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# Say it quietly, but we still do not know how Quiet Eye training works – comment on Vickers

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## TA COMMENTARY

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It is a testament to her energy and enthusiasm that Joan Vickers has championed the impact of the Quiet Eye (QE) for 25 years. However, to focus on just the longevity of the endeavor would do a disservice to the originality of her early studies (Vickers, 1992, 1996), and the insights that she first derived from her vision-in-action approach. Much of what Vickers alluded to in these early studies has since been supported via developments in our understanding of the cognitive neuroscience of visual attention (e.g., Corbetta & Shulman, 2002). However, while the findings reviewed by Vickers (2016) are robust (notwithstanding potential publication bias issues), there is still a lack of understanding as to the specific mechanisms by which QE and QE training exert their performance advantage.

## ABSTRACT

The Quiet Eye (QE) construct, first reported by Prof Joan Vickers 25 years ago, has proved to be an enduring perceptual cognitive variable. Not only does it reliably differentiate more from less proficient performance, but it appears to provide an insight into how competitive pressure impacts upon the planning and control of visually guided skills. Perhaps the most exciting findings from an applied perspective are the performance advantages conferred from QE training. In this commentary we suggest that QE research needs a period of consolidation, rather than expansion if the mechanisms underpinning these performance effects are to be better understood. We need to manage the difficult balancing act of ensuring consistency in definitions and methods, while recognizing the importance of inter and intra- task (and individual) variability. This may require different experimental and analytical methods than those currently used.

### Keywords:

attention – online control – pre-programming – anxiety – gaze

## QE training

The authors of this commentary have invested more time than most on testing the efficacy of QE training in populations as varied as children with developmental coordination disorder (Miles, Wood, Vine, Vickers, & Wilson, 2015) to experienced sporting performers (Vine, Moore, & Wilson, 2011; Wood & Wilson, 2011); in tasks as varied as laparoscopic surgery (Wilson et al., 2011) to machine gun shooting (Moore, Vine, Smith, & Wilson, 2014). We have consistently found a significant performance advantage compared to groups receiving typical movement-related instructions, whether this be in terms of immediate or delayed retention, or in transfer to more demanding (stressful) conditions. However, it is less clear *why* these ef-

facts arise and whether there are similar mechanisms at play in each case.

Even when multiple process measures are examined, the picture is still often unclear.

For example, in a golf putting task, we found that a QE trained group of novices revealed post-training improvements that were not apparent in the control group: significantly better performance; smoother putting mechanics; longer QE durations; and greater decreases in cardiac and forearm muscular activity (Moore, Vine, Cooke, Ring, & Wilson, 2012). However, only one of the putting kinematic variables was found to mediate the group differences in performance under pressure. So if longer QE durations are not explaining the group differences in performance, what does this say about the mechanisms underpinning QE training (and the role of QE in general in supporting performance)? How much of the benefit simply comes from what QE training does *not* focus on (i.e. technical, movement-related instructions)?

What has become clearer is that QE training has to be considered as more than just a visuomotor intervention. Moore, Vine, Freeman, and Wilson (2013) found that group-based differences in performance under pressure *were* mediated by a psychological interpretation of the stress they experienced (the ratio of the demands of the situation to their resources to cope). Other studies have shown that QE training acts as a more implicit form of motor learning (Vine, Moore, Cooke, Ring, & Wilson, 2013) and improves perceptions of psychological control when anxious (Wood & Wilson, 2012). Therefore, the positive QE training results might be telling us more about generic psychological and physiological changes that occur via the taught pre-performance routine, rather than any specific role for QE itself. To further our understanding of how QE might impact upon performance will therefore require novel experimental designs and a departure from replication studies. For example, there is a need to consider: appropriate control groups (Why just technical-training comparisons?); and transfer tasks (Are there any cross-over benefits?); the exploration of QE dose-response relationships (Is an optimal threshold duration enough?); the manipulation of the timing and location of the QE period (What degree of variability can be withstood before performance disruption occurs?); and the role of different phases of the QE (Is early or late information more important?).

## Neural structures underlying QE

The main concern we have about putting all our eggs in the neuroscience basket is that we may not really learn more about the underpinning mechanisms that we cannot estimate from what we already know about the cognitive neuroscience of goal-directed, visually-guided movement in general (e.g., Land, 2009). All routes point towards a critical role for the dorsal lateral prefrontal cortex (e.g., Corbetta & Shulman, 2002) as Vickers (2016) outlines in her target article. Will confirming this knowledge really help us improve our QE training interven-

tions – especially when we know that tasks will have to be deconstructed beyond recognition to enable valid brain imaging (Walsh, 2014)? Indeed it is somewhat ironic to think that Vickers adopted her vision-in-action approach 25 years ago in order to move away from a ‘watching performance on screen’ approach. The functionality of brain imaging will improve at an incredible speed, enabling more ecologically valid insight into the neural processes underpinning perception and action. In the meantime, there is still much to learn from improved experimental methods and novel analysis techniques.

## Uncovering the QE in other tasks

Vickers (2016) points out that the QE has been isolated in nearly 30 tasks, with varying spatial and temporal demands. When a concept can be shown to be critical in so many tasks, it becomes harder to specify how it achieves its benefits. Therefore, we would argue that rather than seeking to isolate the QE for a range of new tasks, we need to better understand the role of the QE in tasks where we already know ‘something’. For example, in golf putting the late portion of QE appears to be critical in supporting performance (Vine, Lee, Walter-Symons, & Wilson, 2015), whereas in interception tasks early information is more important (e.g., Miles et al., 2015). What might these differences tell us about a consistent role for QE in underpinning performance? Does simply reporting a total QE duration (as done in most studies) provide sufficient explanatory power? One key requirement for QE theory development is therefore the use of consistent definitions and analysis methods. Sometimes, QE is defined up until the initiation of movement (e.g., in golf putting, Mann, Coombes, Mousseau, & Janelle, 2011; and basketball, Vickers, 1996) whereas other times, the duration is defined as extending throughout movement (e.g., in golf putting; Vine et al., 2011; and basketball, Harle & Vickers, 2001). Similarly, more work is needed to understand how technique variations (e.g., high vs low style of shooting in basketball) impact on QE. Both styles of shooting might have different QE locations, timings and durations, but could serve the same general function; providing the motor system with visual information as late as possible in the movement (cf. Oudejans, van de Langenberg, & Hutter, 2002).

As well as inter-individual differences in expert-QE, there is also little consideration of intra-individual (functional) variability in terms of optimal QE locations, timings and durations (cf. Seifert, Buttons, & Davids, 2013, in limb movement). Most research still publishes grouped data, whereas we know that experts can use different visuomotor strategies for the same task. For example, Jordan Spieth (mentioned by Vickers, 2016, as the best clutch putter in golf) switches between two completely different approaches to the visuomotor control of putting: either fixating the ball (a ‘typical’ QE) or fixating the hole as he putts. What do the differences (and similarities) between these strategies tell us about how he uses vision to plan and guide movement? Do such variations potentially account for the non-

significant QE-performance findings that have been found in the published literature (and non-published data sets)? Would QE training that focuses on fixations to either target reveal similar performance advantages (Lee, 2015)?

## Conclusion

The current commentary is written from the position of a critical friend. We too have invested much of our careers on trying to understand the influence of anxiety on motor performance through disruptions in QE, and the potential benefits of QE training for effective and efficient skill acquisition; and we have frequently fallen short in our attempts to better understand the QE. There is much exciting work being carried out across a number of groups; but 'replication' studies in new tasks, and the publication of pretty brain pictures while participants lie in scanners, is unlikely to push the field forward. Admittedly, the type of experimental designs that might elucidate QE mechanisms *are* challenging and *will* require much deliberation compared to the 'easier pickings' of replicating current designs in different populations. However, we believe that this challenge needs to be embraced in order to push this field forward. The exciting news is that there are still plenty of questions left to be answered in the next 25 years of QE-related research.

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The authors have declared that no competing interests exist.

## Data Availability Statement

All relevant data are within the paper.

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