

<b>Institution:</b> University of Exeter		
<b>Unit of Assessment:</b> UoA 24 Sport and Exercise Sciences, Leisure and Tourism		
<b>Title of case study:</b> Using eye tracking research to improve training and performance under pressure		
<b>Period when the underpinning research was undertaken:</b> 2008-2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Mark Wilson Samuel Vine	Professor Associate Professor	2006-present 2010-present
<b>Period when the claimed impact occurred:</b> 2015-2020		
<b>Is this case study continued from a case study submitted in 2014?</b> N		
<b>1. Summary of the impact</b> (indicative maximum 100 words)		
<p>Improving the effectiveness of training is an important challenge for high performance and safety critical industries. Wilson and Vine's research on the assessment and training of gaze behaviour is transforming professional practice in a range of these industries, by significantly enhancing participants' performance and reducing training costs for providers. This impact was achieved in the following ways: The research has been commercialised by a spin-out company, Cineon Training Limited, and developed into award-winning immersive learning products for the oil (e.g., [text removed for publication], pharmaceutical [text removed for publication] and healthcare (NHS)/Royal College of Surgeons) sectors. The research has also been embedded within mandatory training curricula for [text removed for publication] military forces and surgical registrars and contributed to medal-winning performance for an Olympic sport [text removed for publication]. As such, Wilson and Vine's influence on training has rippled out from the narrow confines of sport to other domains where there are important socio-economic and health-related benefits.</p>		
<b>2. Underpinning research</b> (indicative maximum 500 words)		
<p>Picking up the right visual information at the right time is critical to making accurate decisions or movements, especially when the demand for precision is high, and skills must be performed under pressure. Expert practitioners in a range of fields demonstrate optimal information pick-up, sometimes known as the 'quiet eye', to coordinate perception, decision-making and action. However, experts are unable to accurately verbalise the cognitive processes by which they perfect the quiet-eye, hindering access to their implicit knowledge. Traditional training, involving learning through experience, can therefore be time-consuming and sometimes ineffective. Since 2008, Wilson and Vine's research has objectively measured the attentional processes of experts during the performance of real-world skills, via mobile eye-tracking, and developed and tested alternative approaches in which this information is provided to learners via videos, verbal cues, or virtual reality simulations. By combining these insights with developments in psychological theory, the researchers have sought to accelerate and improve the training process by developing and applying novel forms of quiet-eye training (QET).</p> <p>In 2010, Wilson and Vine published the very first studies showing that QET could be applied to novices, accelerating the acquisition of golf-putting [3.1] and basketball-shooting [3.2] skills. These skills also proved more robust when under pressure, compared with those acquired via typical coaching instructions focused on movement control. Subsequent research, funded by an Economic and Social Research Council (ESRC) Business Voucher, demonstrated that even experts could enhance their own performance with QET: low-handicap golfers putted better under pressure in laboratory tests and improved their on-course competitive performance (~2 putts fewer per round) compared to a control group. [3.3]</p> <p>These early positive findings and subsequent mechanistic studies [e.g. 3.4], created a launchpad for further practical work in other real-world settings beyond sport. For instance, a 2009 ESRC grant provided the opportunity to apply this novel approach to laparoscopic surgical</p>		

## Impact case study (REF3)

skill-learning. Again, following initial research that sought to understand the visuomotor processes underpinning skilled performance in these tasks, a randomised control trial revealed the advantage of QET: trainee surgeons were significantly quicker in completing a virtual-reality surgical task under demanding multi-tasking conditions, compared with trainees receiving standard training instructions [3.5]. This study - and the funded impact work that followed it - formed the initial evidence base for the inclusion of QET in the mandatory training curriculum for urology surgeons in the UK [5.6].

Based on the success of QET in sport and in surgery, the Exeter researchers were funded by the Ministry of Defence (via the Defence Science and Technology Laboratory, DSTL) to conduct an initial proof-of-concept study examining small-arms maritime marksmanship [3.6]. This research identified benefits of QET, with the QET group displaying more effective gaze control and more accurate shooting performance than the control group. Further grants (2015 and 2016) provided the evidence base for the adoption of QET to improve current procedures for elite specialist users who are required to learn a range of difficult visuomotor skills, before performing these under life-or-death pressure [5.8, 5.9]. This research also 'closed the circle', in that it helped develop the expertise in how QET could aid shooting under psychological and physiological pressure that supported the impact in sport, [text removed for publication] [5.10].

### 3. References to the research (indicative maximum of six references)

1. **Vine, S.J. & Wilson, M.R.** (2010). Quiet eye training: Effects on learning and performance under pressure. *Journal of Applied Sport Psychology*, 22, 361-376.  
<https://doi.org/10.1080/10413200.2010.495106>
2. **Vine, S.J. & Wilson, M.R.** (2011). The influence of Quiet eye training and pressure on attentional control in a visuo-motor task. *Acta Psychologica*, 136, 340-346.  
<http://doi.org/10.1016/j.actpsy.2010.12.008>
3. **Vine, S.J., Moore, L.J., & Wilson, M.R.** (2011). Quiet eye training facilitates competitive putting performance in elite golfers. *Frontiers in Psychology*, 2, 8, doi: 10.3389/fpsyg.2011.00008. <http://doi.org/10.3389/fpsyg.2011.00008>
4. Moore, L., **Vine, S.**, Cooke, A., Ring, C., & **Wilson, M.R.** (2012). Quiet eye training expedites motor learning and aids performance under pressure: The roles of response programming and external attention. *Psychophysiology*, 49, 1005-1015.  
<https://doi.org/10.1111/j.1469-8986.2012.01379.x>
5. **Wilson, M.R., Vine, S.J., Bright, E., Masters, R.S.W., Defriend, D., & McGrath, J.S.** (2011). Gaze training enhances laparoscopic technical skill acquisition and multi-tasking performance: A randomized controlled study. *Surgical Endoscopy*, 25, 3731-3739.  
<https://doi.org/10.1007/s00464-011-1802-2>
6. Moore, L.J., **Vine, S.J.**, Smith, A., Smith, S.J., & **Wilson, M.R.** (2014). Quiet eye training improves small arms maritime marksmanship. *Military Psychology*, 26, 355-365.  
<https://doi.org/10.1037/mil0000039>

### 4. Details of the impact (indicative maximum 750 words)

Many sectors, from competitive sport to healthcare and the military, continually seek to improve the efficiency and effectiveness with which participants are trained. For complex skills, where visual information needs to be processed to guide precise decisions or movements (e.g., performing delicate surgery or accurate marksmanship), picking up the right visual information at the right time is critical. Acquiring this optimal information pick-up, or the 'quiet eye', is thus a goal of many training programmes. But, although proficient at the quiet eye, experts are unable to verbalise precisely how they gain this proficiency. Therefore, training typically requires learners to improve their performance through personal experience (i.e., learning from mistakes), a time-consuming and sometimes ineffective approach, particularly when the taught skills must then be performed under stressful conditions.

Wilson and Vine's research into the assessment and training of gaze behaviour, or quiet-eye training (QET), has generated an entirely novel approach to training that accelerates the learning

process: trainees are provided with information obtained from eye-tracking to attain the quiet eye, enabling them to leapfrog traditional, experience-based stages of learning. Furthermore, QET produces better performance under pressure. First developed in sport, Exeter's widely applicable research insights are now beneficially impacting training in many other high-performance and safety-critical domains, significantly enhancing participants' performance. The research has also directly led to the establishment of a commercial company delivering QET to more than a thousand staff across oil, pharmaceutical and healthcare sectors.

Further details of the significance and reach of Exeter's impact are now outlined.

#### **Creating a new start-up company with benefits for safety training for the oil, pharmaceutical and healthcare sectors.**

Wilson and Vine's research insights underpin the formation and commercial viability of UK start-up Cineon Training ([www.cineon.training](http://www.cineon.training)). Launched in 2016 as a collaboration between the University of Exeter and Cineon Productions, and supported by an ESRC Impact Acceleration Award, the company provides training for safety critical industries using virtual-reality (VR) simulation tools, and offers solutions co-developed with Wilson and Vine's research team.

**Significance:** [text removed for publication] [5.1]. The unique selling point of its VR tools is the incorporation of gaze behaviour assessment and training insights directly informed by Exeter's research.

**Reach:** The company is developing training for major customers in several different safety-critical industries. The impact of the Exeter research thus reaches thousands of employees internationally, and is transforming training philosophy, policy and practice across diverse sectors:

- **Oil:** Concawe (a division of the European Petroleum Refiners Association, representing 40 of the world's largest oil companies) approached Cineon Training to develop training for improving safety on oil refineries in Europe via virtual-reality QET [5.2]. The training improves hazard awareness skills in operators, reducing accidents and was ranked in the top ten VR experiences of 2019 [5.3]. To date, the training has been adopted by [text removed for publication], reaching an estimated 500 trainees by the end of 2020 [5.1].
- **Pharmaceuticals:** A VR QET tool developed by Cineon Training for a major pharmaceutical company, [text removed for publication], has been permanently adopted at its Portugal facility which produces 14.6 million vials of medicine per year, each requiring inspection by a trained operator. To date, 65 existing and newly recruited inspectors have received training across two separate phases [5.4].
- **Healthcare:** Training to support the safe use of personal protective equipment was developed by Cineon, Vine & Wilson for NHS staff during the COVID-19 pandemic, reaching ~500 trainees via an online platform in April 2020 alone, after which it became open access to all health and social care organisations in the U.K. [5.5].

#### **Improving effectiveness and efficiency of Urology Surgery training**

Urology was the first branch of surgery to use endoscopic and key-hole techniques and is often a trend-setter for minimally-invasive techniques. The 'Urology Bootcamp', an innovative and practical training course which won an education award at the Zenith Global Health Awards 2019, is the UK's first mandatory training programme for qualified surgeons in any discipline. The Course Director wanted to shorten the time needed for trainees to reach proficiency on fundamental technical surgical skills, and thus improve the overall effectiveness and efficiency of the training camp. Following a presentation of Exeter's research to the Royal College of Surgeons' Commission on the "Future of Surgery" (2018) - he invited the Exeter researchers to develop gaze-based training videos for the course [5.6]. Since 2019, trainees now watch the videos – hosted directly on the Bootcamp online environment - ahead of course attendance, to assist in the pre-learning of these key skills, and can access the videos during the module to consolidate their learning.

**Significance:** As a direct result of Exeter's work, trainees from the Bootcamp reported '*being more aware of controlling gaze to control movements*', '*increased feelings of confidence*' and the value of ongoing "practising using the video as a guide". [5.6]

**Reach:** Due to the significant benefits offered by Exeter research, the Director has '*fully integrated these concepts into our technical skills training module, taken by all urologist trainees in the UK*'. [5.6] This impact on training now benefits all 50 to 60 UK urologists who complete the Bootcamp annually, with plans to apply the same training approach to urologists in Belgium, Portugal, and Turkey, as well as to other surgical disciplines in the UK, which are expected to follow urology's innovative approach [5.6].

#### **Enhancing training infrastructure for [text removed for publication] military training**

Since 2012, the Exeter researchers have been commissioned by the Defence Science and Technology Laboratory (DSTL) to develop novel training approaches; a partnership that has been highlighted as a successful case study of 'Supporting our World-Leading Defence' in the government's 2020 UK R&D Roadmap (p16) [5.7]. Much of this work has focused on an element of counter-terrorism training for [text removed for publication], which was hitherto identified as particularly challenging for the Ministry of Defence (MOD).

**Significance:** [text removed for publication] the benefits of the bespoke QET resources were summarised by the manager of DSTL's 'Maximising Human Performance (MHP)' project, after their first adoption in 2017: '*Trainees provided with the gaze training instructions showed a greater increase in their accuracy of execution of the tasks over the course, compared to trainees from a previous cohort who received the standard training. Additionally, both senior officers in charge of managing training, and instructors delivering training were positive about its benefits to them. ... the videos simplified initial verbal teaching of the principles of the task, meaning that ... more time was available for practice in the training arena.*' [5.8] The ongoing significance of Exeter's contribution to the success of this training programme is revealed in a 2019 Impact Bulletin published for military audiences by DSTL, which states that, '*the novel training technique enhances ... traditional methods of technical training enabling accelerated skill acquisition ... facilitating a winning-edge capability and reduced training costs*' [5.9].

**Reach:** Exeter's impact has already been profound within the UK's [text removed for publication] military regiment, in that **all** individuals going through selection since September 2017 now receive the new QET-enhanced training programme for counter-terrorism training. [5.8] Additionally, '*the videos are also being used on a one-to-one basis to assist students who may be struggling with learning the skills.*' [5.8], revealing how the resources have been flexibly embedded within training procedures by the instructors themselves.

Furthermore, the benefits of Exeter's research are being extended more generally to military capability via the DSTL. In 2017, DSTL noted that "*[this work] has benefitted our aims ... to provide the MoD, and our partners, with cutting-edge research to support their human capability. The success of these interventions ... has impacted significantly upon the strategic planning of DSTL, with future research plans considering the extension and exploitation of this work to other tasks and cohorts*' [5.8]. This exploitation has since begun, with the 2019 DSTL Impact Bulletin reporting that DSTL's collaboration with the Exeter researchers: "*has also generated interest with international partners (via NATO and TTCP), which allows them and the UK to benefit as they exploit this research in alternative contexts.*" [5.9].

#### **Improving performance [text removed for publication]**

[text removed for publication]

#### **5. Sources to corroborate the impact** (indicative maximum of 10 references)

1. 2020 letter from the Director of Cineon Training. This letter outlines the company status and highlights the impact of Dr Vine and Prof Wilson's research on the conception and on-going success of the company.



2. 2019 letter from the Head of the Science Executive, Safety Management Group, Concawe, highlighting the specific member companies of Concawe who have adopted the training.
3. Our project for Concawe was ranked 9<sup>th</sup> in Virtual Reality Marketing's (the World's biggest business directory of VR studios) top 10 VR marketing experience of 2019:  
<https://web.archive.org/web/20200504093229/https://www.virtualrealitymarketing.com/blog-posts/top-10-vr-marketing-experiences-of-2019/>
4. 2020 letter from the Digital Transformation Manager, [text removed for publication], describing the implementation of the VR training tool at [text removed for publication].
5. University of Exeter press release (2020) on launch of Personal Protective Equipment (PPE) training for NHS workers during COVID-19:  
[https://web.archive.org/web/20200929150623/http://www.exeter.ac.uk/news/homepage/title\\_790393\\_en.html](https://web.archive.org/web/20200929150623/http://www.exeter.ac.uk/news/homepage/title_790393_en.html)
6. 2019 letter from the Course Director of 'Urology Bootcamp', outlining how gaze-based training has been incorporated into the mandatory training curriculum for technical skills development for all UK-based urology surgeons.
7. UK Research and Development Roadmap 2020, which discusses how DSTL has partnered with University of Exeter (p.16) to help develop the next generation of training infrastructures for UK military personnel.  
[https://web.archive.org/web/20210203152603/https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/896799/UK\\_Research\\_and\\_Development\\_Roadmap.pdf](https://web.archive.org/web/20210203152603/https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/896799/UK_Research_and_Development_Roadmap.pdf)
8. 2017 letter from the Manager of DSTL's 'Maximising Human Performance' project. This outlines the impact that our training had on both the trainees and trainers in the specific user group, and DSTL in general.
9. Impact Bulletin produced by the Defence Human Capability Science and Technology Centre (2019), designed to summarise and disseminate the impact of our DSTL project to military audiences to aid the exploitation of this work to other national and international partners.
10. 2020 letter from the Performance Director of the [text removed for publication]. This outlines the rationale for approaching Dr Vine and Prof Wilson, and describes the impact that the projects had on Olympic preparation policy and athlete performance.