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Abstract:	This PPT contains a presentation on gaze pattern analysis and Artificial Intelligence in dentistry given in the AI for Dentistry Symposium on 21 March 2023.

Gaze pattern analysis and Artificial Intelligence in dentistry

Dr. Lubaina Arsiwala-Scheppach | 21 March 2023 | Boston, USA

DISCLOSURE OF CONFLICT OF INTEREST

Falk Schwendicke and Joachim Krois are co-founders of an AI start-up called dentalXr.ai

WHAT IS EYE TRACKING ?

WHY EYE TRACKING?

WHY EYE TRACKING?

- Academic: researchers use information about eye movements to assess attention, compare group behavior, measure visual responses, and more.

- Industry: Leading consumer brands use eye tracking to better understand customer experience and product performance by measuring visual attention to key messages in advertisements, placement and branding, package design, and more.

EXISTING EVIDENCE?

- Efficient and thorough inspection of medical images leads to faster feature recognition and better clinical reasoning.

- Professionals employ both a heightened focus to certain features and prior knowledge, leading to a context-dependent gaze behavior.

- Much of the previous literature has focused on the comparison between experts and novices, confirming that experts are usually faster, but nevertheless more accurate.

- Moreover, image content has been shown to have a significant impact on expert eye movements

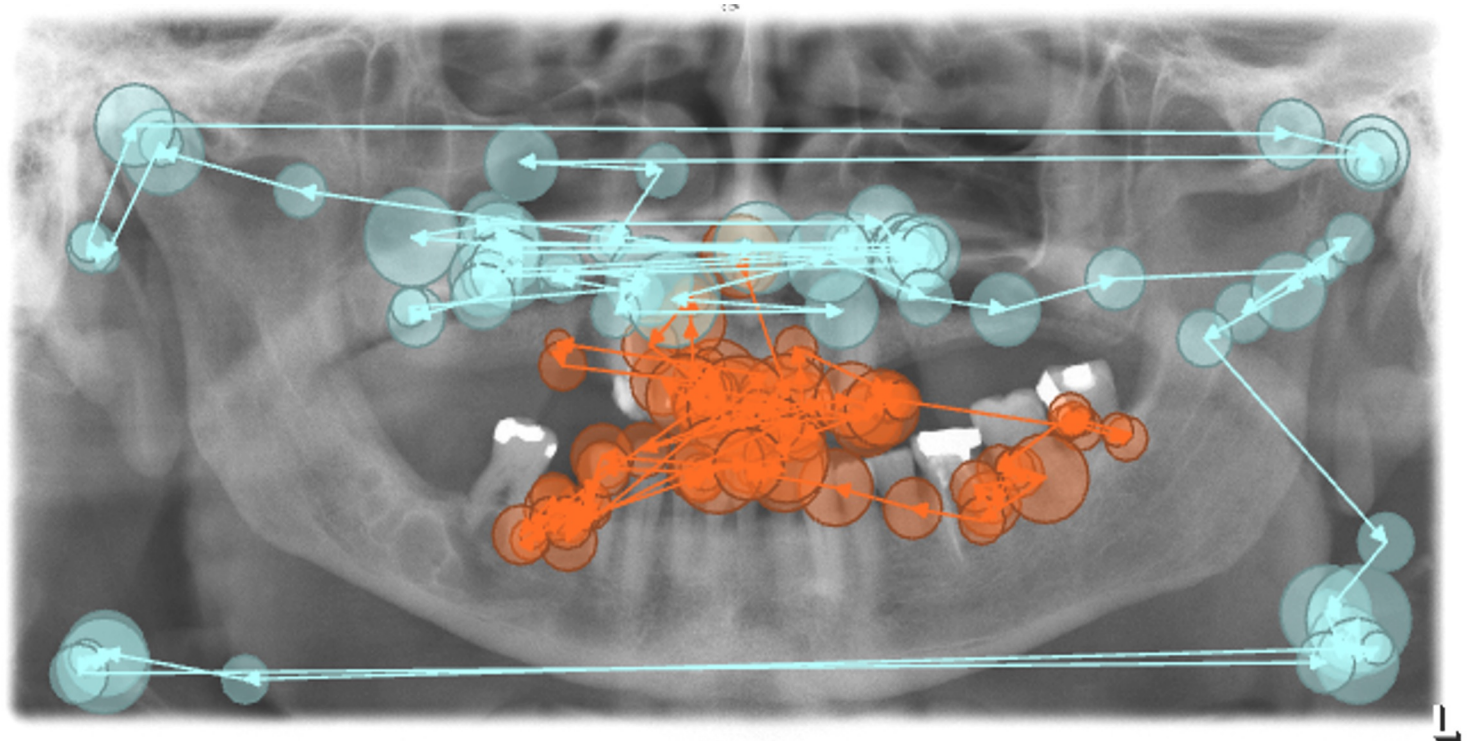- Different gaze patterns for different types of images.

TERMINOLOGY

Scan Path
The path followed by your eyes when viewing a field for a given task.

Gaze Pattern
The characteristic feature of your scan path.

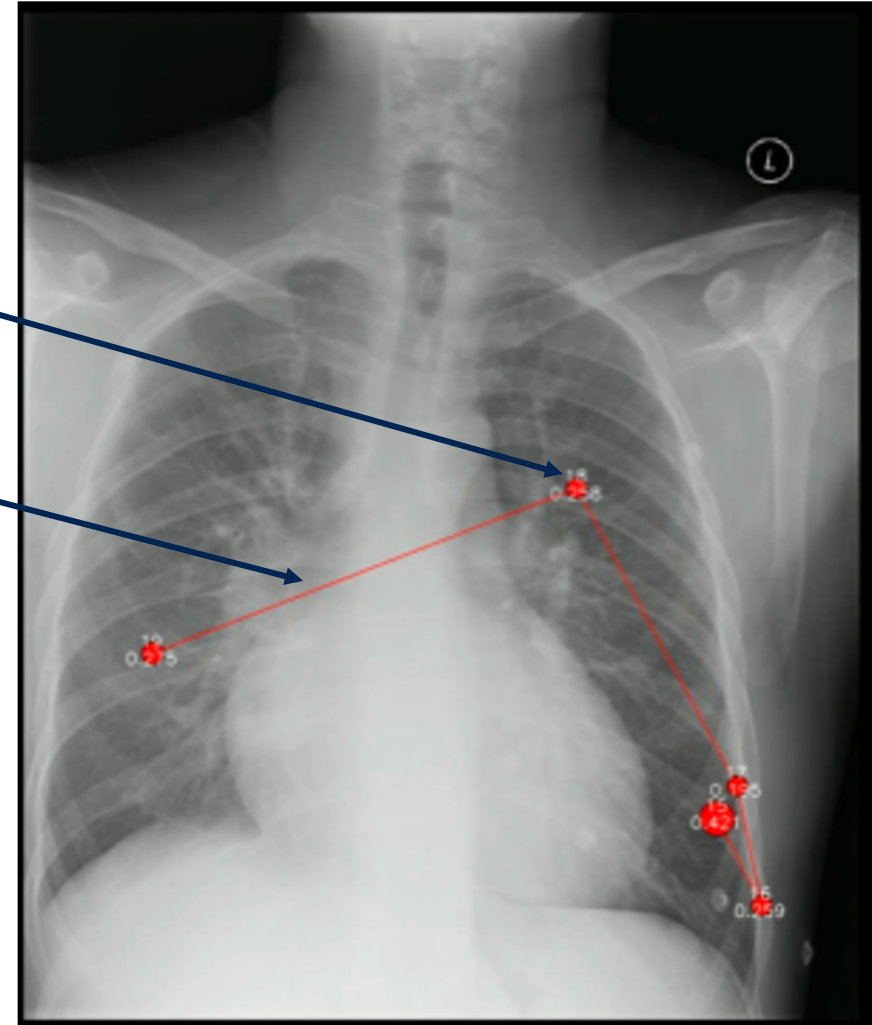Compare and classify gaze patterns for behavior recognition.

TERMINOLOGY

Fixations
Area that you focus or linger on.

Saccades
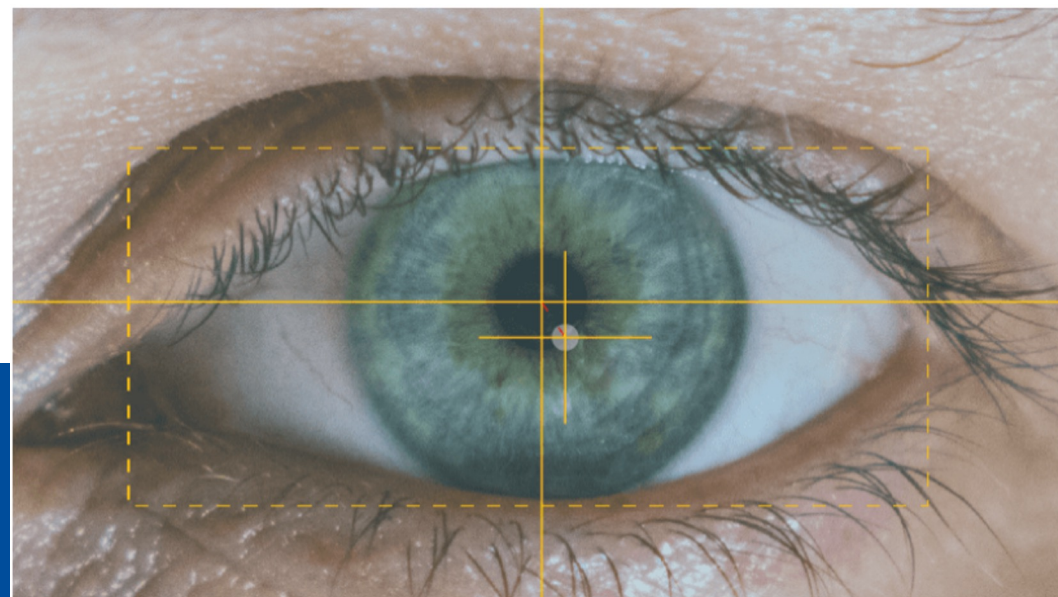The transitions between areas of focus.

EQUIPMENT

Eye tracker

Screen-based devices require respondents to sit in front of a monitor. These devices track the eyes within certain limits.

Eye tracking software

It turns the stream of data that comes from the eye tracker into interpretable insights and visualizations.

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AI:✚ AI for Health
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EQUIPMENT

Glasses-based device

HOW DOES EYE TRACKING WORK?

Light from infrared cameras is directed toward the participant's pupils, causing reflections in the eye. These reflections can provide information about the movement and direction of the eyes.

Then the eye tracking software turns this data into gaze patterns which give researchers the insights they are looking for.

USE OF AI IN EYE TRACKING

1 Pupil detection: In real-world scenarios, automated pupil detection faces various challenges, such as illumination changes, reflections (on glasses), make-up, and physiological eye characteristics.

2 Gaze pattern analysis i.e., use of convolutional neural networks to detect fixations, saccades, and other eye movement types.

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An example of our study

- Participants: 22 dentists

- Images: 140 bitewing radiographs

- Task: Diagnose primary caries in bitewing radiographs of the permanent dentition

- Healthy teeth, teeth with caries, teeth with restorations (fillings)

- During this task, the dentists' eye movements were tracked.

- Our aim was to characterize their gaze patterns.
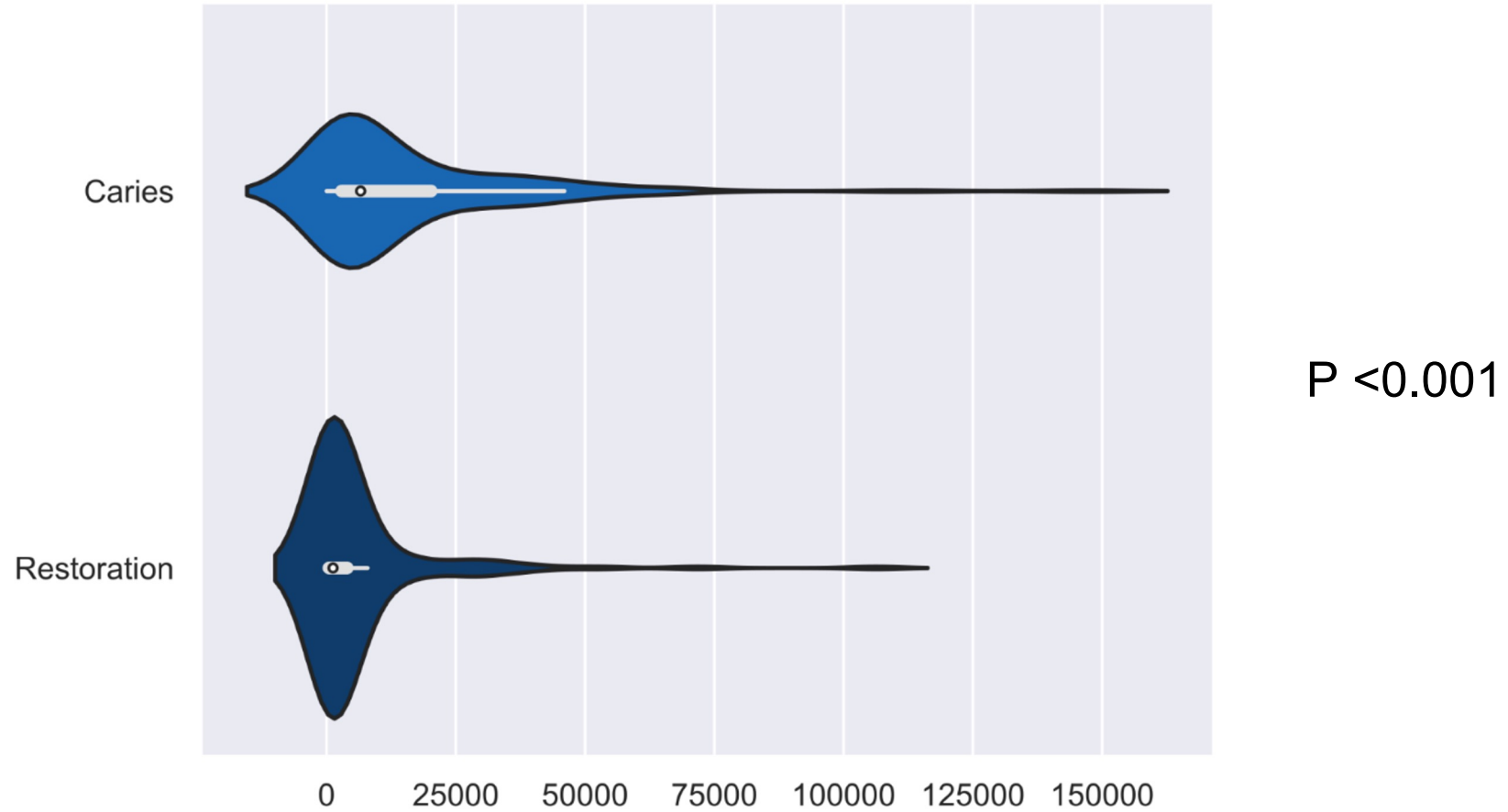
RESULTS

1

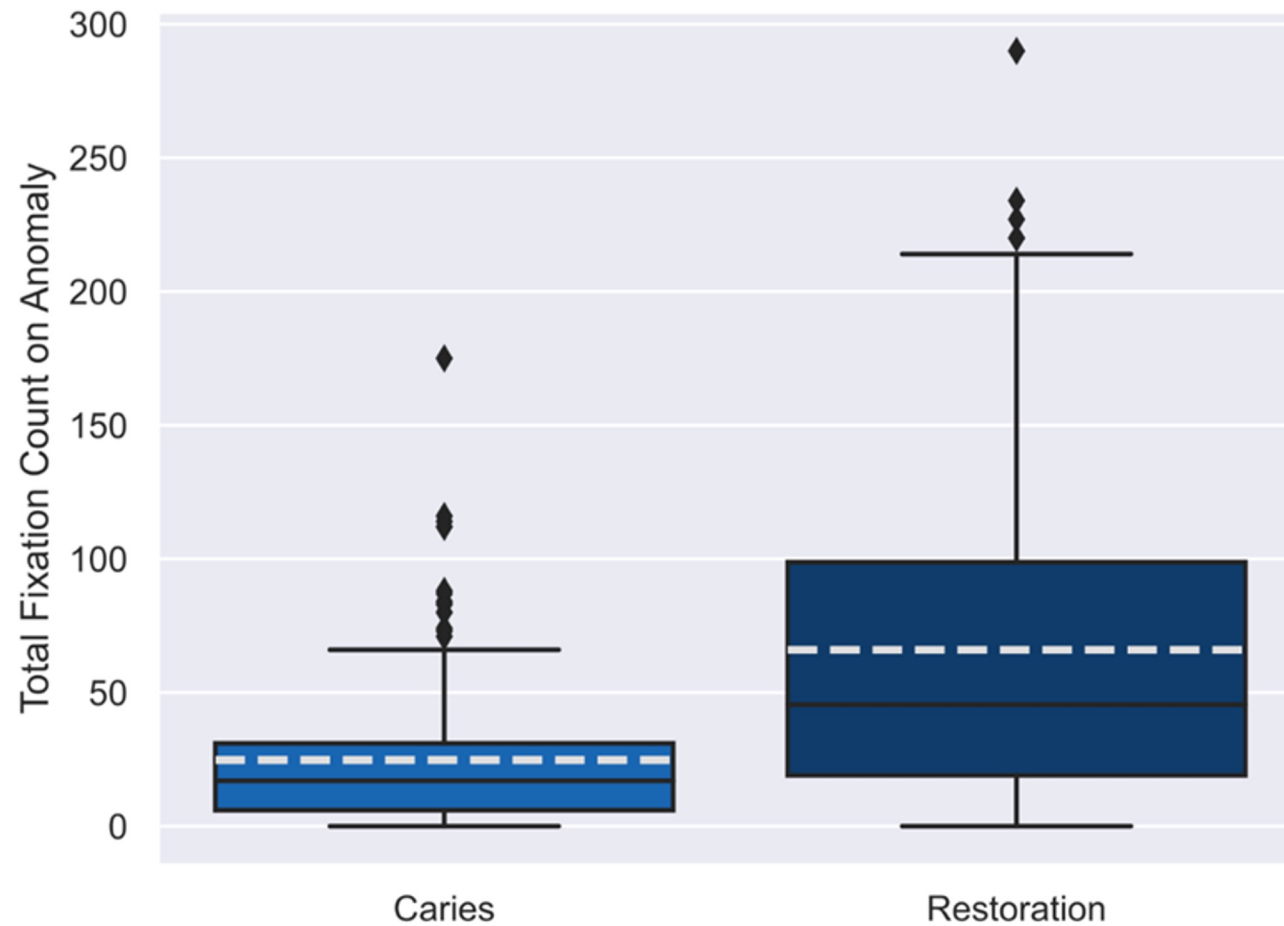Time to 1st fixation

2

Fixation count

3

Fixation duration

RESULTS

Time to First Fixation, milliseconds

P <0.001

RESULTS

Fixation Count

P <0.001

RESULTS

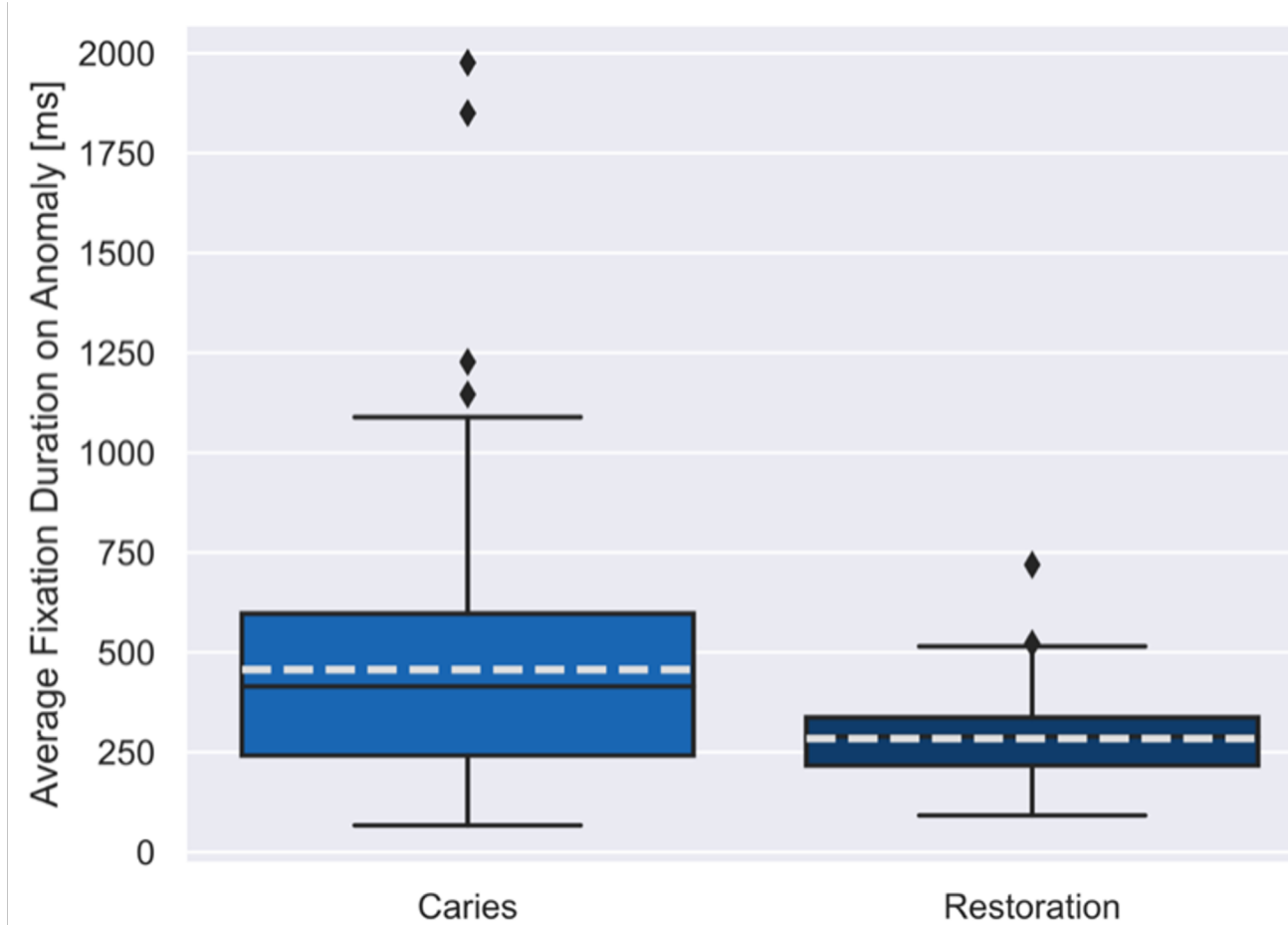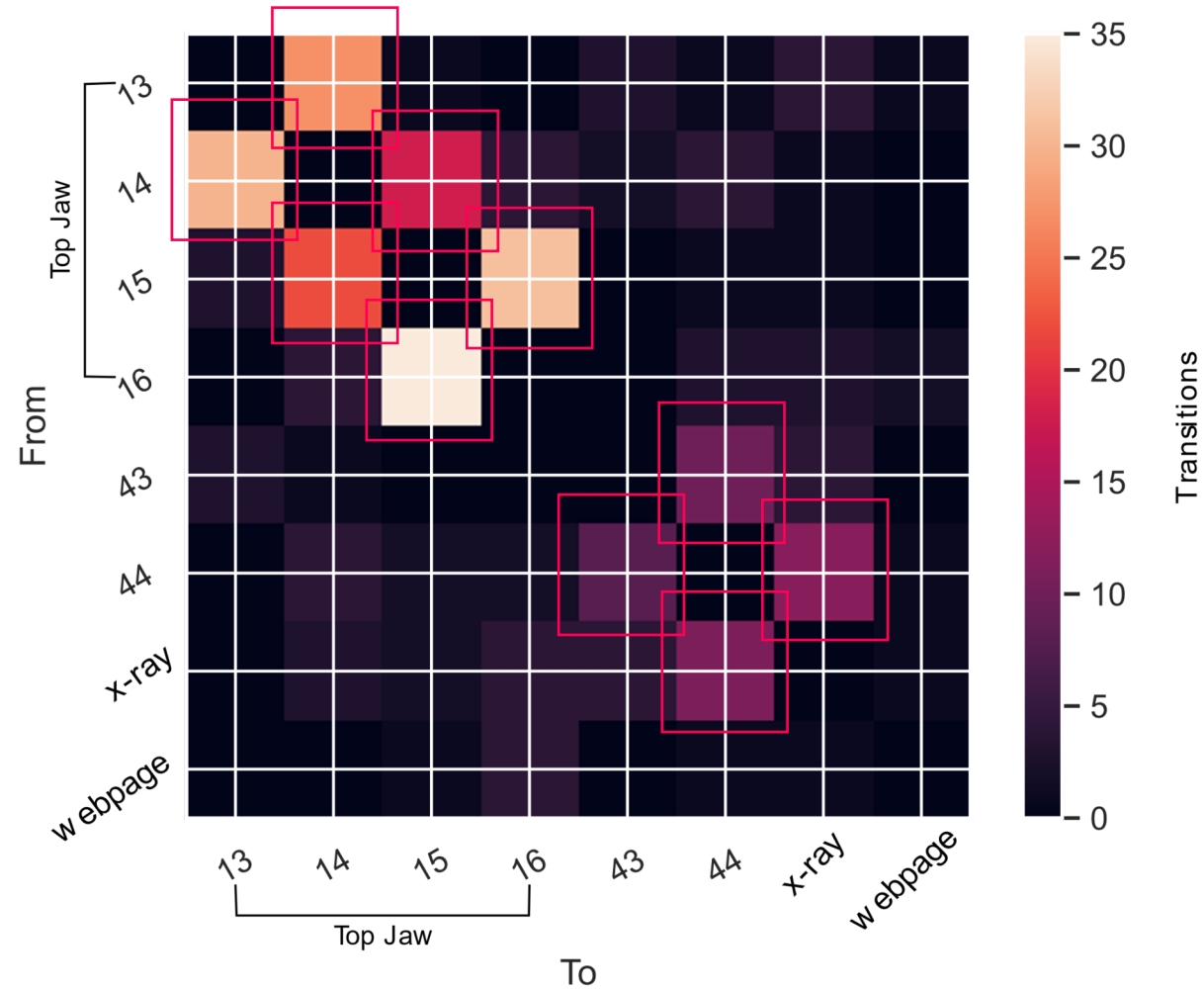**Average Fixation Duration**, milliseconds

P = 0.002

RESULTS

Gaze transitions

Applications of eye tracking

- Automated expertise recognition

- To create more seamless user-AI interactions

- Augmented or virtual reality

- Psychology
  Knowing when and how people look is essential for understanding how attention is distributed. Eye tracking is widely used within psychological tests.

- Healthcare
  Studies have used eye tracking in diagnosing autism, as well as other neurological disorders. Future uses may employ eye tracking in providing optimal patient care in medical settings.

Applications of eye tracking

- Neuro-marketing
  Following gaze patterns while people shop has been a growing topic within neuro-marketing for many years. Being able to see what people attend to or ignore can be crucial for implementing optimal packaging design, store layout, and point-of-sale displays.

It is also valuable to study the gaze patterns of website visitors.
- How long does it take them to find a specific product on the site?
- Which kind of visual information do they ignore (but are supposed to respond to)?
- Where do your website visitors look?
- What do they look at and how much time do they spend looking at it?

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SUPPLEMENTARY SLIDES

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Quality checks on scan path data

- Gaze signal > 0.60

- Scrolling behavior: Erroneous data points were excluded

EYE TRACKING TOOL

- The remote eye tracker used was the *SmartEye Aurora* running at 60Hz and positioned under a monitor (1920 x 1080px).
- Participants were unconstrained and positioned approximately 70cm from the system.
- Gaze data was collected the whole duration of the experiment.
- Gaze data was then pre-processed using the *iMotions* software (version 8.2.22899.4).
- Event detection was the *iMotions* implementation of the I-VT algorithm, with a minimum fixation duration of 60ms and a velocity threshold of 30deg/s.
- The current analysis used the fixations reported from the software, which are interpolated between the left and the right eye.
- We interpret fixations as the areas of attentional focus related to the stimuli presented on the screen.