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Perception and action are tightly coupled to the task dynamics in soccer goalkeeping tasks

Representing reality: Investigating the perception-action couplings of expert soccer Goalkeepers under representative constraints

Benjamin Franks^{1,3}, William Roberts^{2,3}, John Jakeman³

1. Football Coaching and Management, University Campus of Football Business (UCFB), Wembley, United Kingdom
2. School of Sport and Exercise, University of Gloucestershire, United Kingdom
3. Faculty of Health and Life Sciences, Oxford Brookes University, United Kingdom

Background ZAP 1

Shifting epistemologies and technological developments have allowed for exploration of more dynamic and in-situ experimental research environments. Using Brunswik's (1955) *representative design* it becomes possible to investigate the causal relationship of the organism-environment system (ZAP 1).

Objectives

This study aimed to add an additional context to the growing work on representative constraints on skilled behaviour. As a recognized perception-action variable, the Quiet Eye was utilized as the perceptual mechanism to be studied. ZAP 2 ZAP 3

Methods

N = 4 Expert English Soccer Goalkeepers (26.3 ± 4.2 yrs) were used in a typical penalty kick (ZAP 2) (Dicks et al., 2010) and a representatively designed experimental condition (ZAP 3) (figure 1). A total of 225 (118 PK; 107 RK) were recorded. Head-mounted Sensomotoric-instruments (SMI-ETG) were used to sample the visual gaze at 60_{Hz}. The videos of the visual gaze and the motor actions were time synchronized and placed in a manually created 'Vision-In-Action' system (adapted from Klostermann et al., 2018) and the Quiet Eye (The QE is the final fixation of 100ms or more occurring prior to and continuing into motor action). Paired samples t-tests were used to compare between conditions for Quiet Eye (QE) duration, onset and offset, and fixation location frequency.

Results

Significant differences were observed between conditions for QE duration ($t_2=2.66, p = 0.03$), QE onset ($t_2=4.75, p = 0.02$) and QE offset ($t_2=3.36, p \leq 0.03$) (table 1). In the representative kick, fixations were shorter (-5.18%), onset was later (+15.20%) and offset later (+8.92%) (Figure 2). Significant differences ($t_2=3.27, p \leq 0.05$) were observed within trial for QE location. In the penalty kick, a greater number of fixations were directed towards the ball (6.75 ± 2.22) than the VP (2.25 ± 1.26) (table 2). However, in the representative kick, there was no significant differences between mean number of fixations at the ball (7.75 ± 2.22) and VP (6.25 ± 3.5) (Figure 3).

Discussion

Consistent with Klostermann et al. (2018), the more representative task was not replicable to the penalty kick condition, strengthening the argument of task-specificity and the constraint-individual interaction highlighted in the ecological dynamics domain (Figure 4). These findings highlight the importance of appropriately sampling information in the optic array through the use of representative task constraints.

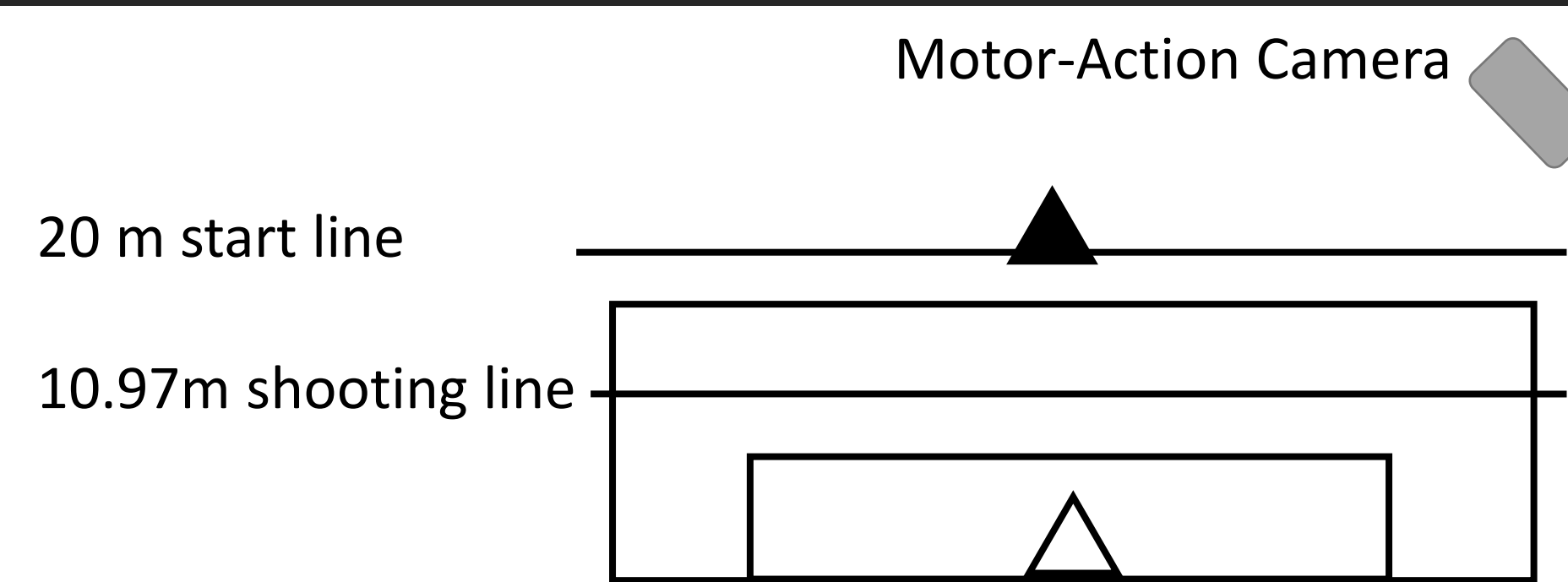


Figure 1: Representative Kick Experimental Task. Δ = Goalkeeper, \blacktriangle = shooting player. The shooting player starts from the 20m line and moves freely with the ball and must strike at goal by the shooting line.

Table 1: Quiet Eye measures between task conditions with significance.

| | QE Duration (%) | QE Onset (%) | QE Offset (%) |
|---------------------|-------------------------|----------------------|-------------------------|
| Penalty Kick | 50.75 ± 2.84 | 21.13 ± 4.21 | 73.48 ± 1.58 |
| Representative Kick | 45.57 ± 0.93 | 36.38 ± 4.30 | 82.40 ± 3.79 |
| Significance | $t_2=2.66, p \leq 0.05$ | $t_2=4.75, p < 0.05$ | $t_2=3.36, p \leq 0.05$ |



Table 2: Condition by fixation by Quiet Eye measures.

| Trial | Location | QE Duration (%) | QE Onset (%) | QE Offset (%) |
|-------|----------|-----------------|--------------|---------------|
| RK | Ball | 45.36 ± 2.78 | 40.23 ± 3.67 | 87.13 ± 2.26 |
| | VP | 45.43 ± 3.17 | 32.76 ± 2.21 | 77.99 ± 5.38 |
| PK | Ball | 53.05 ± 3.81 | 25.71 ± 3.29 | 78.86 ± 5.74 |
| | VP | 45.67 ± 6.02 | 20.18 ± 1.67 | 65.79 ± 5.73 |

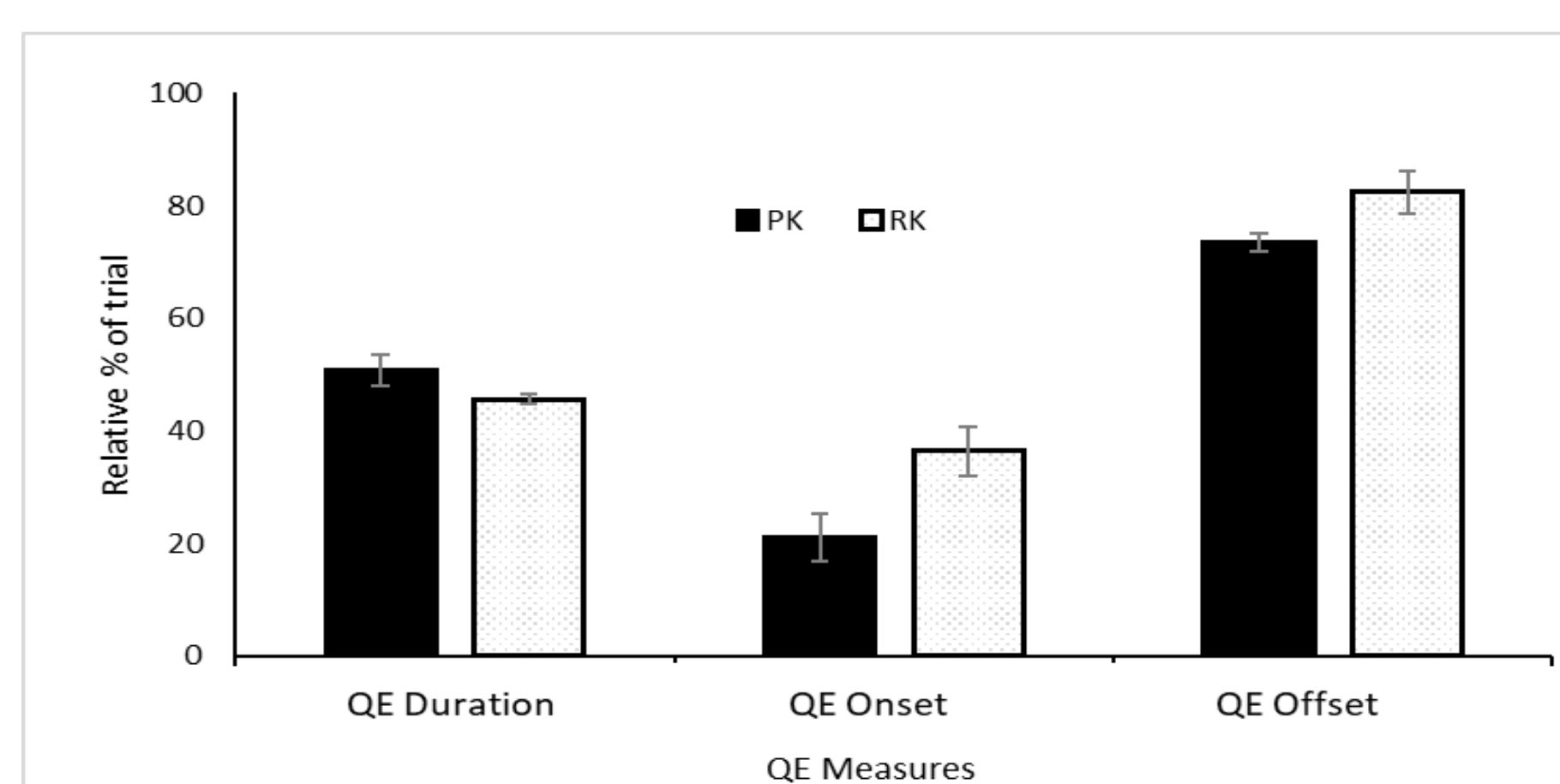


Figure 2: Penalty Kick v Representative Kick showing relative mean (±SD) for QE measures.



Figure 3: Mean fixation location and frequency, Left image = Penalty Kick, Right image = Representative Kick. Small - Large circle = Low - High fixation frequency. Transparent - Opaque circle = Short - High fixation length.

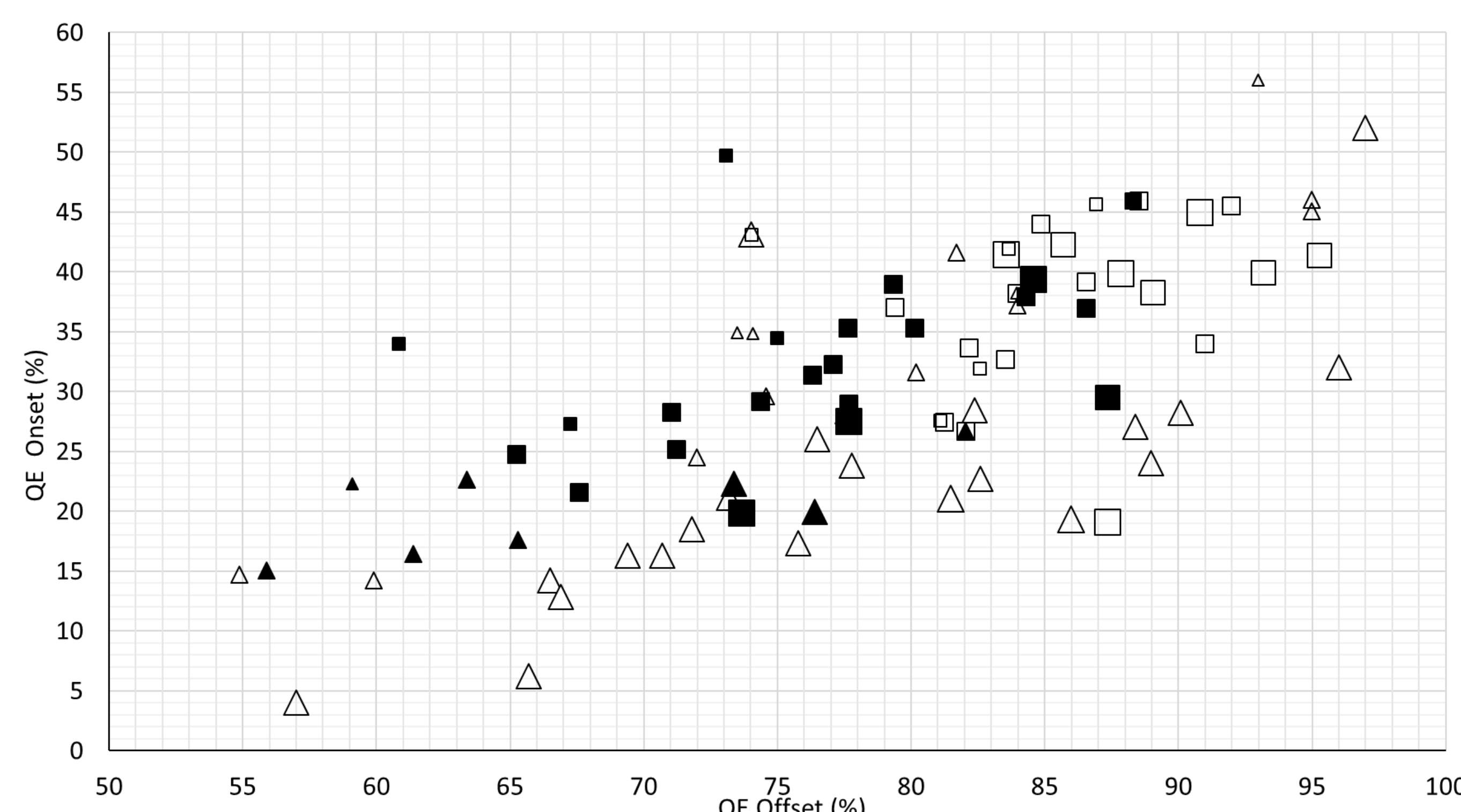


Figure 4: Total raw data for all trials in all conditions presented as relative QE onset and offset for all goalkeepers. Shape: Δ = PK \square = RK; Colour: Black = Fixation at VP, White = Fixation at ball; Size: \triangle = 15-30% (of total trial length), \square = 31-50%, Δ = 51-75%

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