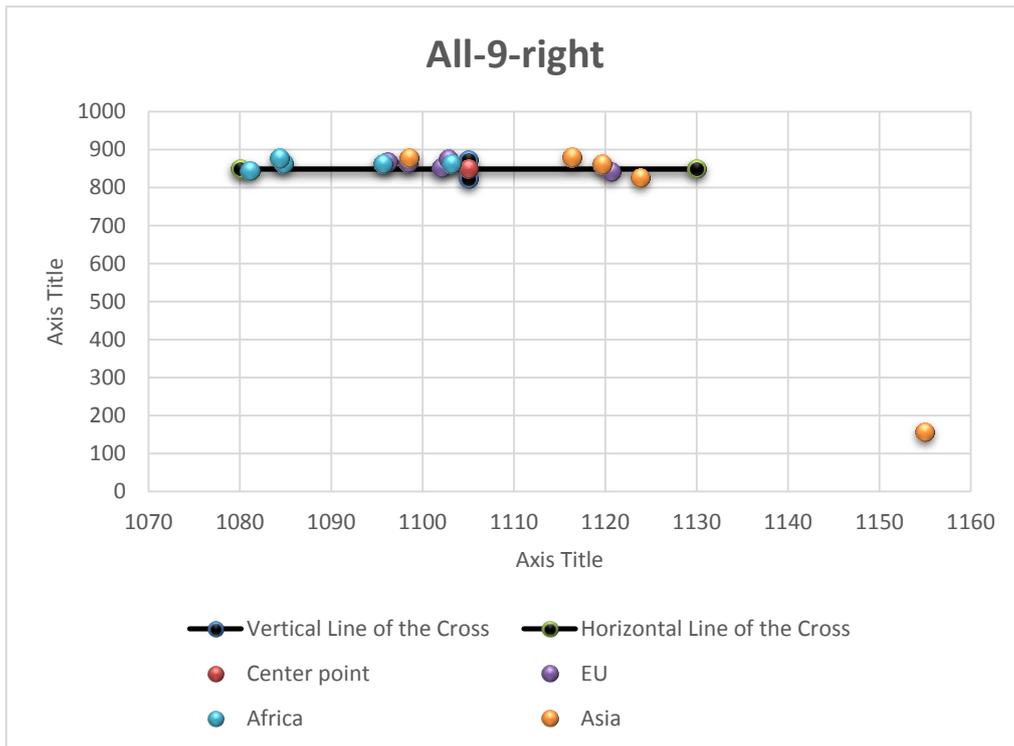


Figure 68. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Right eye

Figure 68 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis X. The number of participants whose mean gaze point is out of the set area-1, P15 from the group Asia.

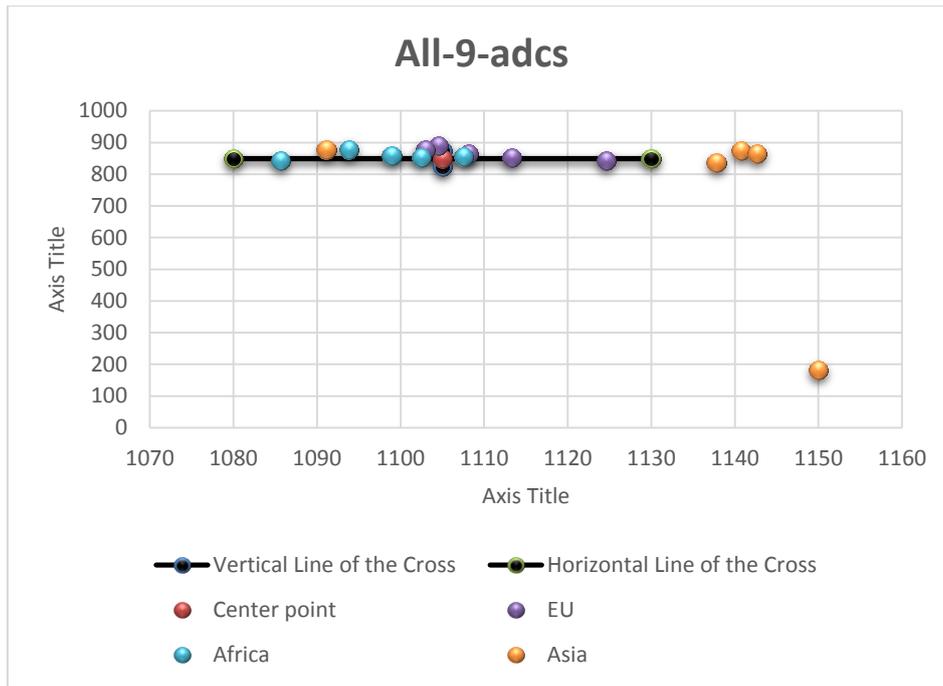


Figure 69. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Both eyes

Figure 69 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 3.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis X. The number of participants whose mean gaze point is out of the set area-4, from the group Asia.

### 3.4 Mean gaze coordinates of all participants at the Image 4

Cross position-downer left corner (Figure 70).



Figure 70. Cross-position-downer left corner

Figure 71 shows the algorithm of presenting the results in the section: Image 4-Cross position-Downer Left corner → for 5,7,9 seconds → for the left, right, both eyes → for group of participants EU (P1-5), Africa (P6-10), Asia (P11-15).

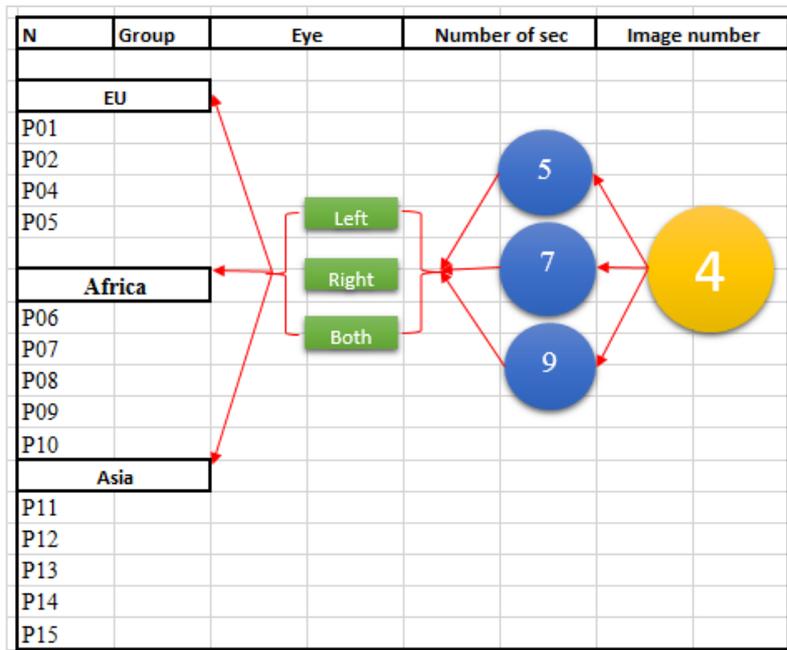


Figure 71 The algorithm of data presentation of the Image 4

Table 11. Mean coordinates of the gaze at the Image 4. Recording time-5 sec

Center point			MEAN					
X	175		5 sec					
Y	849		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	187,69	912,09	176,16	839,18	181,67	875,38
	P2	95 %	200,20	833,76	133,74	840,05	163,05	837,36
	P3	90 %	178,62	861,10	175,09	843,41	176,59	852,08
	P4	99 %	205,09	843,60	193,57	831,14	199,07	837,10
	P5	100 %	181,62	849,60	148,14	858,67	164,61	853,88
Africa	P6	85 %	179,75	856,02	174,28	859,99	176,79	857,76
	P7	98 %	213,10	796,95	213,97	797,22	213,13	796,71
	P8	96 %	210,03	855,34	156,78	774,24	183,28	814,70
	P9	94 %	217,78	897,68	158,23	847,00	187,75	872,09
	P10	98 %	165,08	836,38	166,71	841,46	165,61	838,68
Asia	P11	88 %	211,65	859,23	196,35	854,01	203,74	856,37
	P12	74 %	212,74	845,63	226,76	862,17	219,64	853,82
	P13	83 %	162,07	806,20	123,59	815,69	130,34	813,96
	P14	94 %	189,43	869,01	169,52	867,31	179,07	867,94
	P15	48 %	1057,01	817,42	1052,83	814,95	1068,45	822,66

Table 11 shows the Mean X and Y coordinates of the fixation at the Image 4 for left, right and both eyes during the recording time of 5 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

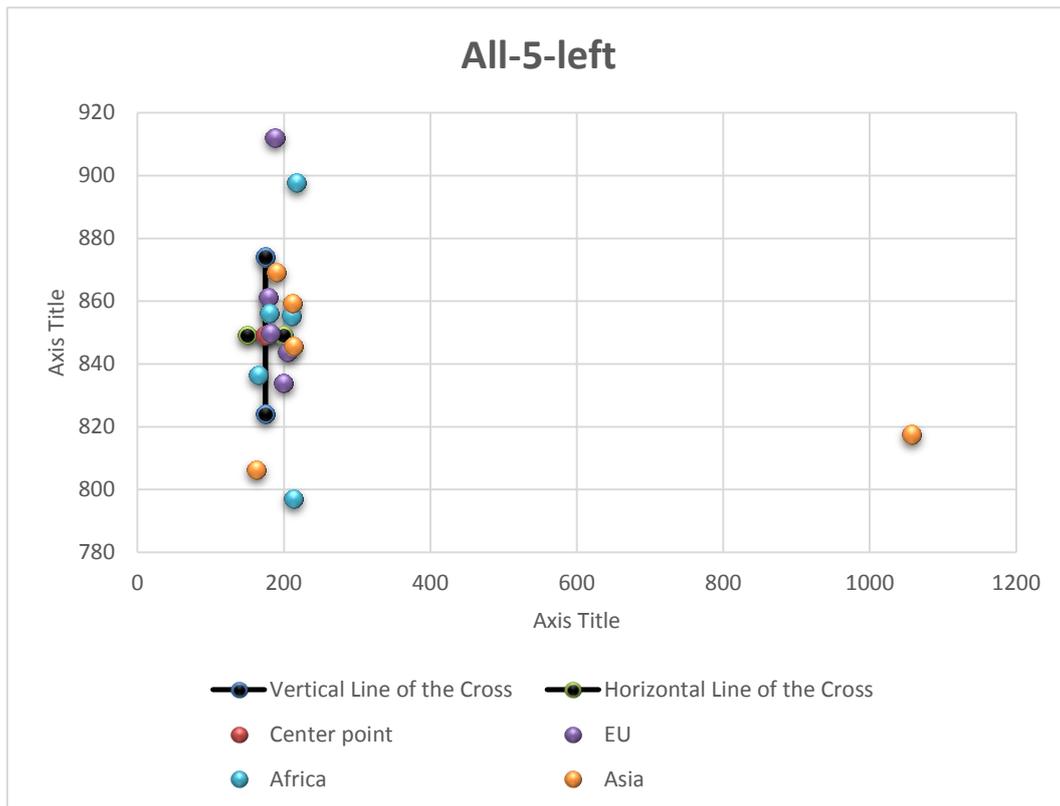


Figure 72. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Left eye

Figure 72 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-10, from all groups.

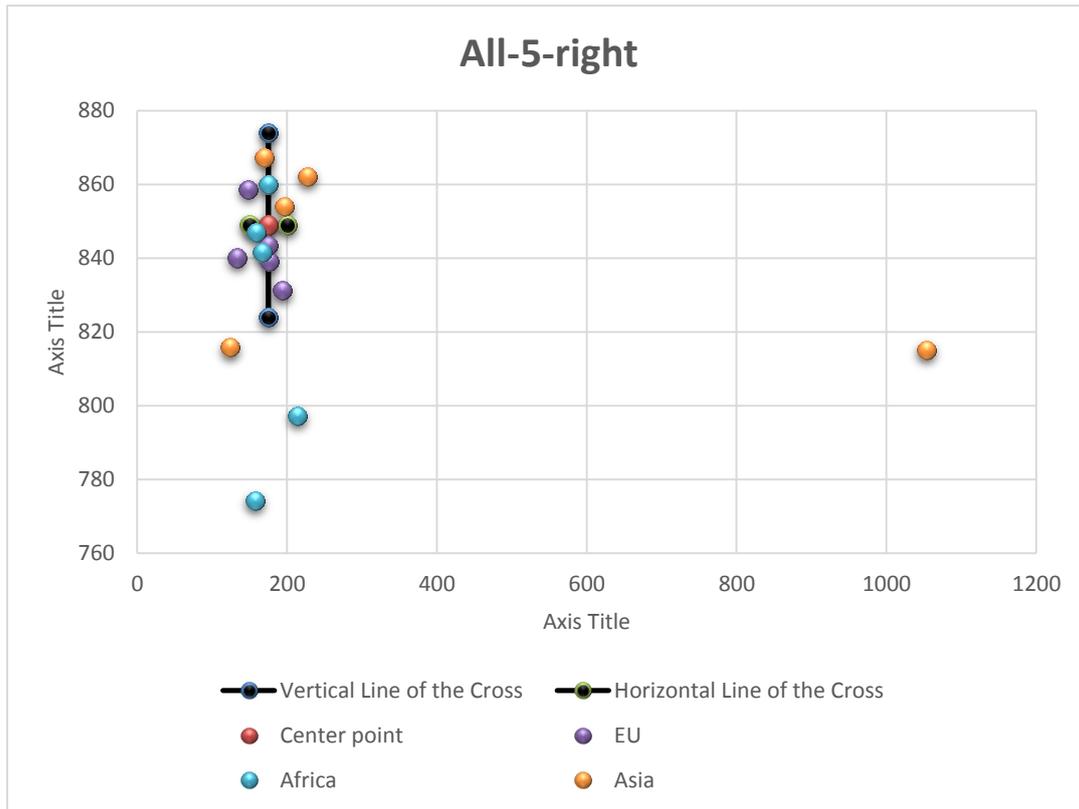


Figure 73. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Right eye

Figure 73 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-7, from all groups.

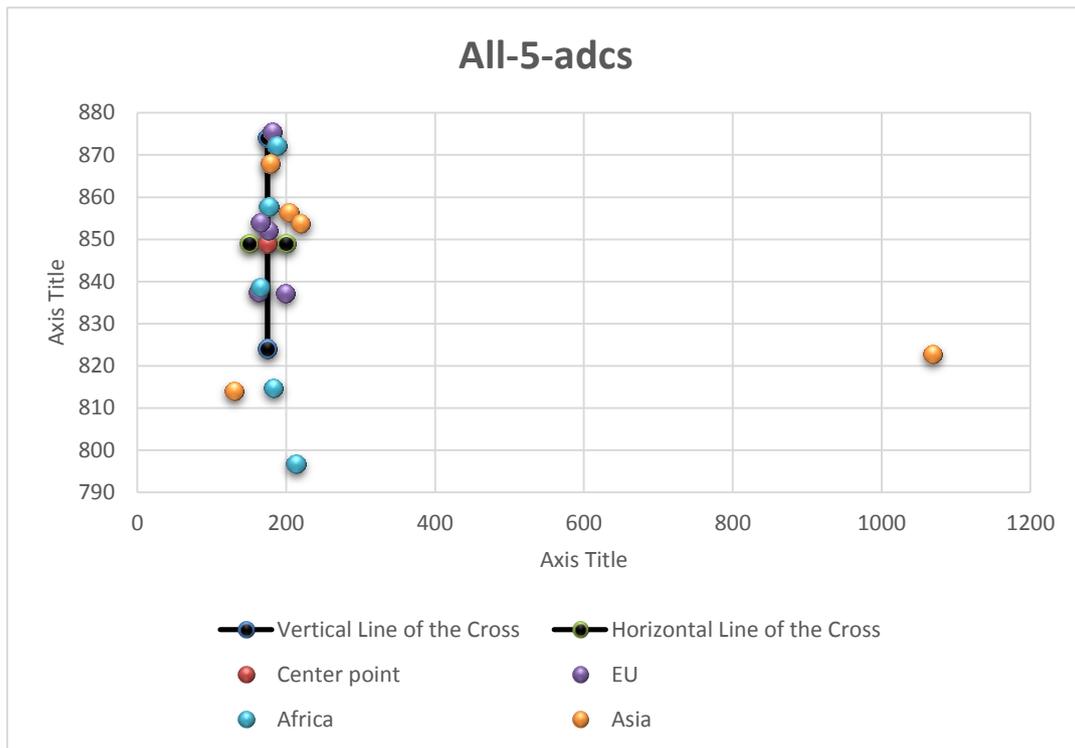


Figure 74. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Both eyes

Figure 74 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-4, from all groups.

Table 12. Mean coordinates of the gaze at the Image 4. Recording time-7 sec

Center point			MEAN					
X	175		7 sec					
Y	849		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	186,65	924,92	174,39	839,52	180,28	881,98
	P2	95 %	200,17	824,59	136,87	837,47	164,78	832,20
	P3	90 %	172,11	861,25	168,58	845,93	170,06	853,42
	P4	99 %	177,92	858,24	161,16	853,79	161,16	853,79
	P5	100 %	179,43	864,00	153,67	872,06	153,67	872,06
Africa	P6	85 %	172,69	867,79	170,47	864,36	171,00	866,19
	P7	98 %	210,16	788,98	214,26	795,53	211,96	791,99
	P8	96 %	207,74	873,71	143,91	782,39	174,45	826,85
	P9	94 %	203,77	918,58	135,96	844,65	169,69	881,49
	P10	98 %	165,36	851,90	159,78	853,00	162,34	852,31
Asia	P11	88 %	203,02	865,01	188,82	861,06	195,88	862,87
	P12	74 %	118,21	875,30	206,85	879,46	162,10	877,89
	P13	83 %	153,94	847,42	120,28	861,28	120,24	863,45
	P14	94 %	186,87	854,34	165,58	871,30	175,95	862,58
	P15	48 %	1116,20	830,15	1085,63	830,69	1111,11	835,66

Table 12 shows the Mean X and Y coordinates of the fixation at the Image 4 for left, right and both eyes during the recording time of 7 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.



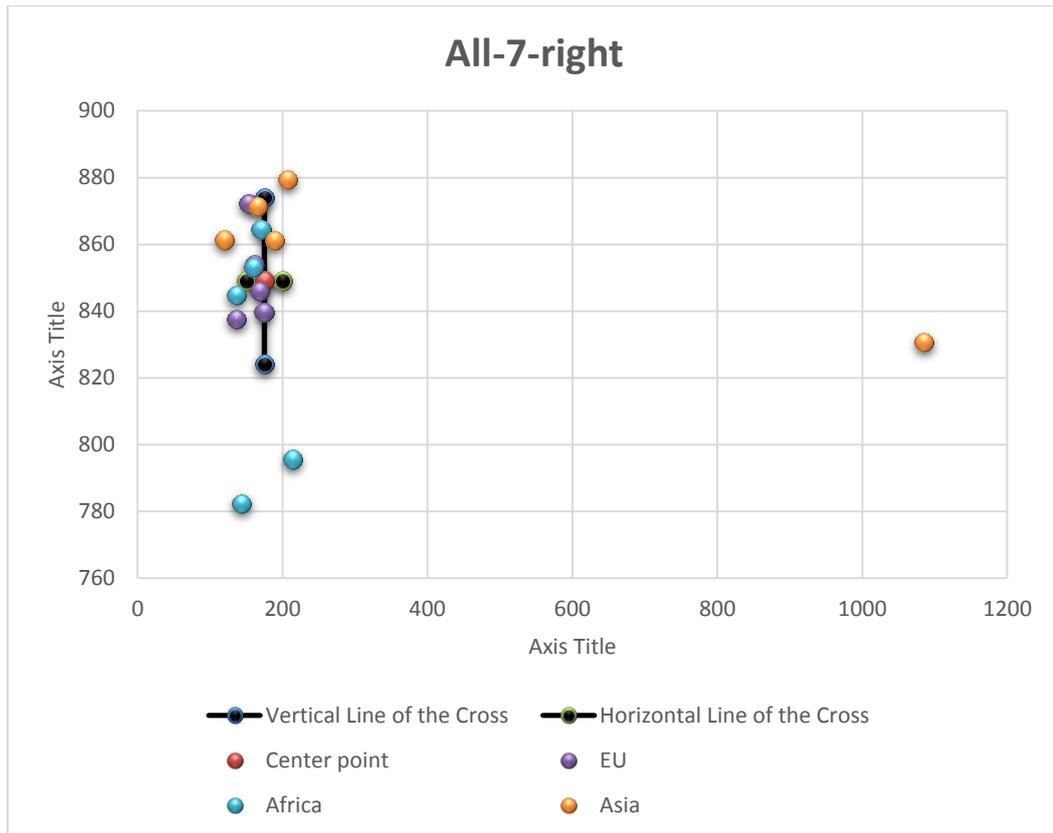


Figure 76. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7 seconds. Right eye

Figure 76 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-7, from all groups. The mean coordinates of the respondent P15 lie down out far away from the set area.

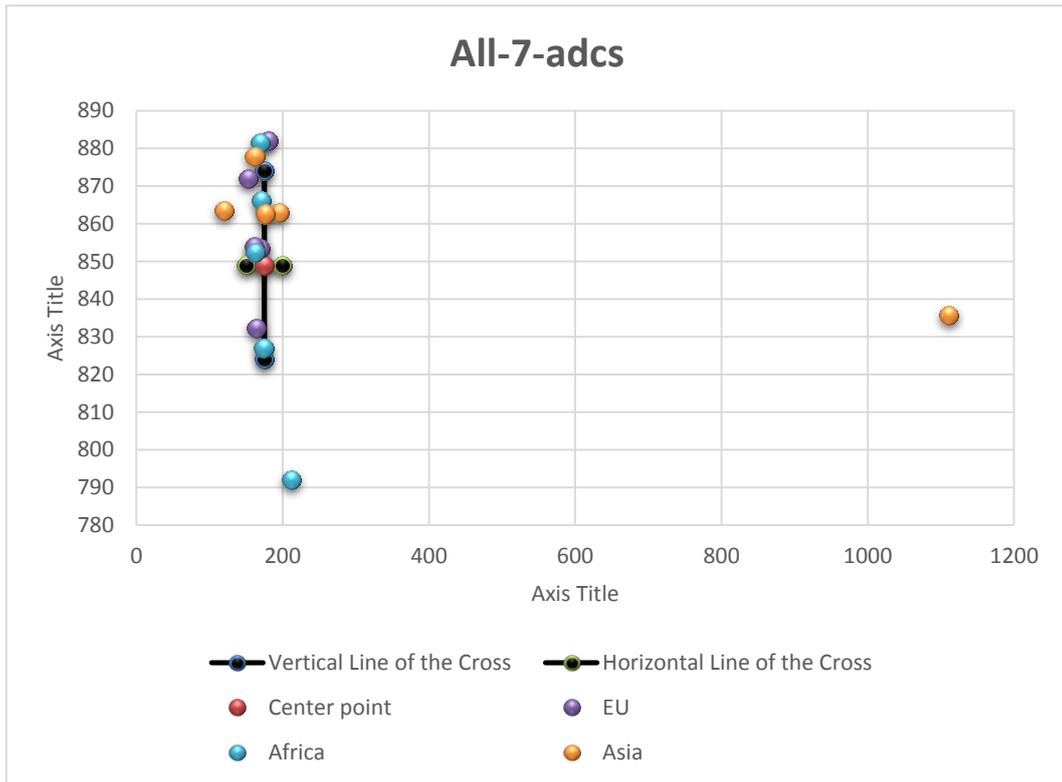


Figure 77. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7 seconds. Both eyes

Figure 77 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-8, from all groups. The mean coordinates of the respondent P15 lie down out far away from the set area.

Table 13. Mean coordinates of the gaze at the Image 4. Recording time-9 sec

Center point			MEAN					
X	175		9 sec					
Y	849		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	195,47	922,18	168,69	850,50	181,77	886,64
	P2	95 %	206,57	832,83	128,62	850,64	165,23	842,31
	P3	90 %	158,76	869,78	154,05	847,11	156,24	858,41
	P4	99 %	177,80	873,78	167,81	877,08	172,56	875,17
	P5	100 %	170,79	879,54	179,97	881,64	175,14	880,34
Africa	P6	85 %	158,39	832,72	164,83	831,81	161,08	832,62
	P7	98 %	182,20	809,48	184,19	826,42	182,90	817,79
	P8	96 %	204,31	872,96	134,44	773,16	167,40	821,20
	P9	94 %	211,46	905,91	146,76	835,19	178,84	870,31
	P10	98 %	159,48	861,48	157,43	873,87	158,15	867,53
Asia	P11	88 %	192,74	879,97	179,24	877,85	185,75	878,67
	P12	74 %	197,63	868,68	228,69	867,12	213,22	868,20
	P13	83 %	179,72	841,53	158,03	863,19	156,27	862,06
	P14	94 %	177,68	828,03	160,00	865,85	168,60	846,69
	P15	48 %	1134,55	864,09	1085,11	873,12	1112,14	868,12

Table 13 shows the Mean X and Y coordinates of the fixation at the Image 4 for left, right and both eyes during the recording time of 9 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

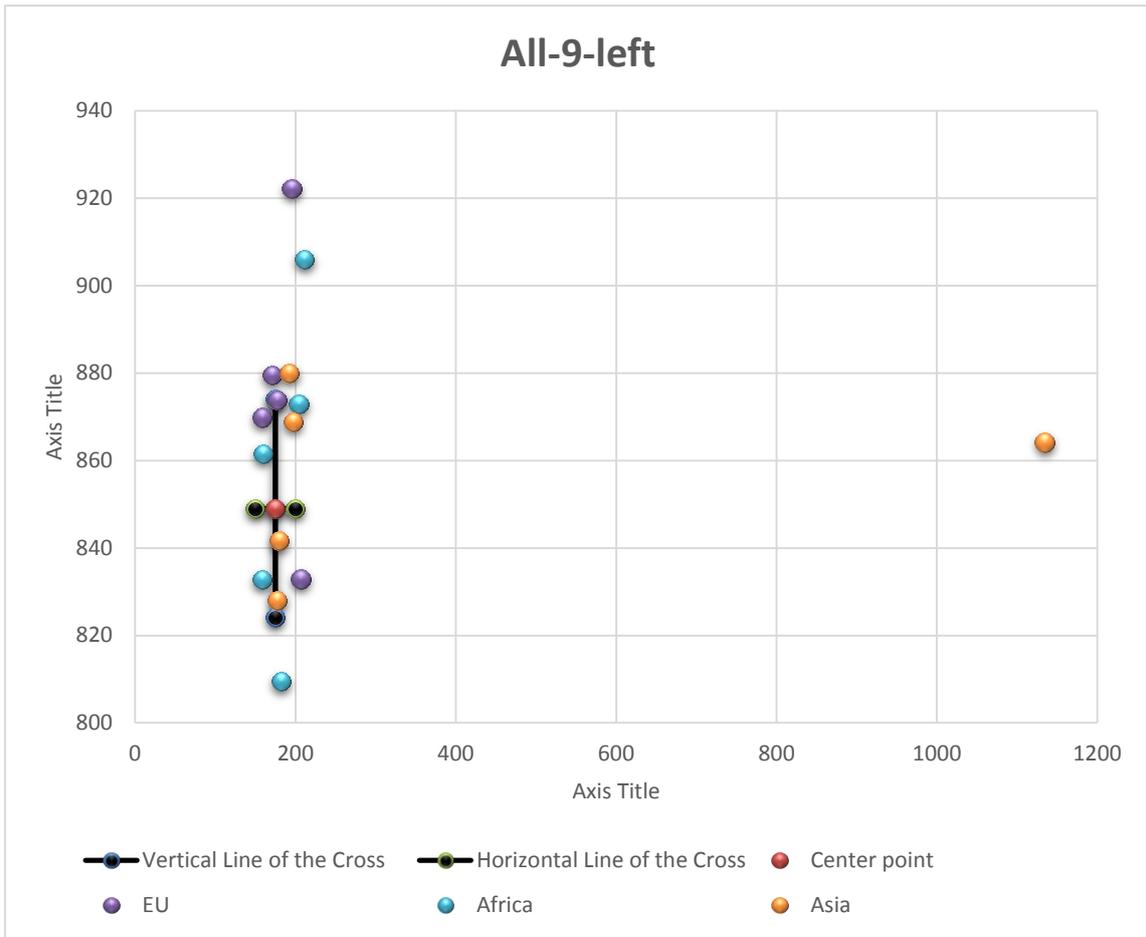


Figure 78. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Left eyes

Figure 78 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-11, from all groups. The mean coordinates of the respondent P15 lie down out far away from the set area.

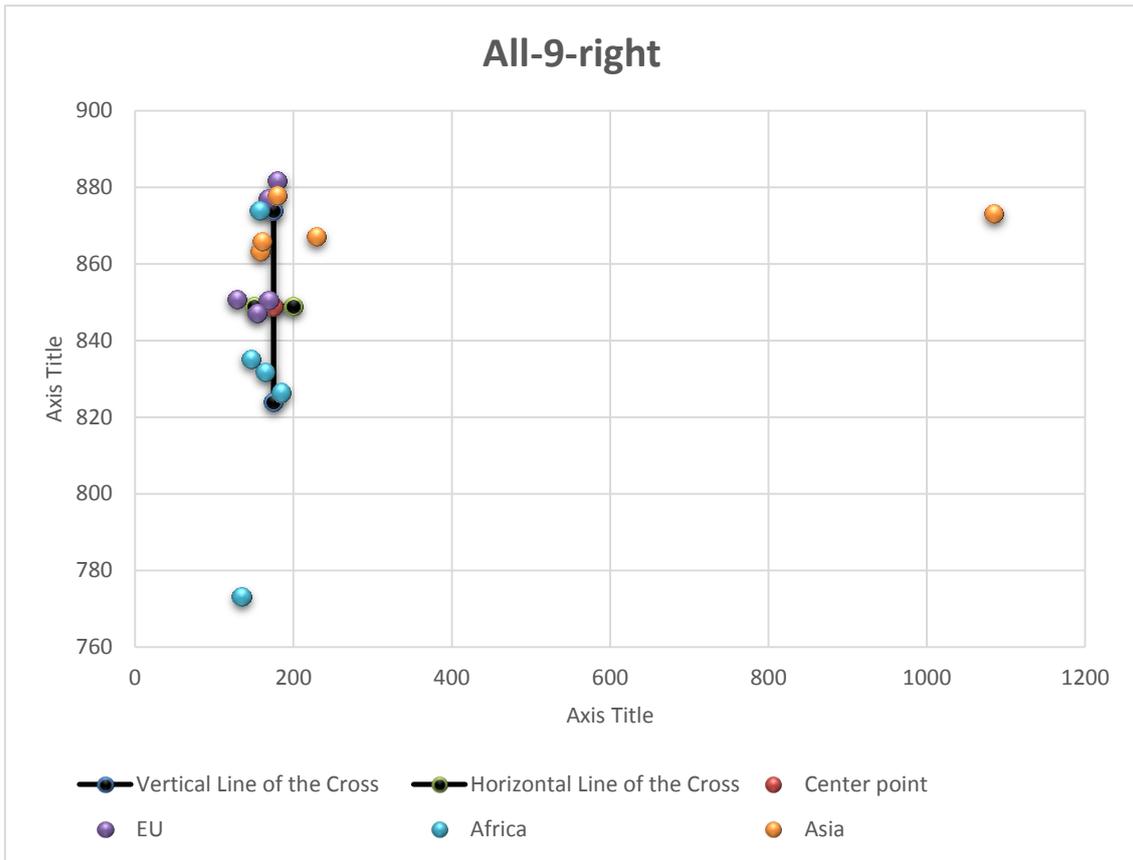


Figure 79. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Right eye

Figure79 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-11, from all groups. The mean coordinates of the respondent P15 lie down out far away from the set area.

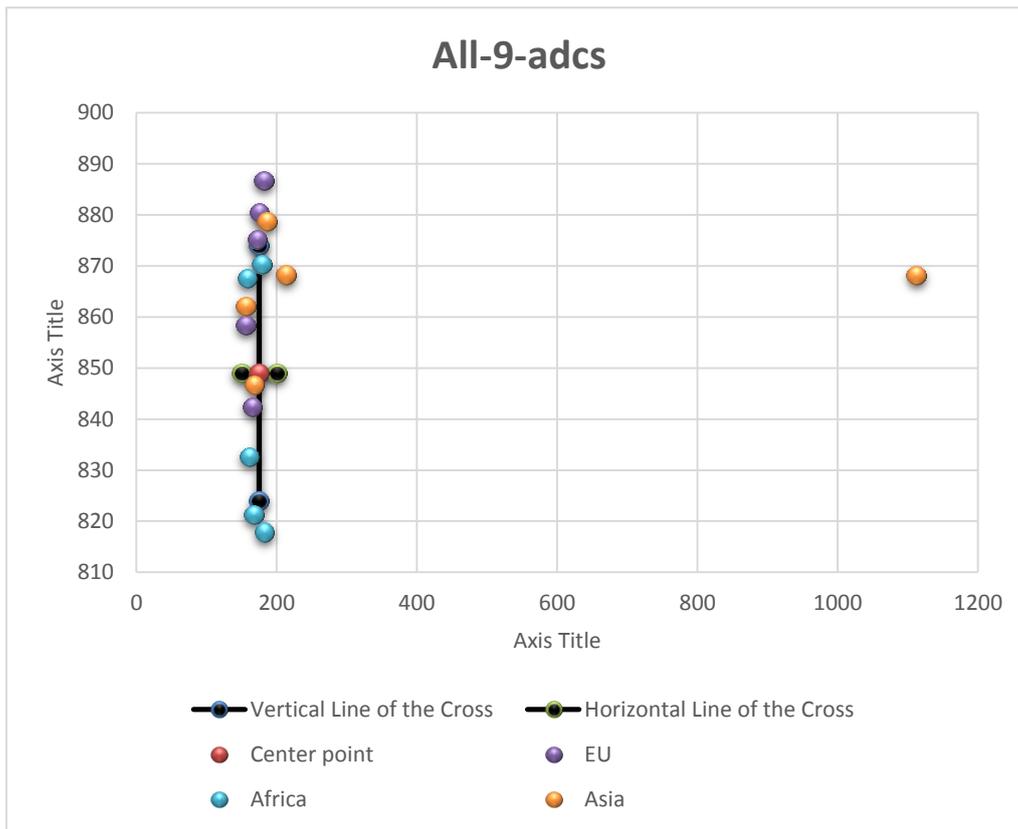


Figure 80. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Both eyes

Figure 80 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 4.

Intersection with the Cross area-presents for few participants. Intersection with the center of the Cross-no one. Deviation- significant for all groups along the axis Y. The number of participants whose mean gaze point is out of the set area-10, from all groups. The mean coordinates of the respondent P15 lie down out far away from the set area.

### 3.5 Mean gaze coordinates of all participants at the Image 5

Cross position-center (Figure 81)

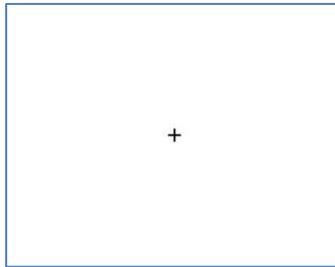


Figure 81. Cross-position-center

Figure 82 shows the algorithm of presenting the results in the section: Image 5-Cross position-Center → for 5,7,9 seconds → for the left, right, both eyes → for group of participants EU (P1-5), Africa (P6-10), Asia (P11-15).

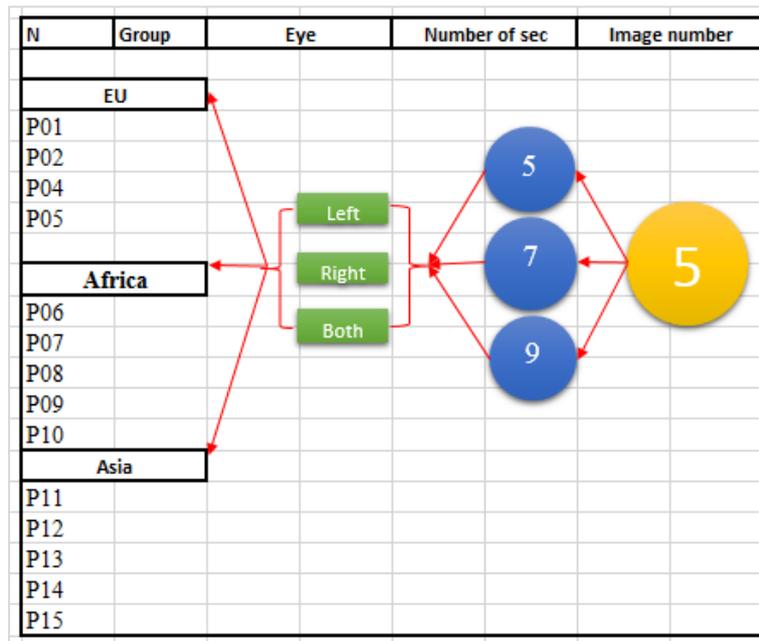


Figure 82. The algorithm of data presentation of the Image 5

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Table 14. Mean coordinates of the gaze at the Image 5. Recording time-5 sec

Center point			MEAN					
X	640		5 sec					
Y	512		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	655,6	559,4	629,8	528,4	642,4	543,6
	P2	95 %	662,4	531,3	631,9	540,1	647,0	535,4
	P3	90 %	641,9	526,5	638,5	524,4	640,0	525,1
	P4	99 %	633,8	525,5	633,2	505,0	633,3	515,0
	P5	100 %	640,1	529,4	633,2	527,4	636,4	528,1
Africa	P6	85 %	628,4	511,5	632,8	515,3	630,3	513,1
	P7	98 %	634,7	505,3	639,6	502,8	636,9	503,8
	P8	96 %	651,2	506,8	619,3	526,7	635,0	516,5
	P9	94 %	644,7	521,3	621,1	529,9	632,5	525,1
	P10	98 %	630,9	502,3	629,9	502,6	630,1	502,2
Asia	P11	88 %	618,0	528,3	617,2	525,6	617,3	526,9
	P12	74 %	687,5	481,2	635,7	579,0	661,1	532,1
	P13	83 %	657,6	488,5	645,5	517,2	651,3	502,8
	P14	94 %	659,7	481,2	636,1	487,8	647,2	483,8
	P15	48 %	200,3	835,4	191,3	822,2	180,6	839,4

Table 14 shows the Mean X and Y coordinates of the fixation at the Image 5 for left, right and both eyes during the recording time of 5 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

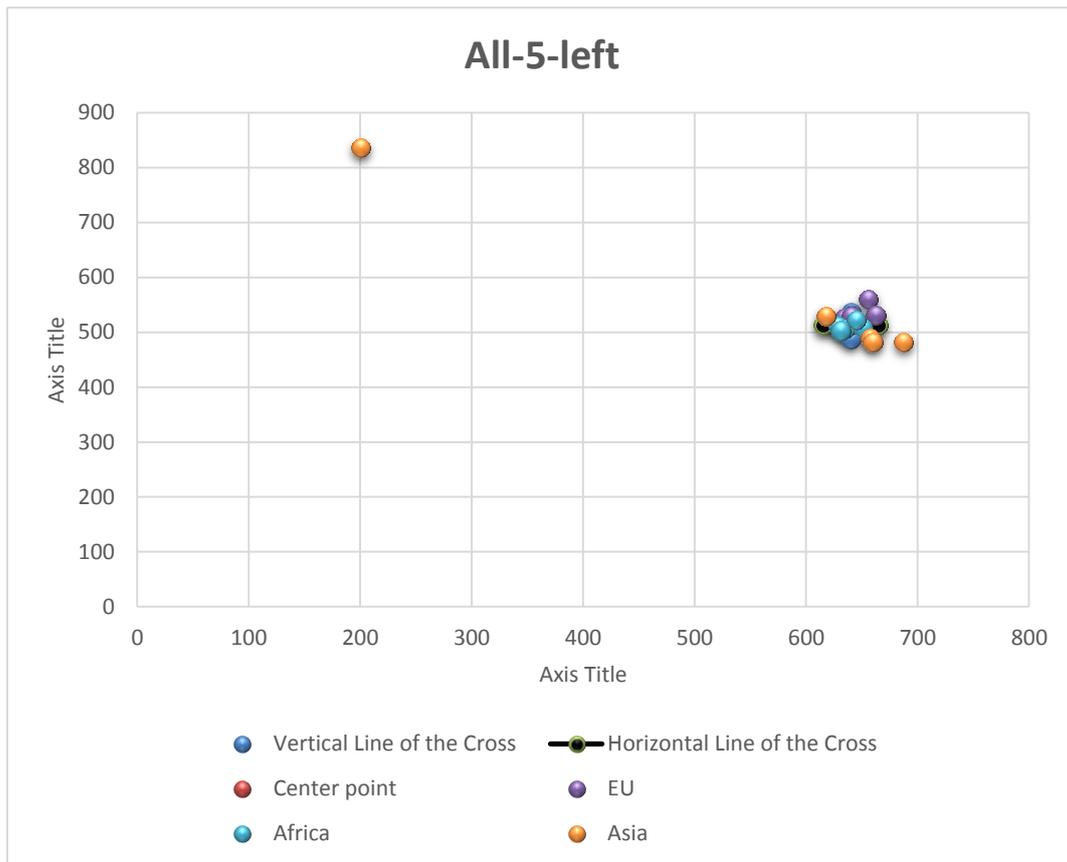


Figure 83 Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Left eye

Figure 83 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of the respondent P15 lie down out far away from the set area.

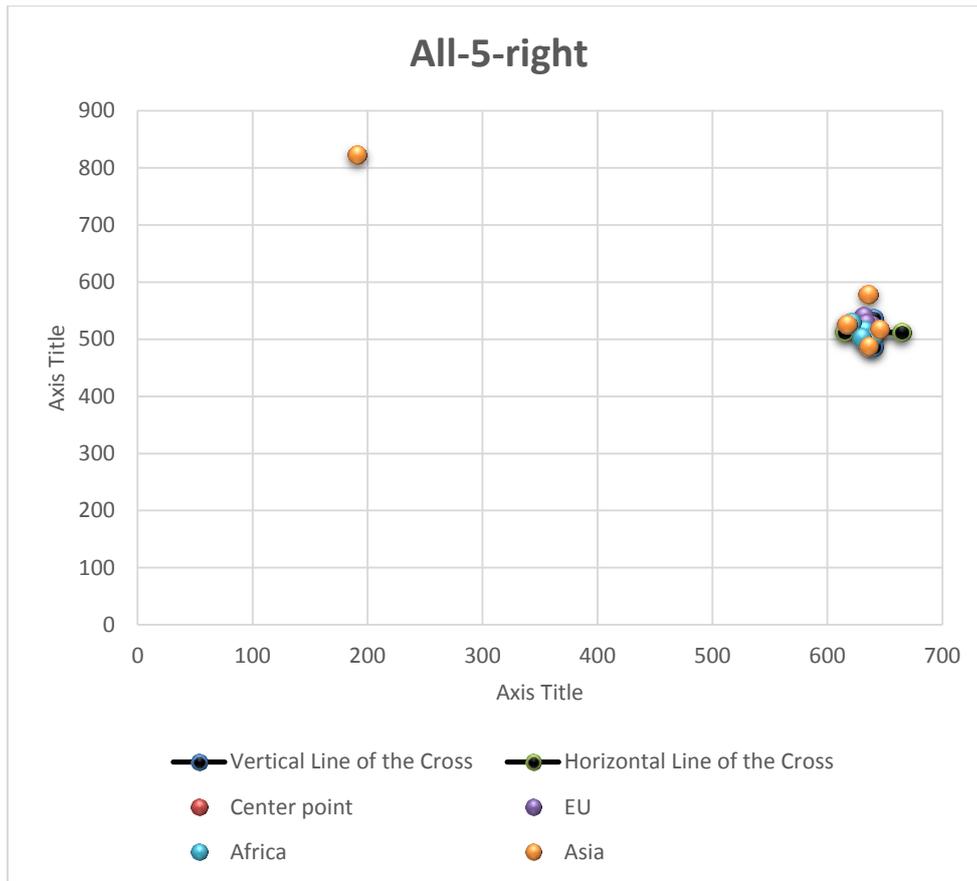


Figure 84. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Right eye

Figure 84 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. Insignificant shift –to the right part of the Cross. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of the respondent P15 lie down out far away from the set area.

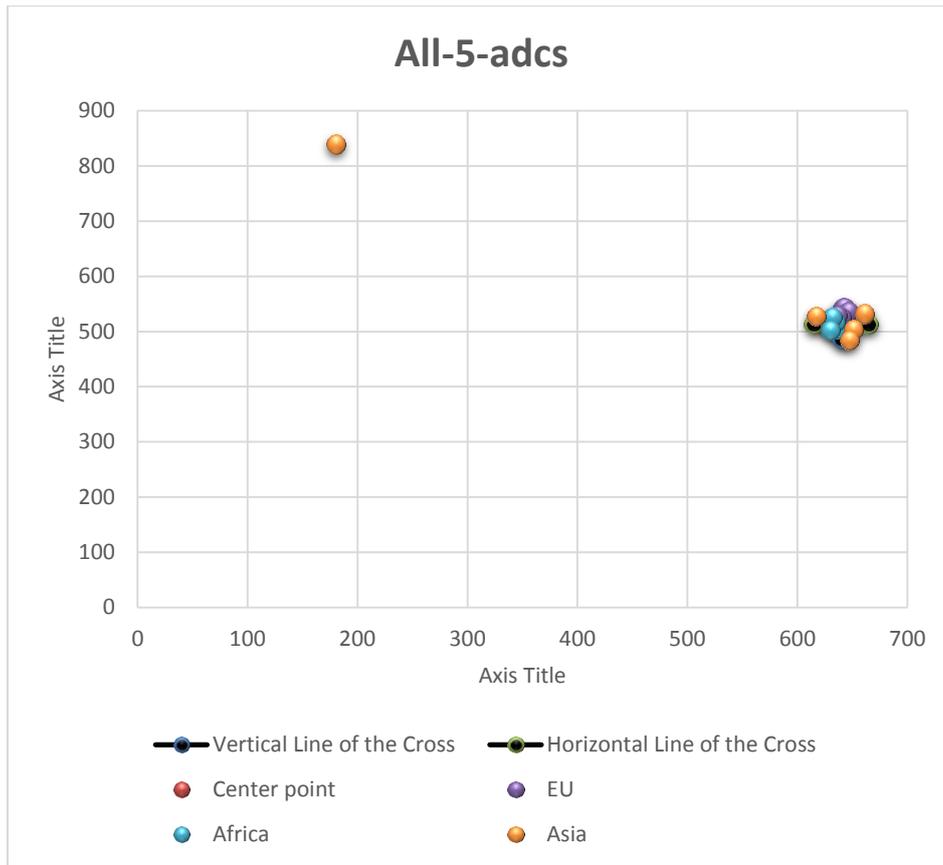


Figure 85. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-5 seconds. Both eyes

Figure 85 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 5 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of the respondent P15 lie down out far away from the set area.

Table 15. Mean coordinates of the gaze at the Image 5. Recording time-7 sec

Center point			MEAN					
X	640		7 sec					
Y	512		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	669,5	563,8	627,8	519,5	648,4	541,4
	P2	95 %	665,0	512,1	617,2	539,6	640,8	525,7
	P3	90 %	640,7	529,9	636,9	525,5	638,5	527,5
	P4	99 %	633,9	517,8	632,1	501,7	632,7	509,5
	P5	100 %	638,8	510,0	622,6	493,0	630,5	501,2
Africa	P6	85 %	636,9	502,8	640,3	507,5	638,4	504,9
	P7	98 %	640,3	507,8	644,8	507,9	642,3	507,6
	P8	96 %	648,7	512,2	620,4	529,0	634,3	520,4
	P9	94 %	651,8	527,7	617,5	524,0	634,4	525,6
	P10	98 %	636,7	510,3	631,4	508,5	633,9	509,2
Asia	P11	88 %	625,8	531,2	623,6	524,1	624,5	527,7
	P12	74 %	743,0	470,7	698,6	562,8	719,6	519,1
	P13	83 %	654,0	490,6	643,6	496,5	648,9	492,0
	P14	94 %	656,5	499,3	637,3	501,1	646,7	499,9
	P15	48 %	214,5	859,1	189,8	831,1	206,5	850,8

Table 15 shows the Mean X and Y coordinates of the fixation at the Image 5 for left, right and both eyes during the recording time of 7 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

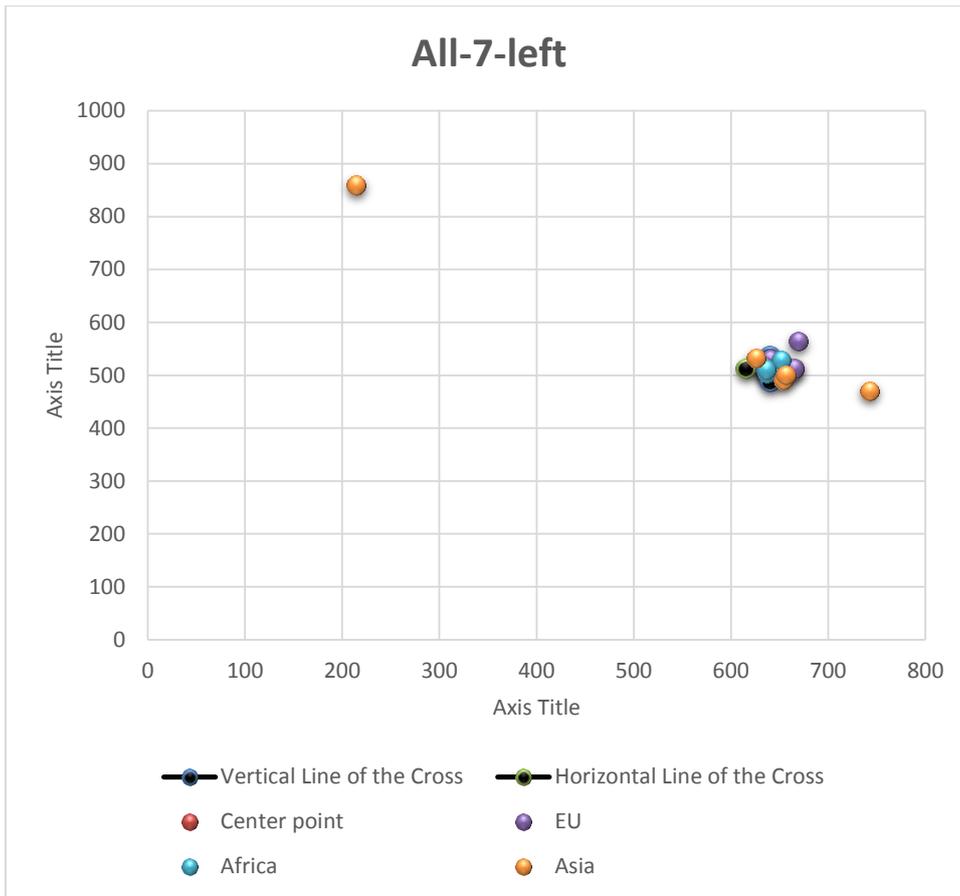


Figure 86. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7 seconds. Left eye

Figure 86 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of two respondents of the group Asia lie down out far away from the set area.

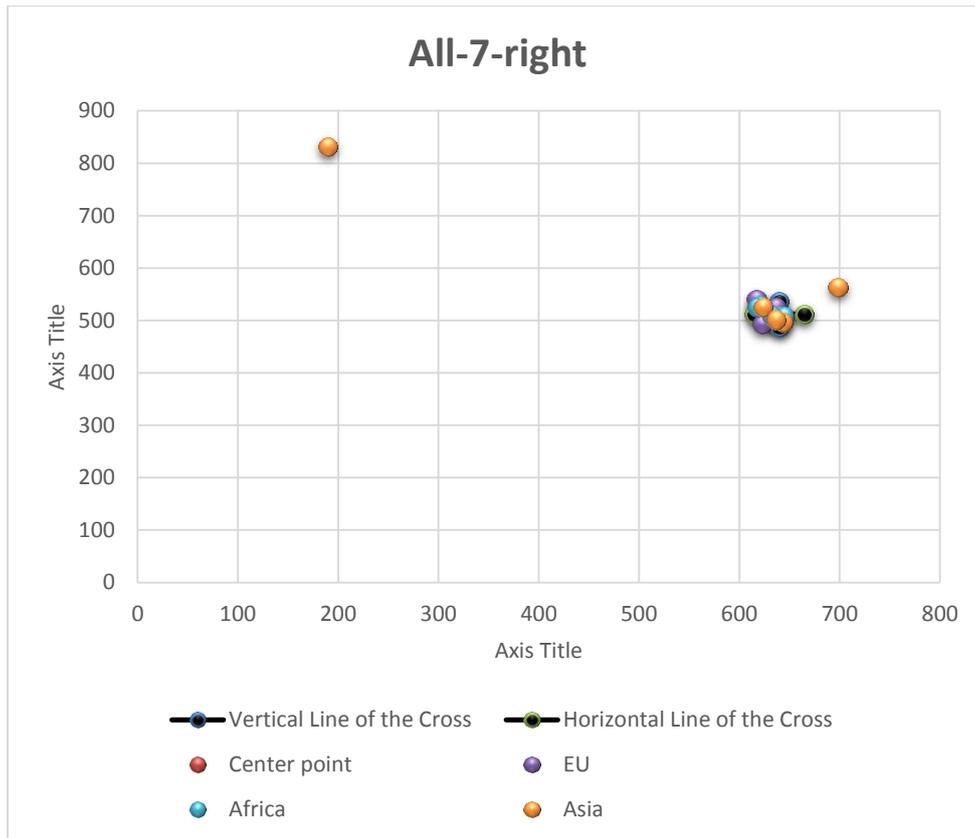


Figure 87. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7 seconds. Right eye

Figure 87 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. Insignificant shift to the right part of the cross. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of two respondents of the group Asia lie down out far away from the set area.

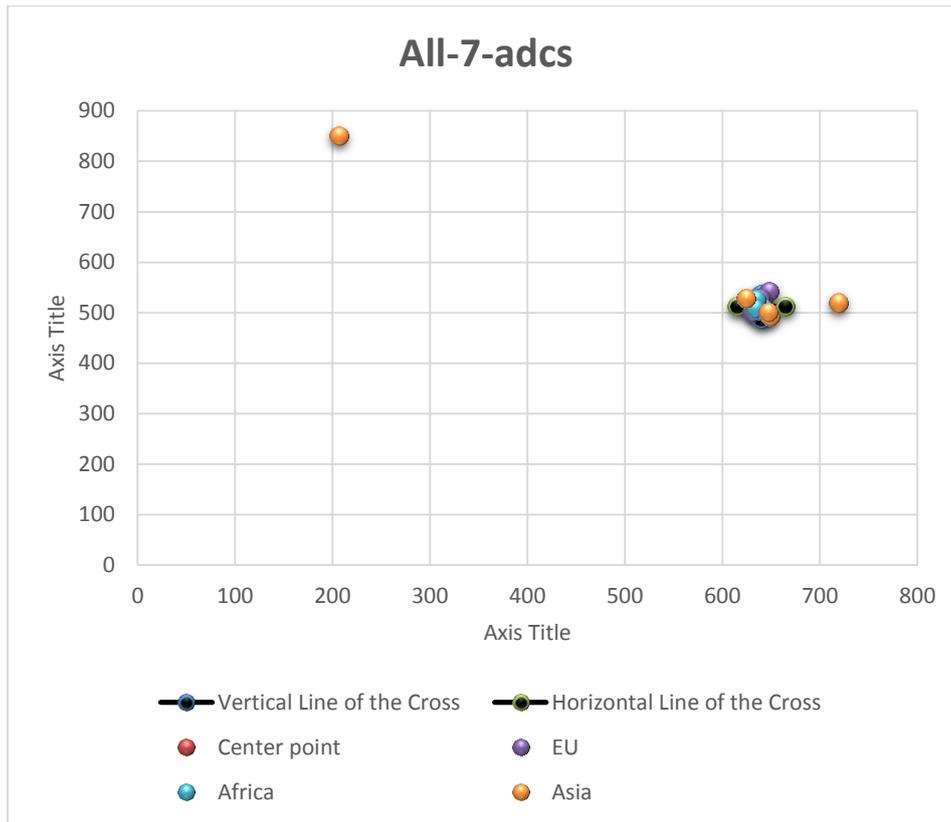


Figure 88. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-7 seconds. Both eyes

Figure 88 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 7 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of two respondents of the group Asia lie down out far away from the set area.

Table 16. Mean coordinates of the gaze at the Image 5. Recording time-9 sec

Center point			MEAN					
X	640		9 sec					
Y	512		left		right		adcs	
Group	Part	%	x	y	x	y	x	y
EU	P1	94 %	665,8	611,2	634,2	506,0	649,9	558,6
	P2	95 %	672,1	499,1	617,6	535,9	644,5	517,3
	P3	90 %	643,0	525,8	639,3	509,5	640,9	517,5
	P4	99 %	636,4	519,4	633,7	506,6	634,8	512,7
	P5	100 %	642,0	516,4	626,7	498,9	634,1	507,5
Africa	P6	85 %	638,9	507,1	639,6	514,4	639,0	510,4
	P7	98 %	637,3	509,5	642,1	509,1	639,5	509,0
	P8	96 %	651,7	501,1	618,4	516,2	634,8	508,4
	P9	94 %	652,7	527,4	615,0	521,5	633,9	524,5
	P10	98 %	634,4	513,5	631,2	510,1	632,5	511,5
Asia	P11	88 %	623,8	530,9	625,7	527,8	624,9	530,0
	P12	74 %	916,0	520,8	873,1	593,2	896,1	557,9
	P13	83 %	626,0	527,0	619,0	576,8	622,3	551,7
	P14	94 %	667,0	479,8	640,9	491,4	653,7	485,4
	P15	48 %	186,0	874,4	134,8	862,8	174,6	871,1

Table 16 shows the Mean X and Y coordinates of the fixation at the Image 5 for left, right and both eyes during the recording time of 9 seconds for all participants. The percentage of the recording, the exact coordinates of the set Cross and its center are also presented.

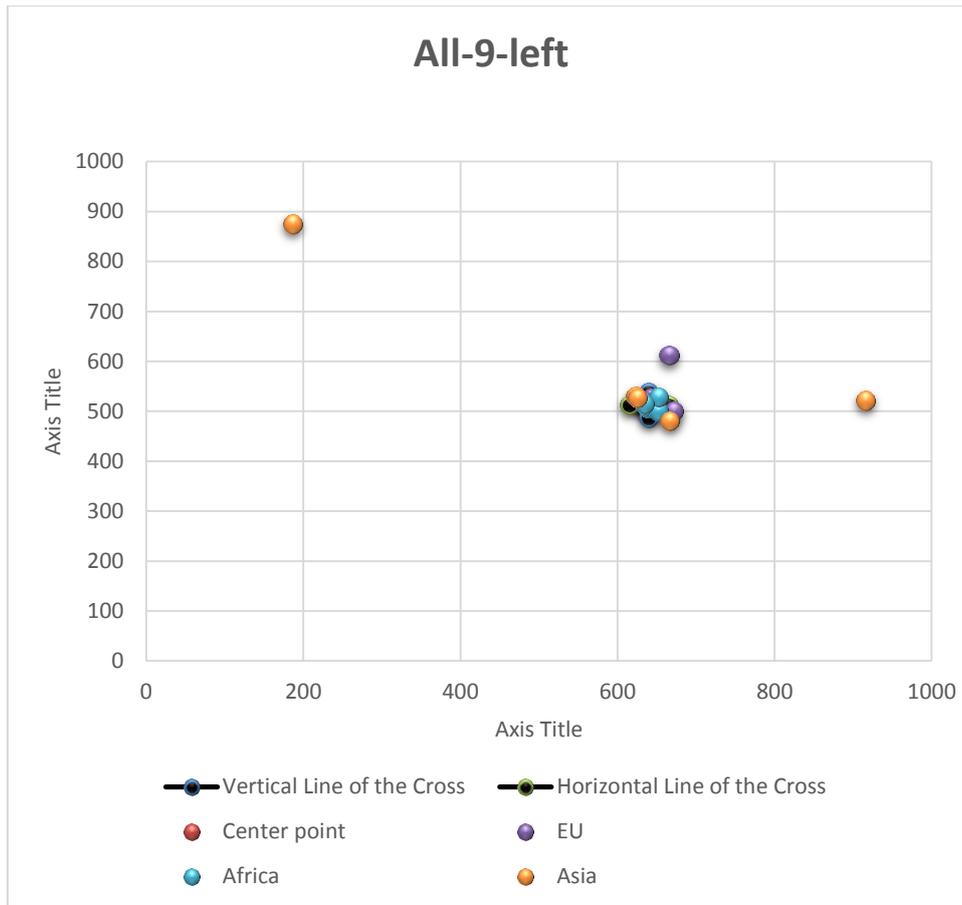


Figure 89. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Left eye

Figure 89 represents a comparison of the Mean coordinates of the fixation of the left eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of two respondents of the group Asia lie down out far away from the set area. One respondent of the group EU has a low accuracy of the mean point comparing to the location of the Cross.

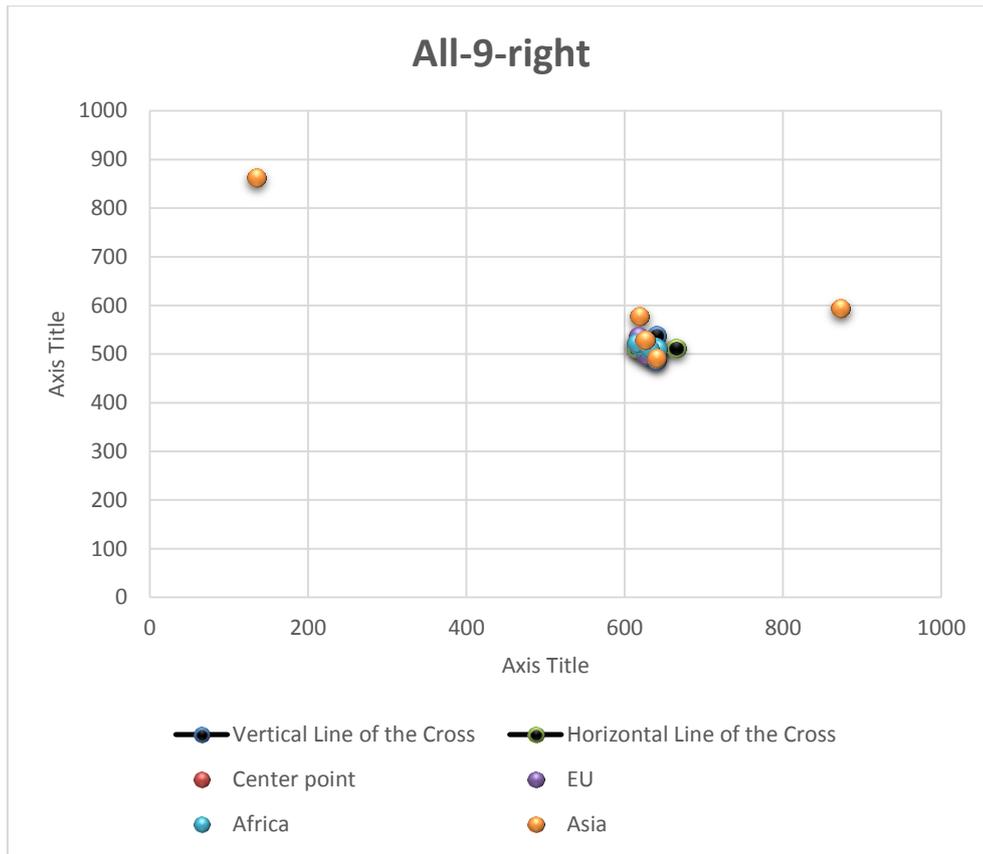


Figure 90. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Right eye

Figure 90 represents a comparison of the Mean coordinates of the fixation of the right eye for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of two respondents of the group Asia lie down out far away from the set area.

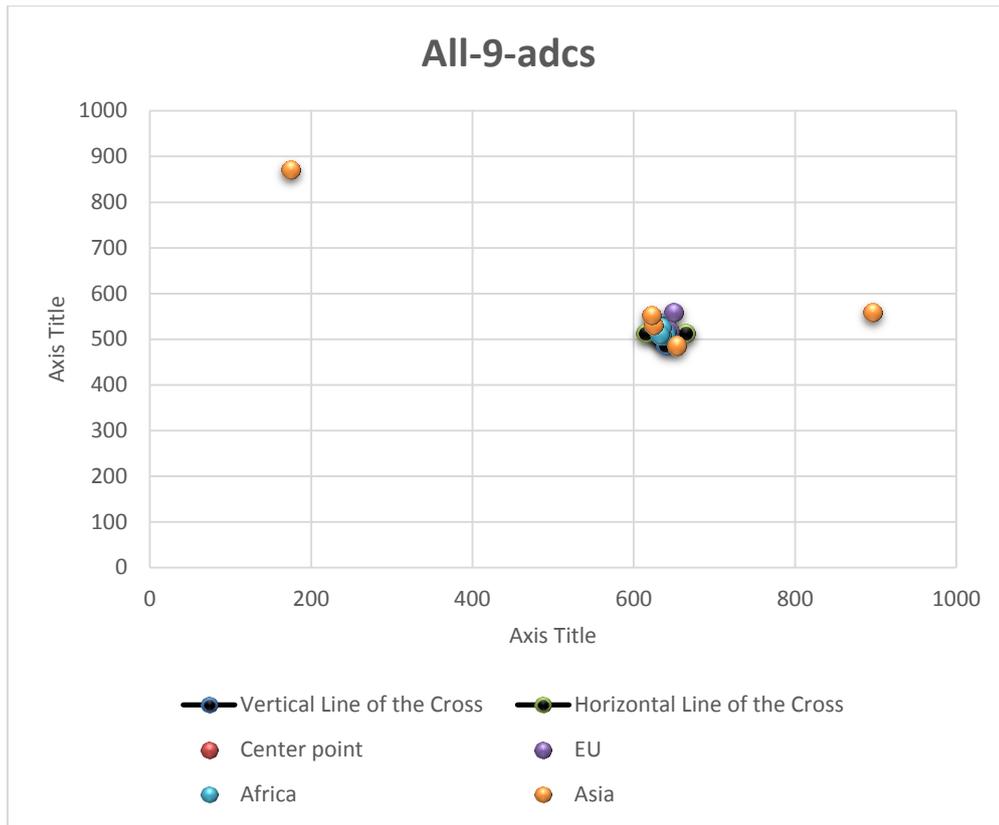


Figure 91. Location of the Mean gaze relative to the location of the Cross and the Cross center. All participants. Time-9 seconds. Both eyes

Figure 91 represents a comparison of the Mean coordinates of the fixation of both eyes for each participant of all groups during the recording time of 9 seconds and the coordinates of the location of a set figure of the experiment “Cross” and its center at the Image 5.

Intersection with the Cross area-presents for most of participants. Intersection with the center of the Cross-most of respondents. Deviation- insignificant. The concentration of the mean gazes at the area of the Cross or nearby it is high. The mean coordinates of two respondents of the group Asia lie down out far away from the set area.

## 4 DISCUSSION AND CONCLUSION

Based on the results of a particular experiment the author has come to the conclusion that the Eye-tracker provides a quite high accuracy of measurements of the data recorded during the experiment as after processing raw data the researcher could determine the accuracy of human perception of each particular participant, compare it with the exact coordinates of the set figure and get the tendency of eye movements and human perception of each participant separately and within each group.

According to the observation and data processing the researcher comes to the conclusion that within all groups of participants –European, African and Asian, during the experiment including three parts of 5, 7 and 9 seconds at all Images it's observed a progressive decrease of the accuracy of the mean gaze of all participants from the first part of the test with a duration of 5 seconds to the last with a duration of 9 sec. This fact can be explained by the tiredness of eyes and reduction of the concentration and attention of the participants and complication of rotation of an eyeball to the diagonal.

The most stable index of accuracy during the whole test is shown by the African group of participants as their deviation from the set area is the smallest. The African group of respondents showed well results with an allowable deviation. Worse results are shown by the Asian and European groups of participants with a bigger deviation from the set area. However, the tendency of deviation of European and Asian groups of respondents differs: within a European group a smaller deviation from the set Cross is observed and it concerns most of participants of the group whereas within an Asian group the participants have shown a higher deviation of the mean gaze coordinates but it concerns only several participant of the group. However, the highest number of intersection of the mean gaze point with the exact center of the Cross are shown by European respondents.

Within tested Images there's a tendency of shifting of the mean indexes of all participants to the left part of the set area when the right eye is tested and the shift to the right part of the cross area considering the data of the left eye.

The most notable results are shown by the participant P15 of the Asian group with no one intersection with the Cross which can be explained by the researcher with a low

eyesight of the participant and as a result –a low percentage of recording. Thus, as the participant didn't have any factors that could possibly influence recording results (very long thick eyelashes, strong and bright makeup, outside noise) it's possible to conclude that the level of the eyesight of the participant directly influences on the accuracy of the measurement of the gaze.

Considering each image separately it's important to mention that the highest accuracy was shown at the Image 5 with the cross at the central position which was predicted by the researcher before as this location of the set area is the most comfortable to look at and all eye movements of all participants started from the central point during the experiment which is seen at the Heatmaps and Gaze Plots of a particular research.

At the Image 2 with a Cross position at the upper right corner the shift of the mean gaze of all participants is observed along the horizontal axis of the figure even more to the right side while the shift of the mean point at the Image 4 with a Cross position at the lower left corner is strongly marked along a vertical axis which may be explained due to the location of the cross- at the Image 2 the cross is located closer to the area of best observation (upper left corner) and at the Image 4-more far away from this area and at the upper corner so that the eye is moving downwards.

The means of most of participants at the Image 3 with a Cross position at lower down corner match the area of the Cross or lie nearby it during the whole experiment time except of the last stage of 9 seconds when the deviation increases significantly.

Interestingly, the results of the mean accuracy of all groups of the participants at the Image 1 with a Cross position at the upper left corner are not significantly differ for the deviation level from the results of other pictures (except of the central position of the Cross) despite the fact that based on previous eye-tracking research the best concentration of the attention of the respondent is exactly at this corner when scanning a web page. (Steve Outing. *Eyetrack III: What News Websites Look Like Through Readers' Eyes*. 2004:3) Thus, it's possible to conclude that the accuracy of perception of a participant doesn't concentrate especially at an upper left corner and doesn't change significantly at different corners of the screen if the main stimulus is placed there.

Thus, after discussion of the main results the research makes the following inferences about the accuracy of a human perception of the stimulus on the screen: the accuracy of

perception changes depending on a racial group; the highest accuracy of observation are shown at the center of the screen as it was expected; the accuracy doesn't change significantly at different corners of the screen but the mean indexes visibly shifts along the axis X at the right (upper and downer) corners and along the axis Y at the left corners of the screen; the accuracy of the gaze point and the observation directly depends on the duration of the test significantly decreasing by the end of a long fixation.

As a particular research is a study in process, the author would recommend to make a particular experiment with an artificial eye for further studies of the Eye-tracking technology.

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<http://www.poynter.org/uncategorized/24963/eyetrack-iii-what-news-websites-look-like-through-readers-eyes>

## APPENDIX 1

Statistical Metrics provided by the Eye Tracker

- **Time to First Fixation**- the time from the start of the stimulus display until the test participant fixates on the AOI or AOI Group for the first time (seconds),
- **Time to First Fixation (Across Media)** - the time from the start of the stimulus display until the test participant fixates on the AOI or AOI Group for the first time (seconds),
- **Fixation Before**- number of times the participant fixates on the media before fixating on an AOI or AOI Group for the first time (count),
- **First Fixation Duration**- duration of the first fixation on an AOI or an AOI Group (seconds),
- **Fixation Duration**-duration of each individual fixations within an AOI, or within all AOIs belonging to an AOI Group (seconds),
- **Total Fixation Duration**-duration of all fixations within an AOI, or within all AOIs belonging to an AOI Group (seconds),
- **Total Fixation Duration (Include Zeros)**- duration of all fixations within an AOI, or within all AOIs belonging to an AOI Group (seconds),
- **Fixation Count**- number of times the participant fixates on an AOI or an AOI Group (count),
- **Fixation Count (Include Zeros)**- number of times the participant fixates on an AOI or an AOI Group (count),
- **Visit Duration**- duration of each individual visit within an AOI or an AOI Group (seconds),
- **Total Visit Duration** – (former Observation Length) duration of all visits within an AOI or an AOI Group (seconds),
- **Total Visit Duration (Include Zeros)** -(former Observation Length) duration of all visits within an AOI or an AOI Group (seconds),
- **Visit Count** –number of visits within an AOI or an AOI Group (count),
- **Visit Count (Include Zeros)**- number of visits within an AOI or an AOI Group (count),

- **Percentage Fixated**-percentage of participants that fixated at least once within an AOI or AOI Group (%),
- **Percentage Clicked**-percentage of participants that clicked at least once within an AOI or AOI Group (%),
- **Time to First Mouse Click** –the time in seconds until the first click is made within an AOI or AOI Group,
- **Time to First Mouse Click (Across Media)**-the time in seconds until the first click is made within an AOI or AOI Group,
- **Time from First Fixation to Next Mouse Click**-the time in seconds from the first fixation in the AOI/AOI Group to the next click that occurs within the group,
- **Time from First Fixation to Next Mouse Click (Across Media)**-the time in seconds from the first fixation in the AOI/AOI Group to the next click that occurs within the group,
- **Mouse Click Count**-number of times the participant clicked inside an AOI or an AOI Group (count),
- **Mouse Click Count (Include Zeros)**- Number of times the participant clicked inside an AOI or an AOI Group (count).

## APPENDIX 2\*

Gaze Plots. All participants. During 5,7, 9 sec. All Images 1,2,3,4,5.

Graphs: *Mean coordinates of the gaze*. During 5,7, 9 sec. All Images 1,2,3,4,5. . Group of participants –European. Participants 1-15.

Graphs: *Mean coordinates of the gaze*. Group of participants –African. Participants 1-15.

Graphs: *Mean coordinates of the gaze*. Group of participants –Asian. Participants 1-15.

Heat Maps. All participants. During 5,7, 9 sec. All Images 1,2,3,4,5.

*Raw data exported from Tobii Studio*. All participants. During 5,7,9 sec. All Images 1,2,3,4,5.

Tables: *Standard Deviation*. All participants. During 5,7, 9 sec. All Images 1,2,3,4,5.

Tables: *Comparison of the Mean coordinates of all participants' gaze and the Mean coordinates of the center of the Cross on the Media*. All participants. During 5,7,9 sec. All Images 1,2,3,4,5.

Tables: *Mean coordinates of the gaze*. During 5,7, 9 sec. All Images 1,2,3,4,5. Group of participants-European. Participants 1-15.

Tables: *Mean coordinates of the gaze*. During 5,7, 9 sec. All Images 1,2,3,4,5. . Group of participants –African. Participants 1-15.

Tables: *Mean coordinates of the gaze*. During 5,7, 9 sec. All Images 1,2,3,4,5. . Group of participants –Asian. Participants 1-15.

*\*The particular appendices are saved and presented on an additional CD-disk attached to the Thesis work due to large size of files*