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FATIH UNIVERSITY
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THE EVALUATION OF VISUAL ATTENTION ON HOSPITAL PERSONNEL BY "EYE TRACKING" METHOD

ARMAN NALÇACIER

MSc THESIS
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ASSIST. PROF. DR. SAİME AKDEMİR AKAR

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FATİH ÜNİVERSİTESİ
BİYOMEDİKAL MÜHENDİSLİK ENSTİTÜSÜ

HASTANE ÇALIŞANLARI ÜZERİNDE "GÖZ-İZLEME" METODUYLA GÖRSEL DİKKATİN DEĞERLENDİRİLMESİ

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YÜKSEK LİSANS TEZİ
BİYOMEDİKAL MÜHENDİSLİK PROGRAMI

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İSTANBUL, HAZİRAN / 2014

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Arman NALÇACIER, a **MSc** student of Fatih University **Institute of Biomedical Engineering** student ID **520112031**, successfully defended the **thesis/dissertation** entitled "**the evalutaion of visual attention on hospital personnel by eye-tracking method**", which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

Committee members

Thesis Advisor: **Assist. Prof. Dr. Saime AKDEMİR AKAR**
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It is approved that this thesis has been written in compliance with the formatting rules laid down by the Institute of Biomedical Engineering.

Prof. Dr. Sadık KARA
Director

Date of Submission: 16 May 2014
Date of Defense: 25 June 2014

To my lovely family,

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I would like to express my gratitude to my supervisor Assist. Prof. Dr. Saime AKDEMİR AKAR for her patience, guidence, advises and encouragement throughout my thesis. Her willingness to motivate me was really helpful to finish my study. I would like to also thank to the board of directors of Yedikule Surp Pırgiç Ermeni Hospital and to the personnel for participating to my thesis experiment.

I would like to thank my family for their endless love, support and especially for their patient during my thesis.

June 2014 Arman NALÇACIER

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ABBREVIATIONS

ADHD: Attention Deficit Hyperactivity Disorder
AOI: Area of Interest
ERP: Event Related Potientials
fMRI: Functional Magnetic Resonance Imaging
LVF: Left Visual Field
IAPS: International Affective Picture System
IPS: Intraparietal Sulcus
KPI: Key Performance Indicators
MEG: Magnetoencephalography
SMI: SensoMotoric Instruments
SPL: Superior Parietal Labule
SSVEP: Steady-State Visual Evoked Potentials
RVF: Right Visual Field

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SUMMARY

THE EVALUATION OF VISUAL ATTENTON ON HOSPITAL PERSONNEL BY EYE TRACKING METHOD

Arman NALÇACIER

Biomedical Engineering Programme
MSc Thesis

Advisor: Assist. Prof. Dr. Saime AKDEMİR AKAR

The purpose of this study was to investigate the visual attention of hospital staff, by the method of eye tracking. Ten doctors, seventeen nurses and fifteen personnel joined this study. In this study, we asked test subjects to find orthographical mistakes in two separete texts, which consisted of eighteen lines and ten columns. Certain information is obtained about number missions, the duration of mission completance and forcible periods by the way of screen records. In our country, the related literature is very limited in terms of the studies realised by eye tracking method. This study can be evaluated as the one of the first academical thesis which analysis visual attention.

Keywords: Visual attention, eye tracking, hospital staff, doctor, nurse.

FATIH UNIVERSITY - INSTITUTE OF BIOMEDICAL ENGINEERING

ÖZET

HASTANE ÇALIŞANLARI ÜZERİNDE GÖZ-İZLEME METODUYLA GÖRSEL DİKKATİN DEĞERLENDİRİLMESİ

Arman NALÇACIER

Biyomedikal Mühendisliği Programı
Yüksek Lisans Tezi

Danışman: Yrd. Doç. Dr. Saime AKDEMİR AKAR

Bu çalışmanın amacı hastane çalışanları üzerinde görsel dikkatin göz izleme yöntemiyle incelenmesidir. Çalışmaya on doktor, onyedi hemşire ve onbeş personel katılmıştır. Çalışmada onsekiz satır ve on sütundan oluşan iki ayrı metinde imla olarak yanlış yazılan kelimenin bulunması istendi. Ekran görüntü kayıtlarının aracılığıyla görev sayısı, görev tamamlama süreleri ve zorluk çekilen zamanlar hakkında bilgi edinilmiştir. İlgili literatürde, göz izleme (eye-tracking) metoduyla gerçekleştirilen görsel dikkat çalışmaları Türkiye'de son derece kısıtlıdır. Çalışma hastane çalışanları üzerinde görsel dikkati incelemede ilk çalışma olarak değerlendirilebilir.

Anahtar kelimeler: Görsel dikkat, göz izleme, hastane çalışanları, doktor, hemşire.

FATİH ÜNİVERSİTESİ - BİYOMEDİKAL MÜHENDİSLİĞİ ENSTİTÜSÜ

CHAPTER 1

INTRODUCTION

1.1 Statement and motivation of thesis

Everything we do, we feel and we do is a function of our nerve system. For centuries scientists tried to describe the relationship between observable or measurable human behavior and thoughts and the structure and the functions of the brain. Nowadays studies to comprehend the brain and the behavior are being held using the behavioral techniques of psychology science, the findings of pathology of medical sciences, the technical evaluation tools provided by mathematics and engineering sciences. Especially the developments on biomedical engineering gave a new dimension to the studies on psychology and made it possible to observe directly between the brain and behaviour and manipulate.

Recent imaging results suggest that parietal areas, especially the superior parietal lobule (SPL) and the intraparietal sulcus (IPS), participate in many different attention tasks and may subserve a general visual attention function. In Fıgure 1.1 shows brain lobes [1]. Parietal activity has been associated with endogenous and exogenous shifts of spatial attention [2], maintenance of attention on peripheral stimuli and divided attention [3], feature integration [4], attentive tracking of moving dots, [5], nonspatial attention [6], object-based attention [6], response selection ti visually presented stimuli [8], object-oriented action [9], and overt and covert attention shifts [10].

There are different ways to measure the attention center of human. In order to measure the eye movements of human on pc screen correctly eye tracking tools can record the visual attention of the user [11].

Eye tracking systems has been designed to measure where the user looks on pc screen. These systems observe the looking points of the user automatically and at real time [12].

Eye movements give information on the parts which attract the attention of the people, information undervalued, the things which annoy them.

Eye tracking method assists to find the personal differences through following eye movements and to interact with the source provided.

Being careful and focusing are important brain functions for the hospital personnel. When we are starting and doing a work we concentrate and focus on it. Our eyes are the most important sensual organ for these procedures. The tests to measure the visual attention have been applied on the hospital personnel (doctors, nurses, other workers) and the results have been analyzed.

The health sector, is the second sector in which the work accidents occur oftenly, as per the report of USA employee statctics.

The accidents occur due to attention deficiency of the hospital personnel and it can end with the death of the patients. The eye movements are related closely with the point that people look to and why they look at that point. Eye tracking device records the point we look and analyses the data. We will try to the find the reasons of visual attention deficiency of hospital personnel by using eye tracking device, this is the major factor of the thesis.

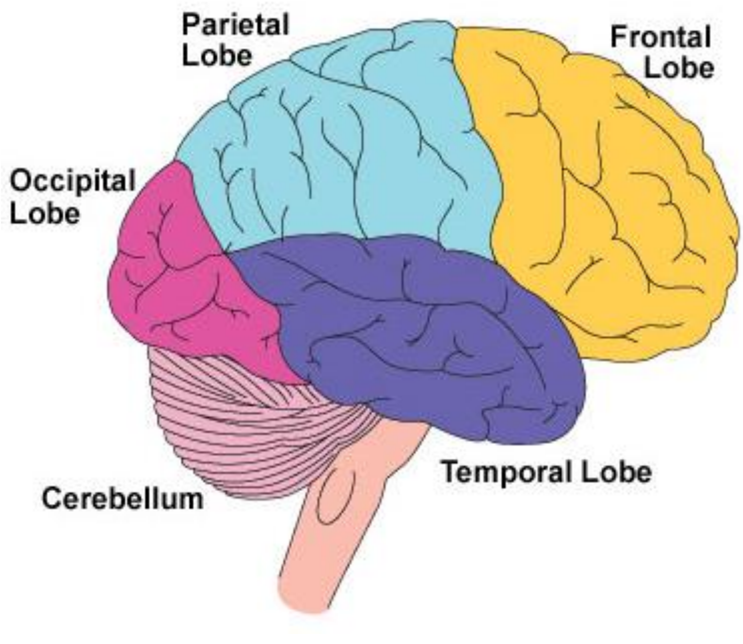


Figure 1.1 Brain lobes [1]

1.2 Purpose of thesis

The purpose of this study was to investigate the visual attention of hospital staff, by method of eye tracking. The objectives thesis are to find the answer the questions as follows.

- The analysis of mission completence duration and focusing ration in visual attention.
- The effects of sex, age and occupation differences on the distribution.
- The attitudes of the test subjects during the survey.

1.3 Thesis Overview

This academical thesis consists of five chapters. **Chapter 1** coverst the introduction, **Chapter 2** includes the literature review, visual attention and eye tracking system. In **Chapter 3**, the test subjects, procedures and eye tracking device are introduced. The results of the analysis are reported in **Chapter 4**. In **Chapter 5** the results, achievements, limitations at the present study and recommendations of the for the future studies are discussed.

The general work plan of this study is presented in Figure 1.1. The first step is the definition of participants and data collection. The second step is execution of the survey and the eye tracking data acquisition. In the third step statistical analysis and evaluation of the results are given.

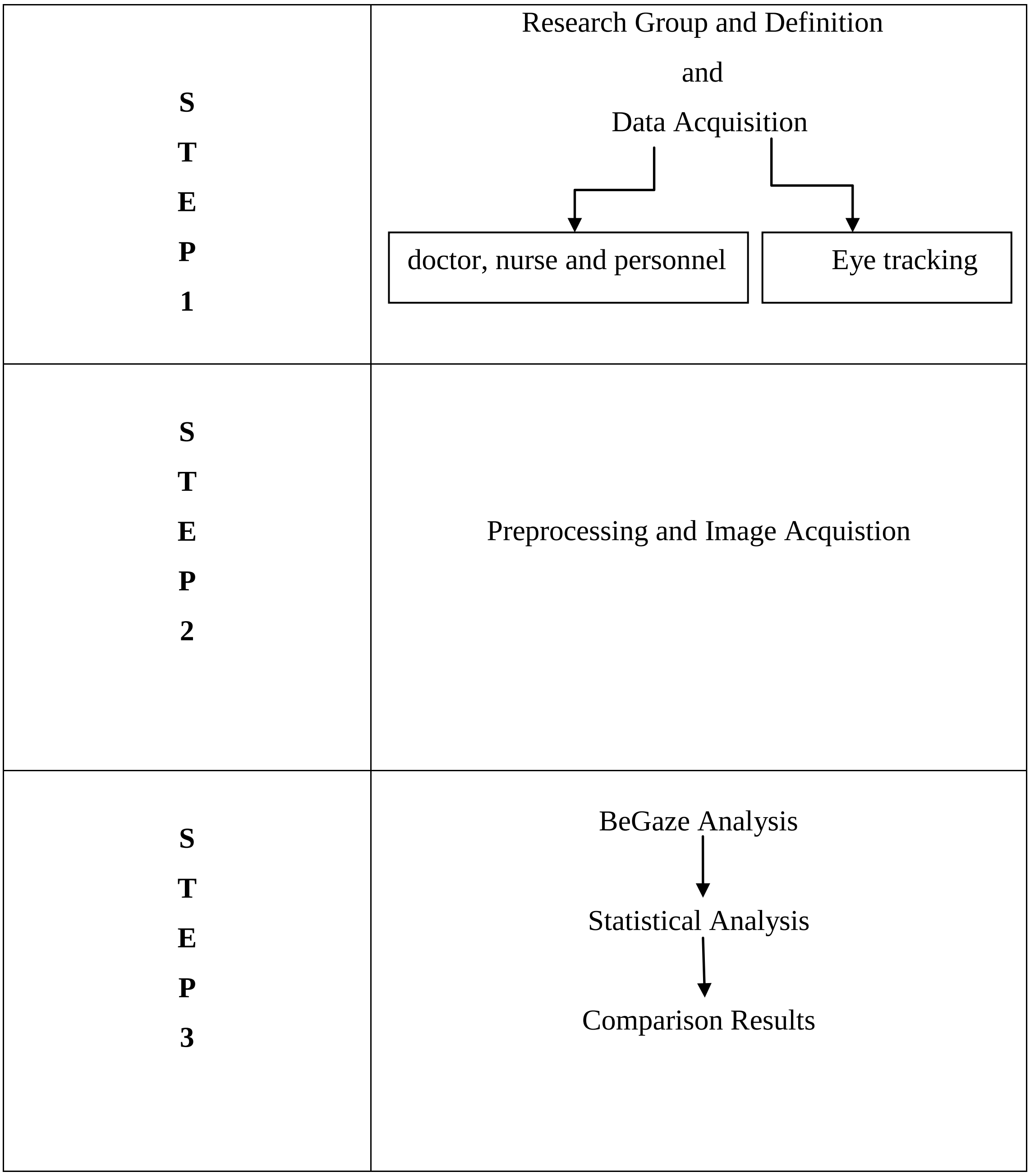


Figure 1.2 General block diagram of the dissertation

CHAPTER 2

ATTENTION AND LITERATURE REVIEW

2.1 Attention

Notwithstanding the limitations of operational sources of nervous system, the information that comes from outside is external. The attention is the filtration of the information, which comes out while the central nervous system is controlled upside down. In other words, it helps to use the moss efficient way. The attention, can be also defined as the capacity of the input selected analysis [13]. In psychology, the attention is defined as the divertion of the mental receiver to the stimulus, which occurs in fenomenale periphery noticed by sense organs [14-16]. The attention includes the activity of reduction of stimulus threshold, in degrees.

The processes related with the attention: Stimulation, vigilance, divertion, selective attention, resistance against disturbance. The discovery of the stimulant, the operation of the determined stimulant, the filtration of the stimulants to the related stimulant while the attention continues, the shifting of attention while convenient, distractibility and creation of a reply to the input are again all attention processes [17]. In location of the stimulant, the targets continously change. The attention modulations catch the appropriate center of the location of stimulant and leaves behind the other stimulants. Cerebral cortex entirely participates to attention modulations. Each cortical area, especially unimodel association are as, supports this during privatization in the codification at the start.

2.2 Visual Attention

The attention is the entire name of different perceptional and engine functions. Even though there is not an accepted classification of this function of the brain, three independent process are used. These are: variable, selectivity, vigilance and the control of the attention. The point where a person looks at, is related with why that person looks at that point [18]. While a person would like to interact with other people, conveys his will by looking into other persons eyes. Our eye movements, can change according to our visual environments structure and our targets.

The movements that occur because of visual environment is called bottom up movements and the movements that occurs because of our eye movement is called up-bottom movements. Bottom up movements approach is used for perceiving the stage that a person is inside. Once a person has an aim, this completely change the eye movement direction [19]. For example, looking a reply for the question "How old these people are?" and the question "How healty are these people?" results in different replies [19]. Yarbus et al. (1967) had investigated the participants scrutinise during 3 minutes by eye movements acquistion. Their procedure is shown Figure 2.1.

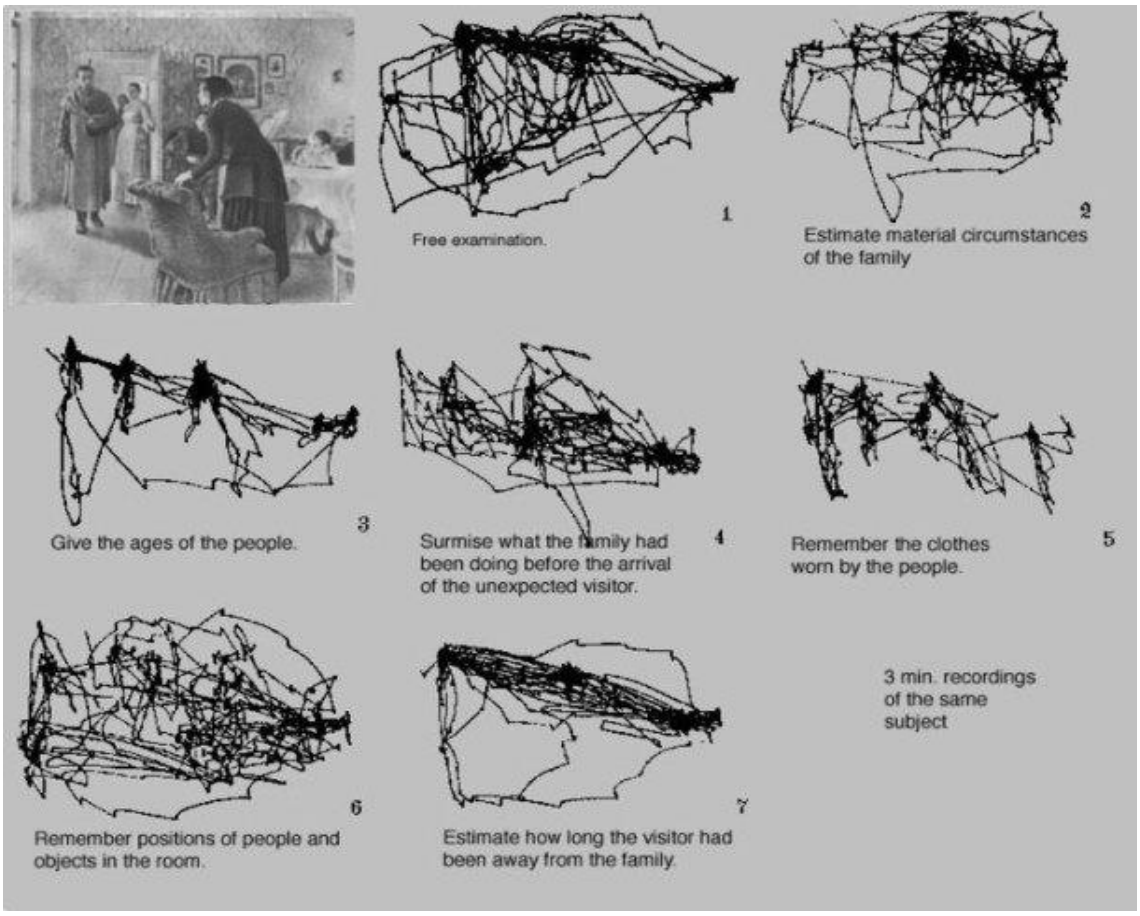


Figure 2.1 Early eye movement recordings [17]

2.3 Top-down vs. Bottom-up

A simple reflection on biological reality tells us that we are unable to, and probably do not need to, attend to every object present in our visual world, and that we perceive only parts of visual data available. Selective visual attention refers to the process of attending to a certain part of the visual information available at the expense of other (unattended) information. This process is a vital cognitive ability for any behaving agent in a complex world, for there is a need to be able to efficiently select the most relevant information that matches the current behavioural goal. The mechanism of this important process, broadly, is the topic of the present thesis.

Visual attention can be drawn to sensory inputs received by retina, to facilitate their later processing in the brain. This happens in a stimulus-driven, 'bottom-up' manner, without necessarily requiring voluntary effort [20]. However, this stimulus-contingent process does not always influence perception and ensuing action in an invariant manner. Processing can also be altered by goal-directed, 'top-down' mechanisms. For example, a salient visual stimulus can be effectively ignored (or even not perceived) when we consciously look for some other target that is more relevant [21,22]. Any type of visual search task, in experimental setting as well as in everyday life, will require the optimal balance of these two processes. We need to be able to make best use of bottom-up stimuli available, whilst making sure that we select what best meets our goals and purposes.

How each of these different attentional operations might work individually or jointly has been investigated vigorously [23-26]. Some researchers have shown that completely irrelevant singletons distract attention away from a target, overriding any top-down effort in search, and from this it has been argued that attention is controlled in a purely bottom-up manner [27,28]. As an alternative account, Folk et al. [29] put forward the conceptual framework of 'contingent orienting', a hypothesis that the bottom-up attraction of attention does not occur automatically but, it is dependent on the 'attentional control setting'. They had their participants search for a target after a spatial cue, which was either a single highlighted cue in one condition or, in a second condition, a uniquely coloured cue displayed with other non-coloured cues. The target was sometimes a character in black presented alone with no other stimuli, and at other times a character in a colour that was uniquely different from the distracters displayed together. The task was to make a forced-choice response to the identity of the character. The data showed that there was a benefit when the target fell where the cue had been flashed, which did not differ between the two cue conditions, but the magnitude of the cost varied as a function of the relations between the critical property of the cue and that of the target - the cost for invalid cues occured only when the cue and the target shared the same property. Folk and colleagues suggested that a task would require a preceding internal setting for task-relevant features and that irrelevant bottom-up information would influence attention only when this information share its properties with the task-relevant features. According to their explanation, the data indicate that bottom-up cueing of attention might not be entirely autonomous on top-down guidance.

There is neurophysiological evidence that the visual system is predisposed towards salient stimuli and, given no top-down factor, attentional selection would be made on the basis of the bottom-up input [30,31]. In contrast, a different body of recent work emphasises the importance of top-down process - which may change even basic perceptual representations. For example, directing attention to a specific location in space appears to alter the phenomenal perception of stimulus contrast [32]. In addition, when attention is focused on a location, the thresholds for luminance and colour contrast are lowered (by about 30-70 %) compared to when it is divided [33]. These results indicate that top-down attentional control can influence early visual processing, and thus that the dirceting attention endogenously can influence what was once thought of as early pre-attentive stages of processing. Some researchers even point out the anatomical fact that there are more feedback connections than feedforward inputs [34], which might indicate possibnle bigger role of top-down process than bottom-up counterpart in attentional selection.

Attentional selection is a deeply interesting cognitive process, which stands right at the centre of our moment-to-moment experience, memory, learning, and ultimately making best possible decisions for survival. As illustrated above, this crucial process comes about through the interplay between external and internal factors. And this interaction steers us in our constant selective perceiving of the space and objects around us.

2.4 Literature Review

The subject of visual attention is vast and could not be duly reviewed in a single paper. The interest in visual attention has grown so much that a PubMed search efficencys about 2400 articles dealing with visual attention since 1980. Almost half of these articles were published since 2005 with over 250 published in 2010 alone. Of these, slightly more than half were behavioral studies (cognitive and psychophysical), and slightly less than half were neurophysiological. Several reviews on visual attention have been published in the last 25 years in the Annual Review of Psychology [35-41] and Annual Review of Neuroscience [42-48].

The first paper in Vision Research that identified attention as a key word was published in 1976, and only 6 more papers were published during the 1980s. The number of articles on attention published since the 1980s is about 330. The rate of publication has steadily increased with time, the number of publications doubled every 5 years from 1970 to 2005. This enlargement has continued, although not as pronouncedly, with about 50% more papers published in 2005-2010 than in 2000-2005. These articles have largely focused on behavioral research, with roughly one in six articles having a focus on neurophysiology. In line with this growth in interest, three special issues on visual attention have been published in Vision Research during the last decade [49-51].

In the past 25 years, and especially within the last 15 years, there has been a growing interest in the mechanisms of visual attention: how visual attention modulates the spatial and temporal sensitivity of early perceptual filters, how attention influences the selection of stimuli of interest, how and where the neuronal responses are modulated, what neural computations underlie the selection processes, and how attention and eye movements interact. Our understanding of visual attention has advanced significantly during this epoch due to a number of factors:

1. Psychophysical research on humans has systematically characterized distinct attentional systems and their effects on perception.
2. Single-unit neurophysiological research in monkeys has yielded a precise forecast of local acitivity, and has enabled researchers to study, how and at what stages attention modulates neuronal responses.
3. Neuroimaging studies, e.g., functional magnetic response imaging (fMRI), event-related potentials (ERPs), steady-state visual evoked potentials (SSVEP), and magnetoencephalography (MEG) have allowed the study of the human brain while it is engaged in attention tasks.
4. Advances in eye-tracking technology in the last 20 years have enabled high-resolution imaging of eye movements during tasks involving perception and attention.

5. Computational modeling has taken into account psychophysical findings and neurophysiological constraints and implemented reasonable brain mechanisms and architectures underlying attention effects on perception.

In general, the influence of attention increases along the hierarchy of the cortical visual areas, resulting in a neural representation of the visual world affected by behavioral relevance of the information, at the expense of an accurate and complete description of it [52]. Realizing that behavioral relevance modulates neural representation led to a reconceptualization of areas that had been considered to be 2 'purely sensory'. For instance , four important fMRI studies of attention published in 1999, showed that spatial attention affect primary visual cortex, V1 [53-55], which, until then, had been considered a purely sensory area. It is likely that attention effects in V1 reflect feedback activity originating in higher level extrastriate areas [56]. Prevelance of adult ADHD among National Comorbidity Survey replication responds to a psychiatric disorder Figure 2.2 [57].

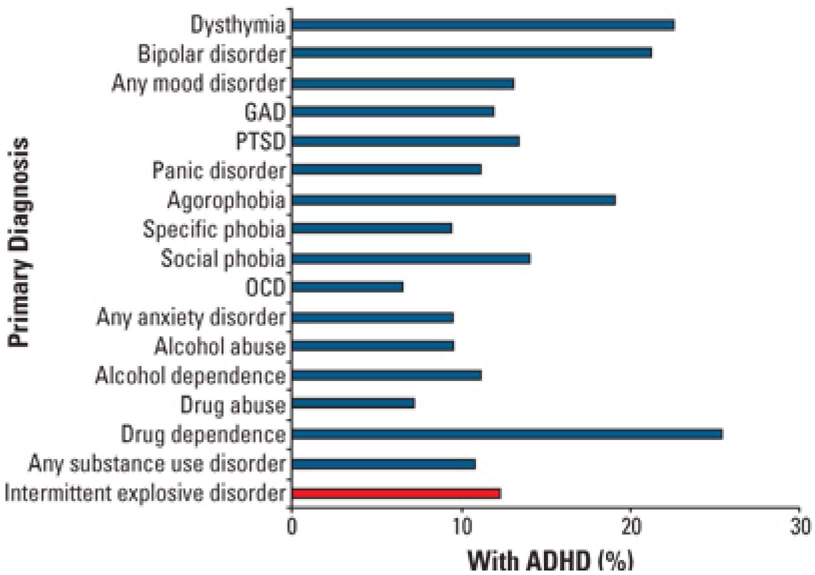


Figure 2.2 The relation between ADHD and psychiatric disorders [57]

2.5 Eye Tracking

Quantitative data required for usability evaluations can be gathered in various ways such as by using brain sensing technologies, software or questionnaires, or eye trackers. Using eye tracking in Human Computer Interaction studies is a slowly developing but a promising method. There is a rise in eye tracking researches recently due to availability of cheaper, faster, more accurate, more mobile and easier to use eye trackers today than in the past [58]. Eye tracking is a technique that records eye movements and allows testers to determine eye-fixation patterns of a person [59]. Young and Sheena have a survey on eye tracking systems. The focus point of an observed person on a screen is called gaze point. Eye tracking allows the tester to capture the gaze of a person and to determine direction of gaze. It is based on measuring the fixations (dwell times) and saccades (fast movements) of these human gazes [60]. Scan path is the resulting series of fixations and saccades. The direction of human gazes shows the focus of visual attention of a human. The tester can interpret what attracted the attention of the observed person from what s/he looked at in eye tracking technique [58]. In other words, eye tracking is used for deducing cognitive processes resulting from the relationship between eye fixations and visual attention focus [61].

There are many techniques to implement an eye tracking system. Some might require special hardware, or wearing a device on user’s head [62]. A system attached to the user’s head tracks eye-in- head direction, or a remote system tracks combined eye-head gaze direction in eye tracking [63]. When the system is head mounted, eye-in-head angles are measured; otherwise, gaze angles are measured.

Using an infrared lighting equipment [64], and highly specialized cameras, incorporating a well-trained neural network [63], are some of the common techniques. The techniques including neural network vary according to the way to capture the eye, the type of neural network, and the input to the neural network.

Eye tracking techniques are classified into two groups; intrusive techniques and non-intrusive techniques. Intrusive eye-tracking systems include physical contact between the sensor apparatus and the user; whereas non-intrusive systems do not include physical contact between user and sensor apparatus, generally benefit from cameras [63]. Some examples for intrusive techniques might be measuring the reflection of infrared light onto the eye, measuring the electric potential of the skin around the eyes, or applying special contact lenses that facilitate eye gaze tracking [66].

On the other side, incorporating one neural network [65], or two trained networks by using light into the user’s eye, or employing neural networks without any special lighting on the user’s face [67] are examples for non-intrusive technique.

Non-intrusive camera-based eye trackers depend on unique properties of the eye from usual images. Figure 2. indicates some of the important anatomical features of the human eye. Limbus is the boundary between two different colors. Camera based eye tracking systems mostly benefit from two boundaries; pupil-iris and the iris- sclera. Iris-sclera which is called as limbus makes it difficult to track due to eyelids. The pupil-iris boundary has less contrast with respect to the limbus. Therefore, better contrast in pupil tracking systems can be provided under infrared or near- infrared light source rather than under visible light. Invisible near-infrared light sources can be detected by many video cameras. When the light source is placed in parallel with the camera, the camera sees the pupil brighter than it does when the light source is placed non parallel. Tracking in parallel position of the light source with the camera is called bright-pupil tracking and in nonparallel position is called dark-pupil tracking. Some eye tracking systems use both parallel and nonparallel sources with the camera in order to combine the two images of the eye to provide better contrast.

Purkinje images are multiple reflections of the light source in different layers of the eye. Purkinje images are listed as follows; first image is the reflection from the outer surface of the cornea, and the second image is the reflection from the inner surface of the cornea, and third and fourth images are produced at the surfaces of the lens. Commonly cused image is called as corneal reflection which is the first one since it is easy to detect [68-70]. The rest of the images require specialized equipment to be captured [71,72]

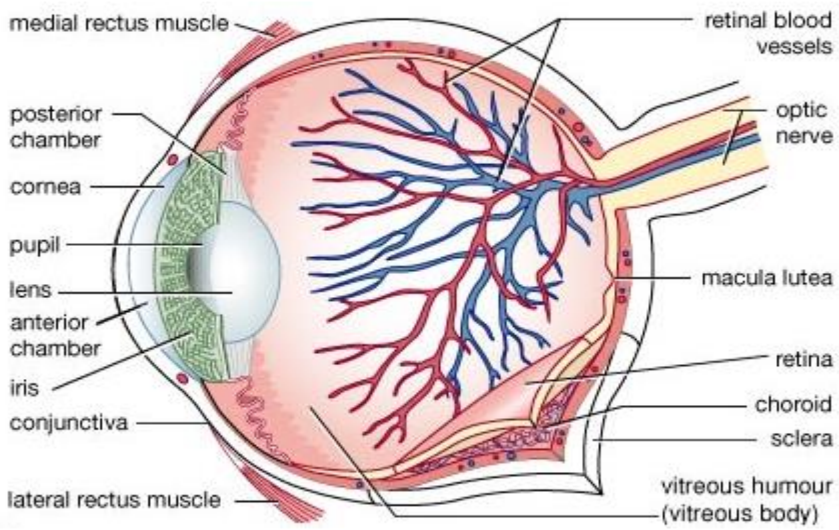


Figure 2.3 Depicts anatomy of human eye [73]

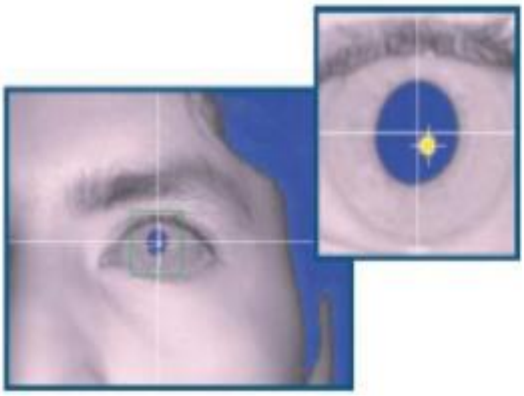


Figure 2.4 Depicts the eye seen by a camera [74]

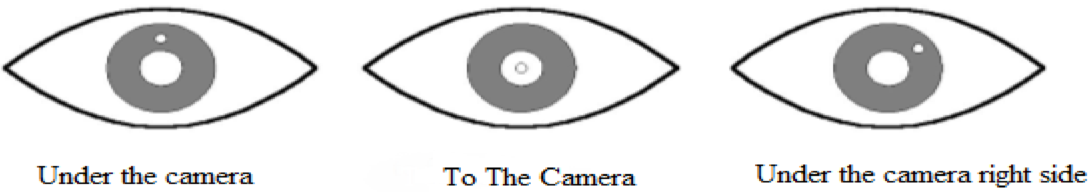


Figure 2.5 The Corneal Reflection Positions Changing According to Gaze Direction [75]

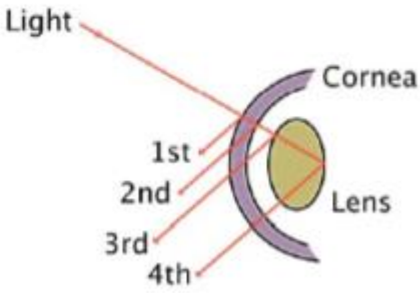


Figure 2.6 Illustrates the anatomical sources of the first 4 Purkinje images [76]

Gaze direction of the eye and head position can be computed by using the relationship between the pupil and the corneal reflection in camera based eye tracking system. The vector between the pupil center and corneal reflection can be mapped to screen coordinates via a calibration procedure. The corneal reflection tracks head movement, and the calibration handles small head motions [63].

Intrusive techniques give more accurate results than non-intrusive techniques, because in intrusive systems the sensor remains fixed with respect to the user's eyes whereas in non-intrusive systems user's head is mobilized and movements are not restricted [77,71]. However,intrusive techniques have the possibility to lead health damages more than non-intrusive techniques.

Eye tracking techniques are advantageous in that their use can be extended, and setting up is fast, and accurate and sufficient data can be attained, and they can tolerate small amounts of mobilization of head without invalidating the calibration [78,79] Camera-based trackers which are generally remote capture the images and aim to come through with the different features of the eye [71]. The amount of head movements that can be tolerated varies. Systems allowing only a few millimeters of head motion typically require a head restraint, e.g. a chin rest, be employed [63].

2.6 Eye Tracking and Attention

It is only recently that researchers have begun to utilize eye-tracking to investigate the dual issues of attention and influence. To date the issue of spatial position has not been addressed but already many questions regarding the nature and control of attention relating with affective pictorial stimuli have been resolved. Based on this past research, two recent studies by Hyönä, Nummenmaa and Calvo have emerged, both of which stem from Calvo and Lang's [80] research. Calvo and Lang presented pairs of emotional scenes to participants and asked them to decide if they were different or similar in valence. It was found that emotional pictures were fixated more immediately, and for longer, within the first 500 ms.

This method was repeated by Nummenmaa, Hyönä, and Calvo [81] , but was improved controlled. They used 16 positive, 16 negative and 16 neutral pictures repeated twice over two experiments. Experiment 1 was a duplication of Calvo and Lang [80] , while in Experiment 2, participants were asked either to direct their gaze to the emotional picture or to the unbiased picture and keep fixated there. Pictures were presented in opposite corners of the screen for 3000 ms. Their scenes were taken from Lang, Bradley, and Cuthbert's [82] IAPS (International Affective Picture System) database and were controlled for valence and arousal. They also controlled for physical characteristics of the stimulus (such as density) and used more sophisticated tracking techniques than the ones which had been employed in Calvo and Lang.

The results from Experiment 1 were similar to their predecessors findings. They showed that the first fixation was more likely to be on an emotional than on a neutral picture, and that first pass and gaze duration measures also showed a greater frequency of subsequent fixations on emotional than on neutral pictures. There was no difference found in these measures between emotionally pleasant vs. unpleasant stimuli.

In Experiment 2, participants showed a strong orienting bias towards emotional pictures (again, equally to pleasant and unpleasant) even when they had been specifically instructed to avoid them. Despite this there was some evidence that a certain degree of control was possible – the probability of making a first fixation on emotional targets was lower in the attend-to-neutral condition.

There was a prejudice towards emotional pictures in early attentional engagement. The proportion of gaze duration for emotional pictures (relative to neutral pictures) in attend-to-emotional condition was greater than for neutral pictures (relative to emotional pictures) in the attend-to-neutral condition. In latter stages of attentional engagement there was an equally strong systematic prejudice towards emotional pictures in the attend-to-emotion condition and towards neutral pictures in the attend-to-neutral condition. The task manipulation, therefore, was the most effective in later processing stages.

The conclusion drawn was that emotional pictures, be they pleasant or unpleasant, capture overt visual attention. From these results it would appear that voluntary avoidance control, an endogenous sub-category of attention, becomes possible with only additional time. This can be seen as there was a greater probability of fixating first on an emotional than a neutral picture, even when participants were explicitly instructed not to do so. The fact that the instructions to attend-to-neutral were not as effective as attend-to-emotional (as measured by gaze duration) also implicates early attention engagement.

The author, however, point to two pieces of evidence which show that endogenous attention does exert some influence. First, the mean latency recorded for the initial fixation on a picture (460-490 ms) was significantly longer than the mean latency of a typically observed reflexive saccade (150-175 ms) [83] . Second, the probability of a first fixation on an emotion picture was reduced in the attend-to-neutral condition, implying that some degree of control and inhibition is possible.

Calvo, Nummenmaa, and Hyönä [84] presented to participants 128 photographs – 64 neutral, 32 positive, 32 negative – all depicting people in emotional states. The experiment employed a 2 [prime presentation (single vs. dual), between subjects] x 3[valence of probe (positive, negative, control)] x 2 [prime-probe relationship (identical, not identical)] x 2 [visual field (left, right)] design. Each participant saw each prime presented twice in the right visual field (RVF) and twice in the left visual field (LVF). The prime picture scenes (one emotive, one neutral) were presented peripherally 5.2° of visual angle away for 450 ms, then a mask was presented for 500 ms, and finally a probe for identification (identical or related) was shown.

Results showed an interaction of prime type (single vs. dual) and scene valence. Participants showed poorer identification of neutral scenes in the dual prime condition due to stimulus competition. The hit rate was higher for emotional than neutral scenes in dual prime condition and there was evidence of impairment in sensitivity in dual prime for control but not emotional pictures. The authors suggest this to be indicative of reduced attentional resources devoted to control pictures in the presence of emotional pictures. The fact that there was no effect in the single prime condition rules out an alternative explanation, such as the effect being due to greater distinctiveness or less complexity, etc., of one of the sets of stimuli. This is an explanation which has been posited in the past based on results from other paradigms such as the dot-probe and visual search tasks Mogg et al. [85].

Overall participants showed an advantage for processing emotional over unbiased information even when there was no competition for resources. Emotional stimuli were also shown to engage attention more even when presentation was task unrelated. Calvo and his colleagues point to two possible explanations to clarify this: selective orienting and encoding yield [84]. Both of these were explored in this study and proof for both was obtained.

Emotional scenes were more likely to be fixated first. This suggests something about these scenes must be perceived covertly (pictures were controlled for luminance, colour, etc., factors which are usually associated with such salience advantages) and so this points towards a selective orienting mechanism. On the other hand, shorter fixations were shown on emotional scenes and shorter times were required to accurately identify emotional scenes covertly. Also, there were more of these shorter fixations on emotional scenes suggesting they were scanned more quickly. This provides support for a processing efficiency mechanism.

These studies show the power of eye tracking to answer questions that other techniques are only able to pose. By recording participants moment-to-moment fixations and saccades, a precise time-line is built up without uncertainty about eye position that accompanies attention research that does not use an eye-tracker. In these three experiments, it was confirmed that any emotional pictorial stimuli, positive or negative, captured attention, and delineated the extent to and conditions under which exogenous attentional shifts could be inhibited. Following such striking results it seems natural to apply some of the techniques described above to the processing of affective text, its spatial position and attention-grabbing properties. A few recent papers dealing with the issue of affective text and spatial position are discussed below. Some questions that remain unanswered are identified and the current study is then described.

2.7 History of eye tracking technology

Eye movements can provide a rich and detailed insight into a person's thoughts and intentions Rayner and Pollatsek [86]. In recent years researchers have increasingly studied eye movements in order to explore cognition in psychology experiments, to understand user behaviour in user interfaces and to control computer-based devices through eye-based input [87,88]. However, the study of eye movements dates back to 1901 when Dodge and Cline [89] developed the first eye tracking system which required participants not to move their heads and recorded only horizontal eye position onto a falling photographic plate. Dodge's method, as it became known, was the first to capture eye movements accurately and non-invasively. This basic technique was used during the 1970s [90].

In the 1920s eye tracking systems were developed further to record two-dimensional eye movement records [91]. The first bulk of eye tracking research focused on the relationship between imagery and eye movements [92-93]. Later the focus moved into the investigation of processes, habits, individual and cultural differences in reading [95,96].

The progress of digital technology and image processing in the 1970s brought a breakthrough in eye tracking systems. Until then eye movements were recorded in relation to the head. But in order to identify where a person is looking on a surface, the head needed to remain still. This restriction was reduced by simultaneously measuring eye movements and the point of regard, the point on a surface where the person was actually looking. This did not entirely eliminate the restriction on head movements, but, with assistance from chin rests and high-back chairs , slight movements of the head could be isolated from eye movements which could yield more accurate eye tracking [97].

The first head-mounted eye tracker was invented in 1948 by Hartridge and Thompson. Until then eye tracking devices were designed in a very tight and restrictive way towards the participant. The design of eye tracking devices improved in 1960 when Macworth and Thomas [98] developed devices, which were less instructive of the participants' head movements.

Therefore, much of the early eye tracking research (through the 1970s) focused on the technical improvement of the eye tracking devices and techniques in order to make eye tracking more accessible, more accurate and better-supported from data collection through analysis using computers. Since then, the technology has progressed to head-mounted eye trackers and the most sophisticated remote devices that do not require any physical contact between the equipment and the participant.

In recent years eye tracking technology has improved significantly and devices are less expensive [99]. Modern eye tracking systems allow head movement, which is an advantage for usability testing, as the user can sit naturally in front of the computer. Such eye tracking devices can be either:

• mounted on the head of a user (for example SMI‘s Head-Mounted Eye Tracking Device, HED-II) or

• remote from the user (for example ASL 504 pan/tilt eye tracker system).

Further, eye tracking can now leave the laboratory, with the recent introduction of mobile devices (for example, ASL’s ‘Mobile Eye’ which incorporates the device into a spectacles frame).

In principle, head mounted devices allow a great deal of head movement, but they are nevertheless sensitive to large movements. They often obstruct a small portion of the user’s visual field, and the user is aware of the system recording their eye movements. Remote devices do not require any physical contact with the user. They usually consist of a miniature camera mounted next to or in front of the computer display. In some cases the eye camera is hidden on the screen [100] which enables a more natural set up of the evaluation session. While engineering improved the technology, psychology began exploring how eye fixations reflected cognitive processes.

2.8 Eye Tracking Terms

Eye tracking technique is described as the following and the recording of eye movements and the pupil during the eye movements. It is possible to group the reaction of the human eye during eye tracking under two classes [101]

The first of these classes is the situation where the eye is motionless (eye blinking, change in the volume of pupil) and the second class is the situation where eye is in moving position (like saccade, fixation etc.) Two movements of the eye which are repeated continuously are the saccade and fixation movements. The saccade movement is the sudden sliding happening between 2 fixation points. The fixation movement follows the saccade movement. During the fixation movement the eye remains stable for 100-200 miliseconds. When it is taken into account that the eye movements realize in miliseconds, the data collected should be processed some filtration and pre-process.Naturally the data should be commented after these studies, and there are many academical researches just on this subject. The control group to be used in the eye tracking technique should selected previously. The basical data to be used in eye tracking studies are the saccade and the fixation movements. By using these two data the other two data named as gaze and scanpath can be generated .

Fixation:

The pupil of someone who is sitting in front of a screen and looking at a picture on the screen focuses on a point by becoming fixed at certain intervals. The moments a pupil becoming fixed is described as 'fixation' [102].

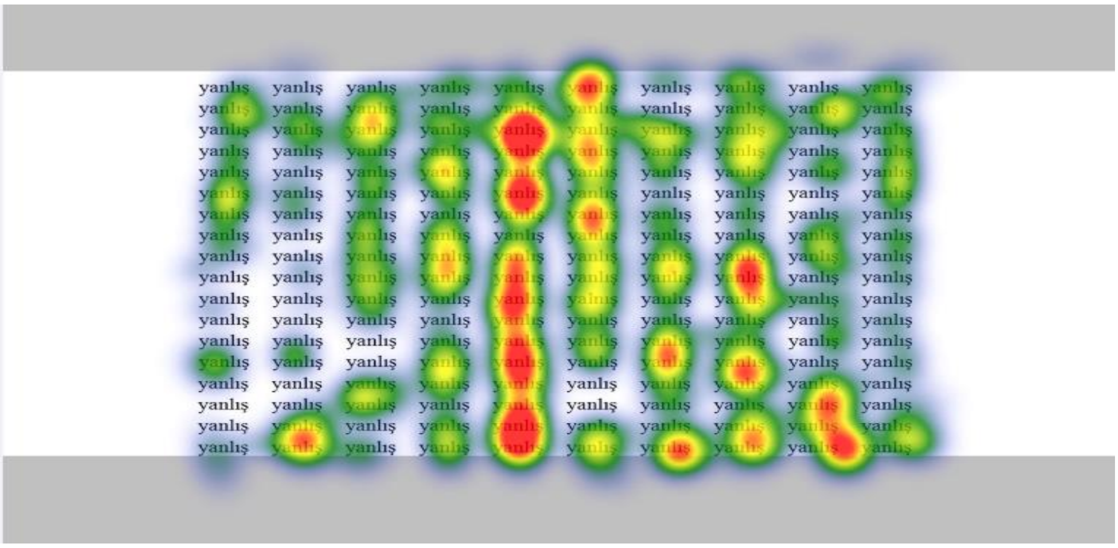


Figure 2.7 Fixation image

Saccade:

The sliding movement of eye between two fixation points is called 'saccade'. As there is no analysis during this movement no information on the clarity of the objects is found. On the other hand contrary saccade movement, like going backward some characters on a text, can give information whether the word is understood or not.

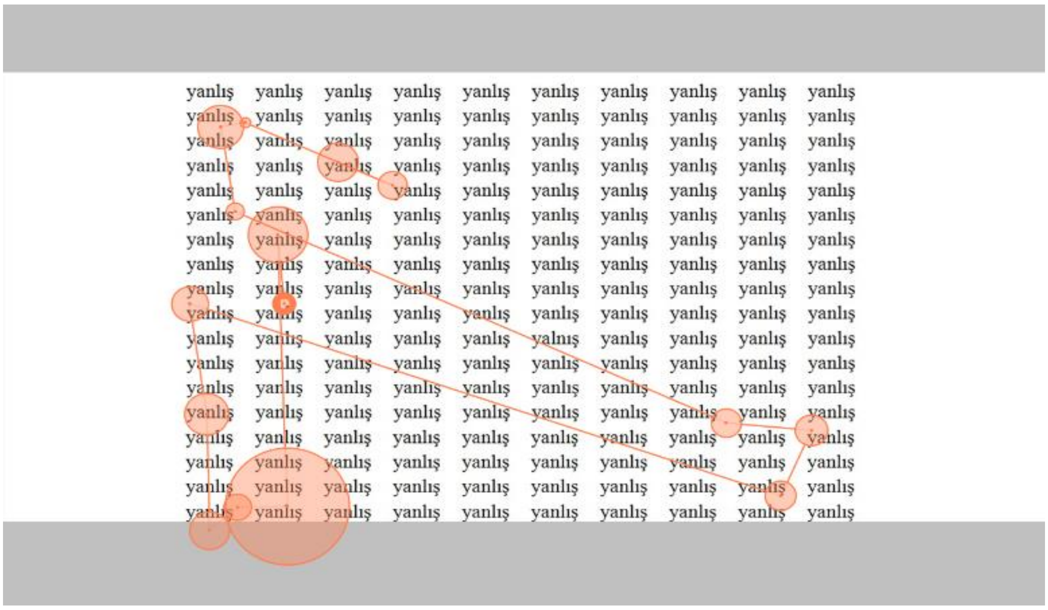


Figure 2.8 Saccade image

Dwell time:

The duration which the eye looks at certain point without focusing at another point. The right gaze duration. Generally it includes to much fixation and very slow saccade gazes among this fixations.

Scanpath:

It is called ‘scanpath’ the series of eye movements composed of fixation- saccade- fixation movements one after another. An ideal searching process is the one realised by small fixation frequency on the desired target on a fixed line [103]

2.9 Eye Tracking Limitations

- Eye tracking is not possible with some people due to physiological reasons, the pupil may not reflect enough light, the iris may be light coloured, the iris may be too big, the iris may be covered by eyelashes or eyelids or the person may have moving eyes. These reasons may make the eye tracking difficult.
- Eye tracking is not possible with some people due to outer reasons, like glasses, lens.
- Some problems may occur during eye tracking, the eyes of the person may

get dry during test and the tracking becomes difficult. It is also possible that while you may track the eye movements of a person one day, you may not track it next day or when you are in the middle of a test the data collected may be unusable.

- During the usage of the remote eye tracking system the movement of the head may cause delays with the eye tracker reset the position of the eye and also may cause losses in the calibration.The methods used to keep the head of the person stable may cause the person to feel unrelaxed and the test environment returns to unnatural one.
- It is not always easy to comment on the eye tracking data. It may be attractive to unite the eye tracking data with the data collected using traditional interview and observation methods.

These limitations may result in the following negative outcomes:

- The participants should not wear glasses, this condition puts limit on the participant pool.

CHAPTER 3

MATERIAL AND METHODS

Information about the participants, the procedure of the research, the eye tracking methods that are investigated in this study are given in this chapter.

3.1 Participants

Totally 42 personnel (doctors,nurses and staff) from Yedikule Surp Pırgiç Ermeni Hastanesi were involved in this study. The clinical and demographic information at the participants are listed in Table 3.1.

Table 3.1 Clinical and demographic information of participants

	Doctor	Nurse	Staff
Number	10	17	15
Male/Female	10/0	2/15	12/3
Age	48.8 ± 7.4	26.9 ± 4.93	34.8 ± 6.38

Inclusion criteria:

- The average age is between 20-65
- They work at least 8 hours a day
- They were not hungry during the survey

Exclusion criteria:

- The personnel who suffer the deficiency of attention and hyperactivity
- The personnel who has consumed alcohol one night before the survey
- The personnel who have psychological disorder and drug addiction
- The personnel who are pregnant

- The personnel who suffer eye illnesses (astigmatism, corneal edema)

The informed consent for the study have been taken from all the participants on Figure A.1.

3.2 Procedure

The study has been conducted in Yedikule Surp Pırgiç Ermeni Hastanesi medical materials depot. Before starting to experiment, the participants were informed about the process. The related chair arrangements were done according to the eye tracking device. In the beginning of the experiment, eye tracking device was attached to the test computer, and then the experiment started with "SMI Expirement" programme the first step is eye calibration. On the calibration screen (Figure 3.1) every single point appeared and the users were asked to look at the black points on the screen. After two seconds of focusing on the points, the programme automatically passed to the other point. At the end, the calibration value was given and according to the results, the calibration was repeated, if felt necessary or the experiment was started.

Figure 3.1 Calibration screen

After correct calibration, in order to obtain eye-tracking data, a text which consisted at 18 lines, 10 columns and totally 180 words was used as a stimulus material (Figure 3.2). One of these words was orthographically was changed. Before the experiment instead of the word "yanlış" in Turkish, it was written as "yalnış". This stimulus display framework projected on large screen until the participant find orthographically wrong word.

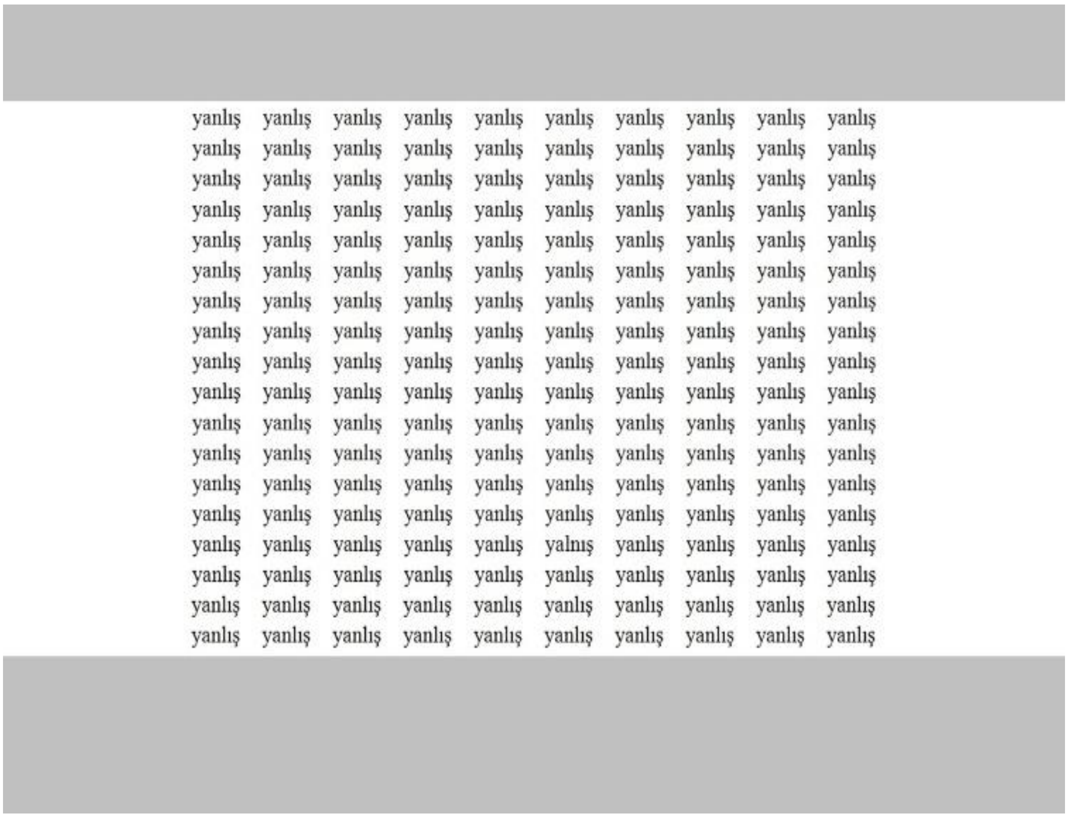


Figure 3.2 Experiment screen

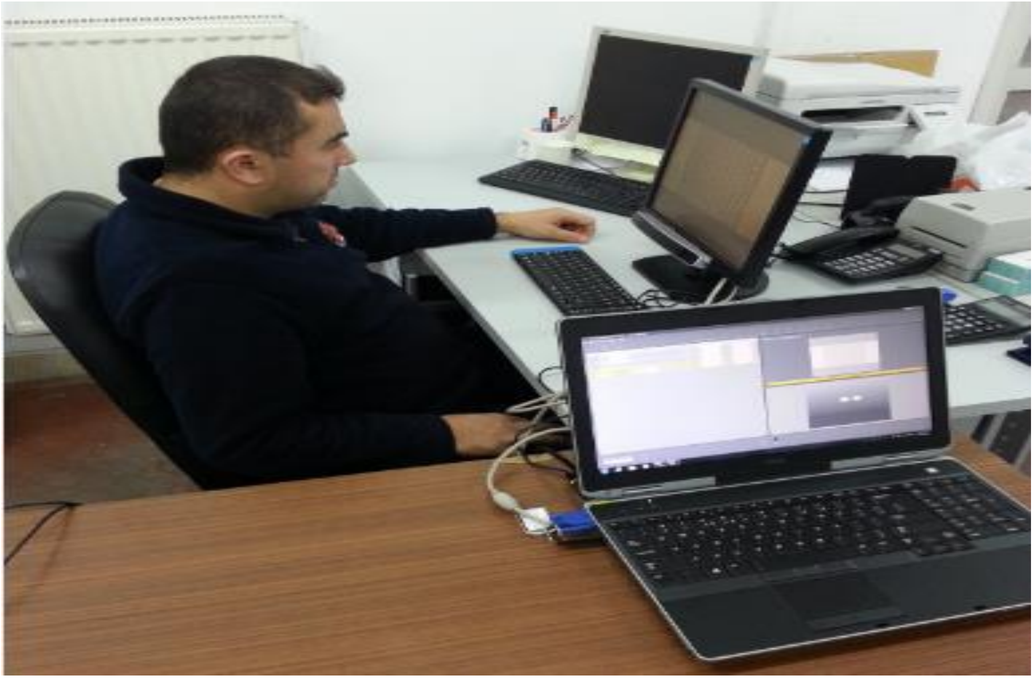


Figure 3.3 Participant in the experimental stage

3.3 Eye tracking device

Eye movements of participants were recorded against the stimulus using the SMI RED-M remote eye-tracking system (Figure 3.3).

3.3.1 SMI RED-M

The SMI RED-m remote eye tracker is an ultra-light, USB only powered, fully portable eye tracking lab by SensoMotoric Instruments (SMI). It is designed for eye tracking researchers who require maximum mobility and flexibility combined with reliable data and the comprehensive set of features and metrics of a scientific grade eye tracker (Figure 3.4) [104].

The plug and play design enables researchers to set up a study wherever participants are: Take the eye tracking lab to a customers's site, conduct research in clinical environments, test interactive learning technologies at educational institutes and conduct in-home research. Performance specifications of SMI RED-M is given in Table 3.2.

Table 3.2 Performance specifications of SMI RED-M [104]

Sampling rate	60Hz and 120Hz
Spatial resolution	0.1°
Gaze position accuracy	0.5°
Tracking range	32 x 21cm at 60cm distance
Latency (end to end)	< 20ms at 60Hz

Figure 3.4 SMI RED-M Eye tracking system [99]

3.4 Data analysis

For the analysis of recorded data, SMI BeGaze Eye Tracking Analysis Software was used.

3.4.1 SMI BeGaze Eye Tracking Analysis Software

The Behavioral and Gaze Analysis (SMI BeGaze™) eye tracking software is fully integrated with the study design and recording software SMI Experiment Center™. By designing an eye-tracking study, recording and finally analysing, visualizing and exporting the eye tracking results - the efficiency gain with the SMI software will be measurable. This software gets more and better eye-tracking results in shorter time [105].

3.5 Extracted and Analysed Features

In this study, two issues are evaluated: the duration of finding the wrong word and the fixation numbers of all the words.

First of all, in area of interest (AOI) Sequence analayasis, the fixation areas of subjects was evaluated on the time band. By Key Performance Indıcator, the dwell time and average fixation numbers are evaluated.

3.6 Statistical Analysis

By SPSS programme, the possible statistical significance among the groups while finding the wrong word was evaluated.

Independent Sample Student's and Analysis of Variance (ANOVA) test was performed for statistical analysis of the recorded data.

Independen Sample Student t-test is executed to differentiate compare the time that the gender groups found the target word. ANOVA is executed to differentiate compare the time that the age and occupation groups found the target word.

3.6.1 Independent Sample Student t-test

The independent-samples t test evaluates the difference between the means of two independent or unrelated groups. That is, we evaluate whether the means for two independent groups are significantly different from each other. The independent-samples t test is commonly referred to as a between-groups design, and can also be used to analyze a control and experimental group. With an independent-samples t test, each case must have scores on two variables, the grouping (independent) variable and the test (dependent) variable. Standard deviation can be calculated as

$$STD = \sqrt{\frac{\sum (X_1 - \bar{X}_2)^2 + \sum (X_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}} \tag{3.1}$$

X_1 represents group one, X_2 represents group two, $\bar{X}_1$ and $\bar{X}_2$ represent group one and two aritmetic mean. n_1 and n_2 refer sample sizes in two groups.

The value of Independent Sample t-test is

$$t = \frac{\bar{X}_1 - \bar{X}_2}{STD} \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

(3.2)

where $n_1 + n_2$ number of observations in both samples of the independent sample t-test [106].

3.6.2 Analysis of Variance (Anova)

ANOVA is a statistical technique to analyze variation in a response variable (continuous random variable) measured under conditions defined by discrete factors (classification variables, often with nominal levels). Frequently, we use ANOVA to test equality among several means by comparing variance among groups relative to variance within groups (random error).

A one-way ANOVA, or single factor ANOVA, tests differences between groups that are only classified on one independent variable. Total sum of squares is

$$SS_T = \sum x^2 - \frac{(\sum x_T)^2}{N}$$

(3.3)

The x represents group and N represents population size.

The sum of squares between groups is

$$SS_b = \sum \frac{(\sum x)^2}{n} - \frac{(\sum x_T)^2}{N}$$

(3.4)

The n represent number per mean, the x represent group and N represent population size.

The sum of squares within groups is

$$SS_w = SS_T - SS_b$$

(3.5)

The degrees of freedom for between groups are $df_b = (number.of.groups-1)$ and the degrees of freedom for total are $df_t = (number.of.subjects-1)$. Therefore, the degrees of freedom for within groups are calculated as $dfw = df_T - df_b$. The mean squares for between and within groups are

$$MS_b = \frac{SS_b}{df_b}$$

$$MS_w = \frac{SS_w}{df_w} \tag{3.6}$$

The F value can be calculated by dividing the mean square for between groups by the mean square for within groups as [107].

$$F = \frac{MS_b}{MS_w} \tag{3.7}$$

CHAPTER 4

RESULTS

This study was performed in Yedİkule Surp Pırgiç Ermeni Hospital. On totally 42 people composing of doctors, nurses and personnel this measurement were applied. The study was divided into 3 group according to the age, gender and occupation.

The gender was stated as male and female; the occupation group was stated as doctors, nurses and personnel; the age group was stated as 20-35, 35-50 and 50-65.

The subject under the experiment were asked to find the word 'yalnış' in the first text (Figure 4.1) and for the second text (Figure 4.2) they were asked to find the same word as well. The reason why we have used two texts, is to be able to compare the differencies between to texts. Their eye movements were recorded using eye tracking device. The measurements acquired from the participants were analysed by SMI BeGaze™ eye tracking analysis software and the statistical analysis was done by SPSS®.

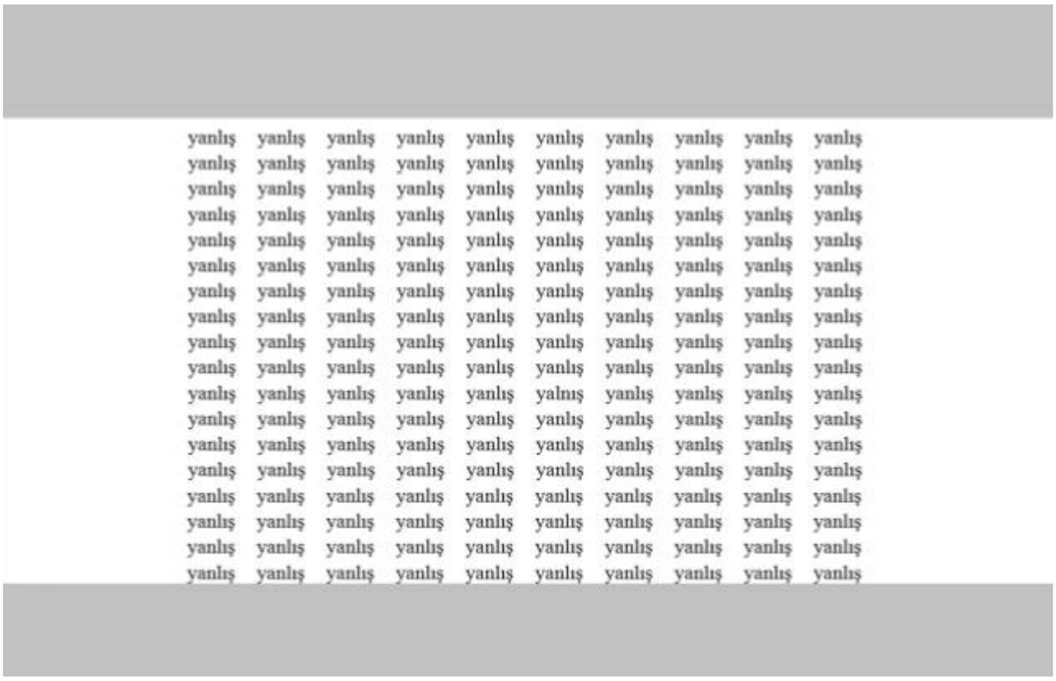


Figure 4.1 Text 1

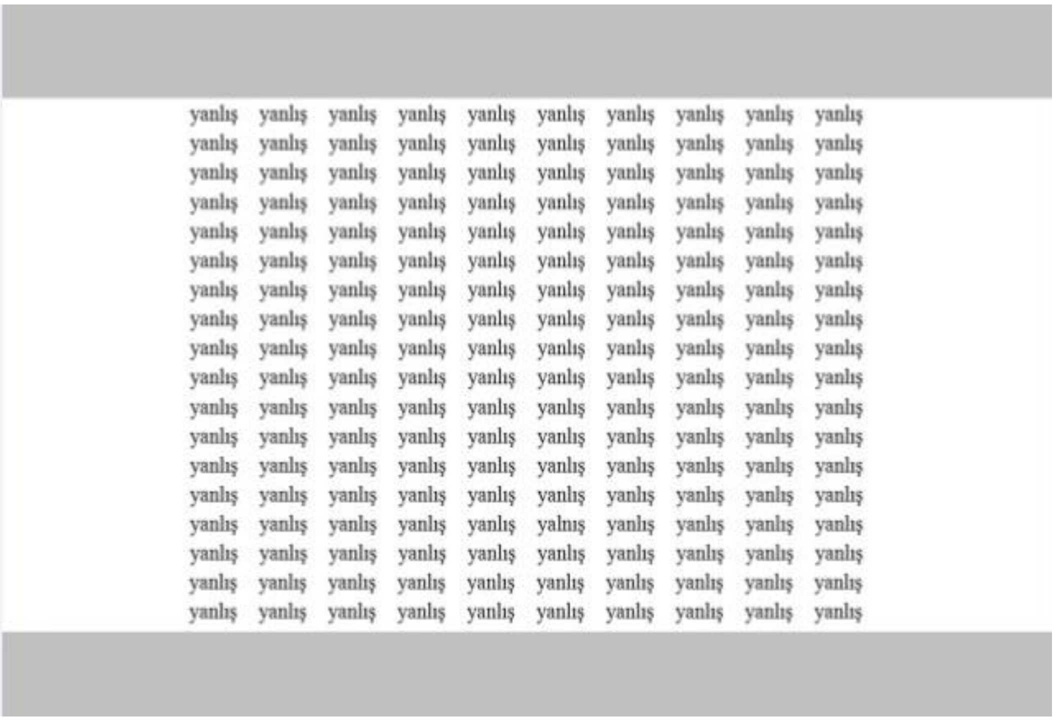


Figure 4.2 Text 2

4.1 AOI Sequence chart

The both text were divided into 4 AOIs (AOI 001, AOI 002, AO 003, AOI 004) and were analysed according to gaze order. In Figure 4.3, the first text is shown as divided in these AOIs, In Figure 4.4 the second text is shown as divided in these AOIs. In these figures the AOI 001 is shown as blue, the AOI 002 as pink, the AOI 003 as green, and the AOI 004 as grey.

Figure 4.3 AOI Editor first text

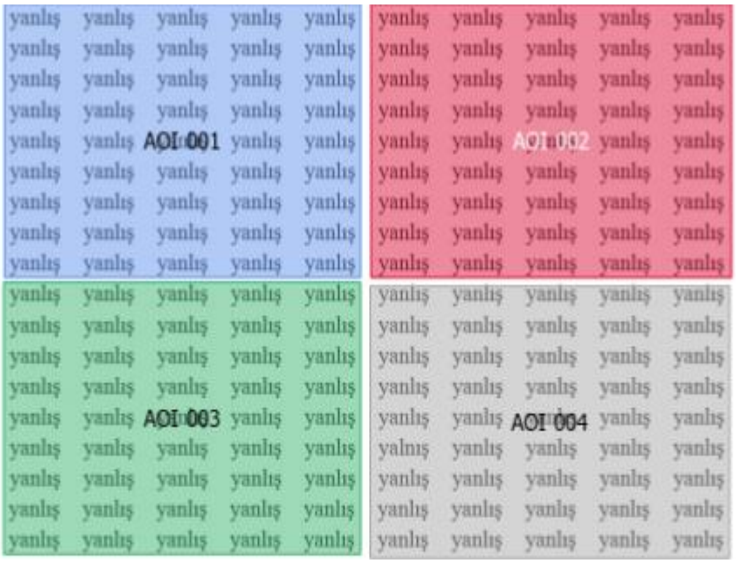


Figure 4.4 AOI Editor second text

The AOI sequence chart analysis of male participants are shown in Figure 4.5 and Figure 4.6. We can understand which AOI the participants gazed in turn by looking at the colours in 4 AOIs. In AOI sequence chart the letters at the beginning of the vertical axes show the occupation of the participants, "d" letter symbolizes the doctors, "h" letter symbolizes the nurses and "p" letter symbolizes the personnel. The numbers beside letters symbolizes the participation order of the participants. The horizontal axes symbolizes the time band. Therefore how long it took a participant to finish the test can be understand from this chart.

In Figure 4.5 and 4.6, the AOI sequence chart analysis of male participants are shown. In the first text, all of the male participants started the test by gazing at the AOI 001, i.e. blue coloured AOI. The word "yalnış" which the participants were required to find was placed in AOI 004 and all the participants finished the test at AOI 004, this meant they found the word. In the second test all the male participants started the study by looking at the different AOIs and it took shorter to find the word target. This may show they focused on the second text much more than the first text. The most interesting point in the first and second text is that the participant "p01" found the target word more quickly in the first text , however "p01" found the target word later than the other participants did. This situation may mean that this participant has difficulties with focusing.

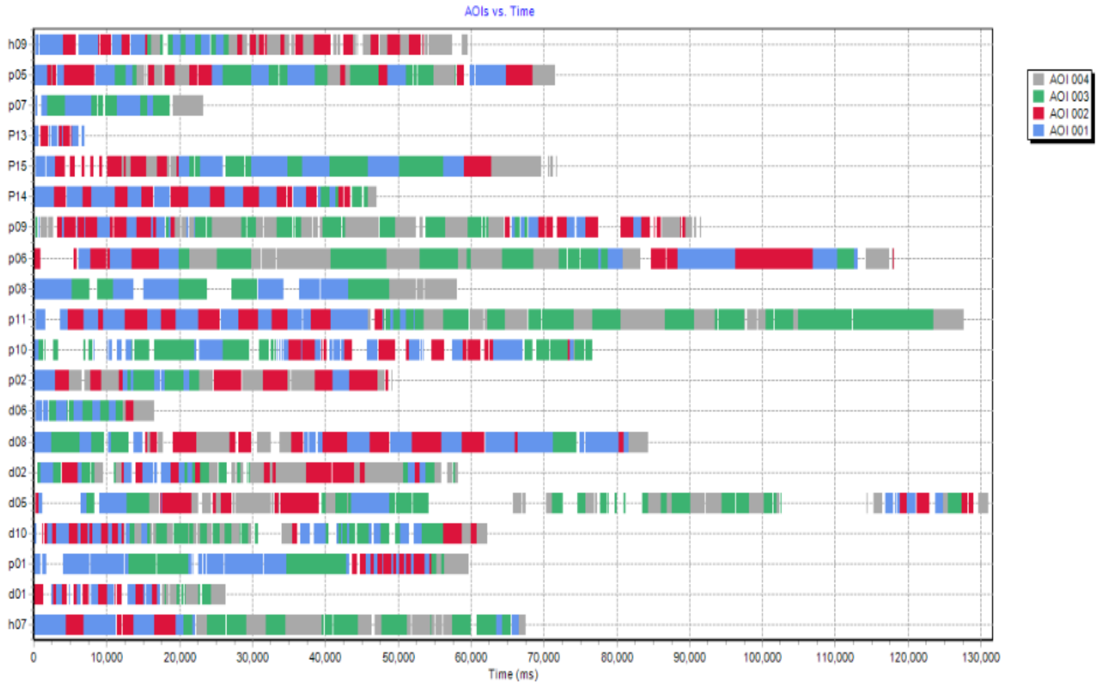


Figure 4.5 AOI Sequence chart of first text for male group

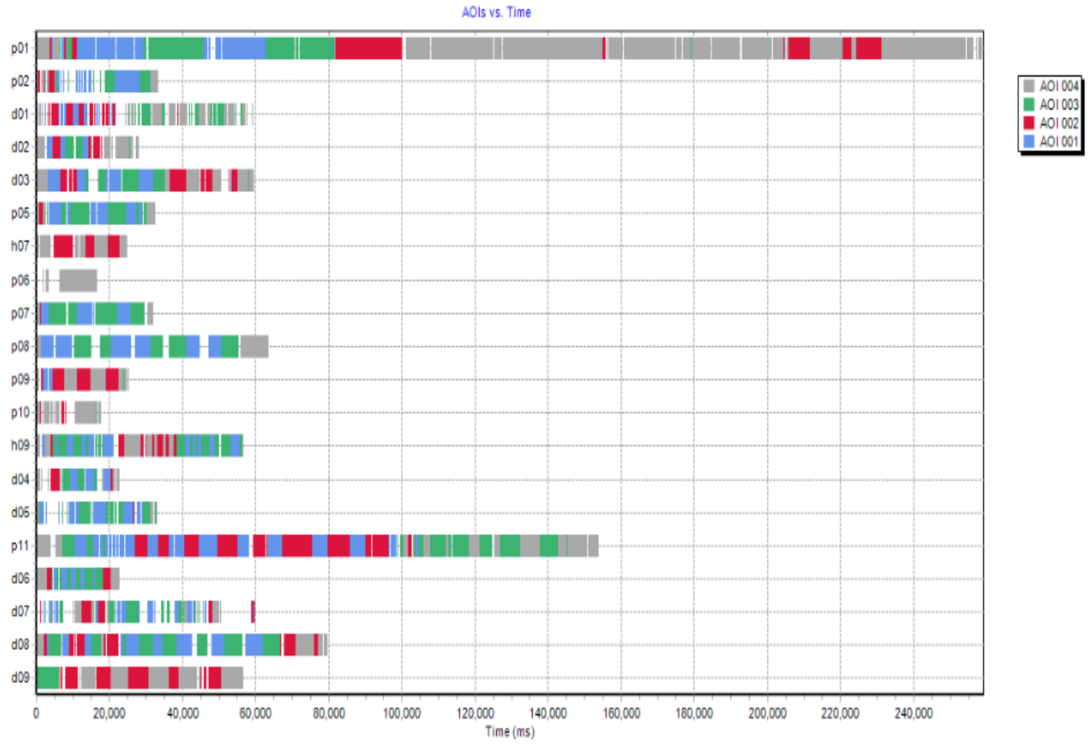


Figure 4.6 AOI Sequence chart of second text for male group

In Figure 4.7 and 4.8 the AOI sequence chart analysis of female participants were shown. They started the first text at AOI 001 and AOI 002 and finished the study in the grey coloured AOI 004 which means they found the target word in the correct AOI. For the second text the female participants started at AOI 004 which included the target word, however they could not find at the first gaze. The female participants found the target word at a shorter time when compared to the first text.

By looking at the AOI sequence chart analysis it can be observed that the female participants finished the task at shorter times than the male participants. When we evaluate the gender groups the male participants finished the first test more quickly while the female participants became more successful to find the word in the second text.

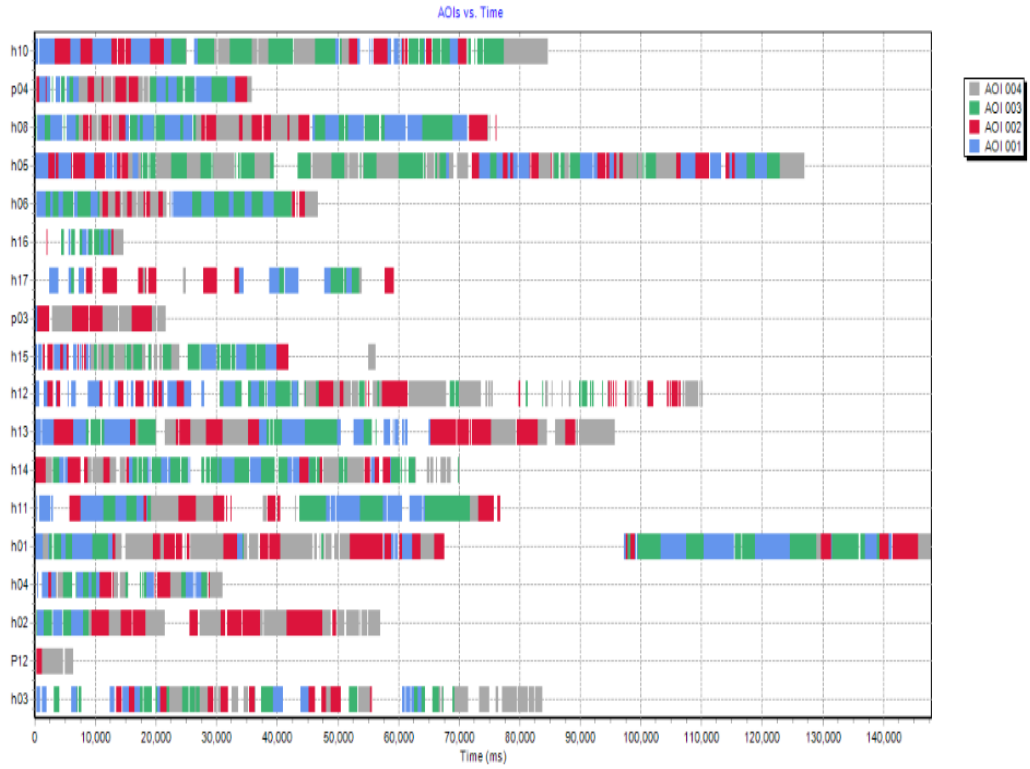


Figure 4.7 AOI Sequence chart of first text for female group

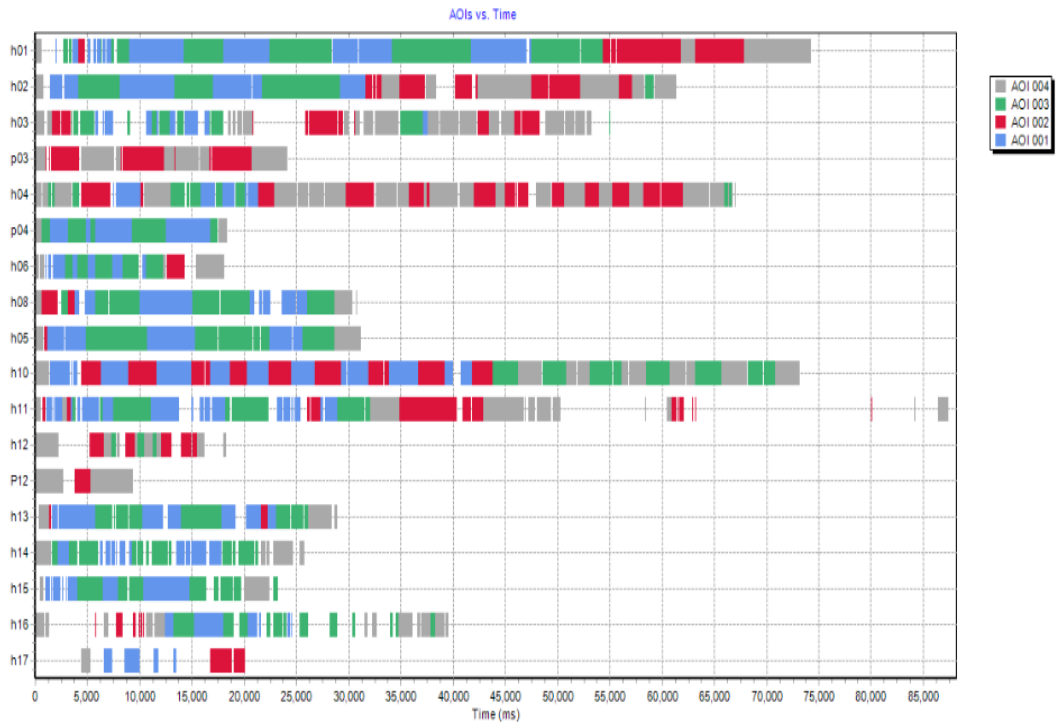


Figure 4.8 AOI Sequence chart of second text for female group

Another classification was done according to age of participants and the first age group evaluated as 20-35. In Figure 4.9 and 4.10 the AOI sequence chart analysis of the age of 20-35 were given. In the vertical axes the first letters of the occupation of the participants and their participation order, in the horizontal axes their timing to finish the test are given.

In the first text the 20-35 age group started to experiment at the blue coloured AOI 001 and finished the task at AOI 004 which included the target word. In the second text the 20-35 age group participants started at AOI 004. They found the word at shorter times when compared to the first text and they scanned the second text more regularly. Another point attracting attention in 20-35 age group is that during the test of the participants "h16" and "h17" in some parts their eye tracking could not be recorded. Eye blurring or changing the sitting position may lead to problems with recording.

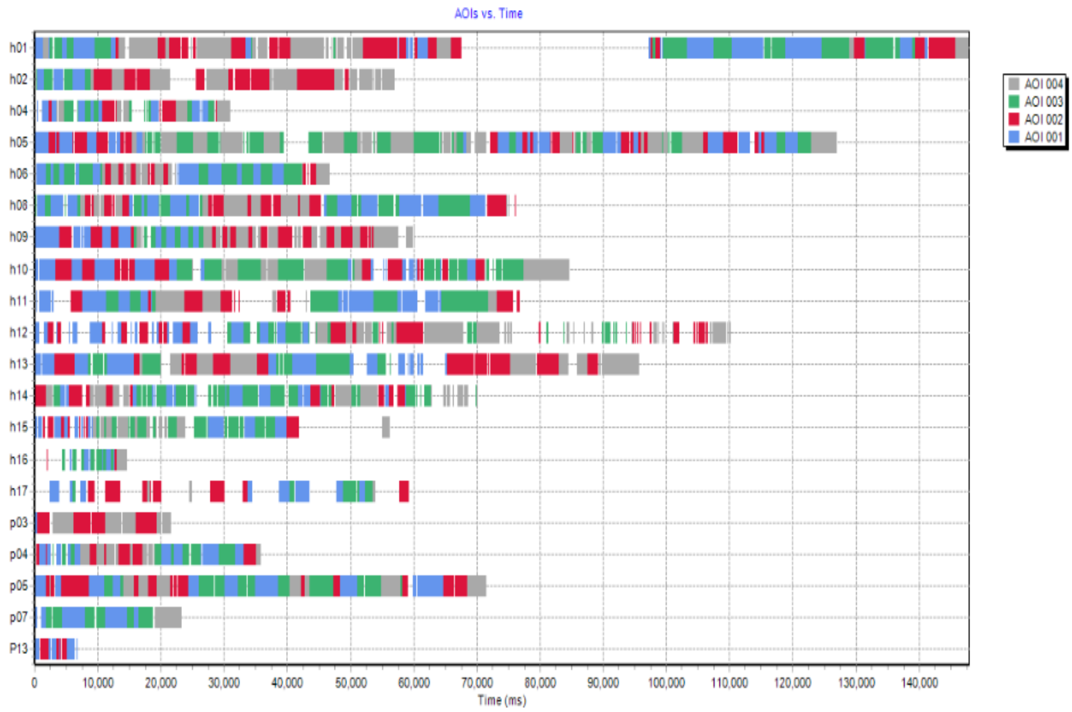


Figure 4.9 AOI Sequence chart of first text for 20-35 years group

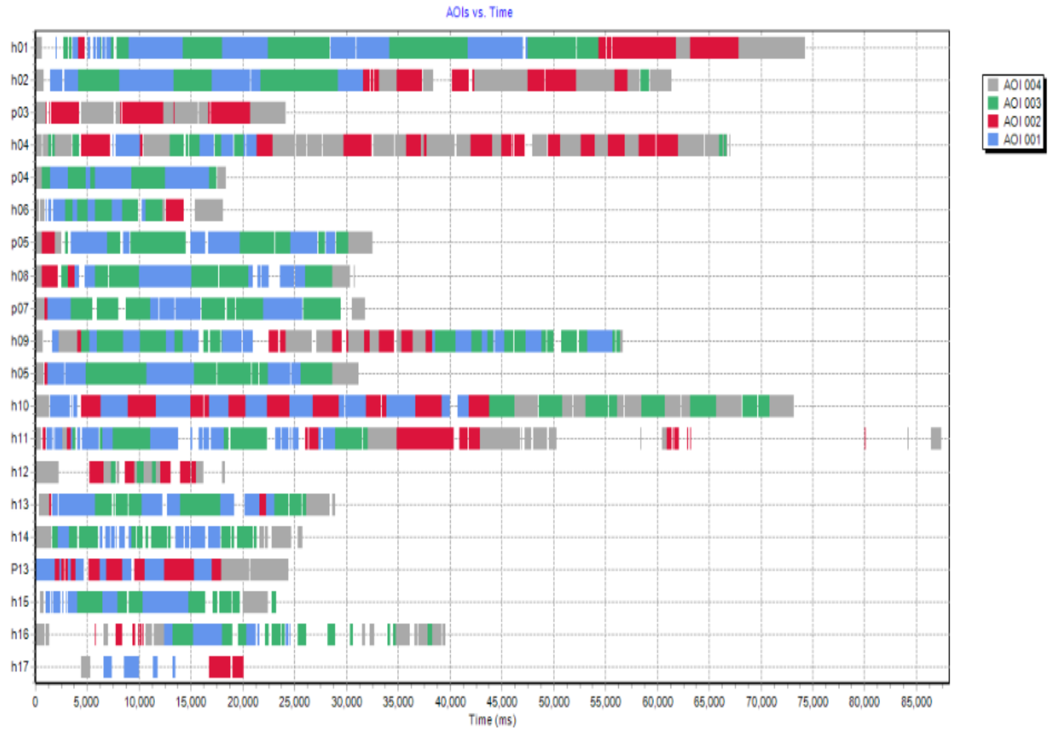


Figure 4.10 AOI Sequence chart of second text for 20-35 years group

In Figure 4.11 and 4.12 the AOI sequence chart analysis of the age group of 35-50 were given. The participants started to study the first text by looking at the AOI 001 and AOI 002 and finished the task by gazing the AOI 004 which included the target word.

The most important point in the first text is that the participant "p12" found the word at a very short time. The age group of 35-50 started the task by AOI 004 and when generally evaluated we can say that all the participants finished the task by checking AOI 004 after a quick gazing at the other AOIs. The participants of this age group paid more attention to the second text and found the target word in shorter time.

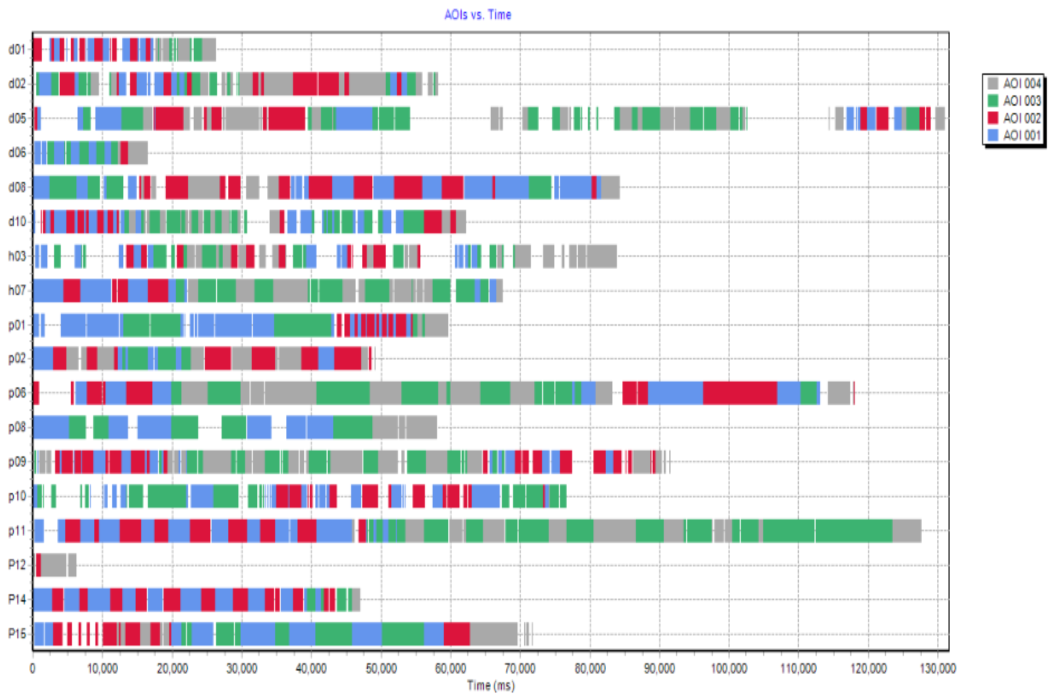


Figure 4.11 AOI Sequence chart of first text for 35-50 years group

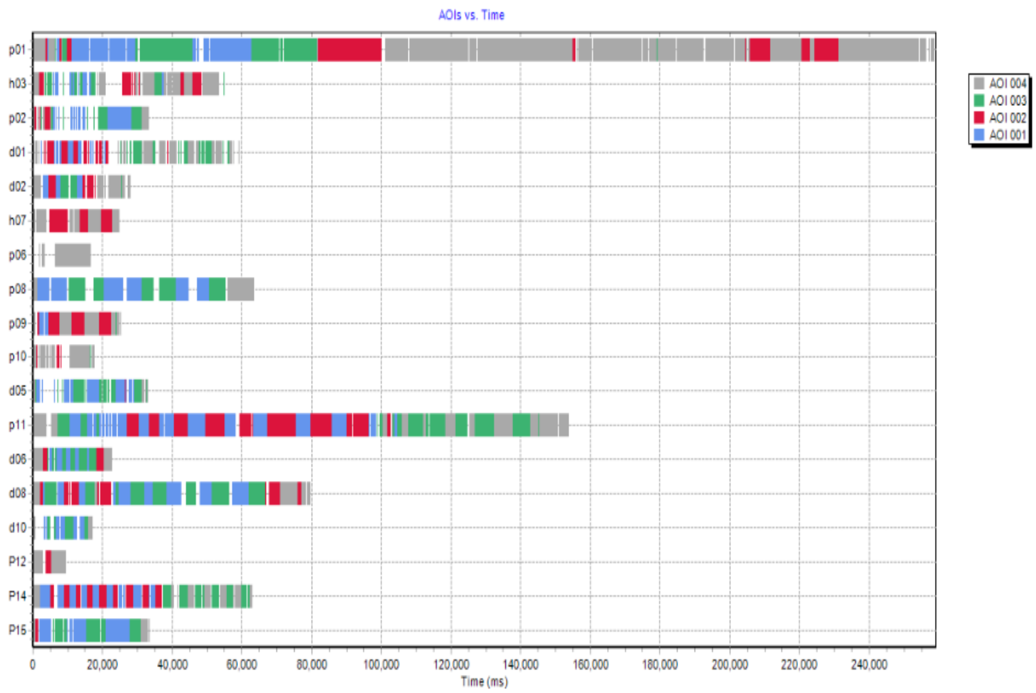


Figure 4.12 AOI Sequence chart of second text for 35-50 years group

In Figure 4.13 and 4.14 the AOI sequence chart analysis of the age group of 50-65 are given. The participants gazed at AOI 001 and AOI 003 at the most in the first text. They followed a more complex way to analyse the second text. The most important point in this group is that except the participant "d03" the other participants had difficulties to find the target word in the second text.

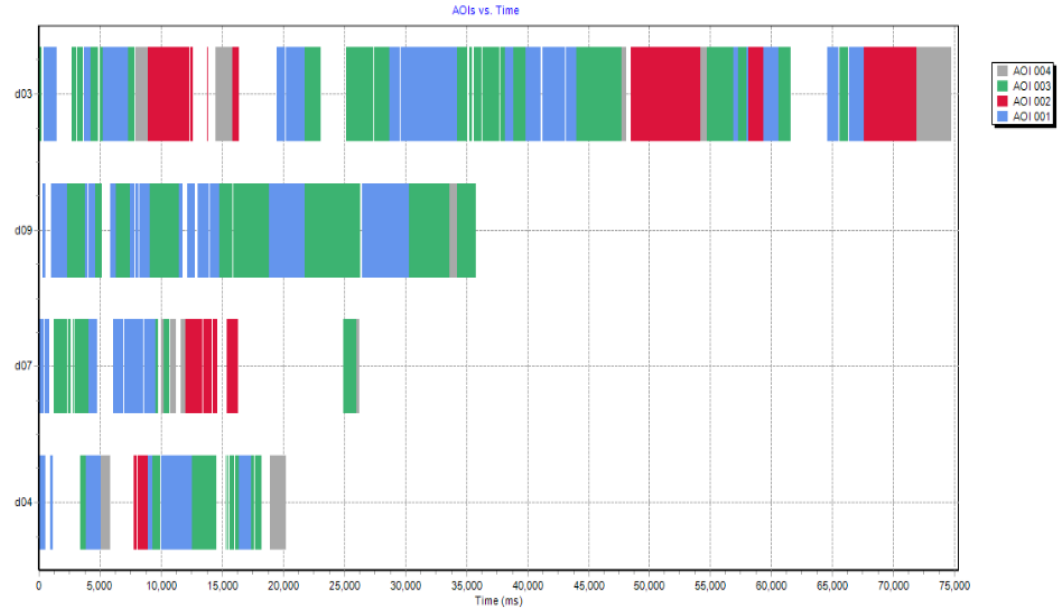


Figure 4.13 AOI Sequence chart of first text for 50-65 years group

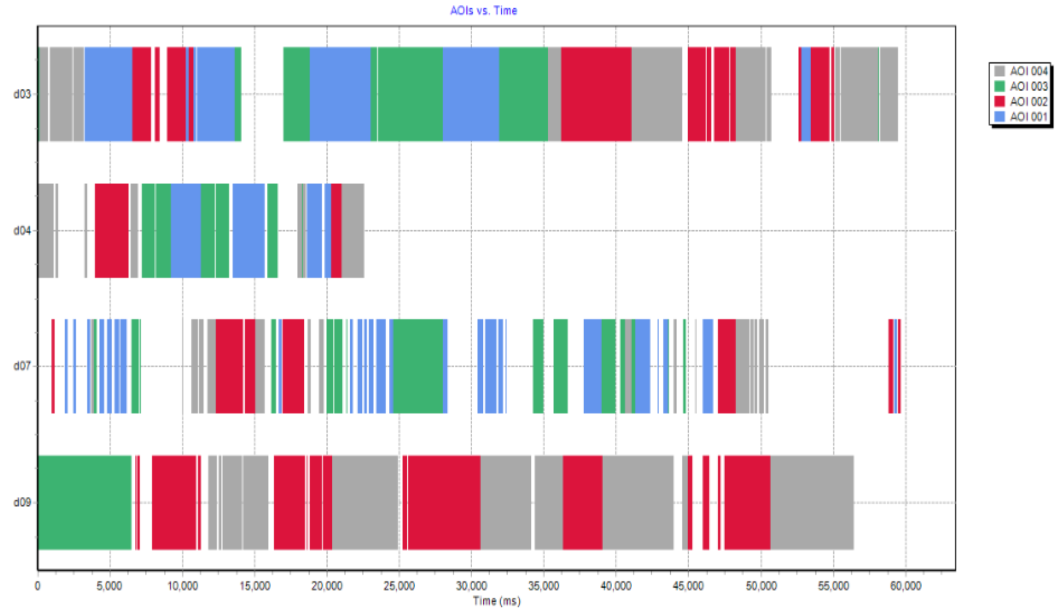


Figure 4.14 AOI Sequence chart of second text for 50-65 years group

Another classification was done by occupation and started with the doctors.

In Figure 4.15 and 4.16 the AOI sequence chart analysis of the doctor group are given. The participants started the first text at AOI 001 and at AOI 004 in the second text. The participants increased their speed in the second text and found the target word more quickly.

When we compare the age groups it has seen that the 50-65 years age group found the word at a shorter time than the other groups in the first text and in the second text the 20-35 years age group found the word more quickly when compared to the other groups.

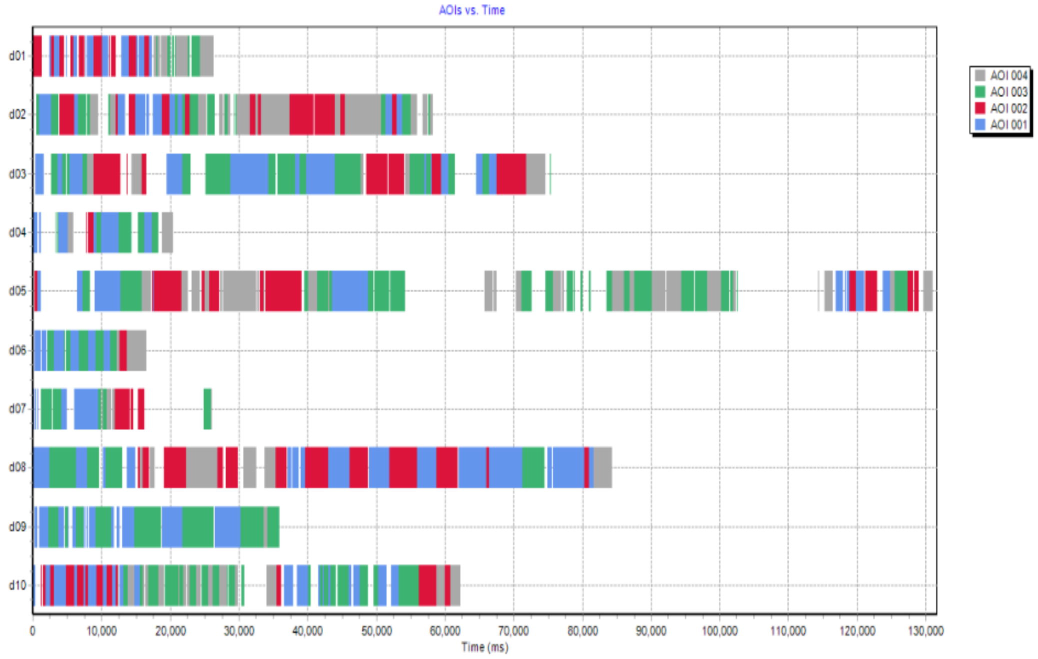


Figure 4.15 AOI Sequence chart of first text for doctor group

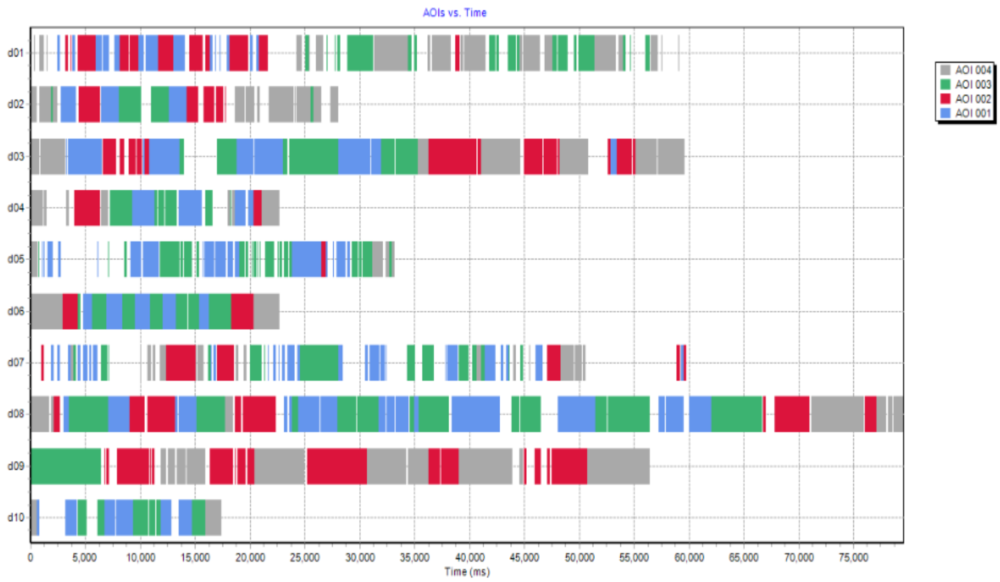


Figure 4.16 AOI Sequence chart of second text for doctor group

In Figure 4.17 and 4.18 the AOI sequence chart analysis of the nurses is given. They started the task by gazing at the AOI 001 in the first text and for the second text at the grey coloured AOI 004 which included the word target. They analyzed the first text very quickly and following a complex way however they analyzed the second text slower compared with the first text. The nurse group analysed the first text irregularly and in a complex way and it took a long time to find the target word. However, they focused on the second text better and found the target word more quickly. The point attracting attention is that the participants "h01" and "h04" spent more time in the second text, i.e. while they found the word quickly in the first text, it took longer time to find it in the second text.

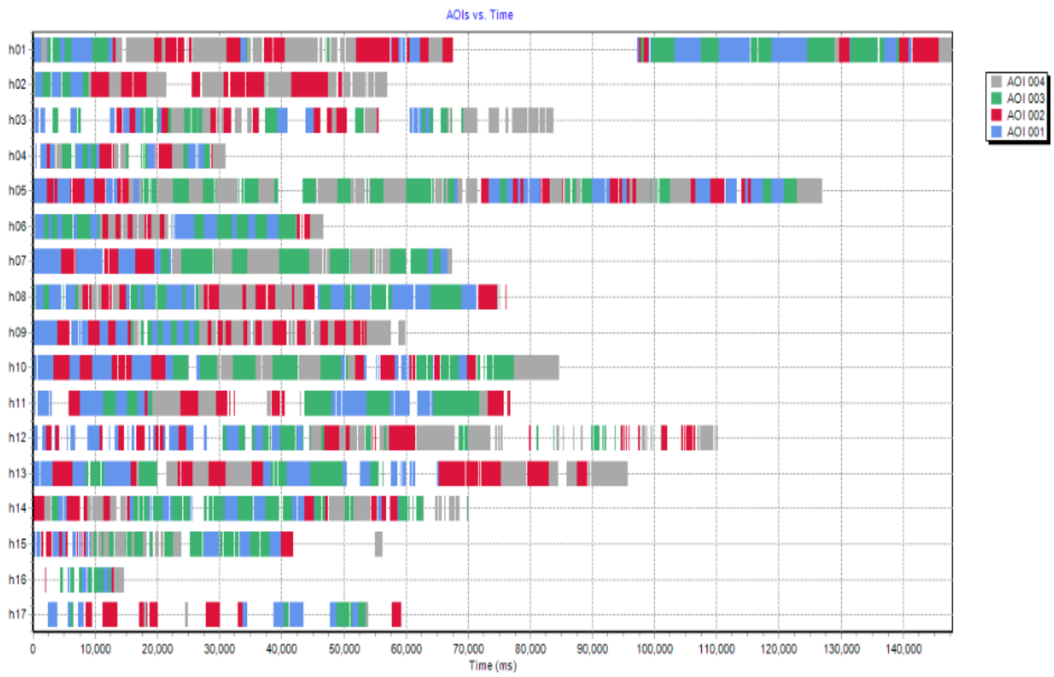


Figure 4.17 AOI Sequence chart of first text for nurse group

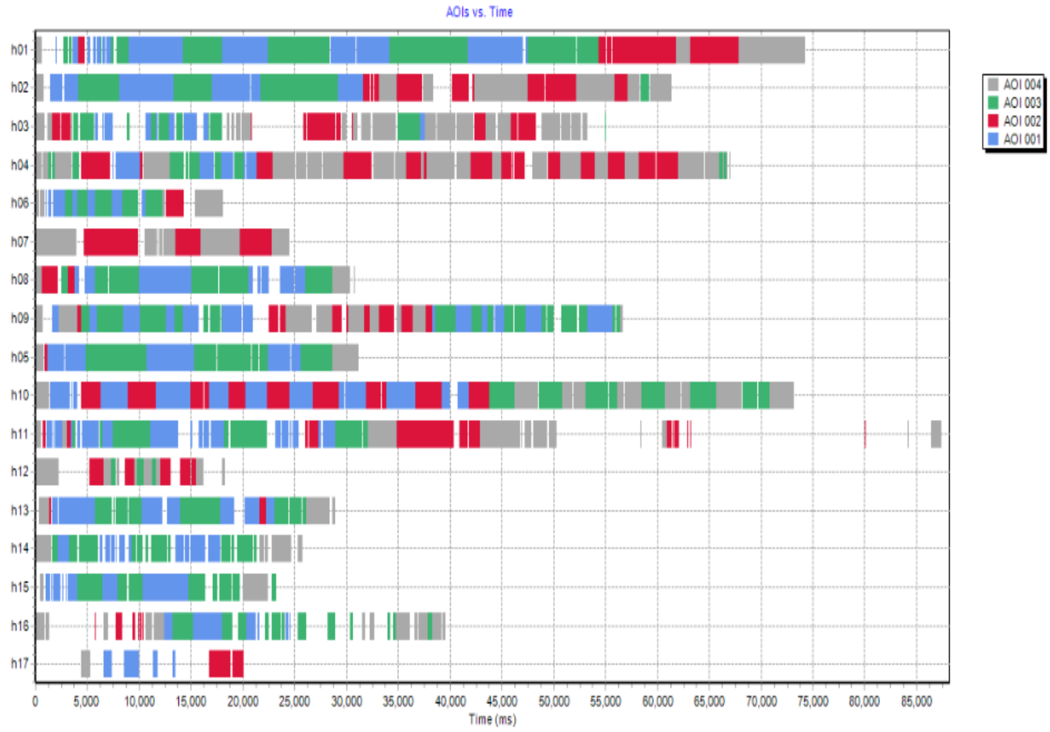


Figure 4.18 AOI Sequence chart of second text for nurse group

In Figure 4.19 and 4.20 the AOI sequence charts of personnel are given. The personnel participants started the first text at the AOI 001and at AOI 001, AOI 003 and AOI 004 in the second text. The participants spent long time in the first text, however their searching time is shorter in the second text, they found the word in a shorter time. It was noticed that the participant "p01" found the word in the second text more easily compared to the first text.

When the occupation groups are taken into account the doctors and the personnel participants found the word in close time in the first text. As for the second text the doctors found the word in shorter time. When the groups are compared it seen that the target word in the secod text is found more quickly compared with the first text. The age group 50-65, was the first group to completed the experiment. Among the occupation groups, the nurses completed the experiment largest duration.

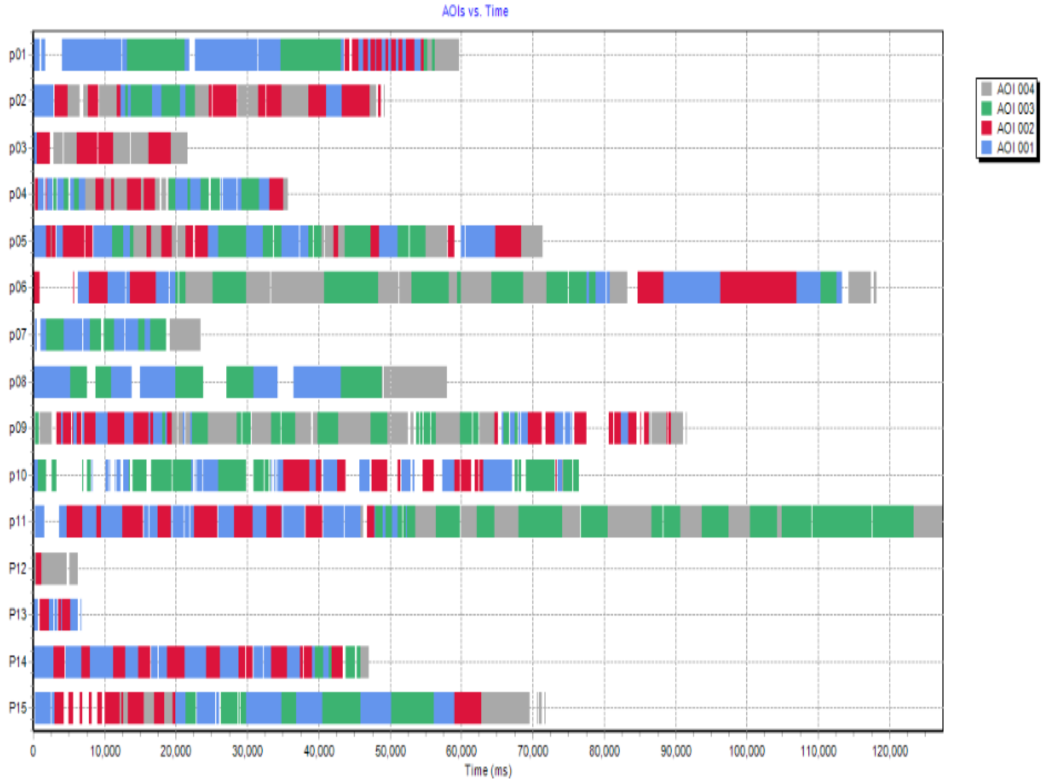


Figure 4.19 AOI Sequence chart of first text for personel group

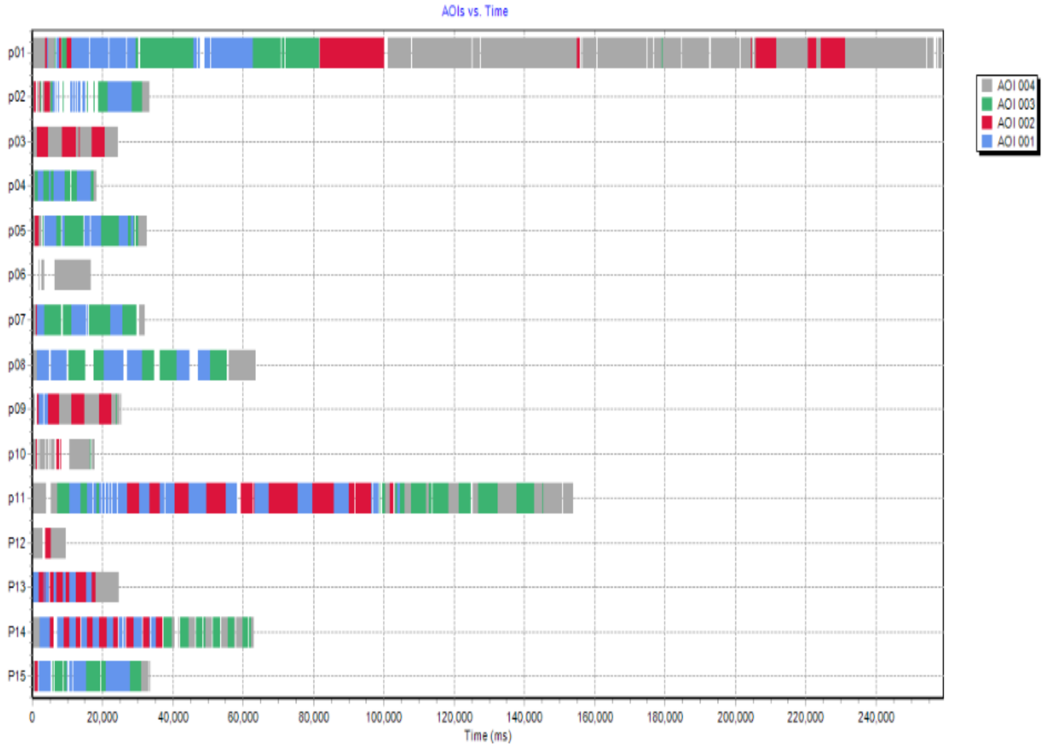


Figure 4.20 AOI Sequence chart of second text for personel group

4.2 Key Performance Indicators (KPI)

The both texts which were divided into AOIs have been evaluated by KPI analysis based on average dwell time and average fixation values.

In Figure 4.21 and 4.22 the KPI analysis of male participants are given. We see that the dwell time is higher in AOI 001 in the first text than other AOIs. This proves that the participants gazed at the AOI 001 much more than the other AOIs. However, when we look at the average fixation it is seen that AOI 004 is the region that subjects are focused more included the target word. As for the second text, the dwell time is at the highest point in AOI 001 and the average fixation is at the highest point in AOI 004.

The male participants focused on AOI 004, which included the target word, in both texts to find the word.

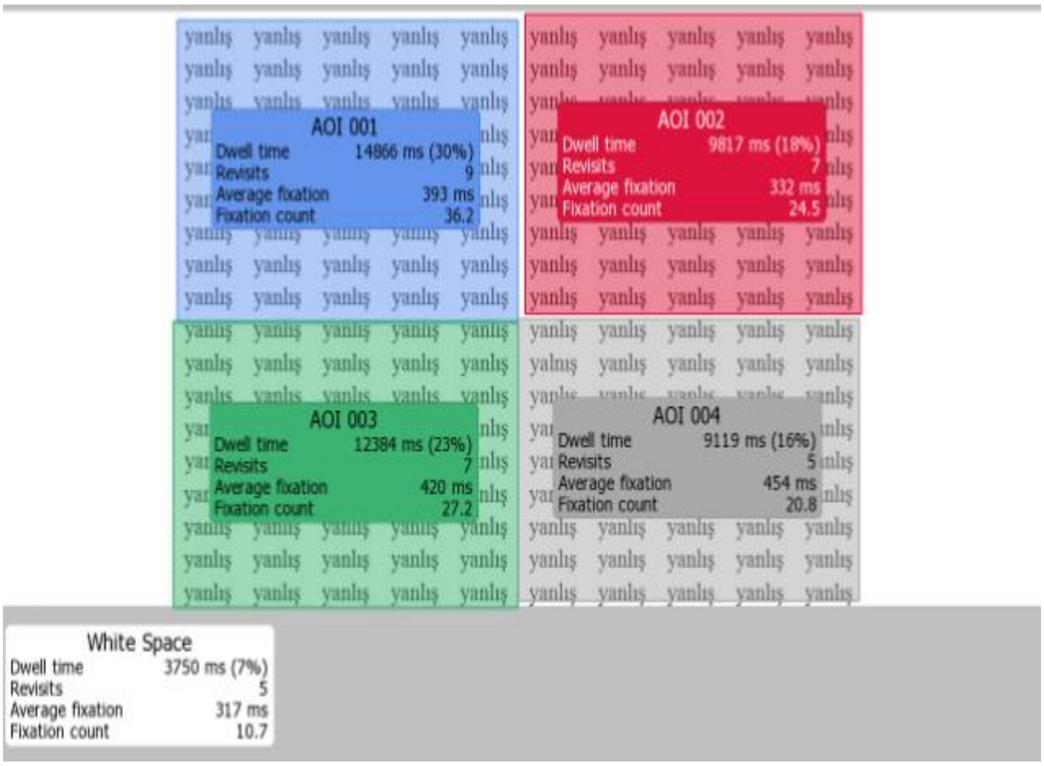


Figure 4.21 KPI of male group in first text

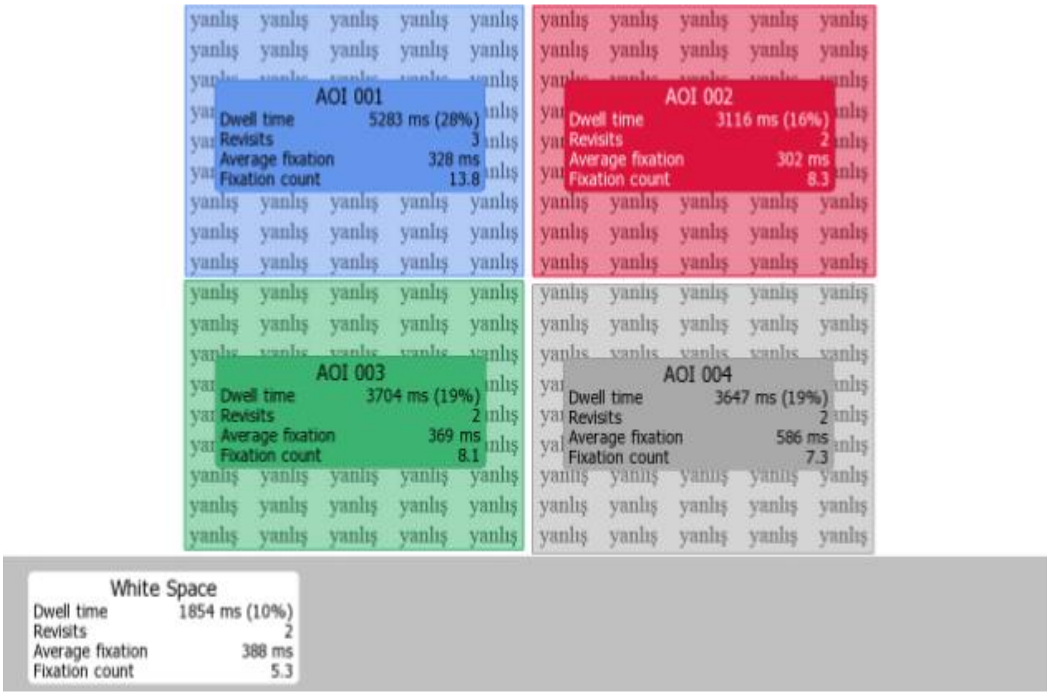


Figure 4.22 KPI of male group in second text

In Figure 4.23 and 4.24 the KPI analysis of female participants are given. In the first text, the dwell time of AOIs are very close, however the average fixation time of AOI 004 is higher than the other ones. Concerning the second text the dwell time is higher in AOI 001 but as in the first text the average fixation time is higher in AOI 004.

The female participants generally spent the dwell time in AOI 001 and the average fixation time in AOI 004. When are evaluated the KPI analysis of female participants it is clear that the dwell time is spent in AOI 001 and average fixation time is spent in AOI 004. They spent less dwell time in AOI 004 and more average fixation time in AOI 004.

In Table 4.1 and 4.2 statistical SPSS Independent T Test is applied to the time spent to find the word by the male and female participants. The statistical analysis results of both male and female participants to find the word in both texts are given. In Figure 4.25 and 4.26 it looks as if that there are differences between the male and female participants however there is no difference statistically, on the time band.

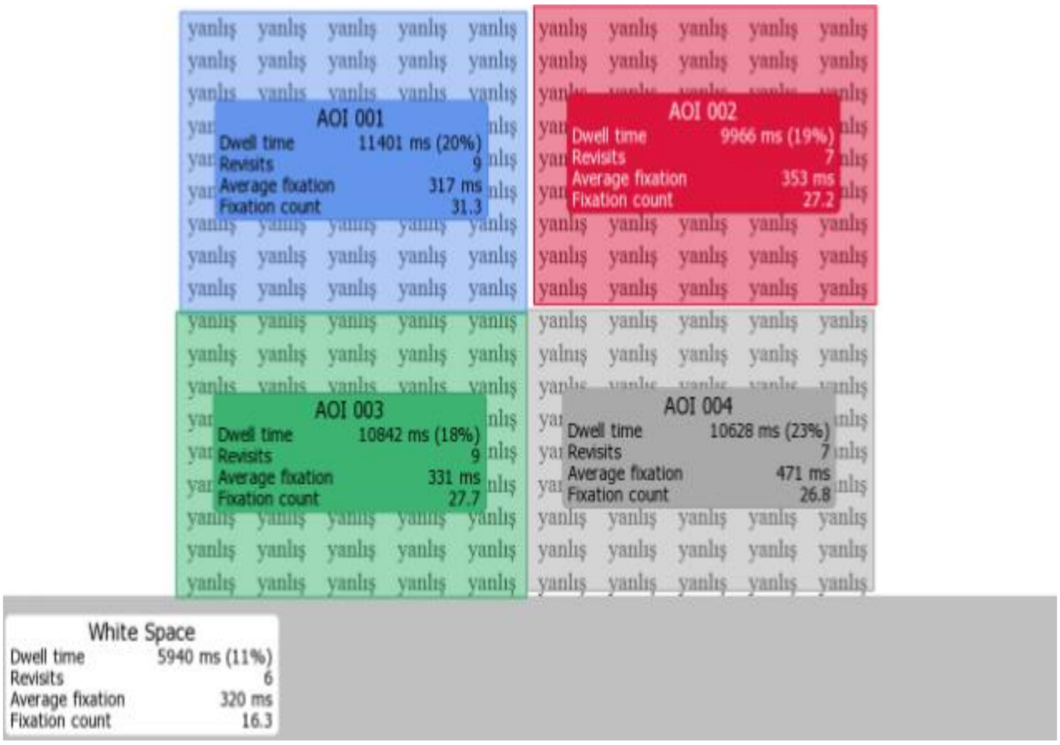


Figure 4.23 KPI of female group in first text

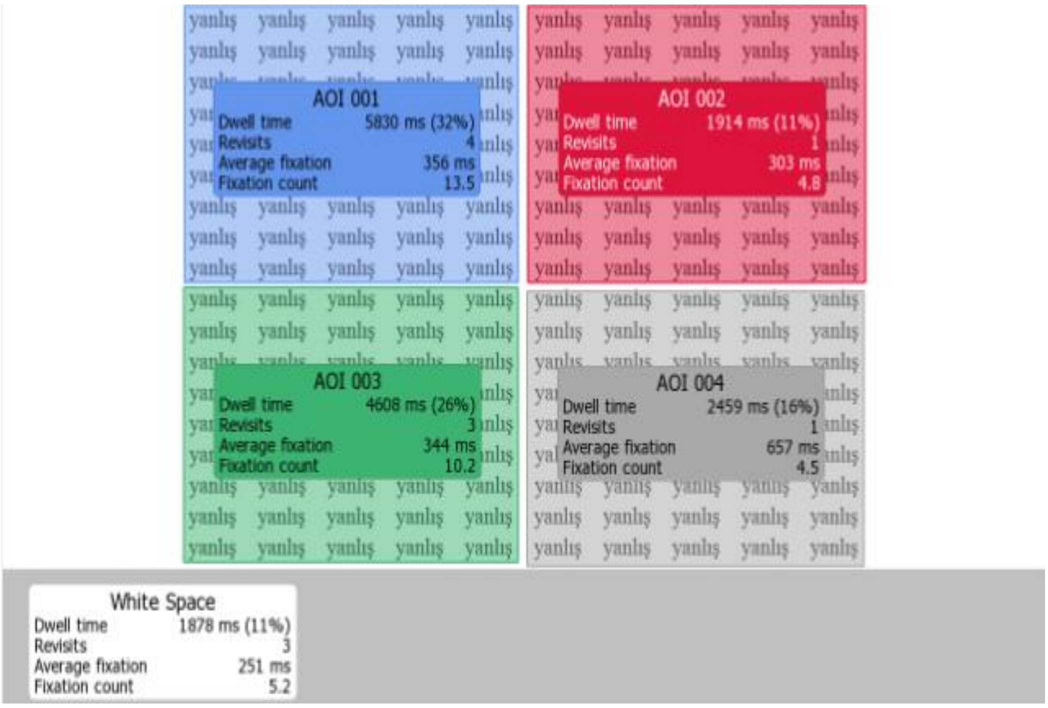


Figure 4.24 KPI of female group in second text

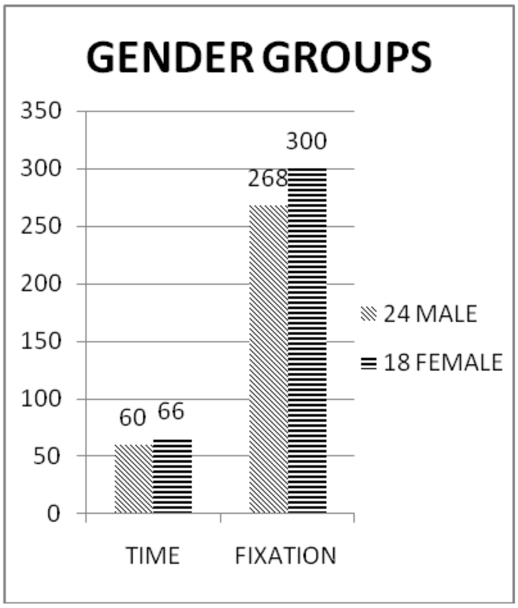


Figure 4.25 Gender groups Text 1

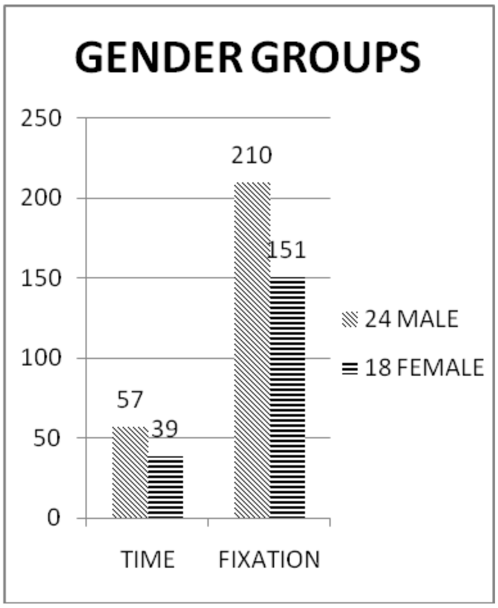


Figure 4.26 Gender groups Text 2

Table 4.1 Comparison Male and Female Text 1 on the time band

	Male	Female	P value
Time band for Text 1	60,9 ± 33,6	66,3± 38,4	0,633

Table 4.2 Comparison Male and Female Text 2 on the time band

	Male	Female	P value
Time band for Text 2	57,9 ± 55,9	38,9 ± 24	0.185

Another classification was done according to age groups and the first age group to be evaluated was 20-35. On the figure 4.27 and figure 4.28 KPI analysis of age group 20-

35 is given. They spent the dwell time mostly in AOI 001 in both texta although the average fixation time is higher in AOI OO4 which includes the required word.

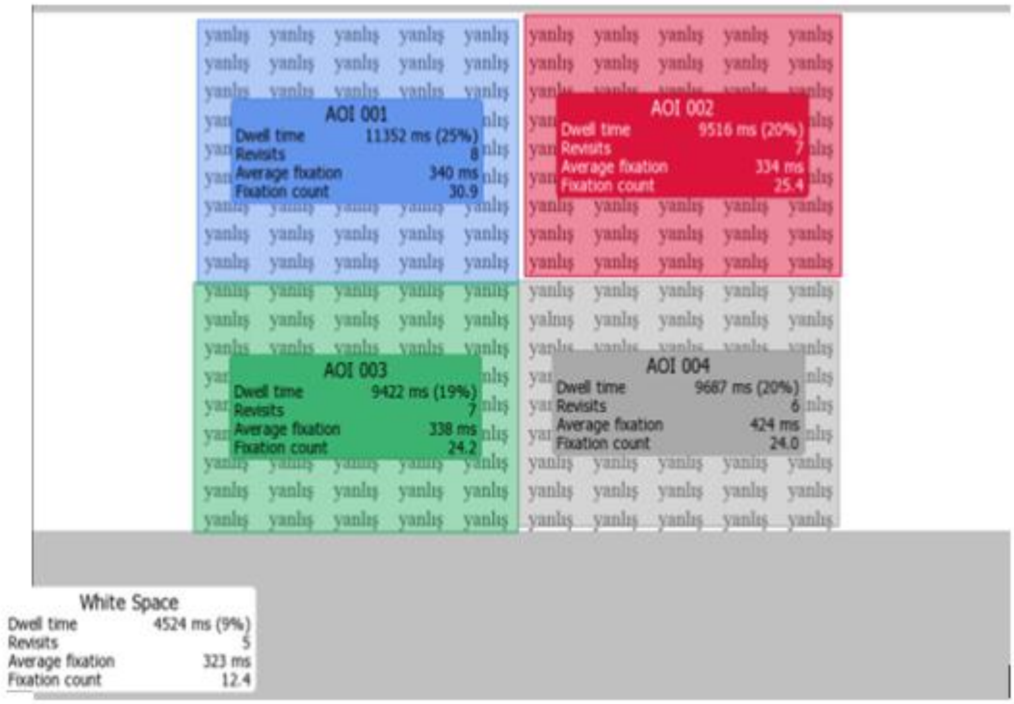


Figure 4.27 KPI of 20-35 years group in first text

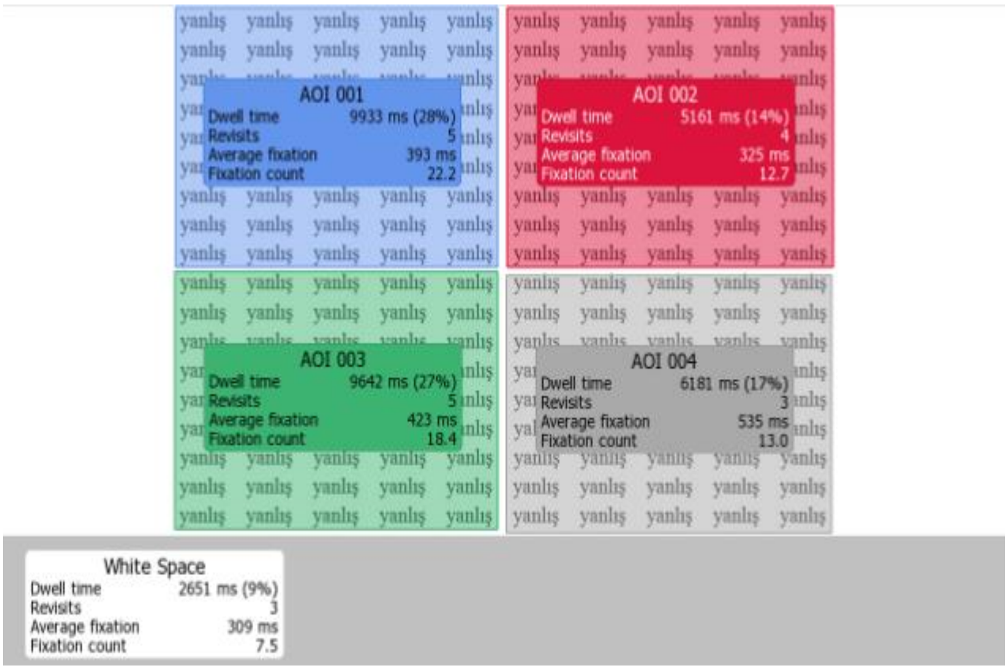


Figure 4.28 KPI of 20-35 years group in second text

Another age classification group is 35-50 and in figure 4.29 and 4.30 the KPI analysis of the 35-50 age group is given. In the first text the dwell time is higher in AOI 001 and AOI 003 however the average fixation time is higher in AOI 004, i.e.they spent less dwell time and more average fixation time to the AOI which included the required word. Similar to the first text in the second text AOI 001 is higher an the average fixation time is higher in the AOI 004. The 35-50 age group focused on AOI 004 .

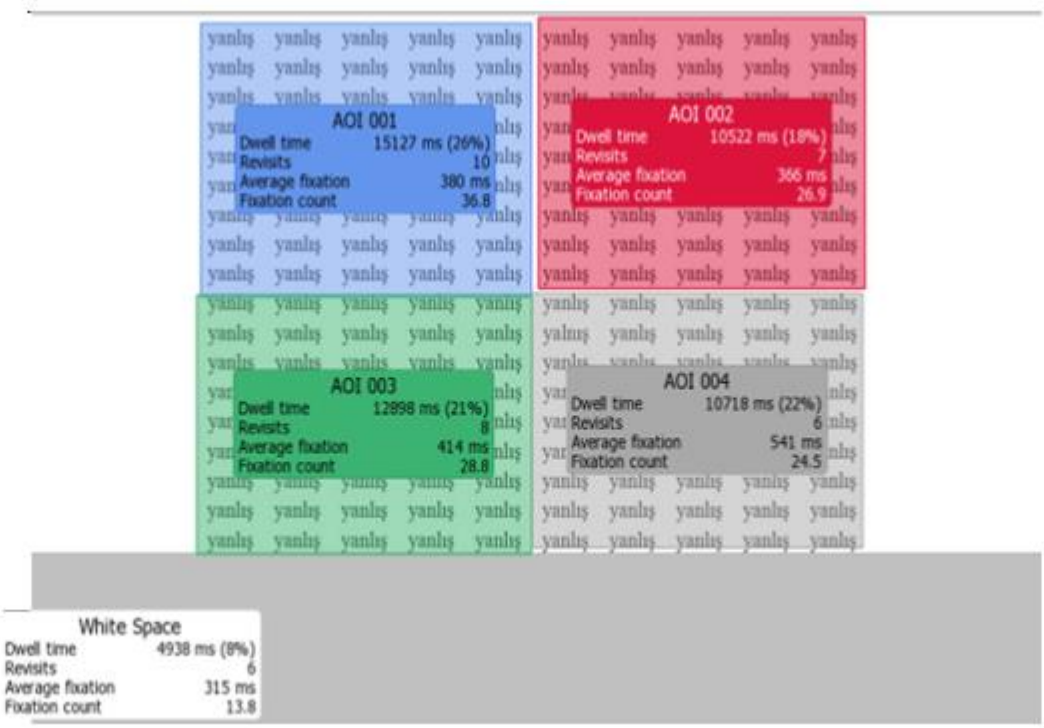


Figure 4.29 KPI of 35-50 years group in first text

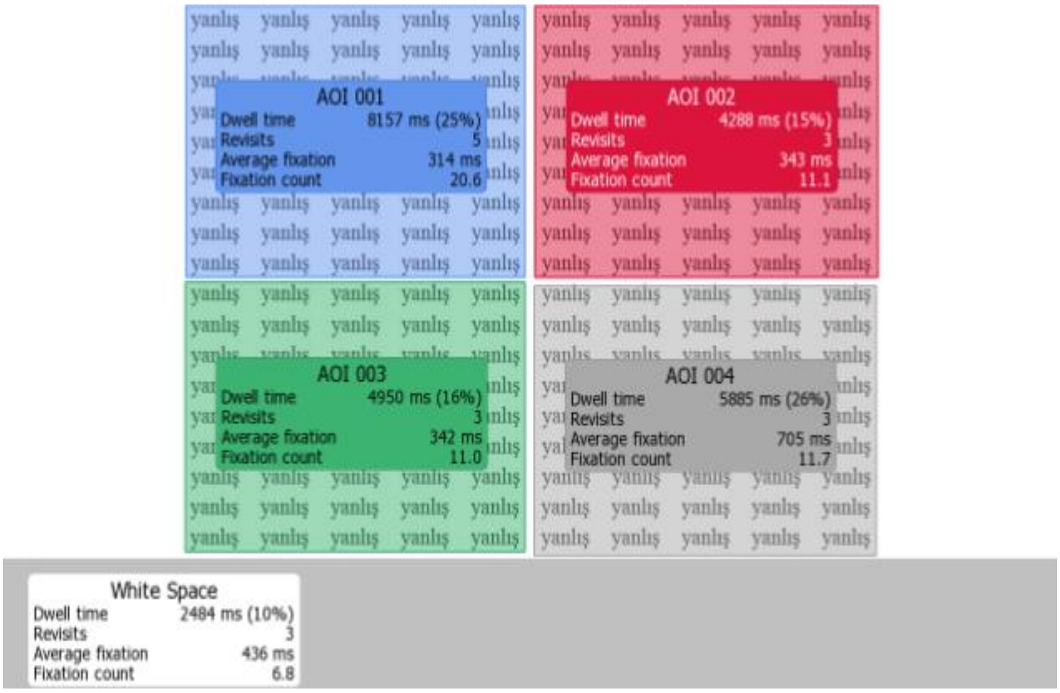


Figure 4.30 KPI of 35-50 years group in second text

The last group of the age group is 50-65 group and their KPI analysis is given in Figure 4.31 and 4.32. In the first text the dwell time is higher in AOI 001 and AOI 003 and the average fixation time is higher in AOI 003. In the second text the dwell time is higher in AOI 004 however the average fixation time is higher in AOI 003 as in the first text.

The age group 50-65 focused on AOI 003 longer unlike the other participants.

SPSS One Way ANOVA has been applied to the statistical analysis of the time range of the age groups, which are divided into groups, 20-35, 35-50 and 50-65, to find the required word Table 4.3 and 4.4. Figure 4.33 and 4.34 the average values of finding the word and the fixation. Although it seems as if there are differences between time fixation parameters among the age groups, no significance level is achieved.

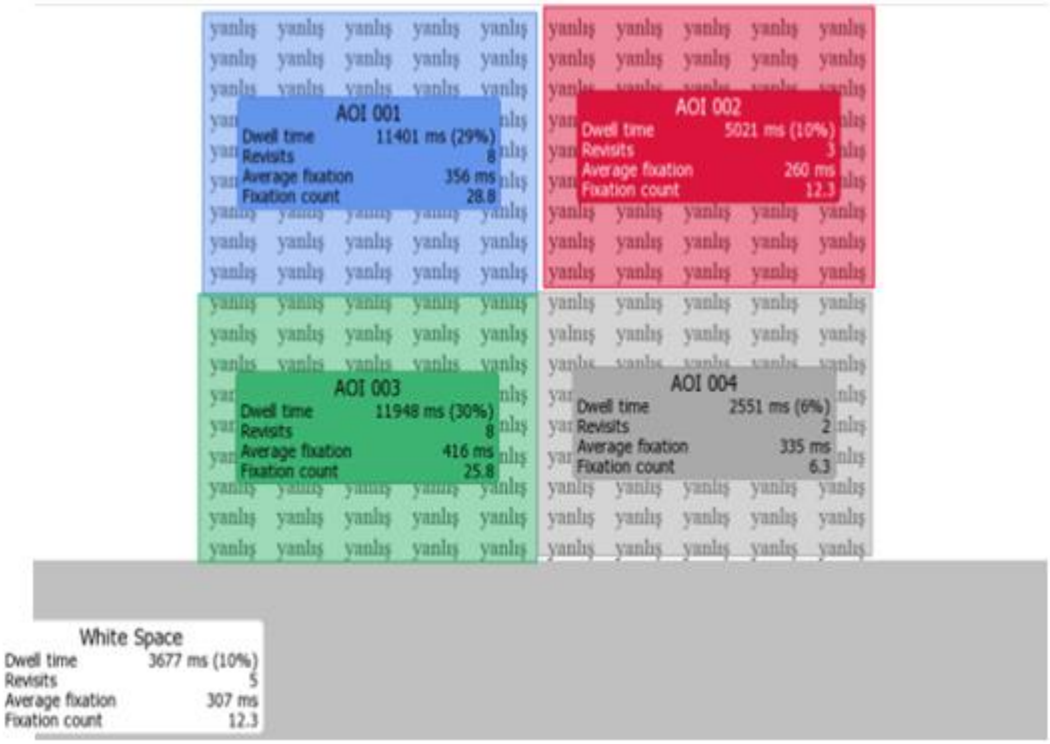


Figure 4.31 KPI of 50-65 years group in first text

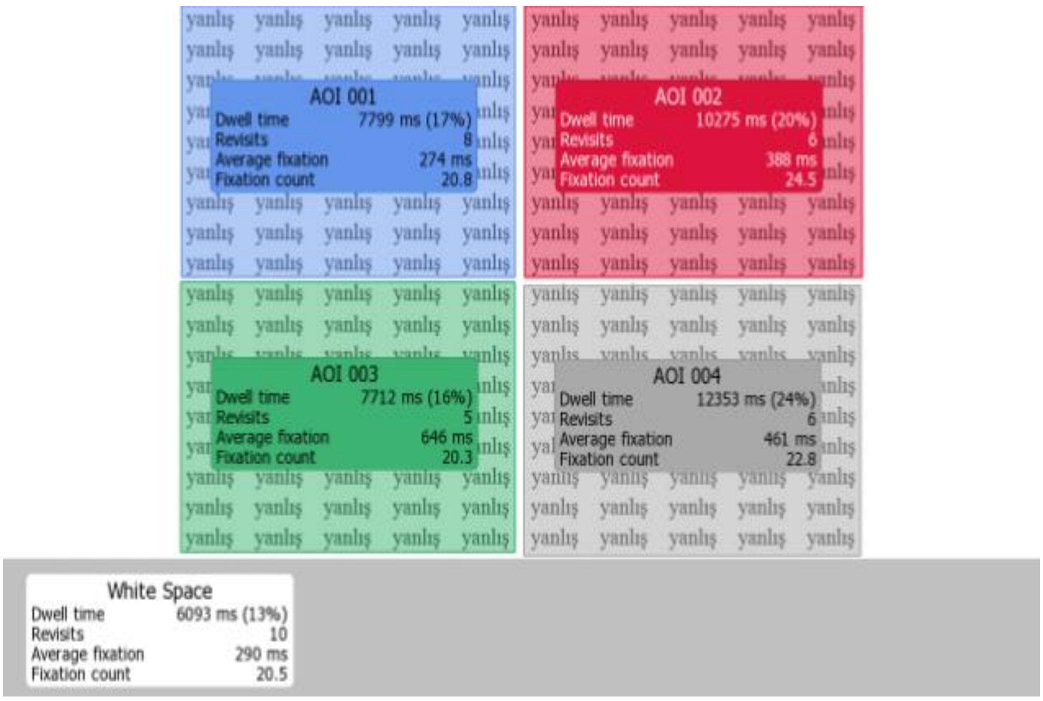


Figure 4.32 KPI of 50-65 years group in second text

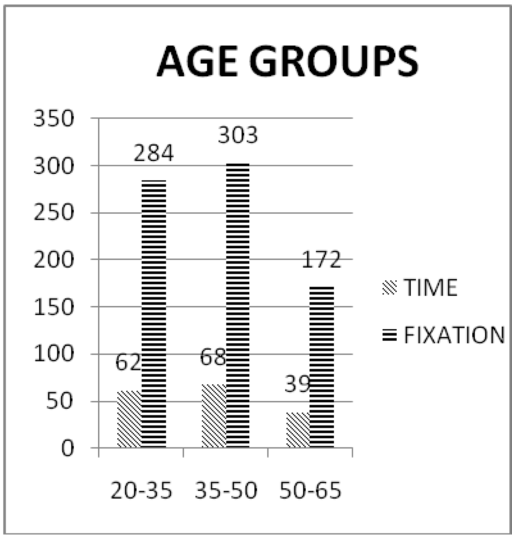


Figure 4.33 Age groups Text 1

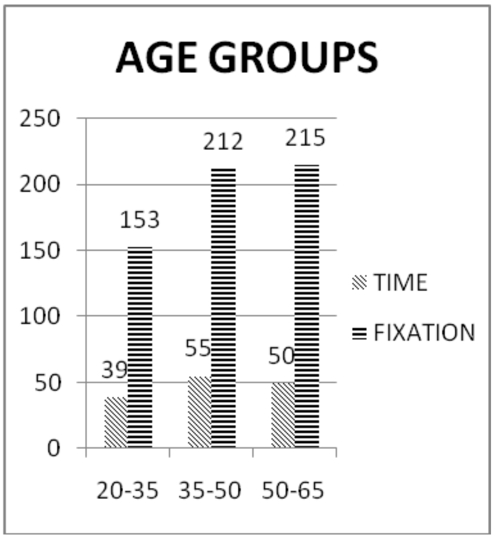


Figure 4.34 Age groups Text 2

Table 4.3 Comparison Age Groups Text 1 on the time band

	20-35	35-50	50-65	P value
Time band for Text 1	62,7 ± 37,1	70,2 ± 35,1	39,2 ± 35,7	0,293

Table 4.4 Comparison Age Groups Text 1 on the time band

	20-35	35-50	50-65	P value
Time band for Text 2	39 ± 22,1	55,1 ± 61	50 ± 18,8	0,123

.

The classification according to the occupation started with the doctors. Figure 4.35 and 4.36 gives the KPI analysis results of the doctors.

In the first text the doctors spent most of their dwell time in AOI 001 and AOI 003 however their average fixation time is divided equally among all the AOIs. Concerning the second text while their dwell time is divided equally in all the AOIs, the AOI 003 and AOI 004 are focused on for fixation time . Generally speaking of the KPI analysis of the doctors the both of the parameters are divided very closely among all the AOIs in both texts.

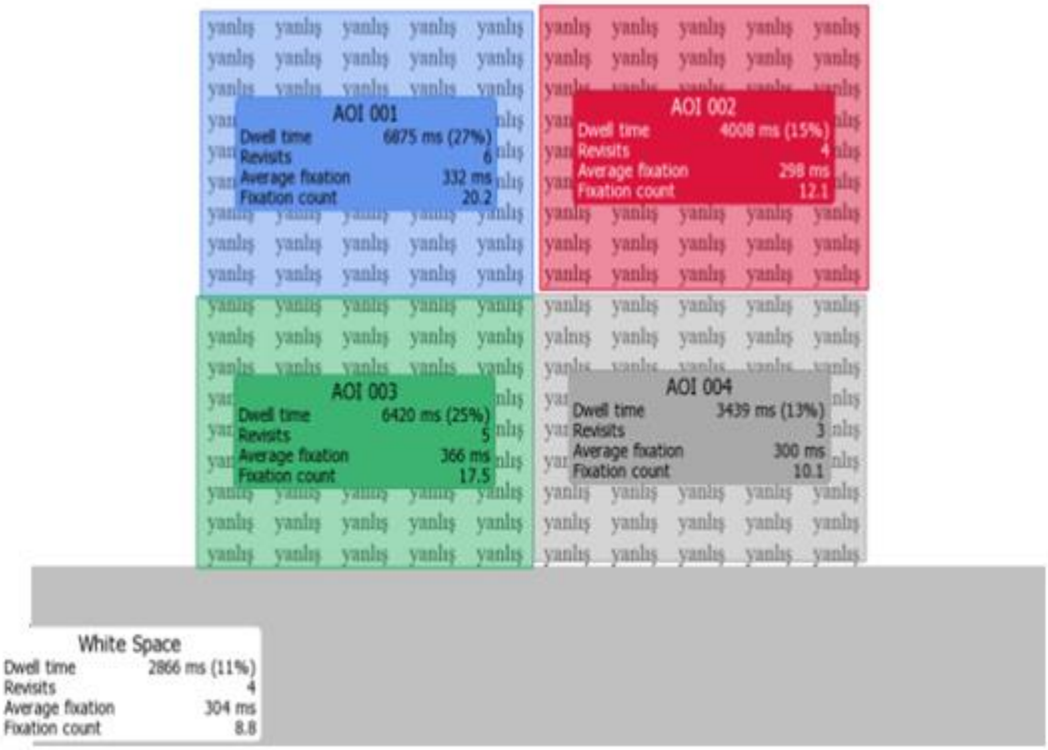


Figure 4.35 KPI of doctor group in first text

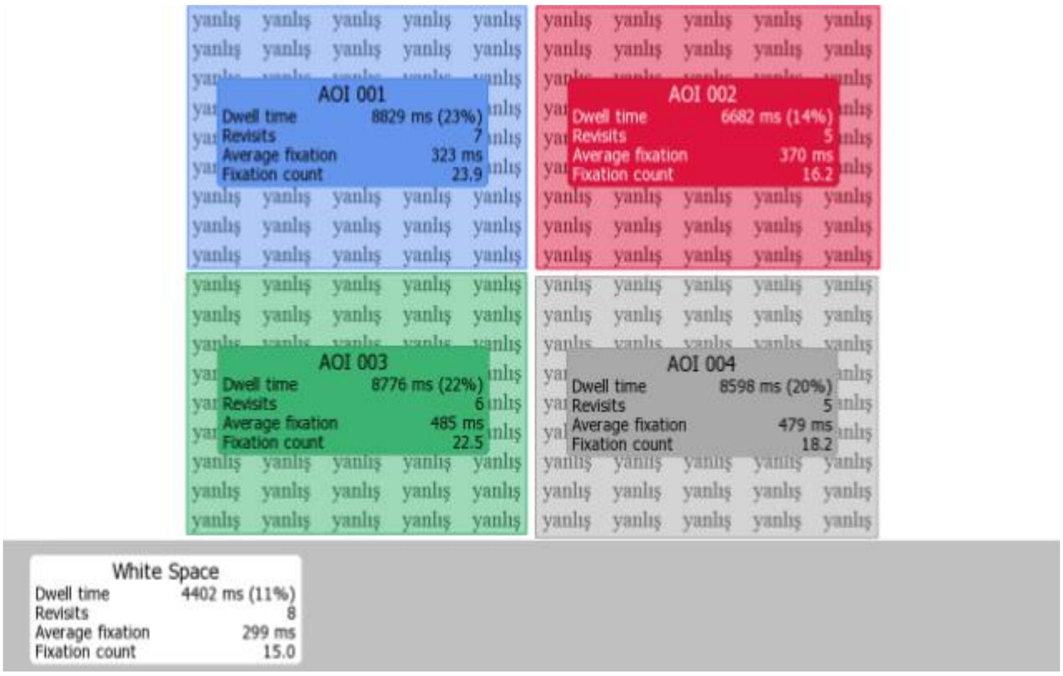


Figure 4.36 KPI of doctor group in second text

Figure 4.37 and 4.38 the KPI analysis results of nurses, another occupation group, are given. In the first text the dwell time average fixation time of all the AOIs are very close. In the second text the least dwell time is on AOI 002 and the most average fixation times are on AOI 003 and AOI 004.

Generally speaking the nurse group focused on AOI 003 and AOI 004 in the second text according to the dwell time and average fixation parameters.

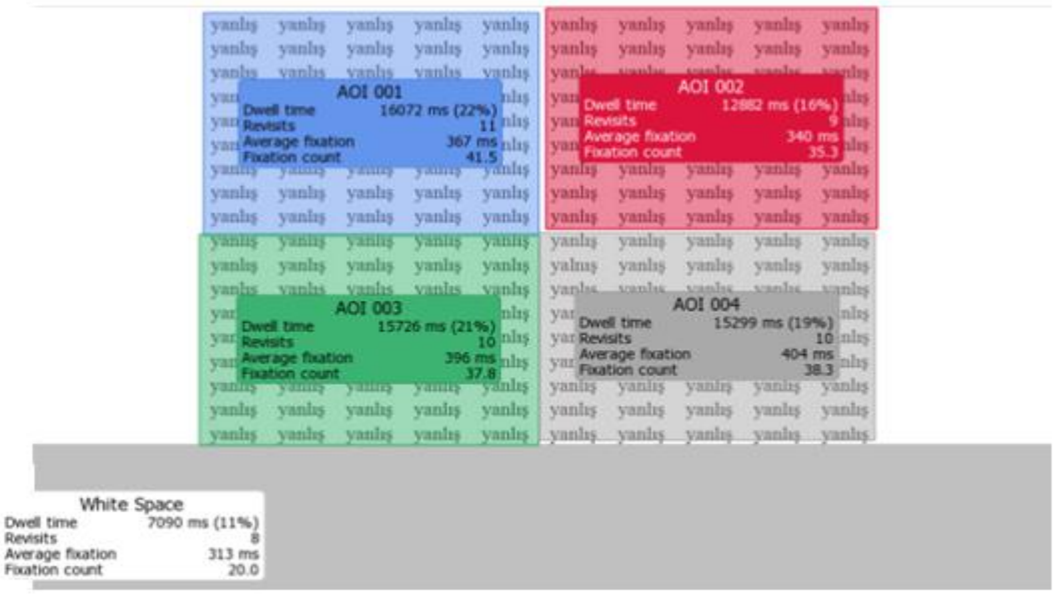


Figure 4.37 KPI of nurse group in first text

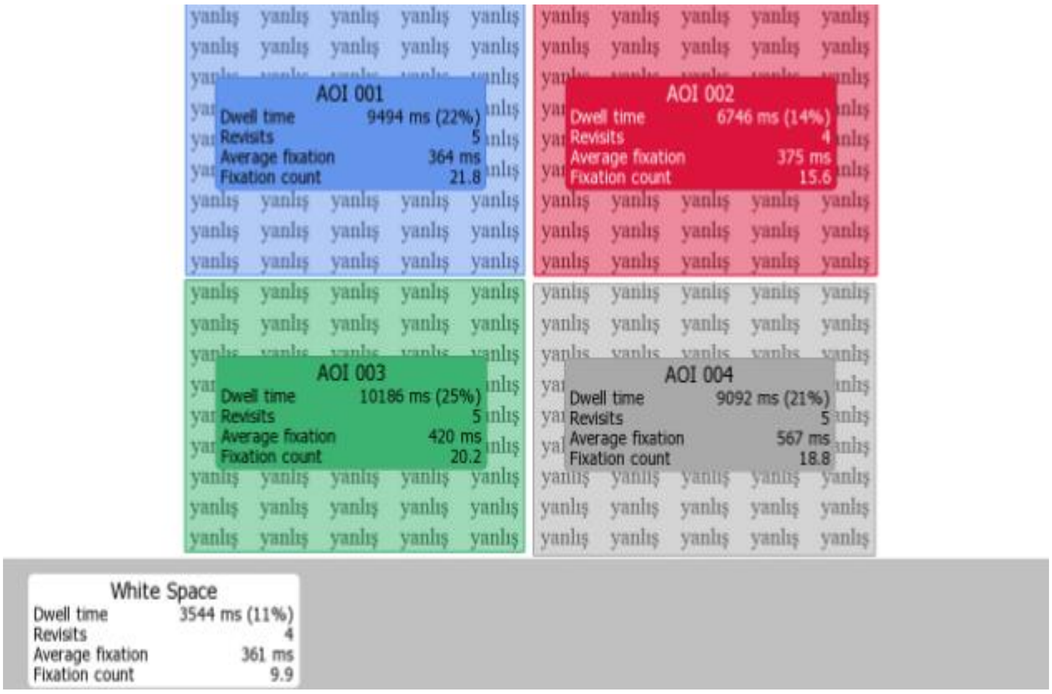


Figure 4.38 KPI of nurse group in second text

The KPI analysis results of another occupation group, personnel, are given in Figure 4.39 and 4.40. The personnel group spent the dwell time mostly in AOI 001 in the first text, however the average fixation time is at the highest in AOI 004 which includes the target word. In the second text the dwell time and the average fixation time are at the highest in AOI 004 when compared with the other AOIs. The KPI analysis results of the personnel group shows that they focused on AOI 004 in both of the parameters.

When we take the occupation groups into account the dwell time is divided equally in all of the AOIs and the average fixation time is spent in AOI 004 mostly.

In Figure 4.41 and 4.42 the average time to find the word required and the average fixation time are given. The SPSS One Way ANOVA test has been used to evaluate tstatistically the time spent to find the word according to the occupation groups Table 4.5 and 4.6. Although it seems as if there is a difference between the occupation groups when considering the average time to find the word, any significant value could not be found statistically.

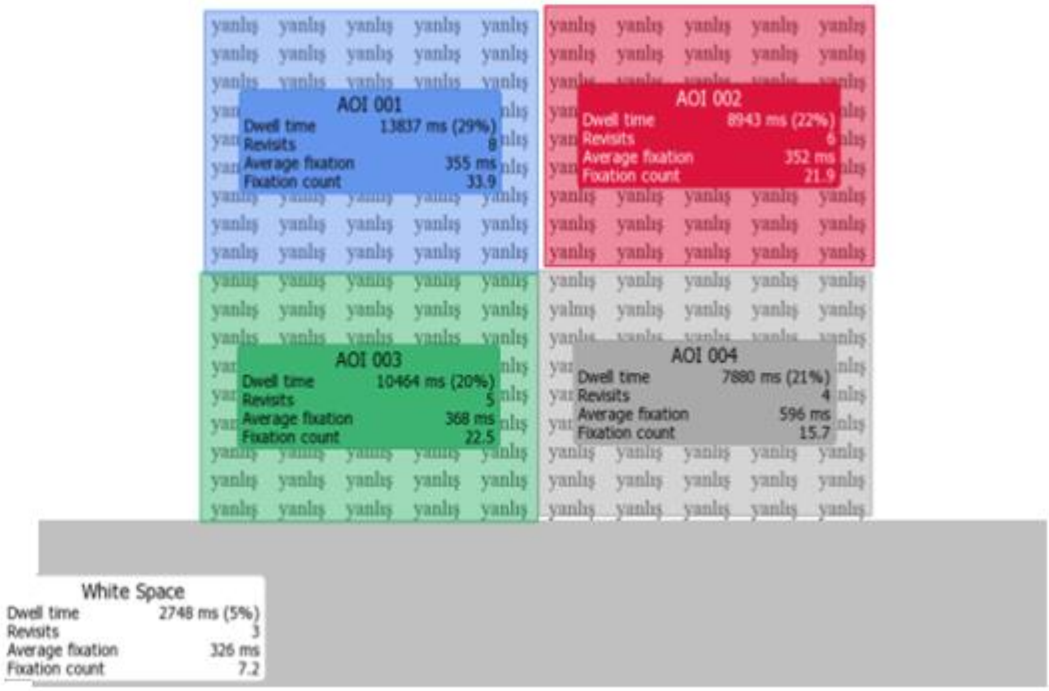


Figure 4.39 KPI of personel group in first text

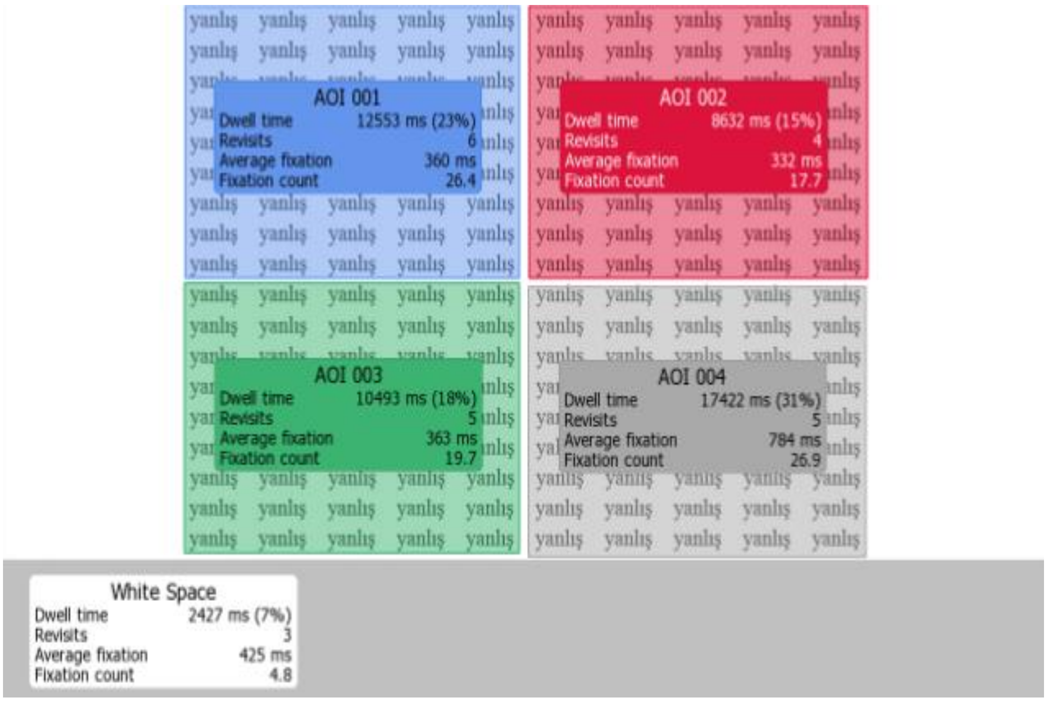
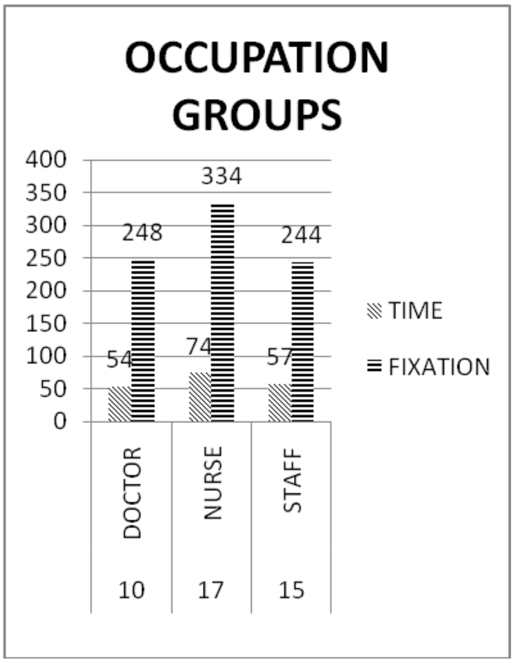


Figure 4.40 KPI of personel group in second text



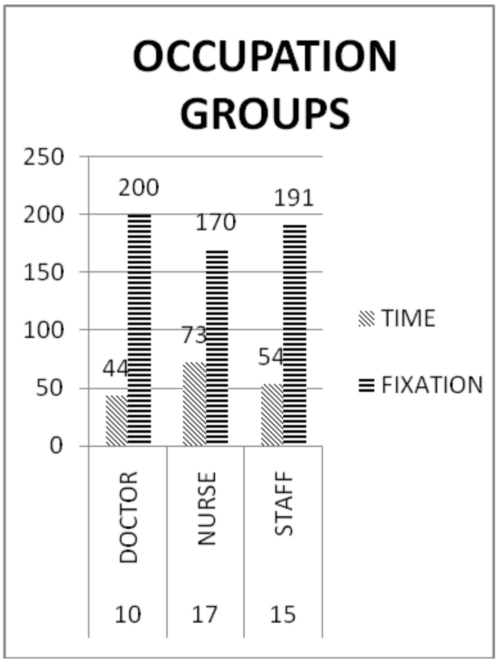


Figure 4.41 Occupation groups Text 1

Figure 4.42 Occupation groups Text 2

Table 4.5 Comparsion Occupation Groups Text 1 on the time band

	Doctor	Nurse	Staff	P value
Time band for Text 1	53,6 ± 36	74 ± 33	57,4 ± 35,4	0,819

Table 4.6 Comparison Occupation Groups Text 2 on the time band

	Doctor	Nurse	Staff	P value
Time band for Text 2	43,8 ± 21,9	42,9 ± 23	53,6 ± 66,7	0,77

CHAPTER 5

DISCUSSION AND CONCLUSION

This study has been done to evaluate the visual attention of hospital personnel. 10 doctors, 17 nurses and 15 personnel of Yedikule Surp Pırgiç Ermeni Hospital have participated to this study. The participants were asked to find the orthographically wrong word in 2 texts containing 18 lines and 10 columns. The participants were required to find the word " yalnış" in two separate texts seen on the monitor linked to the eye tracking tool. The data recorded by the eye tracking tool was analysed afterwards. It was investigated in this study whether there was any meaningful difference among gender, age and occupation as regards the visual attention.

When the AOI sequence analysis of gender group is taken into account we can see that the male and female participants scanned the first text fast and irregularly. However they found the target word more quickly in the second text after a more careful and regular scanning. From the point of the duration to find the target word the male participants found the word faster than the female participants in the first text. In the second text the female participants found the word faster than the males on the contrary. From the point of the focusing quantity it either increased or decreased depending on the duration to scan the text. When statistically analysed it is seen that there is not a meaningful difference concerning the duration to find the target word in both texts by the participants in the gender group.

In the AOI sequence analysis of the age groups the group 50-65 age found the target word faster than the other age groups in the first text. In the second text 20-35 age group found it faster than the other age groups. As in the other groups the target word was found faster when compared with the first text. Any meaningful difference could not be found statistically among the age groups. Among the occupation group the doctors found the target word faster than the nurses and the personnel in both texts. The nurse and the personnel groups had closer results to find the word in the both texts. However they focused on the second text less than the first one , this means that they scanned better after their visual attention was stimulated. As for the occupation group a meaningful difference was not found statistically.

The analysis of the data of the experiment shows that the first text played a stimulative role and the duration to find the target word in the second text lessened . It helped to improve the visual attention and the visual scanning capability rose up. Based on this situation it is reached to a conclusion that after the hospital personnel stimulated their visual attention became more successful. Among the groups in this study a meaningful difference could not be found. It is thought that this is a result of the number of the few participants.

Based on this study the recommendations for futher researches are as follows:

- To increase the number of the participants to have better statistical accuracy.
- To have different experiments with the hospital personnel by applying some changes in the experiment design.
- This experiment has been applied only on the hospital personnel . In another experiment the results of hospital personnel and personnel from other sectors can be compared.

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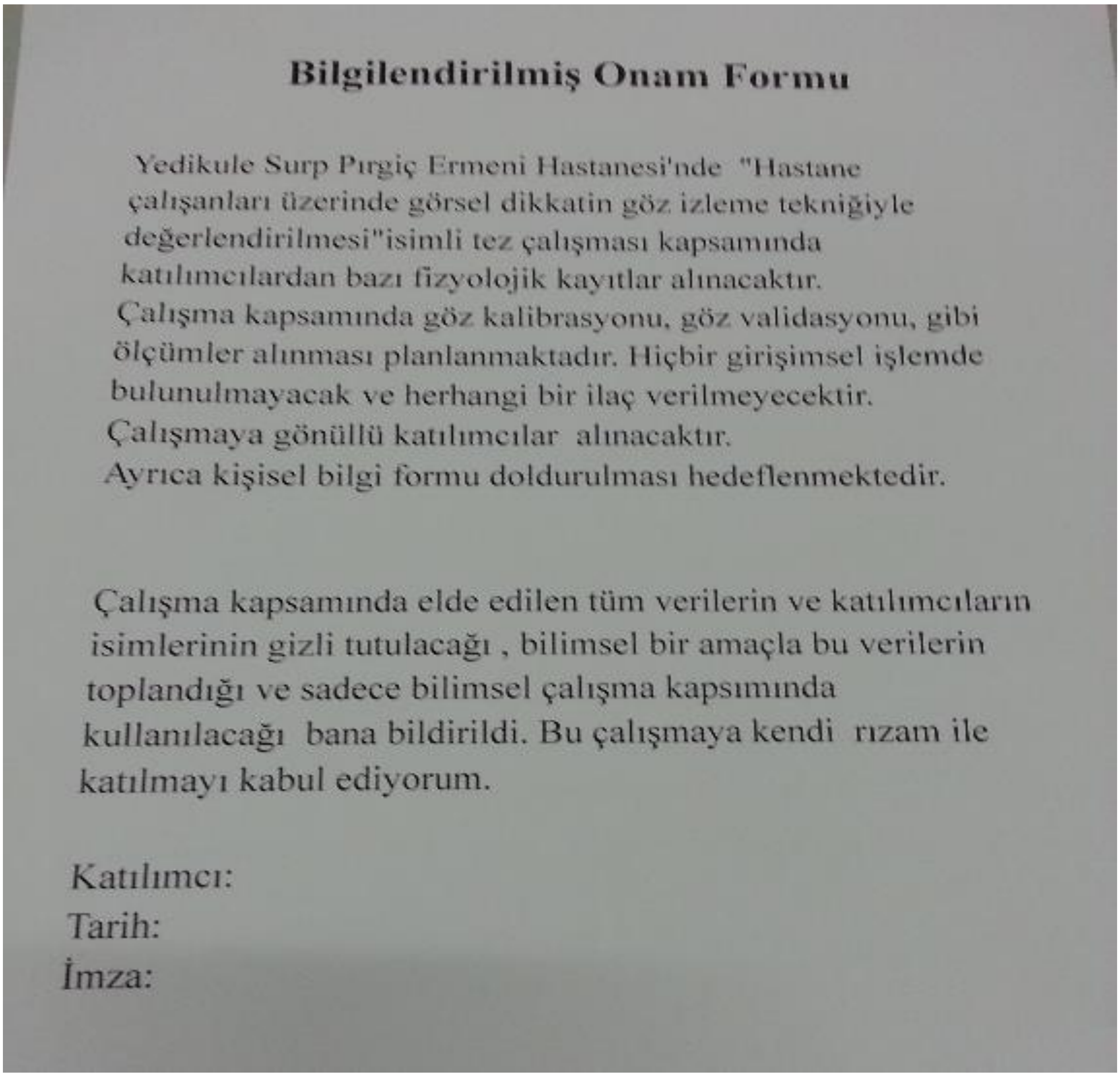
APPENDIX A



Bilgilendirilmiş Onam Formu

Yedikule Surp Pırgiç Ermeni Hastanesi'nde "Hastane çalışanları üzerinde görsel dikkatin göz izleme tekniğiyle değerlendirilmesi"isimli tez çalışması kapsamında katılımcılardan bazı fizyolojik kayıtlar alınacaktır. Çalışma kapsamında göz kalibrasyonu, göz validasyonu, gibi ölçümler alınması planlanmaktadır. Hiçbir girişimsel işlemde bulunulmayacak ve herhangi bir ilaç verilmeyecektir. Çalışmaya gönüllü katılımcılar alınacaktır. Ayrıca kişisel bilgi formu doldurulması hedeflenmektedir.

Çalışma kapsamında elde edilen tüm verilerin ve katılımcıların isimlerinin gizli tutulacağı , bilimsel bir amaçla bu verilerin toplandığı ve sadece bilimsel çalışma kapsımında kullanılacağı bana bildirildi. Bu çalışmaya kendi rızam ile katılmayı kabul ediyorum.

Katılımcı:
Tarih:
İmza:

Figure A.1 Briefing Acceptance Form

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List of Publications and Patents:

PUBLICATIONS/PRESENTATIONS ON THE THESIS