HOW THE LEVEL OF FAMILIARITY WITH AN IMAGE INFLUENCES VISUAL SEARCH PATTERNS

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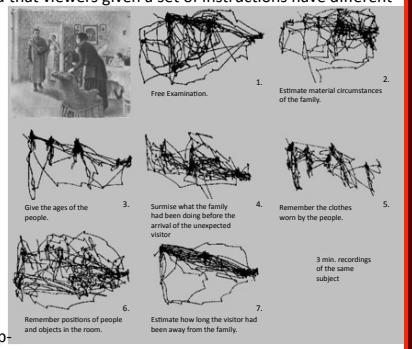
Introduction and Objective

Learning is characterized by an enduring change in behavior under conditions of stimulus. However, certain mechanisms underlying learning continue to elude scientists. We propose that one way to study the process of learning is to use visual search patterns. This project explores whether subjects' visual search patterns change with experience with select images. We propose that as an individual becomes more familiar with an image, they will spend less time exploring the image and focus on fewer, more salient features. Our goal is to document a correlation between an individual's experience viewing a particular image and their gaze pattern when exploring that image.

Background

- Eye tracking records a person's visual gaze, or how they search an image:
  - A visual search pattern is a series of eye movements examining an image
  - Search strategies are formed from context **and** cognition-> Scan Path
  - Yarbus/Buswell found that viewers given a set of instructions have different scan paths than those given no guidance (Image Right)
  - Yarbus/Buswell concluded that knowledge plays a part in determining a search strategy
- Novices typically use a bottom-up search strategy that is based on salience, as they have no basis to form a search (#1)
- Experts tend to use a top-down search strategy based on experience (#2-7)



Unexpected Visitor by I.E. Repin: Picture Yarbus used with subjects to observe gaze patterns. Images 1-7 show the gaze pattern affiliated with each set of tasks. (Yarbus, A. L. (1967). *Eye movements and vision* [Rol' dvizhenil glaz v pro ˇt ˇsesse zreni ˇi ˇa.]. New York: Plenum Press.)

Methods

Adult subjects from the general population were tested using an eye-tracking device that recorded a subject's visual gaze pattern during image viewing. Displayed images came from one of four categories: objects/tools, human faces, animal profiles and animal faces, and were all grayscale. During a trial, each category was shown with one repeated image (shown 10 times) and 15 non-repeated images. Subject's controlled their own advancement and viewing duration for each image. All procedures and protocols were approved by the Boston University School of Medicine IRB.

Applications in Medical School Education

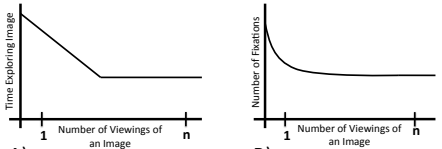
- The ability to track the difference in how a novice (e.g., first year medical student) and an expert (e.g., attending physician) view radiographs, slides, charts, etc.
- Assessment tool for determining progression of learning (tracking students abilities)
- Ability to know how an expert views information allows the ability to teach that search method upfront, instead of learning from experience over time

Hypothesis and Predictions

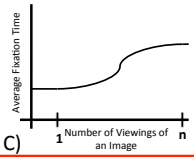
1) Degree of expertise is proportional to experience (n viewings of image)
2) Degree of expertise is an inverse function of time spent viewing an image; and is an inverse function of number of fixations evaluated in the image; and is proportional to time spent on a fixation.

We expect that the first time subjects view an image the image is scanned in novice fashion, exploring using a bottom-up search strategy. As subjects gain more experience with an image the search pattern changes to a top-down search strategy. We measured the length of time a subject views an image, the number of fixations that are made, and the duration of each fixation. Three possible general trends based on our predictions are shown in the figures below.

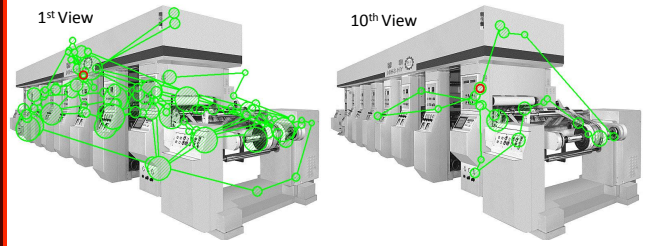
- **Prediction A**: As the number of views increases, the length of time spent observing the image will decrease to a plateau.



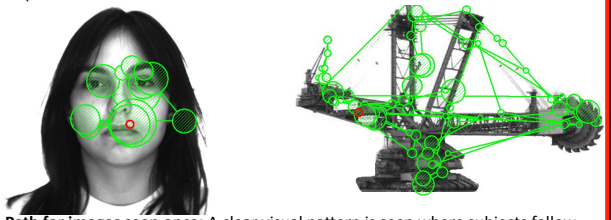
- **Prediction B**: As the number of views increases, number of fixations per view will decrease to a plateau.
- **Prediction C**: As the number of views increases, duration of fixations per view will increase to a plateau.



Results

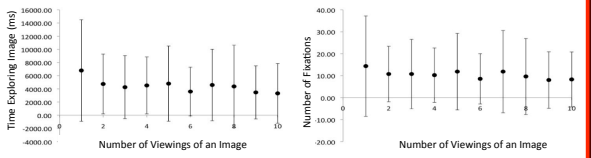


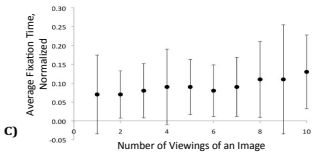
Scan Path Repeated Image: A subject's scan path is shown for the first and tenth time they saw that image. Clear differences include a shorter image duration and fewer fixation points.



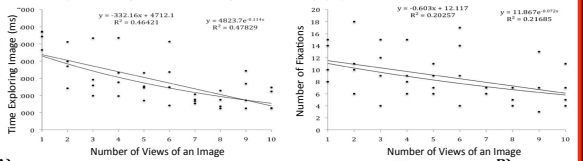
Scan Path for images seen once: A clear visual pattern is seen where subjects follow the shape of the image. This suggests a bottom-up search strategy.

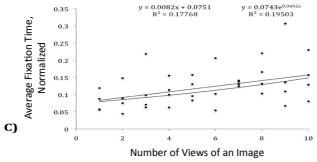
Results Continued





Combined Data of Repeated Images : All points are the average values (mean +/- SD). A) Duration viewing an image, all subjects and categories combined. B) Number of fixations, all subjects and categories combined. C) Average normalized fixation duration, all subjects and categories combined. The general relationships proposed above are seen in the combined data.





Repeated Views for a Subject: Each graph represents the data from one individual viewing images repeatedly. A point refers to a value for subject for a particular image viewed. There are four points per viewing because the data for all four repeated images are shown. A) The duration of viewing of an image. B) The number of fixations per image. C) Average normalized fixation durations per image. It is seen in A and B that the proposed downward slope exist and in C an upward trend is present. However, the predicted models are not perfect as lines of best fit have poor R^2 values.

Conclusions

We conducted graphical and statistical analyses across subjects and per individual subjects and found non-significant trends that support our hypotheses that viewing duration decreased with repeated viewings and that the number of fixations per image decreased with repeated viewings. From these results we conclude that more subjects need to be tested.

In addition, a further question is posed: Do previous points of fixation influence where a subject is looking? This reflects if people use a Markov or Bayesian search strategy, or both, and allow a model to be created to simulate visual search. Future experiments are currently being planned to refine this study.

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