# A Novel Method for Evaluating Expert Multiple Object Tracking Using Competitive Esport

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**Abstract:**

**This study investigates differences in gaze performance strategies for expert and novice eSports players. Using a novel methodological approach combining eye-tracking and computer vision object detection, we present evidence that a fast-paced Esport—Rocket League—can offer an appealing alternative to traditional multiple object tracking (MOT) tasks. Our approach is able to make gaze performance comparisons across different levels of expertise, including complex MOT gaze strategies like center-looking. Our preliminary results show that experts look significantly longer at game objects, and both groups use center-looking as their primary gaze strategy. We find the use of gaze analysis in Esport to be an exciting method to examine expert performance in dynamic and richly complex scenarios.**

**Keywords: Gaze, Multiple Object Tracking, Expertise**

## Introduction

In fast-paced situations like driving a car or playing a team sport, awareness of the position and trajectory of multiple objects is a critical perceptual-cognitive skill. Individuals performing these tasks can show a wide range of expertise, and prior studies have shown a relationship between expertise and perceptual-cognitive skills (Brams et al., 2019). In these studies, medical surgeons and airplane pilots with greater expertise show longer gaze durations on individual objects while performing their professional tasks (Schriver et al., 2017; Tien et al., 2015; Ziv et al., 2016). In these studies, the relevant objects were either not moving or were the sole focus of the primary task. There is a gap in understanding regarding how expert performers deploy perceptual and cognitive skills in tasks that contain multiple relevant moving objects. The standard multiple object tracking (MOT) tasks (Sears et al., 2000; Tombu et al., 2008).

offers one way to address that gap, but we lack an available pool of MOT 'experts' whose performance we can compare with that of novices. In this study, we take a different approach. To address expertise in tracking multiple objects and examine gaze behavior in Esports, we utilize the video game Rocket League (RL) to address the gap.

RL is a game based on the rules of traditional soccer. Like soccer, there are two teams and one ball, and the objective is to score the ball on the opposing team's

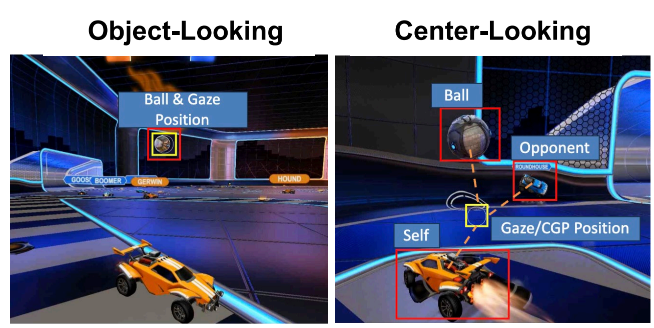


**Figure 1.** Rocket League gameplay screenshots showing object-looking (left) and center-looking (right) gaze strategies.

goal. Unlike soccer, the individual players in Rocket League are cars that can drive around and fly through the air at the discretion of the player. Performance in this game requires the player to be aware of multiple moving objects simultaneously, including their car's position, teammates, the ball, and the opposing players. To do this well, the player must employ a perceptual-cognitive skill that mimics the skills needed for MOT tasks. Using the combination of an eye-tracker and a "you only look once" (YOLO) computer vision object detection algorithm, we can measure real-time gaze position in relation to game objects (Mohan & Simmons et al., 2023). Research investigating MOT have highlighted several gaze strategies (Meyerhoff et al., 2017). Fehd and Seiffert (2008) provide compelling evidence for the "center-looking" hypothesis—a gaze strategy of looking at the centroid of multiple dynamically moving objects. In standard MOT tasks, participants typically use a combination of center-looking and object-looking, with the majority of time spent using the center-gaze strategy (Fehd & Seiffert, 2010). Object-looking is defined as a gaze strategy for MOT, where a person transfers their gaze directly from one object to another. When these gaze strategies are compared in a sports performance context, evidence has shown that center-looking is more optimal for performance (Romeas et al., 2016; Hüttermann et al., 2014). Despite this research, questions involving whether or not this perceptual-cognitive ability develops with expertise remain unanswered.

## Methods

We present a novel method for examining MOT, aiming to characterize how complex gaze strategies relate to expertise. To do this, we synchronized real-time gaze measurement and screen-recorded frame data, allowing us to collect gaze and gameplay data from participants as they played RL.

### Participants

We recruited 17 volunteers, including RL experts (n = 7; Diamond rank and above) and novices (n = 10; below Diamond rank) aged 18-25 with normal or corrected to normal vision for this study through advertisements on Northeastern University's Boston campus. Data was collected in one hour-long session.

### Procedure

After obtaining informed consent, participants were seated 75cm away from the computer screen. We then calibrated the desktop eye-tracker and gave the participant an Xbox controller. Prior to data collection, every participant completed the in-gameRocket League tutorial, learning or reviewing the rules and controls. After the tutorial, each participant completed six 5-minute rounds. Each round contained five other AI players: 2 teammates and 3 opponents. After gameplay, participants were debriefed on the study and paid $20 for their time.

### Materials and Instruments

We monitored gaze with an Eyetech DS VT Mini3 (60hz). A custom Python script recorded gaze data. Separately, we used a YOLOv7 model to detect and identify various in-game objects, including the ball, boost, opponent car, teammate car, and goal. The model was trained on 5,000 images across 5 classes, with an additional 2,000 images for validation. Training was conducted over 1,000 epochs on an NVIDIA RTX 3080 GPU. The model performed, with an accuracy of over 90% for all classes. This high accuracy enabled the precise tracking of key elements within the game environment. We used Lab Streaming Layer (LSL) to synchronize the YOLO model with gaze data to produce time-synchronized gaze and object locations.

### Measures

In this study, we evaluated three different measures using gaze and game object data recorded. **1) Object-Looking:** recorded when the participant aligns gaze with one of the identified game objects (Fig. 1). **2) Center-Looking:** recorded when the participant aligns gaze with the calculated centroid of relevant objects (Fig. 1). The centroid is calculated from the positions of all combinations of 2 and 3 objects detected in a frame of gameplay. If the participant's gaze is located within 1 degree of visual angle on any of these calculated centroids, it is recorded as “center-looking.” **3) Not Center-Looking**: recorded when a participant is neither object-looking nor center-looking.

## Results

To determine how the participants distributed their gaze overall, we analyzed the time spent looking at the game objects vs. not looking at them. Figure 2 shows that both groups of players did not look at any of the game objects for most of the gameplay time. Although the number of game objects the player can see changes from moment to moment depending on gameplay, there are no instances with zero objects on the screen. This result suggested that for the majority of gameplay, players were using a different gaze strategy involving multiple game objects.

We next sought to explain player gaze behavior when they were not looking at objects. Shown in Figure 2, we divided the "Not Object-Looking" time into two new categories: center-looking and not center-looking as described in Measures.

We examined differences between expert and novice players using unequal variance t-tests for each of the categories in Figure 2. The results of these tests show no significant difference between expert and novice players for Not Center-Looking (t(15) = 0.51, p = 0.62)

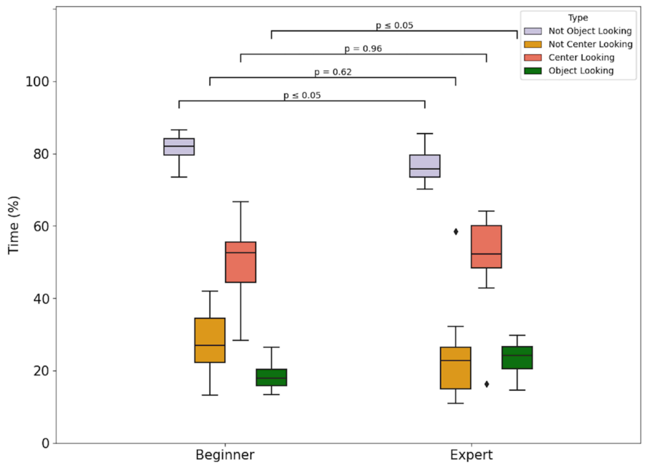


**Figure 2.** Beginner (left) and Expert (right) gaze behavior measured as a percentage of total gameplay time for different looking types.

and Center-Looking (t(15) = 0.05, p = 0.961). However, we did see a significant difference between groups for time spent Object-Looking (t(15) = -2.71, p = 0.025) and overall Not Object-Looking (t(15) = 2.53, p = 0.025).

## Discussion

In this preliminary study, we find patterns of complex gaze behavior that encourage future avenues of research. In line with previous research on expert vs. novice gaze performance, our study shows that experts look for longer periods at individual task-relevant objects. We did not see any significant differences between the expert and novice groups' use of center-looking. However, both groups appear to rely heavily on this gaze strategy during gameplay. Center-looking may be a more fundamental perceptual-cognitive skill than previously appreciated. Moving forward, we plan to continue evaluating experience-dependent differences, including in center-looking performance, transfer time between object classes (Mohan & Simmons et al., 2023), and quiet eye behavior. Although different from traditional MOT tasks, this study affords us the unique ability to learn more about how perceptual-cognitive skills manifest in experts. Ultimately, this research could be an important step in training improved performance on tasks that require MOT.

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