Practicum Presentation

THE FEASIBILITY AND ROLE OF EYE TRACKING IN THE USABILITY EVALUATION OF ELECTRONIC HEALTH RECORDS

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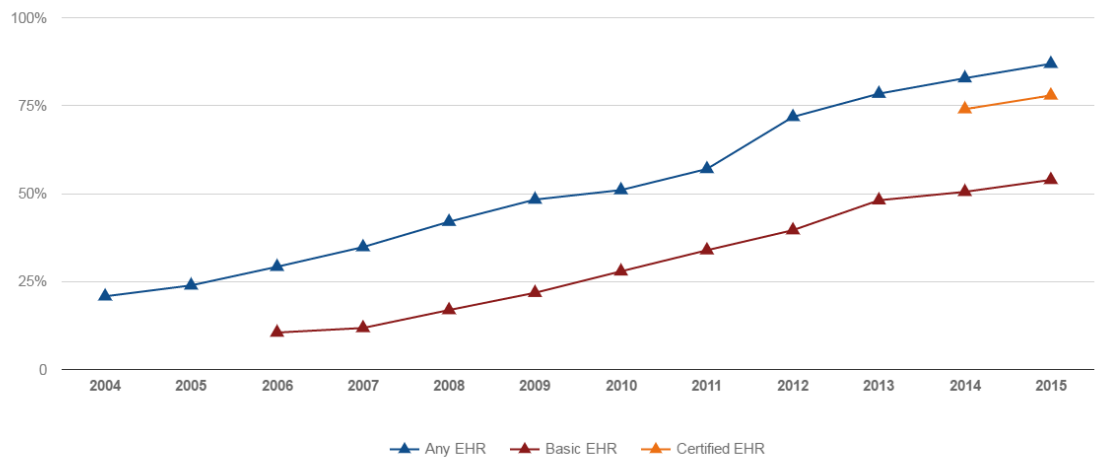
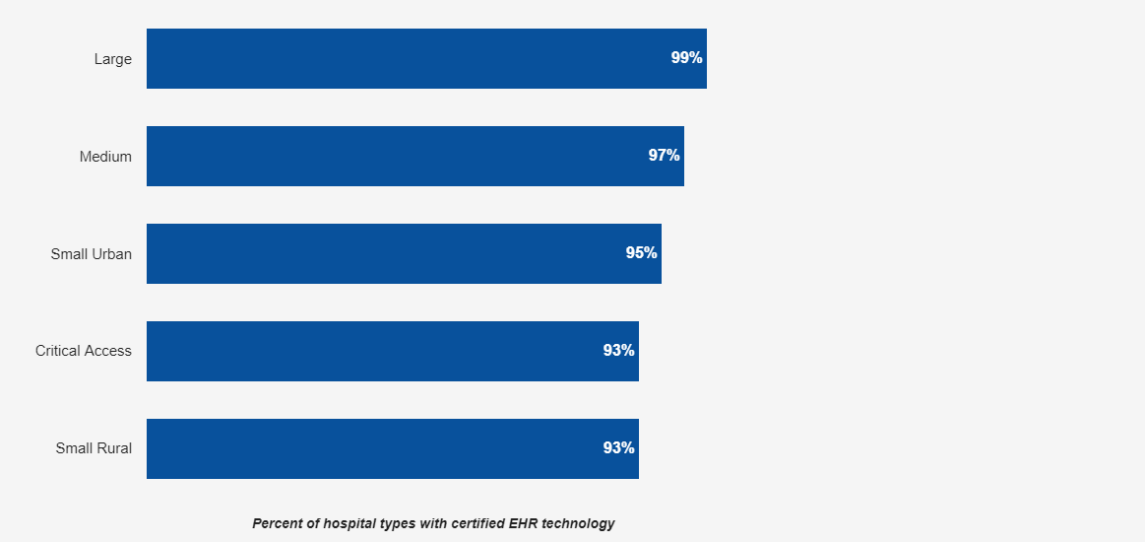
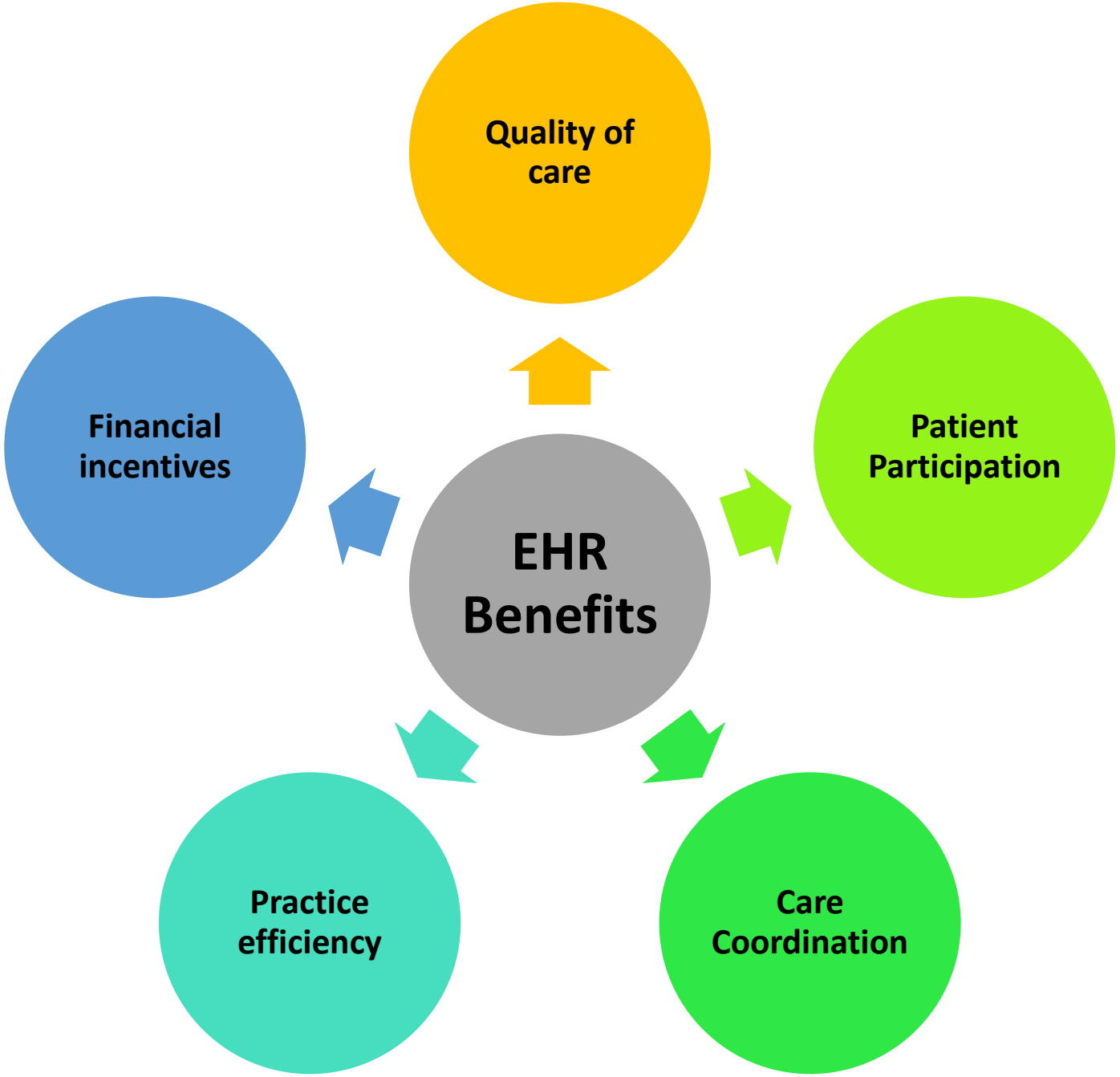
EHR Adoption Rates (ONC)





Electronic Health Records

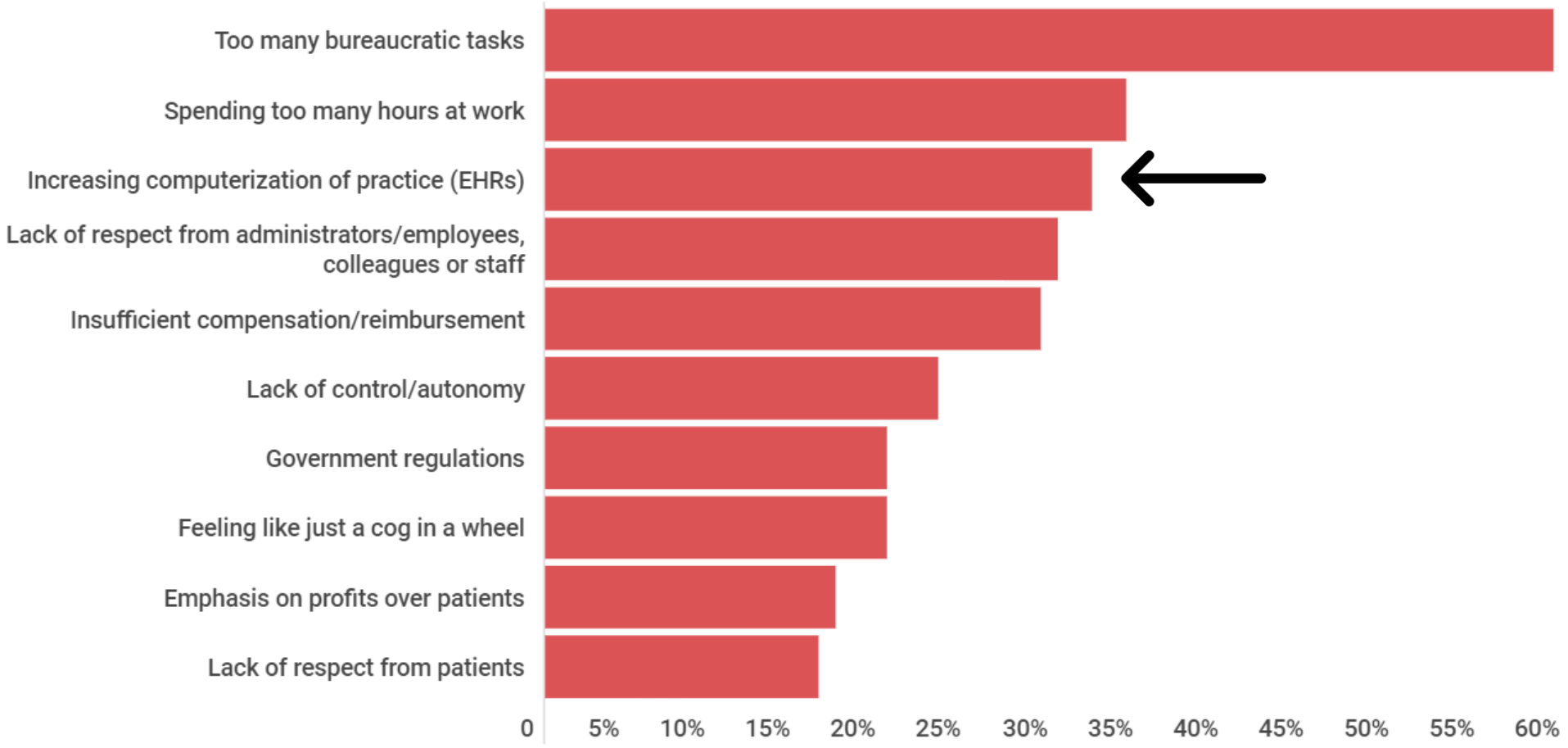
- Patient-centered records that make information available instantly and securely to authorized users
- Contains patient information
- Allows access to evidence – based tools
- Automate and streamline provider workflows


Quality of care
Financial incentives
EHR Benefits
Patient Participation
Practice efficiency
Care Coordination

Physician Burnout

More than **40%** of physicians and **50%** of female physicians are burned out, though doctors in some specialties are suffering more than others, according to ***Medscape*'s 2019 National Physicians Burnout & Depression Report**.

Biggest contributors to burnout



Ways EHRs contribute to Physician Burnout

- Challenges with navigating the user interface
- Documentation time
- Information overload
- Interference with physician – patient interaction
- **Suboptimal Usability**

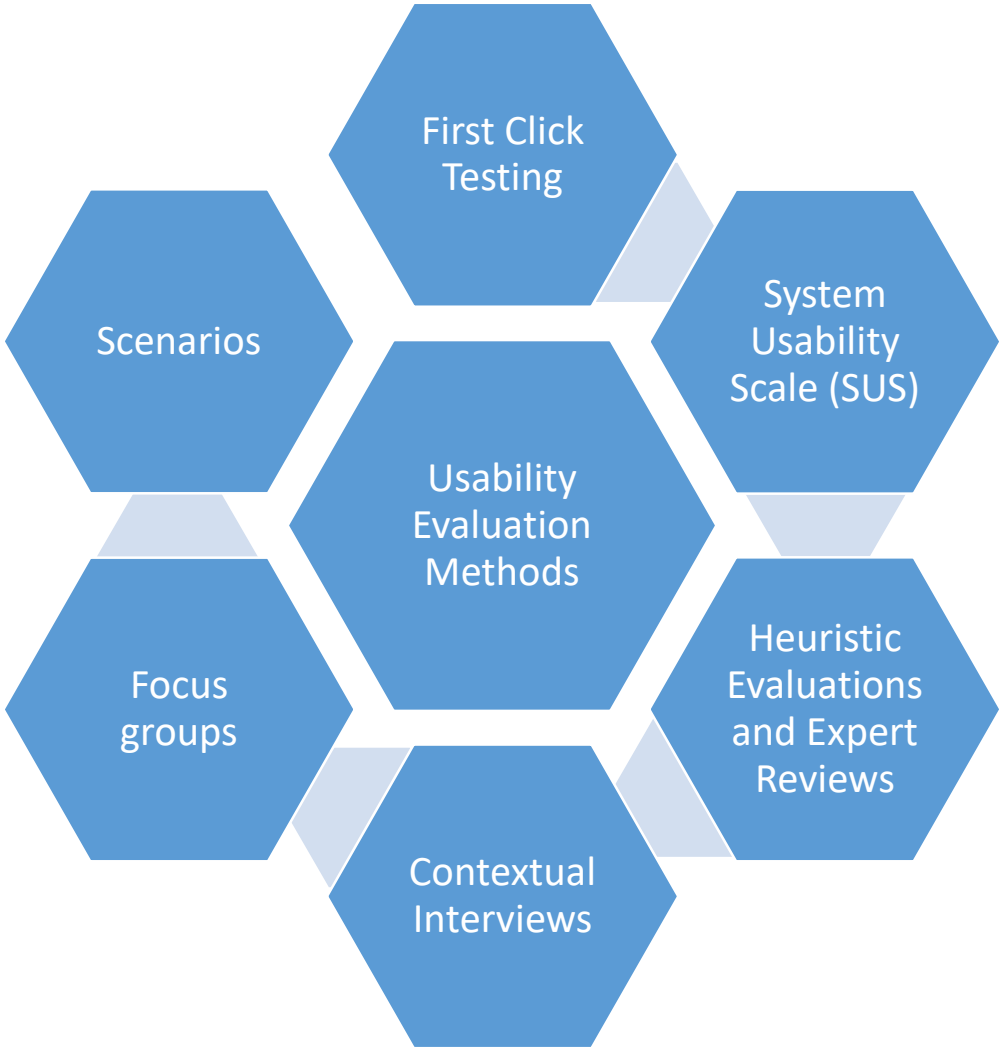
Usability Testing

- Practice of testing the ease of use of a product by a representative group of users
- Often conducted repeatedly throughout the product development cycle

It can help determine:

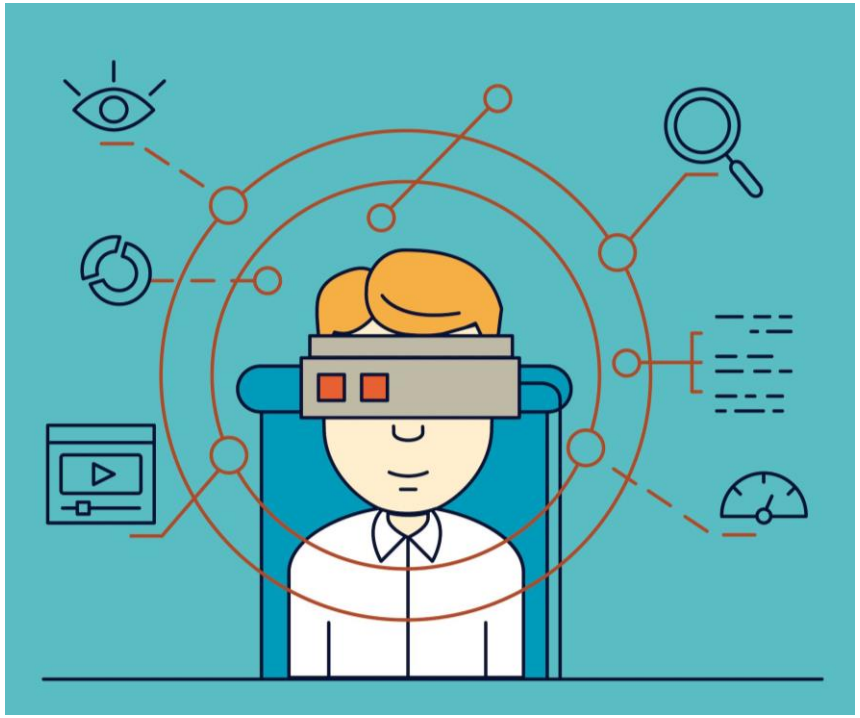
- Problems in advance
- If participants can complete tasks successfully
- The time taken to complete such tasks
- The changes required for optimal performance and achieve intended objectives

Common Usability Testing Methods



Eye Tracking

- process of tracking eye movements or the absolute point of gaze (POG) in the visual scene
- uses invisible near-infrared light and high definition cameras to project light onto the eye and record the direction it’s reflected off the cornea
- The three categories of eye trackers are screen-based, wearable and webcam based.



Review of Literature

- Eye tracking has become much more relevant only since the last few years
- The close relationship between visual stimuli and attention mechanisms makes eye tracking promising for HIT usability research
- The different types of HIT that have been evaluated by eye tracking so far include health information websites, surgical interfaces, decision support systems, computerized provider order entry systems, and symptom and quality-of-life information systems.
- Common metrics evaluated include fixation count and duration, blink rates, pupillary response, dwell times
- Application in usability evaluation of digital health devices

Study Objectives

- To assess the role of eye tracking technology in the usability evaluation of an EHR system
- To identify differences between user subgroups in their interaction with the EHR

Methodology

- 25 medical intensivists with different training levels were recruited from UNC hospital through electronic flyers and emails
- All worked for the medical ICU and used the EHR regularly for routine ICU service
- Participants were made to wear the Tobii© Pro eyeglasses, and then asked to perform a total of 21 routine tasks using the EHR, in a simulation lab.

Methodology - Tasks

Case 1 - Review the record of a middle - aged female patient diagnosed with multisystem organ dysfunction, determine the course of treatment recommended by consulting clinical teams and modify medication orders accordingly

Case 2 - Identify the overnight changes in the respiratory status of an elderly respiratory failure patient, as well as the changes in the mechanical ventilator settings, and analyze microbiology reports

Case 3 - Assess the clinical notes, laboratory results, and treatment records and manage abnormal test results for a young male patient suffering from sepsis

Case 4 - Review the record of a middle - aged male patient suffering from trauma, and post-operative heart failure with volume overload, identify changes in the patient's weight over the last few hospital visits and manage orders for medications and IV fluids

Methodology

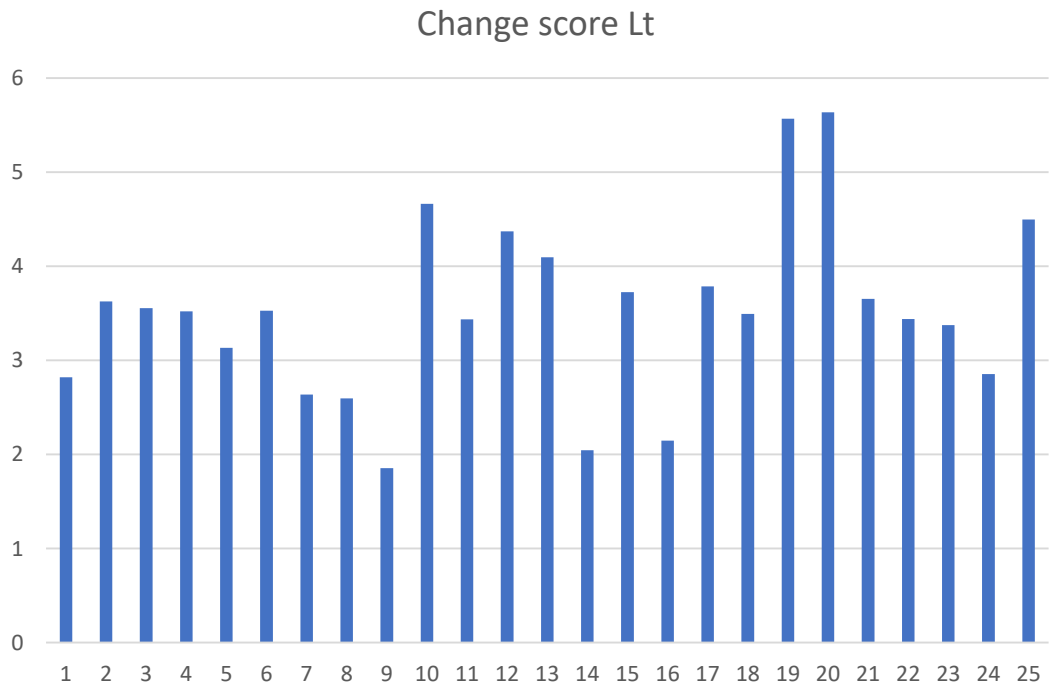
- During this interaction with the EHR, the participants' eye motions were tracked.
- Subsequently, the motion patterns were mapped onto the screenshots of four sections of the EHR – Chart Review, Flowsheet, Results Review and Summary Overview.
- Metrics data was exported, cleaned, and categorized into spreadsheets.
- ANOVA, two-sample t tests, and paired t tests were used to perform statistical analysis in Microsoft Excel©.
- Heatmaps were generated using the Tobii software for role and gender – based groups and compared.

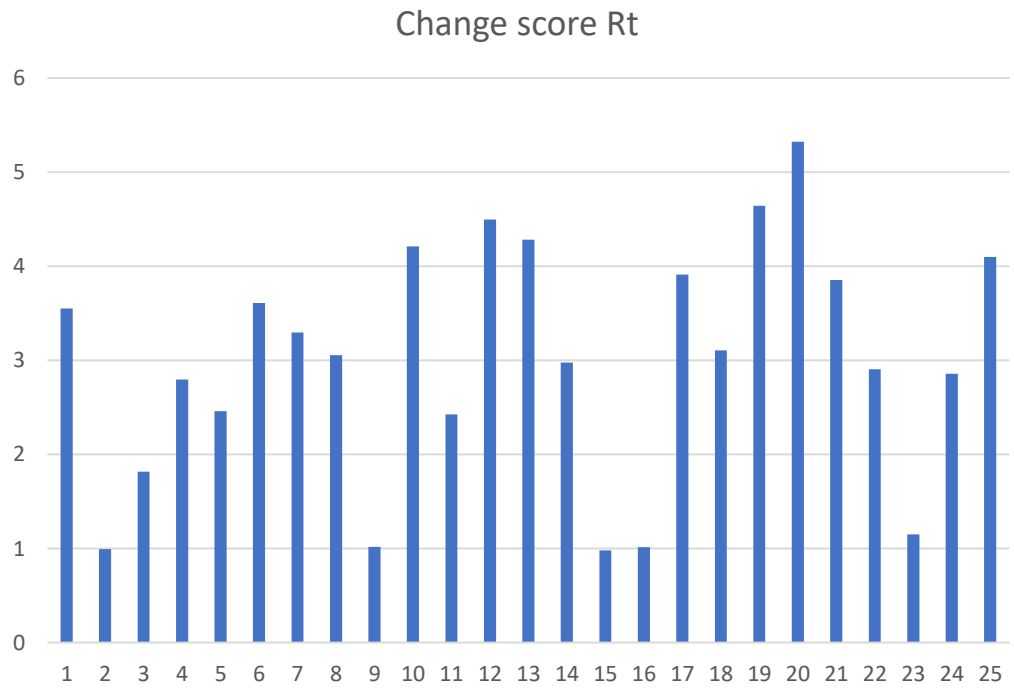
RESULTS

Changes in Pupil Diameter

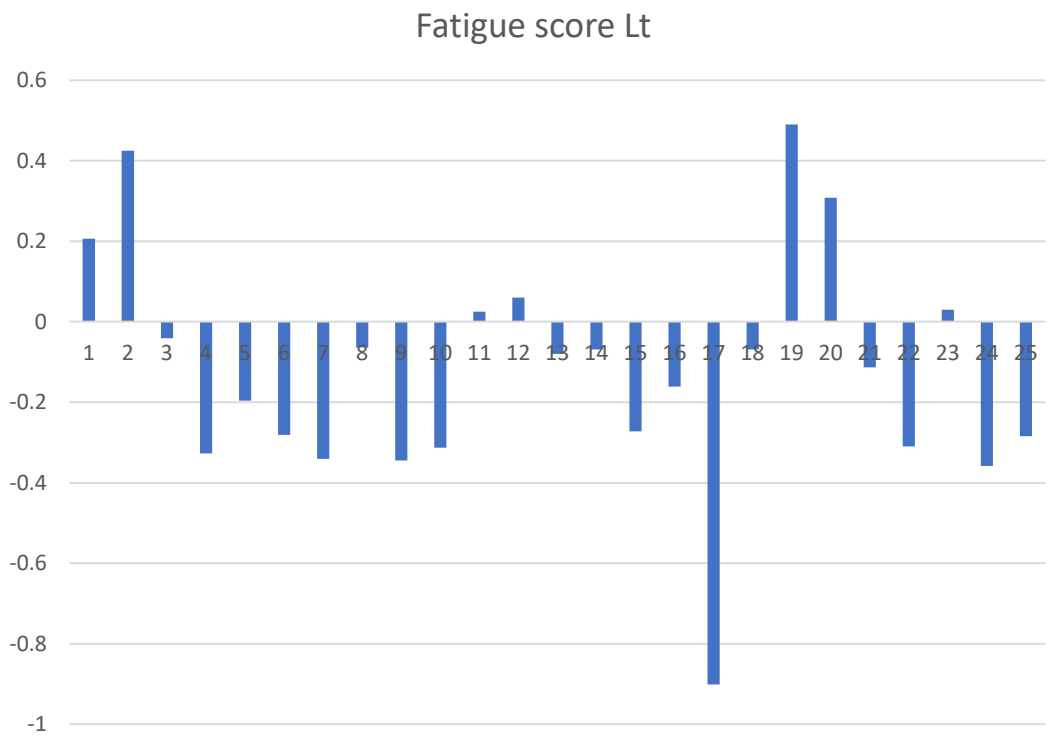
Changes in pupil diameter can reflect high-level cognitive signals that depend on central neuro-modulatory mechanisms

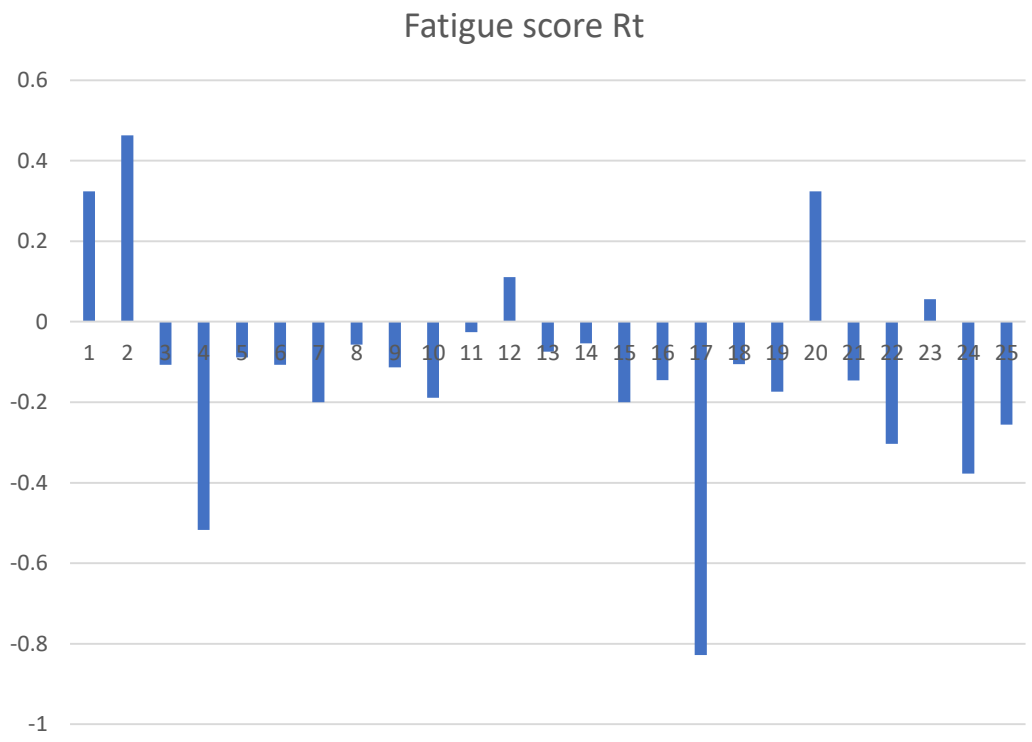
Pupillary response – Change scores



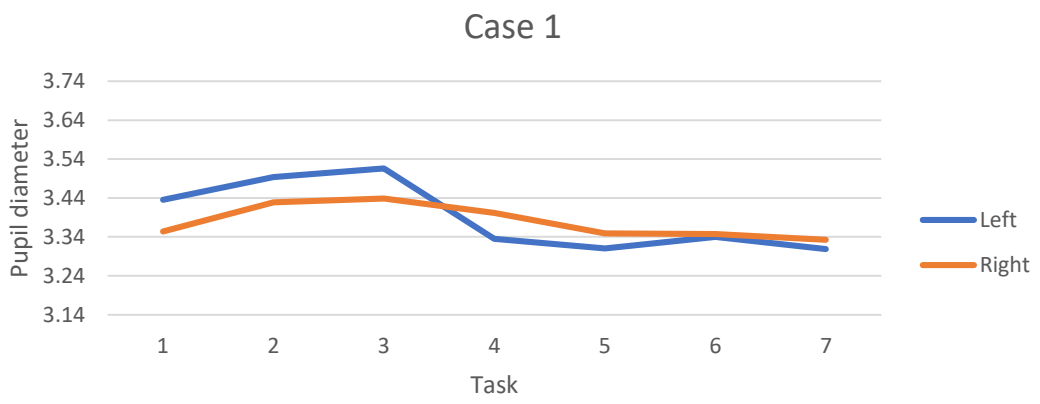


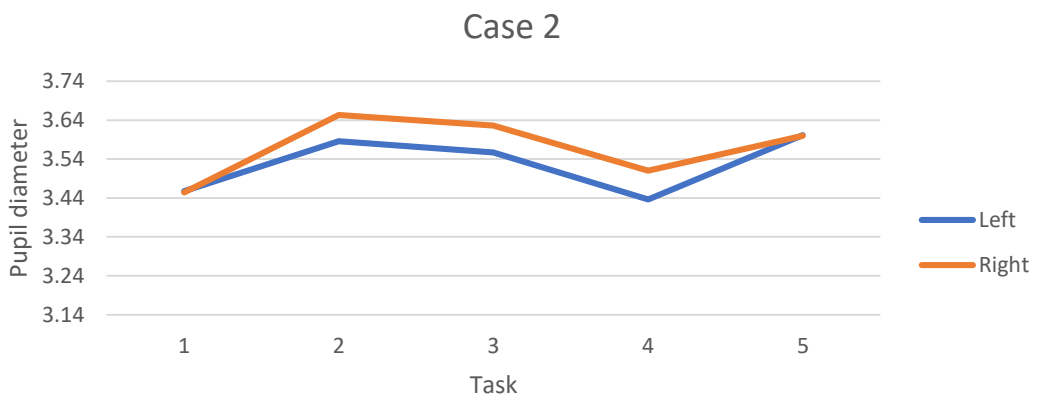
Pupillary response – Fatigue scores

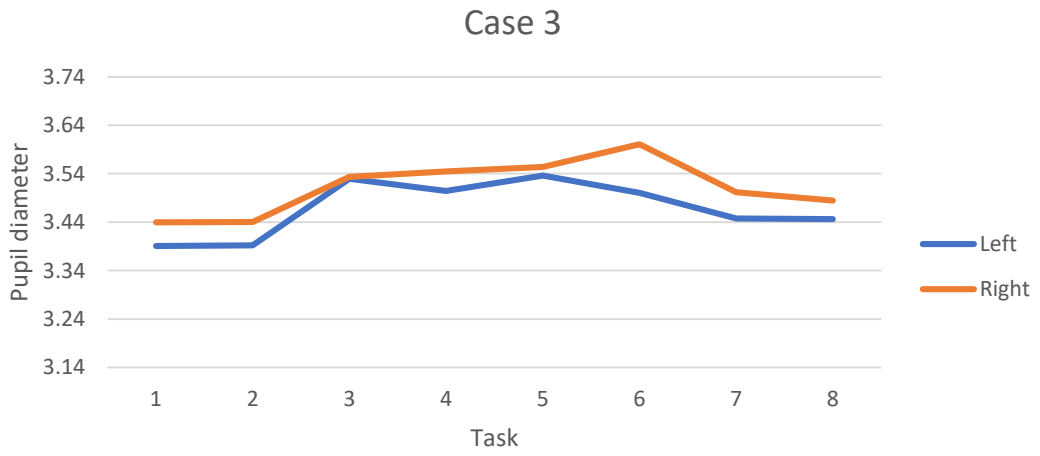


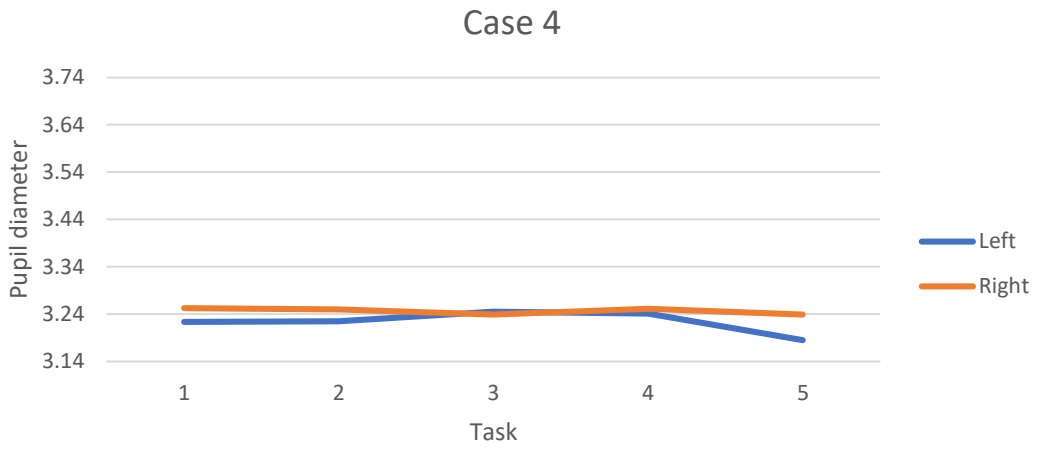


Pupillary diameter across the tasks

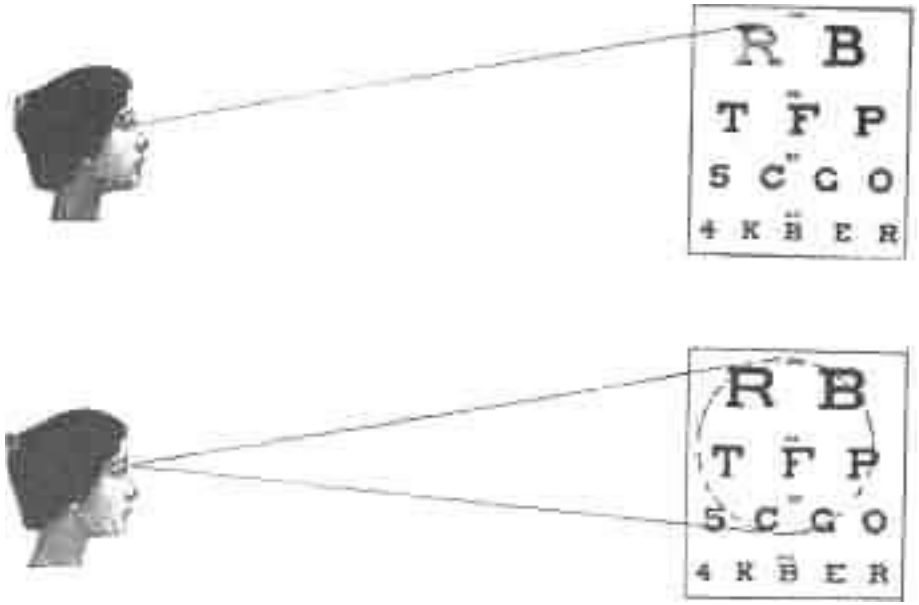






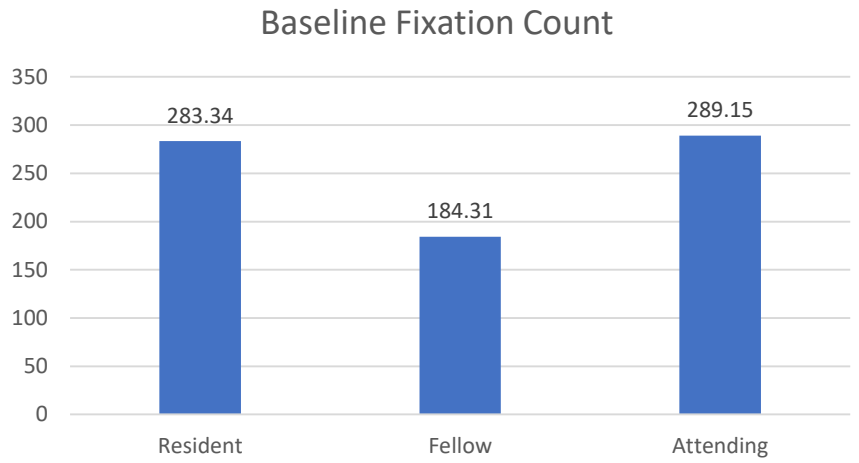


Fixation Count Results



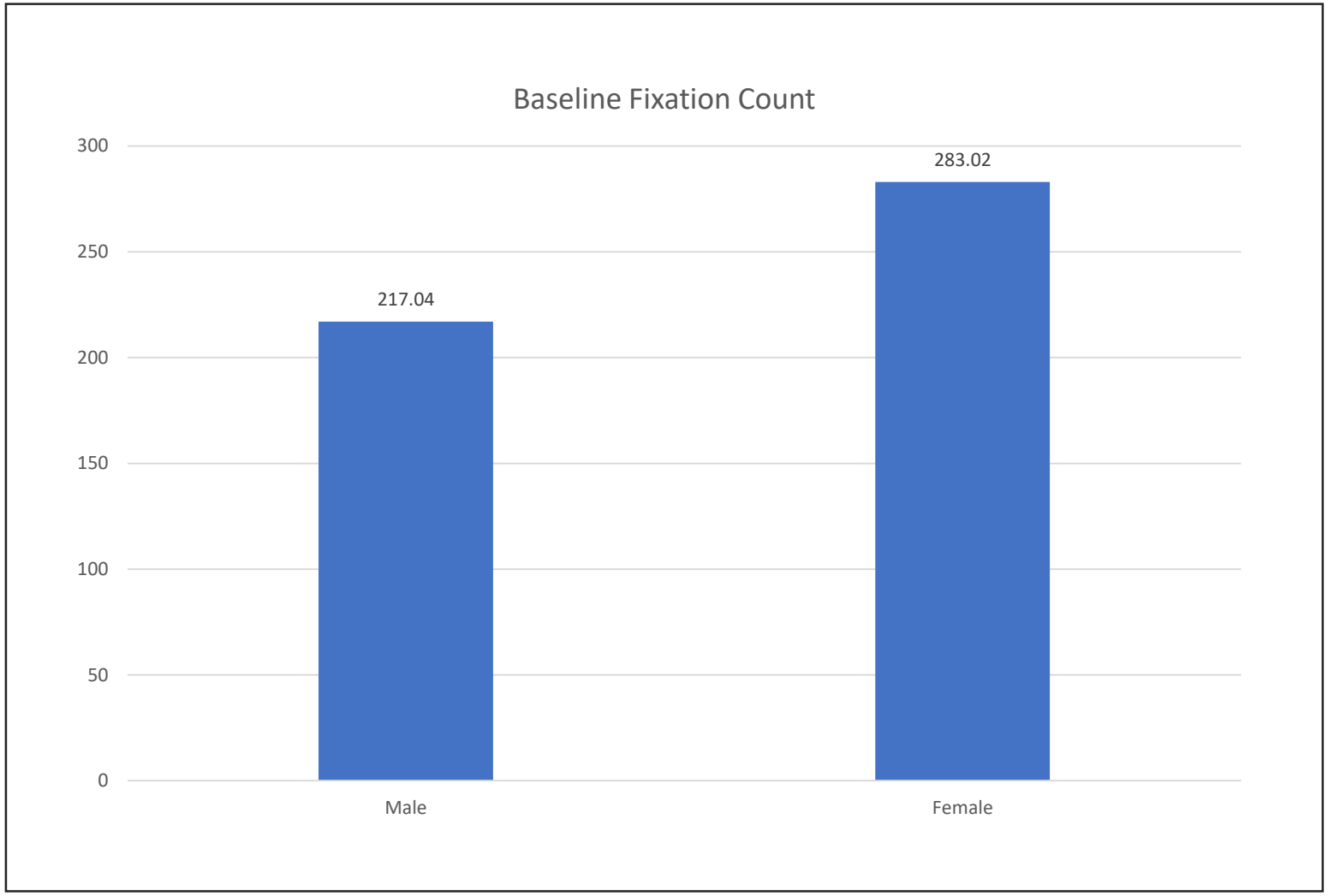
- A fixation is a brief moment during which the eye is stopped on a word or word group, and the brain processes the visual information.
- Fixation count is one of the most common fixation metrics used in eye tracking.
- A high fixation count is thought to be negatively correlated with search efficiency possibly resulting from a poor arrangement of display elements.

Baseline fixation count by Role

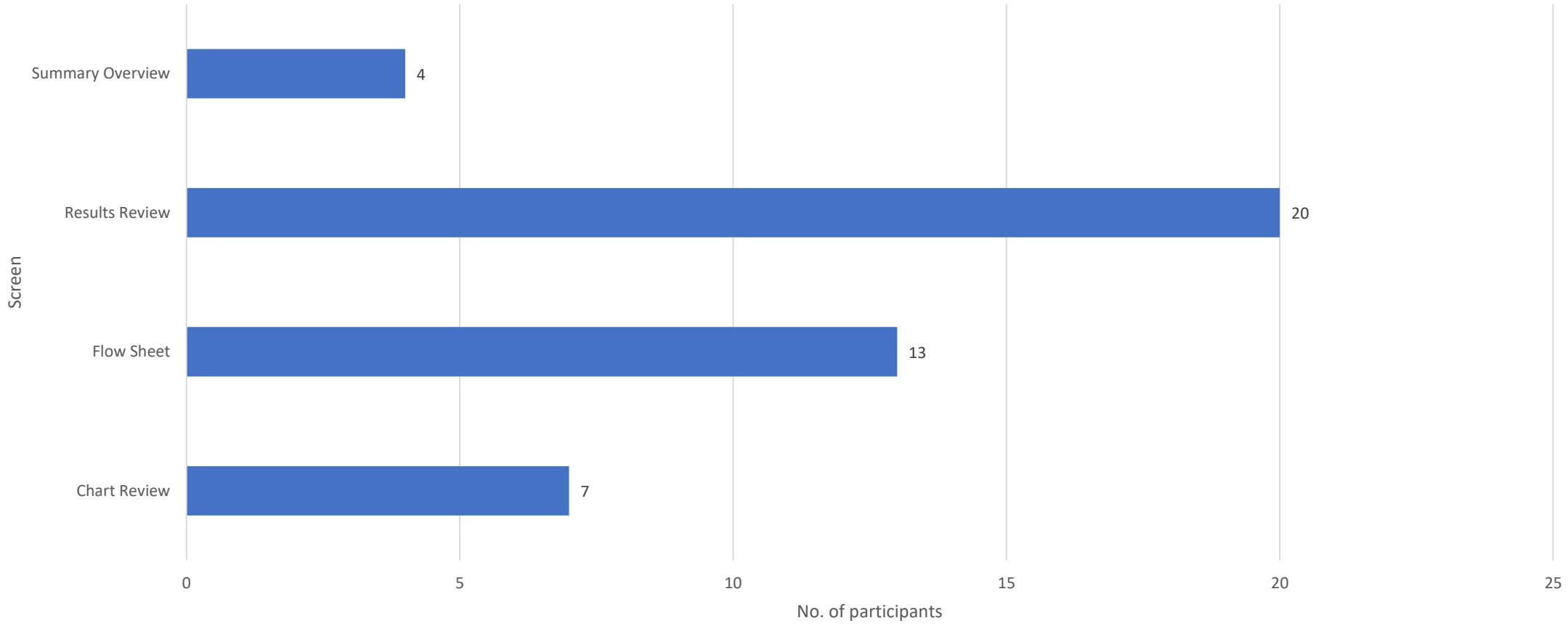


Role pairs	P - value	Result
Resident – Fellow	0.0232	Significant
Fellow – Attending	0.1292	Not significant
Resident – Attending	0.9351	Not significant

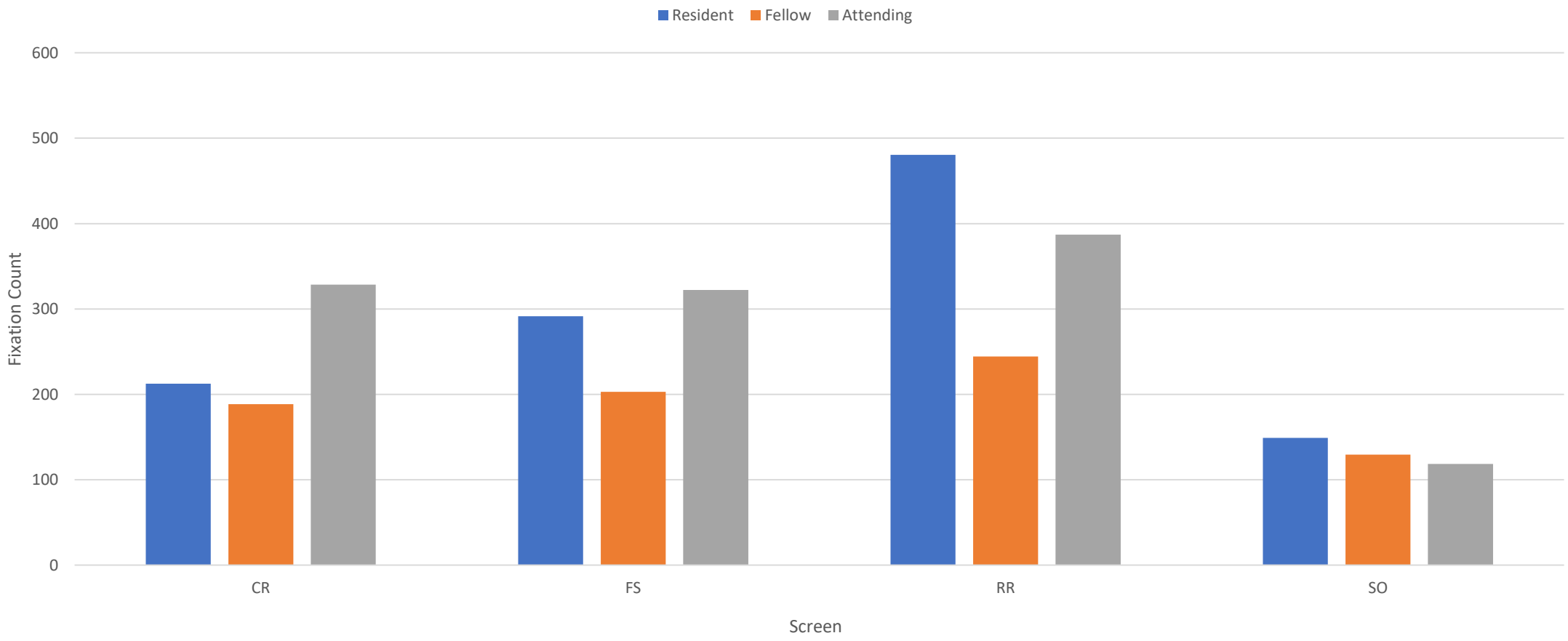
Baseline Fixation count by Gender



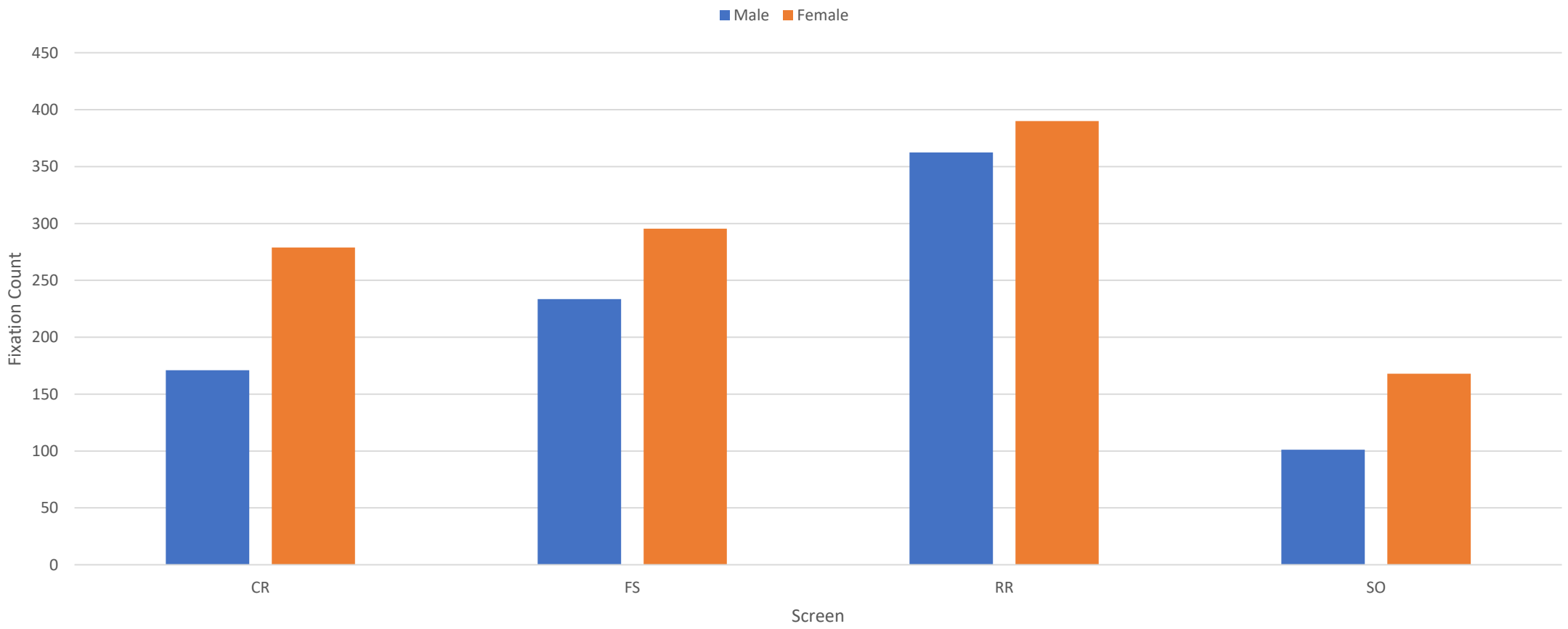
Number of participants who displayed higher than average fixation counts for each screen



Comparison of Roles by Screen



Comparison of Genders by Screen



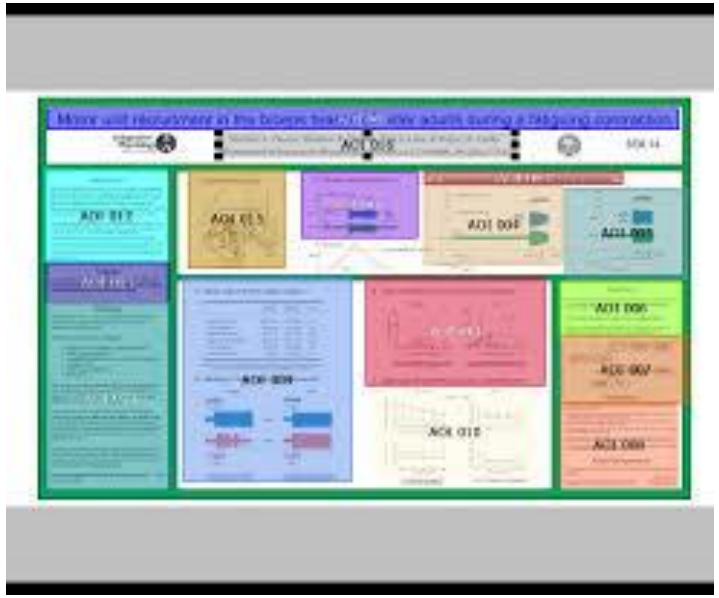
Comparison of performance by same role subgroup in different screens

Role	CR	FS	RR	SO	P value	Result
Resident	212.45	291.45	480.45	149	0.0021	Significant
Fellow	188.44	202.88	244.33	129.33	0.4551	Not significant
Attending	328.6	322.2	387.2	118.6	0.4714	Not significant

Comparison of performance by same gender subgroup in different screens

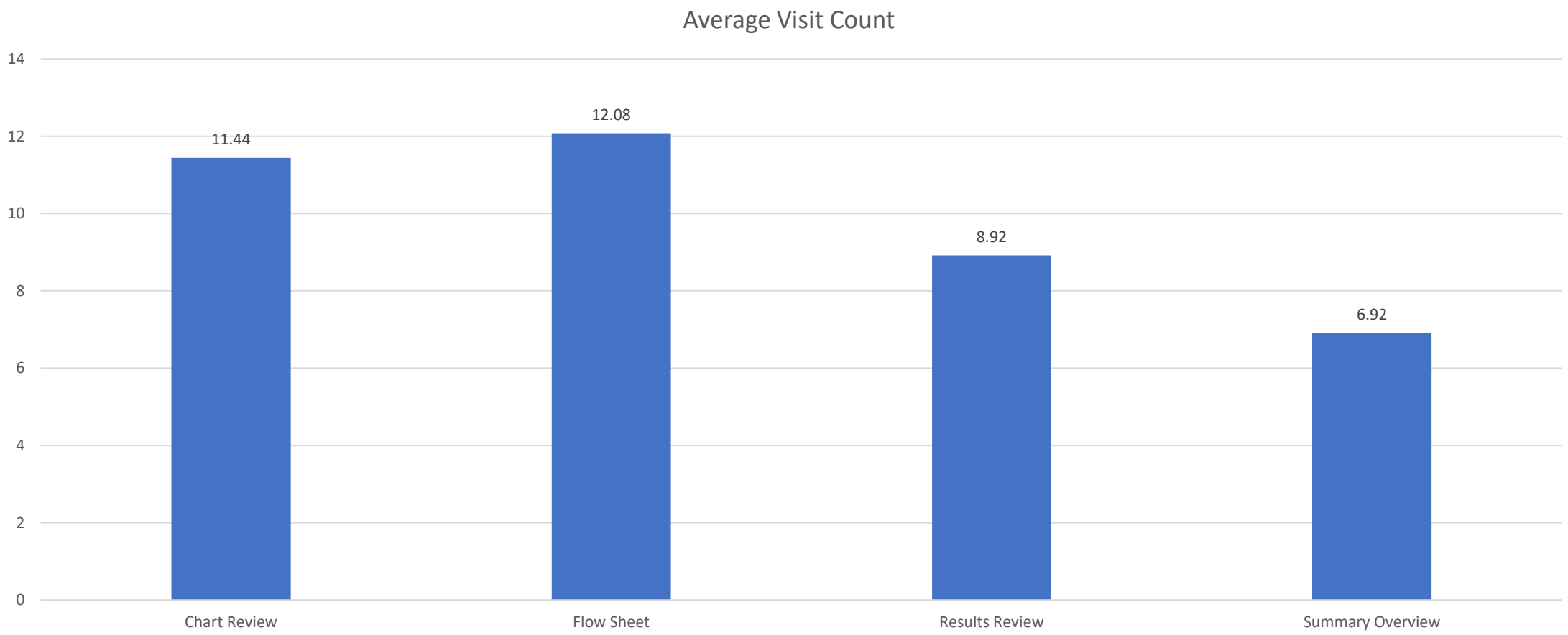
Gender	CR	FS	RR	SO	P value	Result
Male	171	233.5	362.5	101.17	0.0104	Significant
Female	278.77	295.46	390	167.85	0.0922	Marginally significant

Visit Data

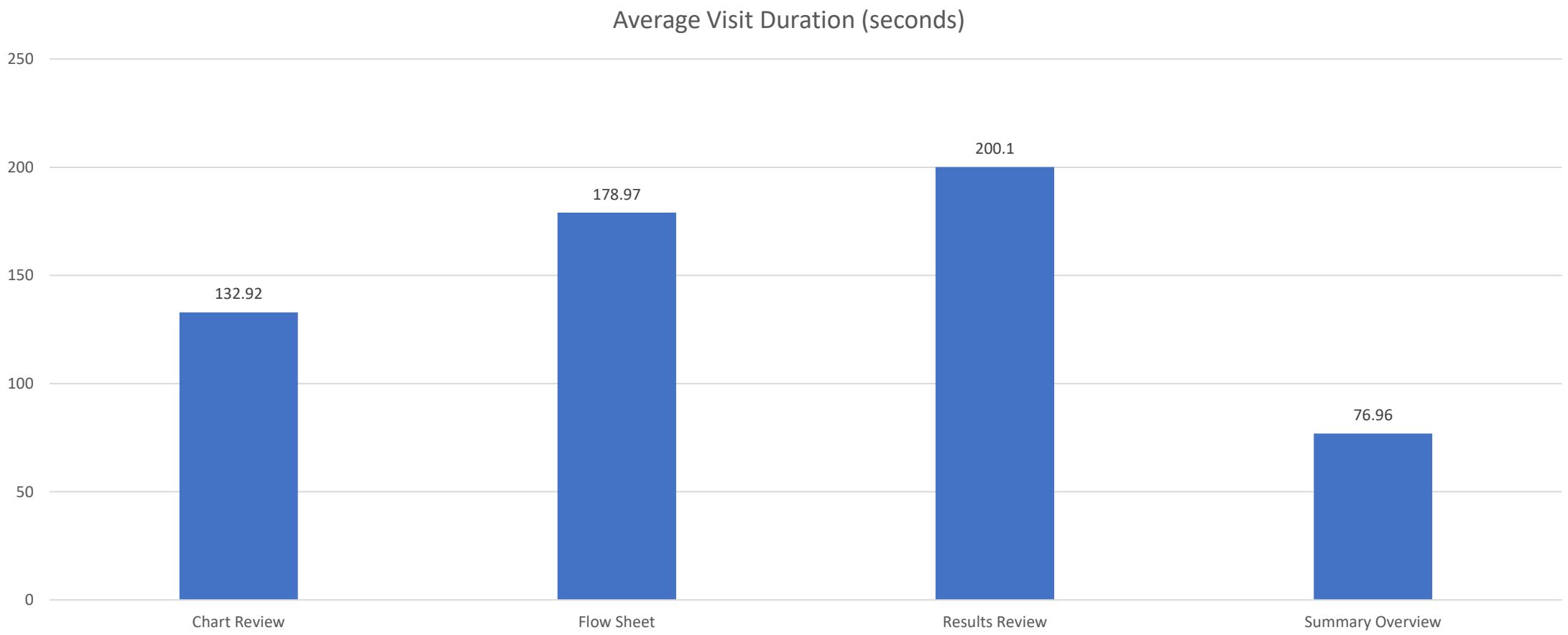


- A visit (sometimes called a gaze) begins when a user first fixates on a specific area and ends when the user fixates on something outside of that area.
- The visit count refers to the number of visits to an area of interest. A high visit count is said to be a good indicator of interest in that area.
- Visit duration is the sum of the durations of each fixation within a visit and is sometimes used as a measure of the distribution of a user’s attention among the areas of interest.

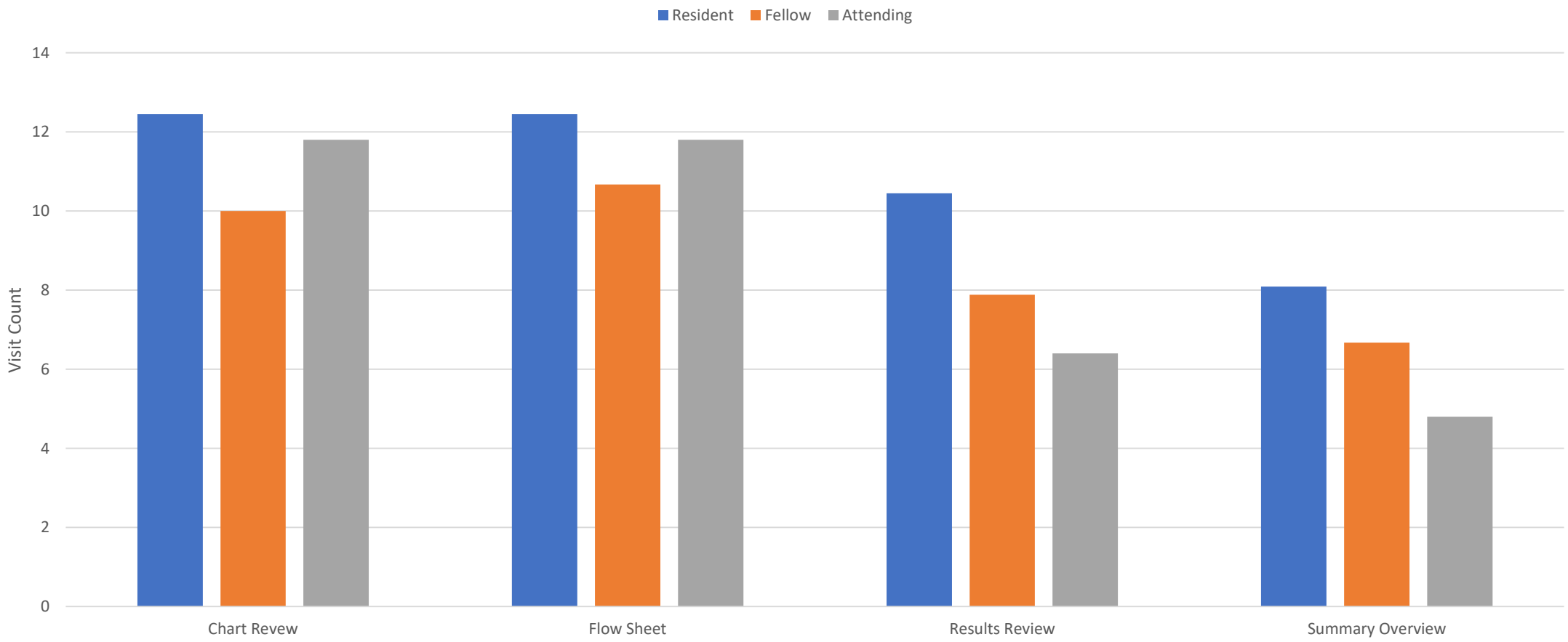
Average number of visits to each screen



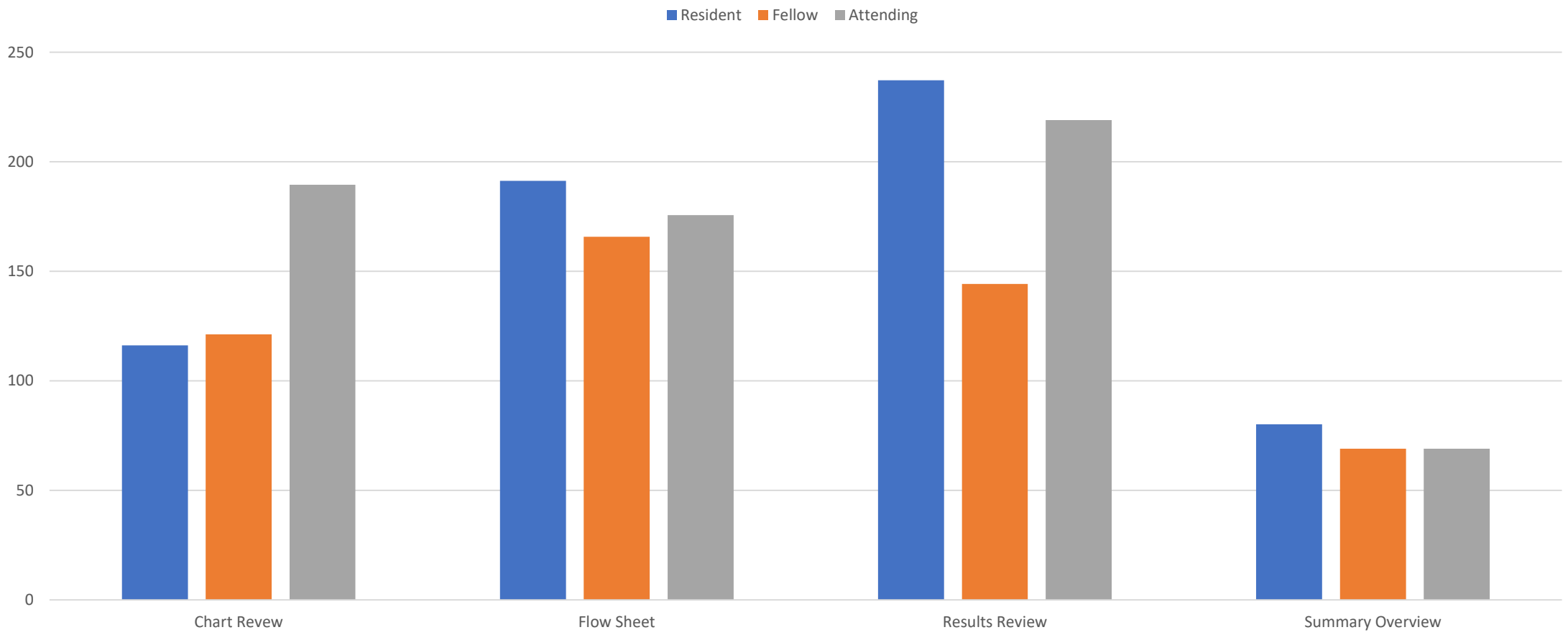
Average duration of visit to each screen



Comparison of visit count by Role

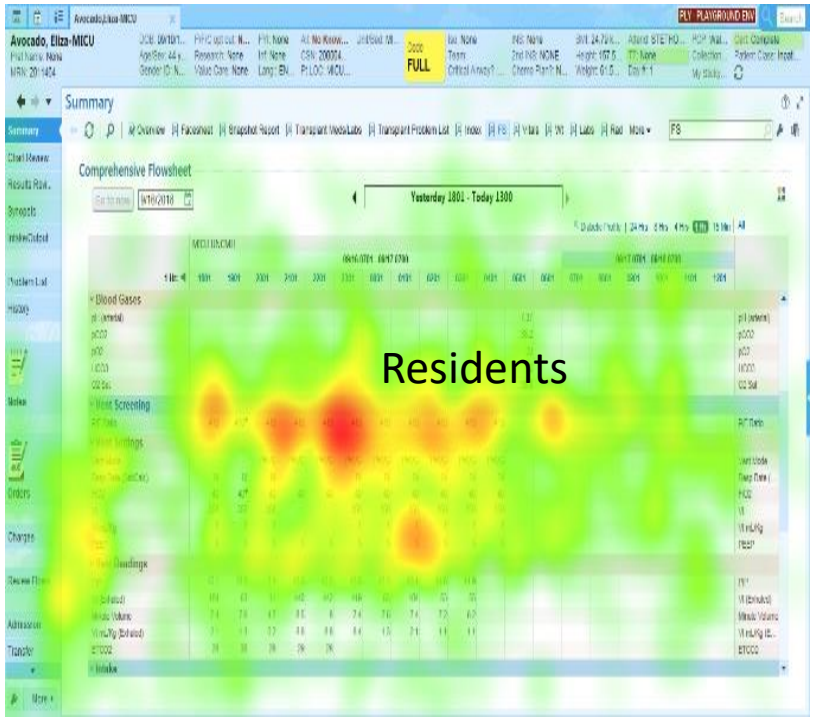


Comparison of visit duration by role

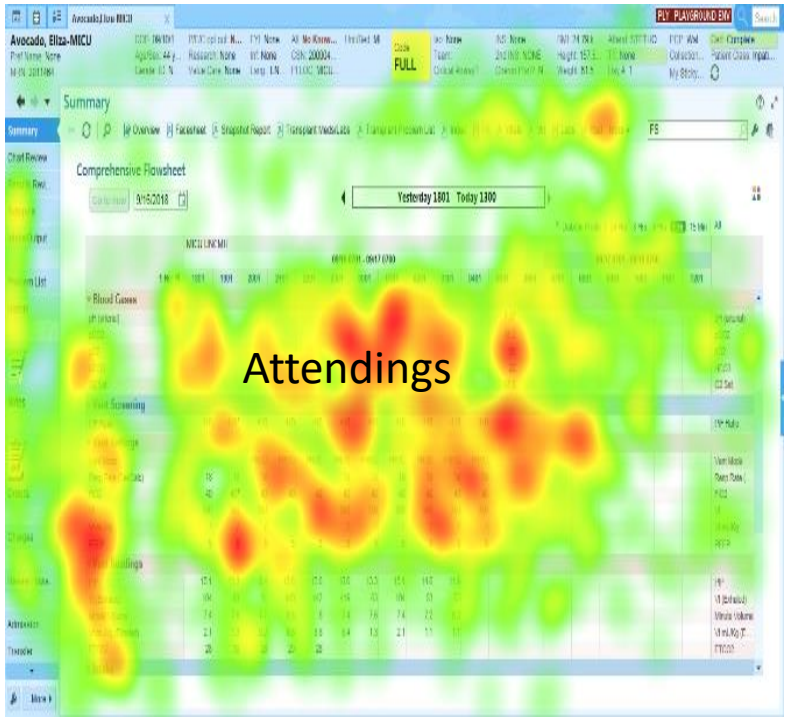


Heat Maps

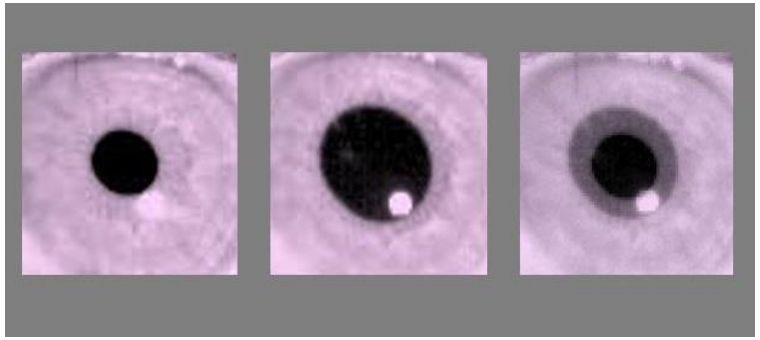
- Data visualizations that can communicate important aspects of visual behavior clearly and with great power.
- They show how *looking is distributed* over the stimulus.
- They can effectively reveal the focus of visual attention for dozens or even hundreds of participants at a time.


Residents


Fellows


Attendings

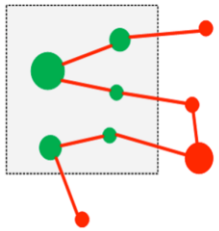
Summary of Findings



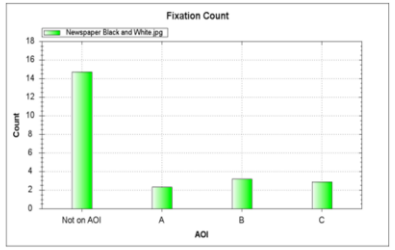
- While the EHR was successful in engaging all the participants, 80% of them experienced fatigue by the time the recordings were completed.
- Task – evoked pupillary responses can provide additional insight into which tasks users find most taxing to perform.
- Measurable changes in pupil diameter have been attributed to differing levels of mental workload, cognitive processing, attentional effort, perception, memory load, decision making, and physiological arousal.

Summary of Findings

Fixation count



- The number of fixations within an AOI.



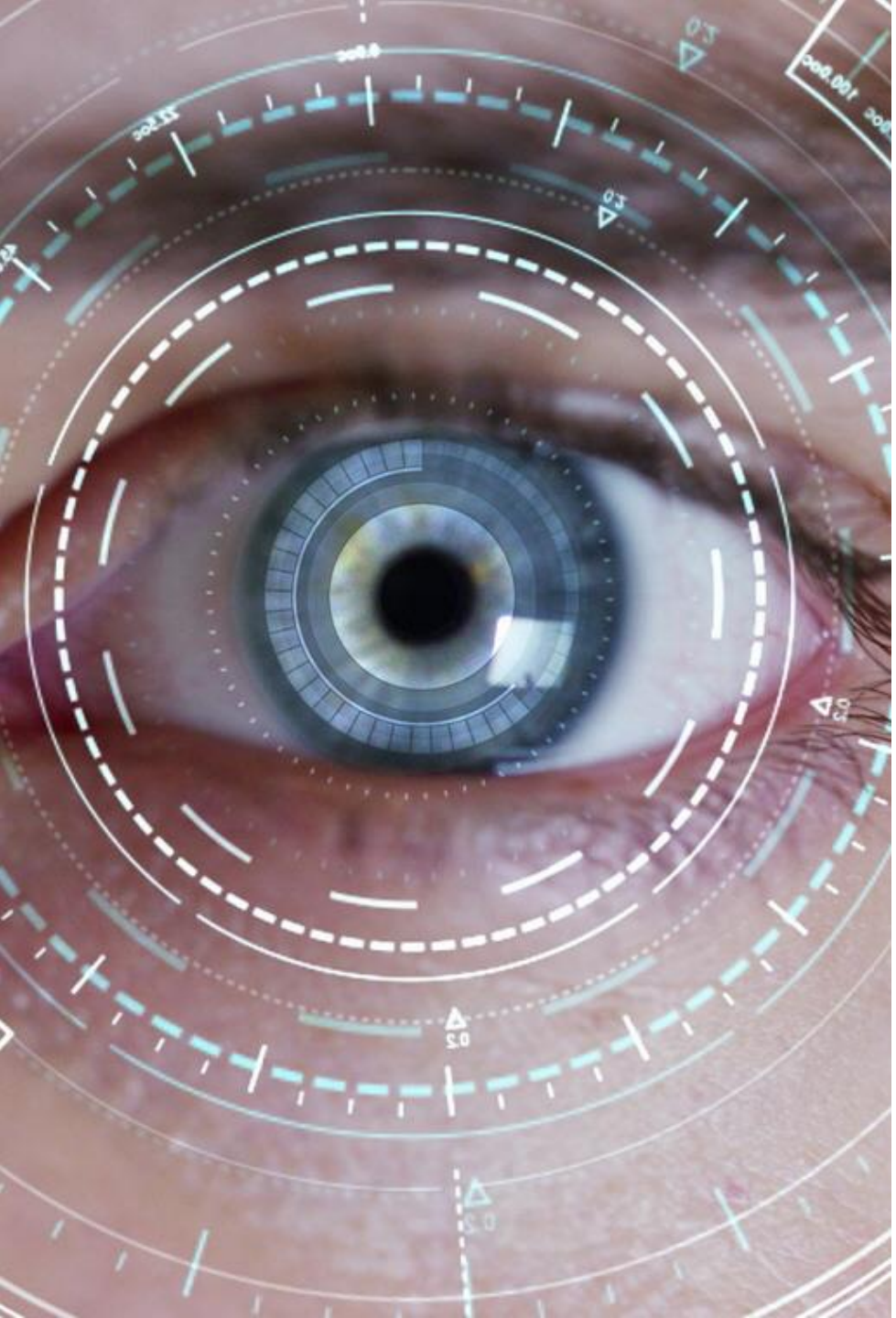
- There were differences in the fixation counts among participants based on their clinical training levels.
- A common interface can produce different experiences among different categories of users.
- All subgroups found the Results Review screen to be the most difficult to find information, justified by the higher average fixation counts compared to the other screens. Summary Overview screen had the lowest fixation counts across all groups suggesting good information organization, which makes it easy to locate information.
- Although there was only a minimal gender-based difference, the overall ranking of EHR pages by search efficiency, was similar among both gender groups.

Summary of Findings

- The Flow Sheet screen was associated with the highest number of visits followed by Chart Review, Results Review, and Summary Overview in decreasing order.
- The Results Review screen was associated with the longest visit duration followed by the Flow Sheet, Chart Review, and Summary Overview screens in decreasing order.
- When the visit counts and durations were broken down by role subgroups, it was seen that the values varied for all the three different groups indicative of their different interests and purposes of usage of the EHR.

Study Limitations

- Recruitment of physicians belonging to only one specialty
- The inclusion of only a single site and single EHR system
- Lack of inclusion of non-physician healthcare providers
- Unequal distribution of participants in the different role subgroups
- Lack of a training baseline



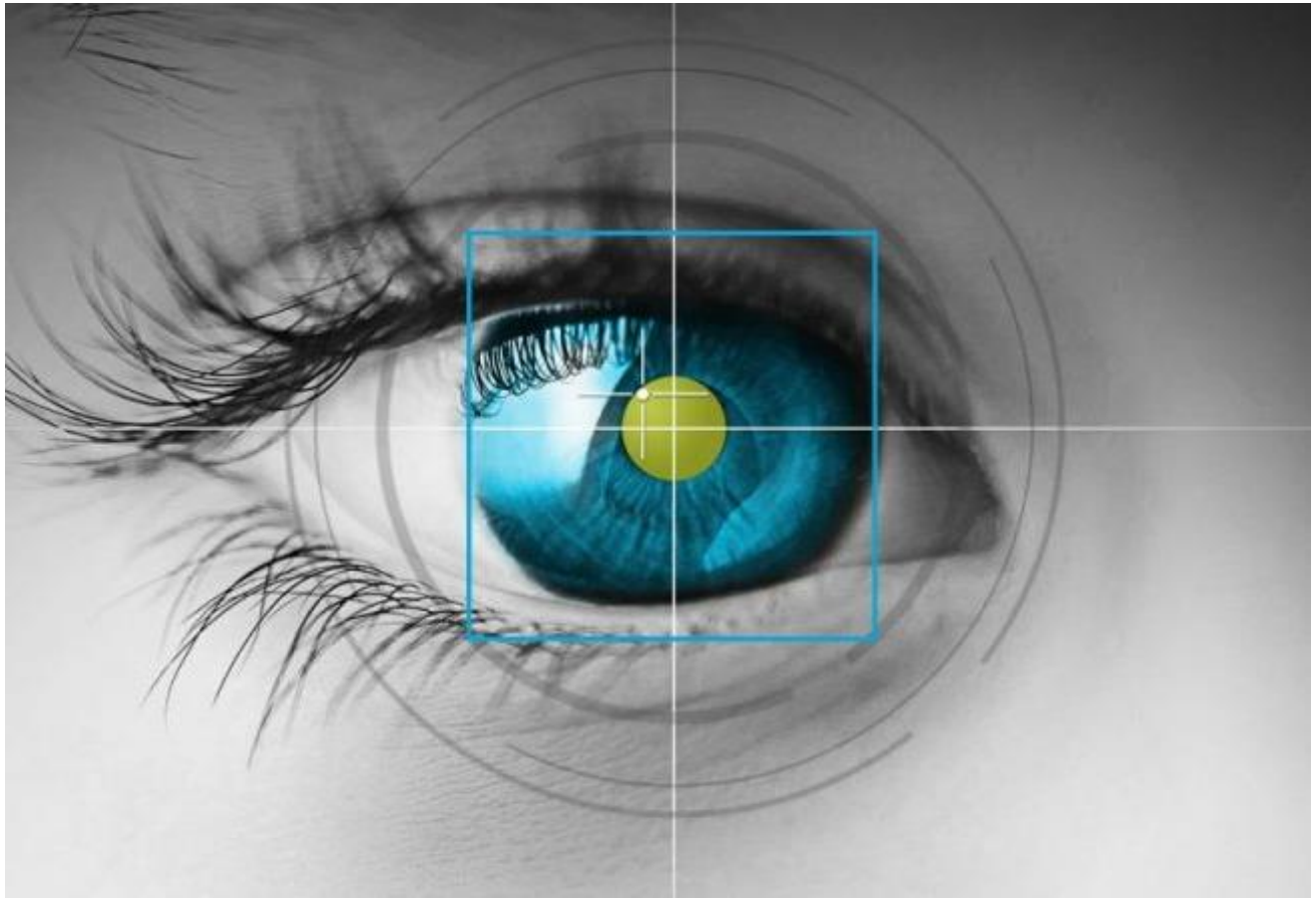
Advantages of Eye - Tracking

Results can help researchers determine:

- if participants have difficulty performing any task
- where they expect to find certain elements
- whether they notice a specific element—such as a link, or button added to a user interface
- whether elements are distracting in a negative way
- how efficiently a design guides participants through a task
- whether there are differences in task performance by user group
- which content and how participants read—in detail or by scanning
- whether a particular design is more effective than another—in terms of user or business goals

- **Eye tracking can help identify behaviors that participants cannot easily articulate**
- **Data generated is usually precise and accurate**

Limitations of Eye - Tracking



- Influence of contact lenses, glasses, and corneal ulcers
- Requirement of considerable financial, time, and, labor resources
- Could be intrusive
- Subject to technical issues
- Eye tracking technology focuses on foveal vision (focused, central vision) and not peripheral vision, which accounts for 98% of our visual field

Conclusions

- Eye tracking methods can serve as a complementary tool for EHR usability evaluation
- Representatives of different user groups must be involved, and their unique requirements are to be taken into consideration for optimal product design

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THANK YOU