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ASSESSING THE EYE GAZE BEHAVIOURS OF ILLUSTRATORS SKETCHING FACIAL EXPRESSIONS FROM OBSERVATION

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ABSTRACT

Sketching is a historical means of sharing knowledge and remains vital for communication across disciplines. Drawing translates mental images and experiences into visual knowledge and expression. Sketching education is steeped in tradition, but emerging digital technologies like eye-tracking glasses allow researchers to, for the first time, see through the eyes of illustrators as they work. This exploratory study uses eye-tracking glasses to measure head and eye kinematics, eye gaze quantity and duration, and production script order of novice and expert illustrators. It introduces terminology, high-fidelity measurement tools, assessment methods, and insights that could influence future drawing pedagogy. Eleven illustration undergraduate students and three instructors wore eye-tracking glasses as they drew facial expressions while referencing live models. Results uncovered four categories of head pitch and eye saccade kinematics and expert and novice gaze differences referencing the model and drawing paper. Experts rapidly gaze at the reference 3.5 times more than the novice who gaze longer and 3.0 times more often than the expert. Novices gaze at their paper for 59% of their drawing time, compared to the experts at 40%. Experts had 18 rapid (less than 1.0 s.) paper gazes, while novices had 8. All participants followed a similar product script, beginning with light construction lines for the head, face, nose, eyes, and mouth in varying orders, then adding darker contour lines, adding detail from the centre outwards. Participants returned to refine eye and mouth facial details 25 – 35 times. This study uncovers previously unseen bio-mechanical movements and observational drawing methods.

Keywords: Eye tracking, drawing pedagogy, sketching research, head and eye kinematics, drawing gaze quantity and duration

1 INTRODUCTION

Sketching is a historical means of sharing knowledge and remains vital for communication across disciplines. It facilitates the translation of mental images and experiences into visual knowledge, extending into diverse domains like design research and business strategies. In the digital age, sketching education continues to evolve, prompting discussions on purposes and processes [1], [2]. Emerging digital platforms for sketching have introduced a new means of generating and assessing visual experiences, consequently impacting teaching and learning. Traditionally, drawing pedagogy tends to assess outcomes rather than processes. However, instructors have begun to explore the benefits of evaluating and teaching through emerging technologies, such as eye-tracking [3], [4]. Eye-tracking has already been used to assess and improve performance in automobile driving and architectural CADD drawing [5], [6]. Our previous eye-gaze research studied pen, hand, and eye motions between novice and expert sketchers while drawing geometric forms from memory [7]. This exploratory study continues the research by assessing the drawing behaviours of novice and expert illustrators while drawing organic forms, or facial expressions, from observation. Traditionally, figure drawing is a core component of art and design training and incorporates observing live models. To avoid recording the models with eye-tracking glasses, this facial expression exercise was selected. The study also introduces kinematic measurements of head and eye motion by quantity and duration and explores scripting order. We expect to define terminology, investigate high-fidelity measurement tools and assessment methods, and uncover appropriate topics to explore. Comparisons between expert and novice illustrators should uncover pattern differences that could influence drawing pedagogy.

2 METHOD

Eleven undergraduate illustration students, the novices, and three illustration instructors, the experts, participated in the study. Ten students were female, and one was male, between 19 and 25 years old, with a mean age of 23. Two instructors were male and one female, between 35 and 43, with a mean age of 40. Tobii 3 eye-tracking glasses and software were used with Adobe Premier Pro to gather and assess data. Prescription eyewear is incompatible with the Tobii glasses and removed for the task. In the drawing task, a student modelled an exaggerated facial expression for a partner student to draw for three to five minutes, and then they reversed roles. Students selected their facial expressions and used their personal sketching tools and paper to draw. The study was conducted in a typical classroom, and all the participants remained in the room during the recording, which took about 1.5 hours. After researchers reviewed the recordings multiple times, metrics were determined through consensus and data was collected through manual observation and with software.

3 RESULTS

3.1 Head & Eye Kinematics

The human head's six-dimensional motion and spatial orientation yield essential sensory information [5] to illustrators during observational drawing tasks. Head motions are classified as Pitch, or nodding up and down; Yaw, turning the head left to right; and Roll, or tilting or. rolling the head around at angles [6]. The human eye has four types of movements. This study only studies saccade movements, rapid eye movements that abruptly change the point of fixation between the reference face and the drawing paper. Saccades range in amplitude from small reading-like movements to large room-scanning movements [7]. Unmanipulated screen captures from the recordings provide visual examples of four different head/eye movement behaviours observed in this study.

3.1.1 Fixed Pitch & Long Saccades (FPLS)

Kinematically, this participant (Figure 1) had a fixed head pitch with no yaw or roll movement; he rarely moved his head, and his eyes did all the movement while drawing.

Figure 1. Reveals a fixed head pitch and long eye saccades

His saccade amplitude between the reference model and the paper was some of the longest in the study. In Figure 1, the ceiling lights remain in the exact location in both images, while the red fixation circle, indicating pupil gaze, changes location significantly (long saccade movement).

3.1.2 Short Pitch & Long Saccades (SPLP)

Kinematically, this participant displayed a short head pitch movement with long eye saccades; her head nodded some, but her eyes moved the most. Figure 2 shows a small change in the location of the background door top in relation to the image's top border. The location of the red fixation circle significantly changes (long saccade movement).

Figure 2. Reveals a short pitch head motion and long eye saccades

3.1.3 Long Pitch & Short Saccades (LPSS)
Kinematically, this participant displayed a long-pitch head movement with short eye saccades; her head nodding is amplified, and her eye movement is reduced.

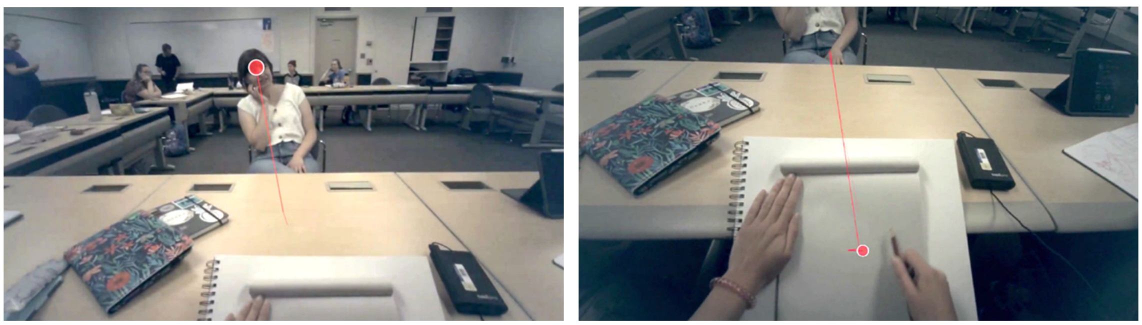

Figure 3. Reveals a long pitch head motion and short eye saccades

Figure 3 shows the reference model cropped out of the second image and the gaze fixation trailing lines (thin red lines) start (the end without the red circle) in locations unrelated to the face or the paper.

3.1.4 Long Roll & Short Saccades (LRSS)
Kinematically, this participant displayed a long roll-pitch head movement with short saccades. This motion is like LPSS but angled and tilted. Figure 4 shows the reference model significantly cropped out of the second image and the distinct angle change of the drawing page and table.

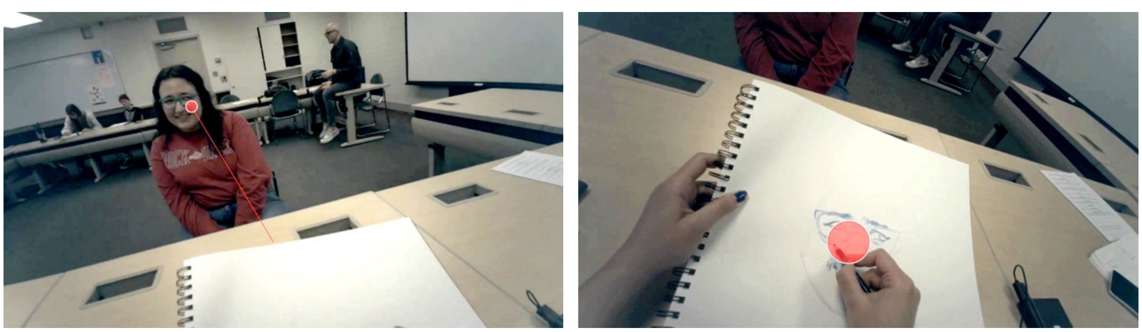

Figure 4. Reveals long roll head motion and short eye saccades

3.2 Gaze Duration and Quantity
3.2.1 Gaze Duration of Reference Model
Novices (blue dots) spent between 23.71% and 35.41% of their time gazing at the reference model. The experts (red) spent between 27.52% and 35.96%, as shown in Figure 5. Indicating little difference between novice and expert behaviour.

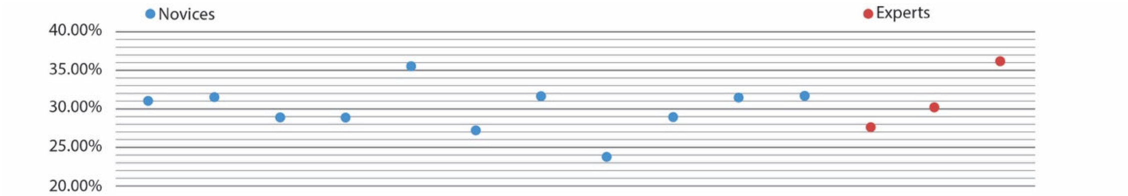

Figure 5. Duration of novice and expert gaze at the reference model

3.2.2 Gaze Quantity and Gaze Duration of both Reference and Paper

The total number of gazes and gaze durations on the reference and the drawing paper were graphed using the recordings from two experts and two novices. Figure 6 shows two of them.

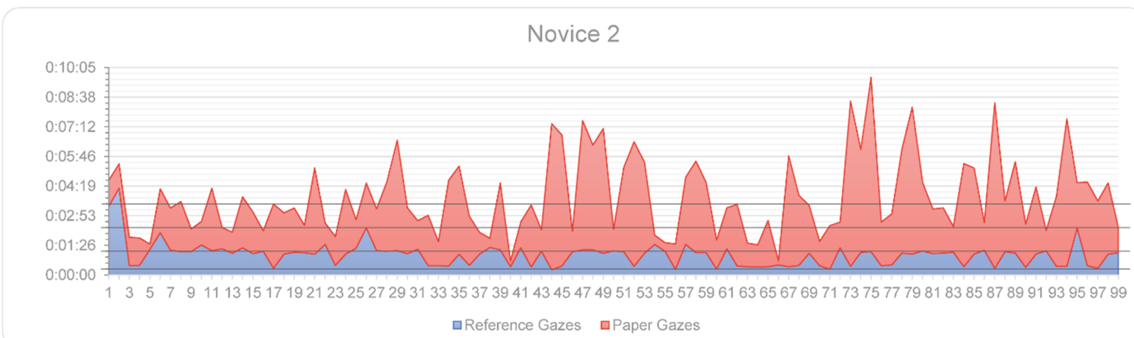

Figure 6. Duration of novice and expert gazes at the reference model and drawing paper

The horizontal axis reports the number of gazes, and the vertical axis reports the duration. The blue area represents reference model gazes, and the red area represents drawing paper gazes. To assess performance differences between experts and novices, five different time segmentations were identified. The first and shortest segment spans 0.0 to 0.25 seconds (s), the second spans 0.26 - 1.0 s., the third spans 1.01 - 2.0 s., the fourth spans 2.01 - 3.0 s., and the fifth is 3.01 s. and longer. These segments are delineated by the four darker black lines crossing the width of the graph.

Figure 7 explores gaze performance within each time segmentation. The vertical axis shows the number of times participants gazed at the reference model and the drawing paper. The colour blocks represent the five different time segmentations.

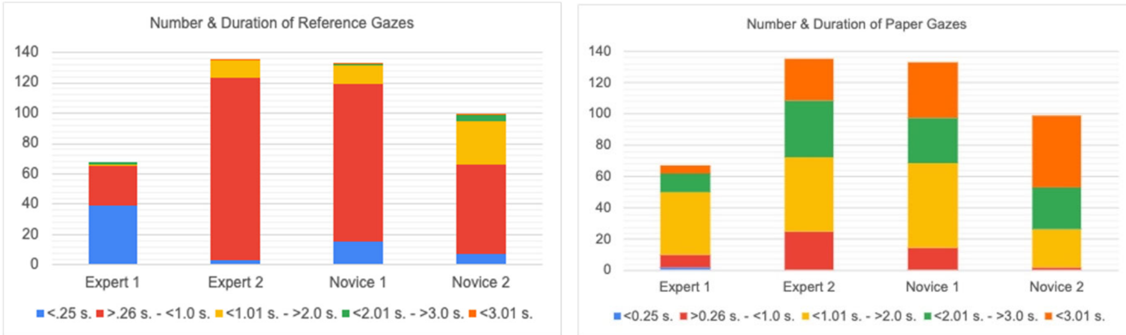

Figure 7. Total assessed number and duration of gazes on the reference and paper

Figure 8 combines the expert and novice gazes at the reference model and drawing paper into averages. Experts had 21 reference gazes at durations less than 0.25 s (blue), while novices had 6, indicating that experts rapidly gaze at the reference model 3.5 times more than the novice. Novices had 23 reference gazes at durations greater than 1.01 s (yellow, green, and orange), while experts had 7, indicating that novices gaze longer at the reference model 3.0 times more than the expert.

Novices gazed at their paper 69 times for longer than 2.01 s. (green and orange colours) or 59% of their drawing time. In comparison, experts gazed at their paper 40 times for the same duration or 40% of their drawing time. Experts had 18 rapid, less than 1.0 s. (blue and red) paper gazes, while novices had 8, a difference of 2.25.

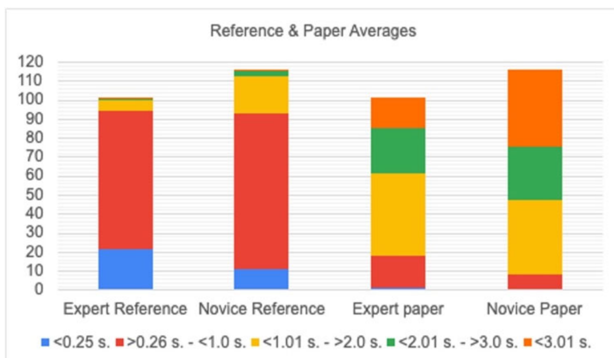

Figure 8. Total average gaze number and duration of reference and paper

Experts have more rapid gazes, less than 1.0 s., referencing the model and drawing than novices. Novices have significantly longer gazes, more than 2.01 s., referencing the model and drawing than experts.

3.3 Production Scripts

Video assessments of three novices and two experts found they lightly drew construction lines for the head, face, nose, eyes, and mouth in varying orders. Then, they added darker lines to the eyes, nose, and mouth contours before addressing the outer face and hair contours. Details were made from the centre outwards. Participants typically paired features together symmetrically and returned often to refine facial details. Differences in construction order between novices and experts were not observed. Data indicates participants returned to refine the eye and mouth areas more than smile lines, cheeks, and ears, as shown in Figure 9.

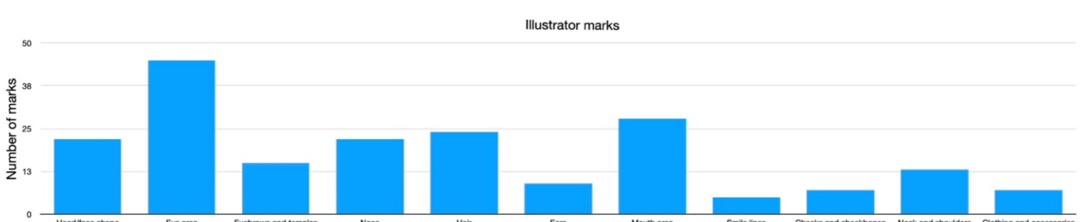

Figure 9. The average number of times participants revisited portrait details

4 DISCUSSION & CONCLUSION

This study was experimental, exploring what and how to measure an illustrator's eye gaze during observational drawing. Observing an illustrator's gaze while they draw is an intimate glimpse inside their head that has not been researched. More data is needed to identify meaningful patterns, but terminology and methods to measure head and eye kinematics and assess gaze duration and count with high fidelity were defined. Exploring script construction exposed that illustrators frequently retouch the mouth and eyes while the nose is drawn early and not revisited, suggesting it is a utilitarian aid in building relationships between facial features.

This study indicates that gaze quantity and duration, when measured in seconds, differ between experts and novices, but it did not teach us why. Do gaze differences, head and eye kinematics, and scripting patterns make a difference in sketching performance? The study has laid a foundation that future studies can exploit. As more meaningful gaze behaviours are identified and defined, they should impact future classroom instruction.

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