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# The Effects of Distraction on Cataract Surgery Performance in Consultants and Trainees Using a Simulator

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**Purpose:** Mental workload is a recognised concept in medicine, and cognitive overload may lead to complications in surgery, including cataract surgery. A better understanding of what factors contribute to this can potentially improve patient safety and decrease surgeon stress. Simulated cataract surgery is now an essential part of training and a safe environment for exploring the effects of cognitive load upon performance. We used the EyeSi cataract surgery simulator to assess the effects of distraction on surgical performance and on ophthalmology trainees and consultants undertaking cataract surgery.

**Patients and Methods:** Consultant and trainee cataract surgeons undertook a simulated list of six cases each, of which half were allowed to proceed without extraneous cognitive load with distraction and half were not. Blood pressure and pulse measurements were taken at three intervals in each of the six cases, as well as surgical scores on the simulator recorded for each case.

**Results:** Distraction did not statistically significantly affect the scores, blood pressure or pulse measurements of either the 10 trainees or 10 consultants. Consultants performed more poorly than trainees overall (P = 0.0229) and suffered more serious errors that returned a score of zero for an individual stage (P = 0.0074).

**Conclusion:** Consultant cataract surgeons performed worse than trainees on the EyeSi simulator, raising questions over whether simulation is as true to reality as has been suggested. An important finding is that ophthalmic training curricula around the world have been adapted in order to include simulated cataract surgery as an essential component of training new ophthalmic surgeons.

**Keywords:** simulation, cataract surgery, ophthalmology

## Introduction

Cataract surgery is recognised to be a stressful experience with a previously published anonymised questionnaire of ophthalmic trainees and consultants in Wales, undertaken in an attempt to shed light on cataract surgery-related stress for the surgeon, as opposed to the patient, demonstrating previously unrecognised levels of stress.[1] That survey, in which 40 out of 57 consultants responded, found that six consultant respondents, a total of 15%, admitted to significant stress amounting to moderate burnout on the Maslach Burnout Inventory caused directly by performing cataract surgery, with every respondent bar one finding training ophthalmic registrars to operate stressfully. The stress was highest amongst junior consultants with more than 80% of respondents exhibiting moderate burnout belonging to this group). This work highlighted for the first time that there was a significant undocumented issue with cataract surgery-related stress that the Royal College of Ophthalmologists (RCOphth) had previously been unaware of. This was raised with the RCOphth and as a result of this study an all UK questionnaire was sent out by the college which provided a more comprehensive insight into cataract-related stress.[2] This more extensive study corroborated the Welsh results and additionally found that

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17% of all cataract surgeons, both trainees and consultants, indicated that they would give up cataract surgery entirely if this was possible.

The concept of cognitive load, as described by cognitive load theory, is potentially useful in understanding what makes cataract surgery stressful for not just trainee surgeons but for all surgeons and relates to the educational aspect of mental workload as a whole.[3,4] The term mental workload itself is used to describe how there are limits to the human ability to process information, not just for educational purposes but to navigate, work and understand the world around us.[5]

Surgeons faced with cognitive overload are more likely to perform errors in their work.[4,6] The aviation industry, often compared to medicine in general and surgery in particular, has studied cognitive load and mental workload extensively in a bid to reduce as much as possible air crashes caused by human error.[6] These approaches focus heavily on reducing distraction, conveying information in as efficient a way as possible and minimising extraneous information presented to pilots that use up working memory with no safety gain for pilot or passengers.[6] Mental workload has been directly related to prescribing errors amongst community physicians, poorer performance at performing laparoscopic procedures, intensive care nurses' ability to correctly read the monitors of complex medical machinery and outcomes in complex cardiothoracic procedures.[7–10] Mental workload and cognitive load have also been noted as factors affecting the communication skills and clinical skills of medical students.[11] As a result of the recognised danger that excessive mental workload poses to healthcare professionals, attempts have been made to improve outcomes by interventions specifically targeted toward reducing the mental workload as much as possible. These include improving intensive care unit display screens to reduce complexity, the use of an electronic patient record to better correlate patient data and digitising mammograms to better be able to compare differences in ultrasound appearance, all by reducing extraneous cognitive load in various forms.[12–14]

Surrogate measures of mental workload have been studied by some such as heart rate measurement during simulated anaesthetic emergencies, although there are several issues with this as the same study advocating it demonstrated that in some participants the heart rate increased in anticipation of issues rather than when the issues actually occurred due to stressing about what lay ahead and then actually decreased during the emergency if it emerged that the situation was not as bad as potentially anticipated.[15] Ophthalmology does, however, have a simulation tool that can help directly measure surgical performance in performing simulated cataract surgery that has been shown to increase ophthalmic trainees' confidence in undertaking this cognitively challenging operation on real patients.[16] A simulator for assisting trainee cataract surgeons to develop their skills in a risk-free environment was developed specifically because of increased complication rates and very variable surgical performance observed with real patients when the surgery was conducted by a trainee ophthalmic surgeon.[17–20] Gradually, computer simulated programmes mimicking every part of the entire cataract operation were developed, validated, and determined to be useful additions to ophthalmic surgical training.[21–23] The simulation platform that was developed for cataract surgery is called EyeSi and is made by a company called VRmagic, Holding AG, based in Mannheim, Germany. It comprises an experience in which simulated cataract surgery takes place on an instrument very similar in appearance and feel to an actual operating microscope, with probes used to operate inside a movable sphere representing the eye mounted in an orbit of a moulded human head. The microscope is controlled with pedals in the same way that an actual operating microscope is, the phacoemulsification machine is controlled with the other foot with a different set of pedals, auditory feedback is provided, and a three-dimensional view of the simulated operation is provided by the eyepieces.[24–26]

Surgeons completing modules of specific steps on the EyeSi simulator were found to perform significantly better than those having not undertaken simulation training, with performance measured using exercises in a wet lab on pig eyes.[27] There is also increasing evidence that both inexperienced and experienced cataract surgeons perform better on live patients after a number of training modules on the EyeSi simulator have been completed, although these studies have been performed without a control group for obvious ethical reasons.[26–29] There have been situations, however, where the introduction of simulation training programs to certain areas previously lacking any such teaching has resulted in the creation of a form of control group, and in these areas, it has been observed that those completing simulation training have a statistically significantly less likelihood of causing actual real-world complications in their patients.[30,31] A Cochrane Review of studies relating to the effect of simulation on cataract training found that more than 80% of published studies did not properly describe their randomisation process, none were masked and all were described as having high or unclear risk of bias leading to a conclusion that while simulated eye surgery could well help reduce complication rates, the evidence was not strong enough to be certain.[32] Despite this, the evidence surrounding the

potential benefit was deemed robust enough for the RCOphth to declare that the completion of EyeSi modules A and B by ophthalmic surgical trainees is now mandatory prior to undertaking any surgery on real patients.[33] There is also evidence that patients are happier allowing trainee cataract surgeons to operate on their eyes if they know a simulated surgical training program has been completed by them in advance.[34]

A study comparing blood pressures in groups of experienced and inexperienced ophthalmic surgeons at rest and immediately after routine cataract operations, as well as measuring blood and urine stress hormones, was conducted mainly in a bid to find out if the inexperienced group was more physiologically stressed.[35] Their results demonstrated that both groups demonstrated a physiological stress response to the same extent, though it must be noted that no pulse rate was measured and the blood pressure was measured after the surgery rather than during, with the resting blood pressure being measured on non-operating days whereby there are many conflicting reasons as to why a difference may be found. Another study using blood pressure as a measure of stress found that surgeons operating on challenging cataracts experienced higher post-operative blood pressure measurements than those surgeons operating on simple cases, although again the blood pressure was measured after the surgery and not during.[36]

The purpose of this study is to determine the effects of distraction as a stressor on surgical performance and on the surgeon in both trainee cataract surgeons and consultants undertaking cataract surgery. The hypothesis is that trainee cataract surgeons will be affected more by distraction due to increased demands on working memory brought on as a result of inexperience and demonstrate this stress with decreased EyeSi scores and increased blood pressure and heart rate. Should this be proven positive then steps can then be taken to reduce distractions to cataract surgeons in training such as banning phone calls during operations, asking theatre staff to keep chatter to a minimum and allocating medical students elsewhere, for the good of the patient and the surgeon. It may be possible that consultants are also affected by distraction as a stressor, though the value of comparing novice and experienced surgeons in this manner is principally to determine if cognitive stress experienced as distraction is related to the expected greater pressures upon working memory found in trainees or is independent of this.

## Materials and Methods

Ethics approval for this study was sought from both the Research and Development Department (RDD) of Swansea Bay University Health Board (SBUHB) and from Swansea University. With regard, the RDD of SBUHB an ethics application was made to the Joint Study Review Committee which concluded, after discussing with SBUHB's Research and Development Director, that the project did not need formal ethics approval and an Information Governance review did not conclude that a formal application to SBUHB's Information Governance team was warranted. An ethics application was also made to Swansea University Medical School's Research Ethics Sub-Committee (SUMS RESC), and the study, assigned number SUMS RESC 2023–0015, was approved. Patients and the public were not involved in the design or the undertaking of this study. This study complies with the Declaration of Helsinki.

Informed consent was obtained from study participants prior to their participation. A study information sheet was created which outlined the purpose of the study, what data was to be collected, how it would be stored, and provided information on who to contact if they had any further questions that were not answered. The study participants were then asked to sign the form if they were happy to proceed. Informed consent was obtained from all participants.

The study was structured to mimic a regular standard cataract list of six patients. Three cases were designated "distraction cases" and the other three "control cases" or "non-distraction cases". The first case was designated a control case in order to allow participants to familiarise themselves with the equipment and procedure, while the second case would be the first of the three cases containing distractions. Cases 1.3 and 5 were control cases in all participants, both trainee and consultant, whilst cases 2.4, and 6 were cases containing distractions. The reason for alternating such was to account for a natural improvement that participants might demonstrate whilst undertaking an identical task six times, as if the distraction cases were all placed at the end of the sequence of six the natural improvement might offset any effect seen by the distraction. The candidates, both trainees and consultants, were not made aware beforehand which cases would contain distractions nor indeed were they made aware of the total number of "distraction cases" to expect. Participants completing the study were asked not to share any details of the procedure employed by the study with any other ophthalmic consultant or trainee.

Each study began by inviting candidates to sit at the operating chair and the information leaflet in Appendix 1a was given them to read. Any questions, short of specific questions about the study itself that would jeopardise the performance, were answered. Following this, each participant was handed a copy of the consent form (Appendix 2). Prior to commencing the study, the candidate would be asked to remove any second layer of clothing on their torso, to enable a blood pressure cuff to be applied over the right upper arm, and to remove their right sock. The second toe of the right foot was used in all cases for this measurement and if a candidate desired an alternate location this was politely refused in order to keep the study parameters as similar as possible for all participants. A debrief proforma (Appendix 1b) was also prepared after the completion of the tasks.

The EyeSi programme chosen was identical in all cases, for both trainees and consultants, and consisted of the "Cataract Challenge" programme which allows a complete cataract operation to be performed through all five stages. All cases were undertaken with a gentle reminder, when needed, regarding what real surgical instruments were represented by which simulation tools, enquiries as to whether the candidate was satisfied and wished to proceed to the next stage and hints where needed if the operation appeared to be affected by a lack of familiarity with the equipment rather than the surgical technique itself. This was the case for operations with both distractions and without distractions and were undertaken by one of the two investigators present in the room, which was the same investigator charged with keeping the scores and operating the blood pressure machine. In all cases, this investigator was the teaching registrar at Singleton Hospital, Dr. Murad Khan. The distractions were lightly scripted and had three elements in each scenario, all of which were present in each of the three distraction cases that the candidate was required to complete (Appendix 3). The choice of distractions was derived from an interactive all Wales teaching session in which the audience was asked what annoyed them the most while operating. The first distraction was a series of phone calls from eye casualty, the second interventions by an observing medical student, played by the principal investigator, and the third was a mimicking of annoying conversations between theatre staff. Each of the three "distraction" cases had all three forms of distraction present.

Each of the five steps seen in a cataract operation mentioned above is scored by the EyeSi simulator out of a hundred with zero representing the lowest possible mark and 100 the highest, as a result of which the total score for each operation undertaken in its entirety can vary between 0 and 500. The total score a participant can achieve in the three non-distraction cases, and likewise the three distraction cases, is 1500 for each category (three cases of 500 potential points each) resulting in a total potential score of 3000 that the participant can achieve across the whole of the six cases.

Data collected included the raw EyeSi scores, as well as the candidates' heart rate and blood pressure (both systolic and diastolic). Statistical significance between the EyeSi scores and the candidate being a trainee or consultant, and their respective heart rate or blood pressure variance was performed using the Unpaired *T*-Test. Statistical analyses were performed using Microsoft Excel.

# Results

## Demographics

Of the 10 trainees recruited, 2 were females and 8 males, and of the consultants that completed the study, 3 were females and 7 males. The RCOphth 2018 workforce census indicates that 54% of UK trainees are males, with 46% females, while 69% of consultants are male and 31% female; the consultant group participating was therefore more representative of national trends than the trainees. The ages of the trainee candidates varied between 26 and 36 years old, while the consultants varied between 35 and 61 years of age. Six out of the 10 surgeons in the trainee group were UK medical school graduates, with all being, by definition, UK ophthalmic trainees. Five out of the 10 consultants who completed the study were UK medical school graduates with 7 out of 10 having completed the UK ophthalmic training program. The number of previously completed cataract operations varied in the trainee group between 51 and 338, while in the consultant group, the range was much more varied with the lowest number being 690 and the highest estimated to be in excess of ten thousand with no clear ability to discern the exact number possible.

## EyeSi Scores, Heart Rate and Blood Pressure Measurements

The most important result is that consultants performed more poorly than trainees overall, though this was not the primary aim of this study. From the analysis of the scores supplied by the EyeSi, simulator consultants performed significantly worse than

trainees in the "distraction" cases, and though the effect of distraction did reduce the consultant score by 55.8 on average, this result was not a significant effect itself (p value 0.2568). Further information about Trainee and Consultant simulation scores can be found below (Tables 1 and 2, Figures 1–3).

**Table 1** Trainee Candidates' Cataract Scores out of a possible 100. Cases 2, 4 and 6 are distraction cases. Cases 1, 3 and 5 are non-distraction cases. Red boxes show "catastrophic surgical errors"

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Case 1** | Rhexis: | 94 | 27 | 16 | 26 | 95 | 0 | 69 | 74 | 27 | 0 |
| | Hydro: | 50 | 0 | 84 | 90 | 53 | 0 | 42 | 94 | 95 | 64 |
| | Groove: | 96 | 69 | 99 | 87 | 82 | 15 | 0 | 73 | 69 | 15 |
| | IA: | 96 | 83 | 69 | 100 | 80 | 0 | 100 | 90 | 42 | 1 |
| | IOL: | 86 | 0 | 0 | 0 | 92 | 0 | 0 | 87 | 96 | 0 |
| **Case 2** | Rhexis: | 79 | 0 | 65 | 59 | 80 | 0 | 3 | 56 | 67 | 60 |
| | Hydro: | 70 | 86 | 90 | 90 | 90 | 0 | 82 | 95 | 94 | 90 |
| | Groove: | 85 | 68 | 86 | 87 | 94 | 44 | 95 | 82 | 94 | 2 |
| | IA: | 83 | 96 | 10 | 96 | 78 | 11 | 100 | 91 | 91 | 20 |
| | IOL: | 77 | 15 | 73 | 84 | 50 | 0 | 0 | 87 | 0 | 0 |
| **Case 3** | Rhexis: | 0 | 0 | 51 | 67 | 87 | 80 | 30 | 91 | 81 | 0 |
| | Hydro: | 90 | 0 | 90 | 90 | 94 | 60 | 89 | 95 | 95 | 90 |
| | Groove: | 86 | 86 | 100 | 87 | 96 | 22 | 80 | 90 | 76 | 75 |
| | IA: | 98 | 100 | 81 | 96 | 61 | 100 | 100 | 100 | 100 | 100 |
| | IOL: | 100 | 0 | 84 | 98 | 79 | 34 | 80 | 95 | 99 | 0 |
| **Case 4** | Rhexis: | 80 | 0 | 46 | 66 | 98 | 19 | 26 | 77 | 64 | 76 |
| | Hydro: | 90 | 90 | 90 | 71 | 93 | 0 | 89 | 95 | 0 | 89 |
| | Groove: | 98 | 98 | 83 | 87 | 80 | 31 | 65 | 77 | 100 | 75 |
| | IA: | 100 | 86 | 56 | 92 | 89 | 0 | 98 | 100 | 100 | 89 |
| | IOL: | 83 | 33 | 98 | 99 | 80 | 0 | 91 | 97 | 90 | 0 |
| **Case 5** | Rhexis: | 72 | 83 | 81 | 80 | 92 | 30 | 11 | 100 | 82 | 44 |
| | Hydro: | 90 | 90 | 90 | 92 | 95 | 44 | 87 | 95 | 95 | 90 |
| | Groove: | 100 | 83 | 87 | 19 | 85 | 76 | 1 | 100 | 100 | 41 |
| | IA: | 100 | 100 | 47 | 87 | 20 | 30 | 50 | 100 | 100 | 95 |
| | IOL: | 80 | 0 | 77 | 98 | 87 | 0 | 57 | 79 | 0 | 0 |
| **Case 6** | Rhexis: | 44 | 51 | 33 | 85 | 80 | 30 | 8 | 75 | 61 | 16 |
| | Hydro: | 90 | 61 | 90 | 95 | 92 | 73 | 68 | 95 | 88 | 86 |
| | Groove: | 100 | 20 | 86 | 85 | 69 | 0 | 75 | 100 | 95 | 57 |
| | IA: | 100 | 74 | 76 | 94 | 80 | 23 | 100 | 100 | 92 | 22 |
| | IOL: | 81 | 59 | 95 | 92 | 75 | 0 | 38 | 80 | 97 | 0 |

**Table 2** Consultant Candidates' Cataract Scores out of a possible 100. Cases 2, 4 and 6 are distraction cases. Cases 1, 3 and 5 are non-distraction cases. Red boxes show "catastrophic surgical errors"

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Case 1** | Rhexis: | 27 | 0 | 0 | 60 | 26 | 73 | 0 | 0 | 0 | 68 |
| | Hydro: | 89 | 0 | 0 | 77 | 90 | 17 | 13 | 43 | 87 | 83 |
| | Groove: | 52 | 100 | 0 | 71 | 0 | 69 | 0 | 0 | 0 | 53 |
| | IA: | 99 | 93 | 7 | 98 | 96 | 0 | 93 | 0 | 57 | 85 |
| | IOL: | 0 | 91 | 0 | 0 | 20 | 86 | 0 | 0 | 0 | 0 |
| **Case 2** | Rhexis: | 0 | 3 | 0 | 0 | 83 | 0 | 0 | 0 | 0 | 0 |
| | Hydro: | 90 | 40 | 0 | 87 | 90 | 70 | 69 | 82 | 0 | 89 |
| | Groove: | 0 | 98 | 57 | 50 | 0 | 33 | 0 | 0 | 29 | 73 |
| | IA: | 91 | 24 | 0 | 98 | 84 | 0 | 59 | 76 | 19 | 96 |
| | IOL: | 0 | 64 | 0 | 0 | 47 | 60 | 51 | 0 | 74 | 0 |
| **Case 3** | Rhexis: | 0 | 78 | 0 | 69 | 74 | 0 | 0 | 20 | 2 | 0 |
| | Hydro: | 90 | 82 | 59 | 88 | 90 | 33 | 82 | 83 | 0 | 84 |
| | Groove: | 5 | 100 | 17 | 67 | 47 | 56 | 69 | 68 | 0 | 53 |
| | IA: | 80 | 75 | 4 | 98 | 88 | 0 | 100 | 100 | 92 | 95 |
| | IOL: | 33 | 86 | 0 | 70 | 40 | 0 | 0 | 17 | 86 | 0 |
| **Case 4** | Rhexis: | 64 | 0 | 0 | 19 | 17 | 0 | 0 | 0 | 0 | 25 |
| | Hydro: | 90 | 90 | 76 | 90 | 90 | 78 | 31 | 90 | 0 | 90 |
| | Groove: | 0 | 0 | 68 | 77 | 58 | 69 | 50 | 43 | 16 | 58 |
| | IA: | 90 | 45 | 0 | 95 | 47 | 0 | 90 | 69 | 91 | 98 |
| | IOL: | 54 | 92 | 0 | 72 | 64 | 0 | 51 | 0 | 83 | 42 |
| **Case 5** | Rhexis: | 0 | 87 | 0 | 89 | 96 | 73 | 0 | 0 | 10 | 68 |
| | Hydro: | 89 | 81 | 0 | 70 | 90 | 90 | 75 | 86 | 0 | 90 |
| | Groove: | 100 | 21 | 68 | 69 | 54 | 56 | 0 | 45 | 8 | 87 |
| | IA: | 100 | 0 | 29 | 96 | 100 | 0 | 100 | 83 | 44 | 82 |
| | IOL: | 0 | 78 | 0 | 96 | 96 | 0 | 56 | 41 | 0 | 80 |
| **Case 6** | Rhexis: | 50 | 0 | 0 | 0 | 69 | 0 | 0 | 0 | 63 | 0 |
| | Hydro: | 95 | 59 | 90 | 86 | 76 | 90 | 82 | 90 | 0 | 90 |
| | Groove: | 0 | 24 | 69 | 33 | 0 | 85 | 0 | 43 | 0 | 0 |
| | IA: | 0 | 89 | 1 | 96 | 40 | 0 | 90 | 0 | 72 | 89 |
| | IOL: | 72 | 94 | 0 | 96 | 86 | 85 | 43 | 53 | 70 | 0 |

For the "distraction" cases the trainees scored an average of 997.5 (Standard Deviation 339.9) out of a possible 1500, while the consultants scored 652.8 (Standard Deviation 163.0), with an unpaired *t*-test result of 0.007 demonstrating significance. For the "non-distraction" cases the trainees scored an average of 975.2 (Standard Deviation 296.2) out of

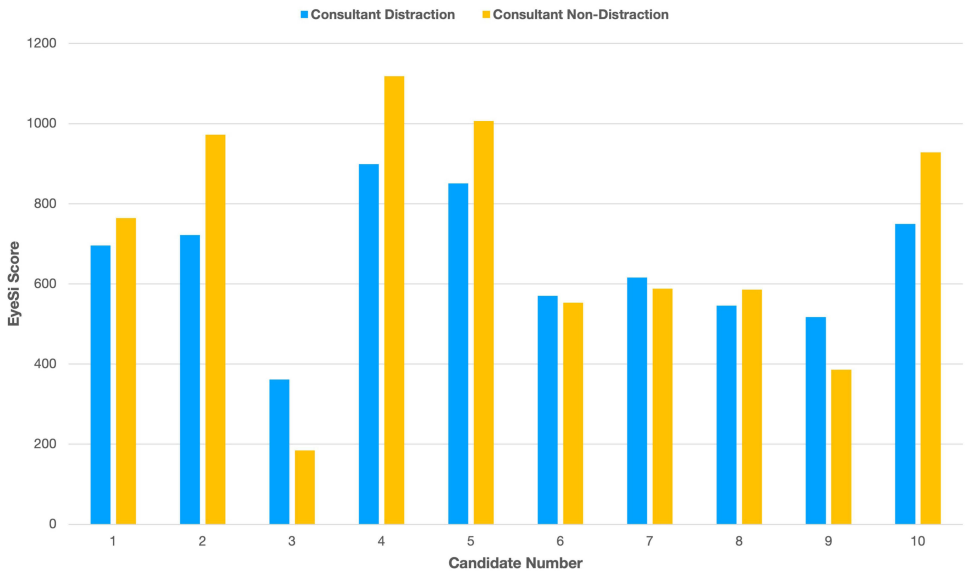


**Figure 1** Graph showing how EyeSi score varied for the Consultants with and without distraction.

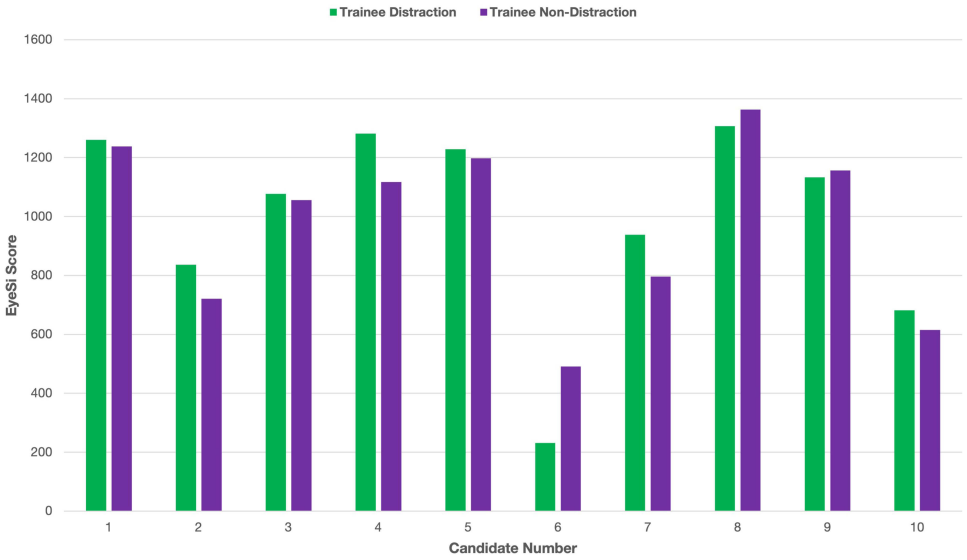


**Figure 2** Graph showing how EyeSi score varied for the Trainees with and without distraction.

a possible 1500, while the consultants scored an average of 708.6 (Standard Deviation 300.1), with an unpaired *t*-test result of 0.0609 demonstrating non-significance. A paired two-tailed test measuring the effect of distraction in trainees revealed a p value of 0.58 with trainees and a p value of 0.26 with consultants, revealing that the effect of distraction itself did not statistically significantly lower scores. The trainees' score in fact rose by 22.3 during the distraction case but this was also not statistically significant (p value 0.8792). A power calculation set for 80% power demonstrated a need for 13 participants in each group for a total of 26 candidates for a reasonable chance of reducing the chance of a type 2 error, so it is possible that with more candidates this result would be more robust. In summary, the only result of significance is that consultants performed worse than trainees during the distraction cases but not with the non-distraction cases. Across both distraction and non-distraction cases taken together, consultants performed poorly compared to trainees. The mean score for a case for trainees was 328.8 out of a possible 500 (Standard Deviation 104.3) and 226.9 (Standard Deviation 76.7) out of a possible 500 for consultants with a p value of 0.002 on the *t*-test.

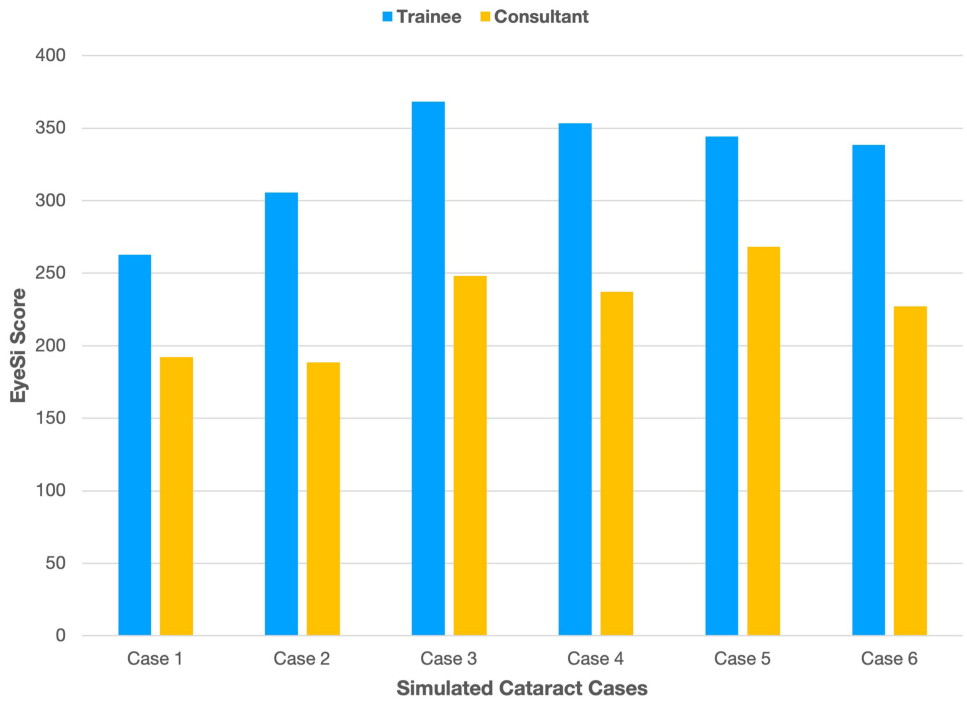


**Figure 3** Graph comparing average EyeSi scores between Consultants and Trainees.

Heart rate measurements averaged 80.9 beats per minute (BPM) across all three readings in each of the three cases in the trainee group (a total of nine measurements) experiencing distraction, compared to 79.8 on average for the non-distraction cases with the trainees. This result was not significant (p value 0.8353). Heart rate measurements averaged 86.3 BPM across all three readings in each of the three distraction cases in the consultant group, and 84.3 BPM in the cases not experiencing distraction. This indicates a rise of on average of 1.1 BPM in the distraction cases in the trainees and 2.0 BPM in the consultant group, and this very small difference was not statistically significantly different (p value 0.6970). The difference between consultants and the trainees as a group, for the distraction cases (p value 0.2869), the non-distraction cases (p value 0.4021) and all cases together (p value 0.3171), was not significantly different. In summary, heart rate measurements did not reveal any significant effect due to distraction within either group or between any groups.

Systolic blood pressure measurement in the trainee distraction cases, averaged across three readings in each of the three cases (a total of nine readings in each of the ten trainees), was 132.9mmHg, with the equivalent reading in the non-distraction cases averaging 132.6mmHg. This small difference was not statistically significant (p value 0.9654). Systolic blood pressure measurement in the consultant distraction cases, averaged across three readings in each of the three cases (a total of nine readings in each of the ten consultants), was 142.1mmHg, with the equivalent reading in the non-distraction cases averaging 142.3mmHg. This small difference was not statistically significant (p value 0.9676). There was no difference between consultant and trainee groups in the distraction cases (p value 0.1200), non-distraction cases (p value 0.1122), or the groups as a whole (p value 0.0976). In summary, systolic blood pressure measurements did not reveal any significant effect due to distraction within either group or between any groups.

Diastolic blood pressure measurements in the trainee distraction cases, again the averaged value of nine measurements in each of ten trainees (a total of 90 measurements) was 78.9mmHg, with the equivalent reading in the non-distraction group being 79.7mmHg. This small difference was not statistically significant (p value 0.8003). The diastolic blood pressure measurement in the consultant distraction case group averaged 87.4mmHg. The average diastolic blood pressure measurement in the consultant non-distraction group was exactly the same, i.e., 87.4mmHg. There was therefore no statistically significant effect of distraction upon diastolic blood pressure results in either the consultant (p value 0.9799) or the trainee groups. There was, however, a statistically significant difference between the consultant distraction cases as a whole and the trainee distraction cases, with a difference of 8.6mmHg (p value 0.0096). There was also a statistically significant difference between the consultant non-distraction cases as a whole and the trainee non-distraction cases, with a difference of 7.7mmHg (p value 0.0315). Across both

distraction and non-distraction cases taken together, the difference in diastolic blood pressure was 8.2mmHg, which was a statistically significant difference (p value 0.0126). In summary, distraction had no significant effect on the diastolic blood pressure of either trainees or consultants, although there was a significant difference between consultants and trainees as a group, with distraction cases, non-distraction cases, and the cases taken as a whole. Further information on Trainee and Consultant's Heart Rates and Systolic and Diastolic Blood Pressure can be found in Tables 3 and 4.

**Table 3** Trainee Candidates' Heart Rate, Systolic and Diastolic Blood Press. Cases 2, 4 and 6 are distraction cases. Cases 1, 3 and 5 are non-distraction cases

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Case 1** | BP 1 Systolic | 132 | 156 | 110 | 126 | 153 | 116 | 141 | 130 | 126 | 114 |
| | BP 1 Diastolic | 87 | 91 | 73 | 88 | 98 | 73 | 81 | 74 | 76 | 68 |
| | HR 1 | 106 | 66 | 95 | 65 | 103 | 63 | 71 | 91 | 81 | 77 |
| | BP 2 Systolic | 136 | 161 | 109 | 124 | 161 | 129 | 134 | 148 | 122 | 184 |
| | BP 2 Diastolic | 91 | 92 | 76 | 79 | 99 | 73 | 73 | 79 | 74 | 87 |
| | HR 2 | 101 | 70 | 88 | 66 | 105 | 65 | 73 | 86 | 76 | 81 |
| | BP 3 Systolic | 150 | 151 | 106 | 117 | 164 | 126 | 139 | 130 | 105 | 124 |
| | BP 3 Diastolic | 90 | 70 | 79 | 82 | 97 | 73 | 65 | 88 | 69 | 70 |
| | HR 3 | 95 | 66 | 89 | 67 | 102 | 64 | 74 | 90 | 86 | 68 |
| **Case 2** | BP 1 Systolic | 126 | 160 | 107 | 127 | 158 | 119 | 141 | 134 | 117 | 136 |
| | BP 1 Diastolic | 77 | 91 | 74 | 73 | 96 | 77 | 83 | 84 | 74 | 84 |
| | HR 1 | 96 | 70 | 85 | 67 | 99 | 66 | 74 | 79 | 74 | 80 |
| | BP 2 Systolic | 131 | 156 | 118 | 134 | 160 | 145 | 125 | 146 | 130 | 168 |
| | BP 2 Diastolic | 89 | 103 | 78 | 80 | 100 | 69 | 79 | 81 | 84 | 87 |
| | HR 2 | 100 | 67 | 94 | 69 | 93 | 81 | 79 | 83 | 83 | 74 |
| | BP Systolic | 131 | 171 | 110 | 122 | 155 | 124 | 131 | 143 | 126 | 115 |
| | BP Diastolic | 64 | 85 | 79 | 88 | 98 | 74 | 79 | 75 | 70 | 72 |
| | HR 3 | 89 | 85 | 82 | 71 | 99 | 67 | 74 | 89 | 82 | 76 |
| **Case 3** | BP 1 Systolic | 135 | 152 | 110 | 118 | 155 | 142 | 139 | 134 | 144 | 137 |
| | BP 1 Diastolic | 83 | 102 | 72 | 82 | 92 | 64 | 72 | 76 | 82 | 87 |
| | HR 1 | 99 | 70 | 85 | 63 | 89 | 64 | 72 | 81 | 80 | 79 |
| | BP 2 Systolic | 125 | 158 | 118 | 107 | 151 | 119 | 129 | 130 | 129 | 94 |
| | BP 2 Diastolic | 84 | 88 | 76 | 48 | 94 | 75 | 75 | 81 | 81 | 80 |
| | HR 2 | 96 | 69 | 80 | 65 | 100 | 60 | 74 | 86 | 77 | 75 |
| | BP 3 Systolic | 131 | 135 | 105 | 127 | 157 | 128 | 112 | 132 | 123 | 146 |
| | BP 3 Diastolic | 81 | 90 | 67 | 56 | 82 | 73 | 68 | 80 | 68 | 89 |
| | HR 3 | 100 | 65 | 92 | 66 | 89 | 62 | 70 | 95 | 85 | 78 |

(*Continued*)

**Table 3** (Continued).

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Case 4** | BP 1 Systolic | 126 | 144 | 108 | 120 | 150 | 118 | 123 | 138 | 121 | 153 |
| | BP 1 Diastolic | 79 | 80 | 75 | 79 | 69 | 67 | 78 | 81 | 84 | 90 |
| | HR 1 | 102 | 68 | 79 | 69 | 95 | 66 | 72 | 81 | 81 | 77 |
| | BP 2 Systolic | 132 | 134 | 105 | 122 | 149 | 116 | 124 | 137 | 124 | 144 |
| | BP 2 Diastolic | 82 | 97 | 72 | 84 | 90 | 61 | 66 | 86 | 82 | 89 |
| | HR 2 | 102 | 70 | 82 | 68 | 93 | 71 | 75 | 86 | 84 | 78 |
| | BP 3 Systolic | 133 | 148 | 107 | 184 | 153 | 105 | 131 | 134 | 124 | 152 |
| | BP 3 Diastolic | 86 | 74 | 74 | 47 | 81 | 51 | 79 | 86 | 72 | 77 |
| | HR 3 | 98 | 70 | 88 | 71 | 107 | 62 | 76 | 91 | 78 | 74 |
| **Case 5** | BP 1 Systolic | 126 | 166 | 105 | 115 | 128 | 110 | 129 | 141 | 121 | 172 |
| | BP 2 Diastolic | 85 | 96 | 71 | 74 | 78 | 66 | 75 | 82 | 85 | 99 |
| | HR 1 | 94 | 67 | 84 | 69 | 92 | 66 | 70 | 84 | 81 | 82 |
| | BP 2 Systolic | 128 | 153 | 107 | 118 | 157 | 130 | 134 | 139 | 123 | 161 |
| | BP 2 Diastolic | 88 | 102 | 75 | 75 | 91 | 65 | 74 | 81 | 80 | 95 |
| | HR 2 | 99 | 70 | 83 | 62 | 96 | 67 | 73 | 86 | 84 | 76 |
| | BP 3 Systolic | 137 | 166 | 104 | 114 | 138 | 132 | 111 | 142 | 130 | 149 |
| | BP 3 Diastolic | 88 | 118 | 59 | 76 | 71 | 65 | 65 | 82 | 76 | 73 |
| | HR 3 | 99 | 72 | 81 | 67 | 101 | 68 | 68 | 82 | 82 | 81 |
| **Case 6** | BP 1 Systolic | 126 | 150 | 108 | 110 | 151 | 120 | 134 | 144 | 141 | 131 |
| | BP 1 Diastolic | 91 | 72 | 75 | 82 | 65 | 64 | 77 | 76 | 80 | 78 |
| | HR 1 | 100 | 68 | 82 | 69 | 94 | 67 | 70 | 88 | 85 | 81 |
| | BP 2 Systolic | 123 | 150 | 118 | 118 | 143 | 107 | 120 | 136 | 118 | 152 |
| | BP 2 Diastolic | 81 | 79 | 81 | 74 | 82 | 65 | 81 | 83 | 78 | 101 |
| | HR 2 | 95 | 70 | 92 | 68 | 92 | 66 | 66 | 85 | 86 | 84 |
| | BP 3 Systolic | 142 | 150 | 120 | 123 | 150 | 120 | 120 | 136 | 112 | 159 |
| | BP 3 Diastolic | 84 | 84 | 85 | 74 | 78 | 63 | 78 | 80 | 68 | 75 |
| | HR 3 | 102 | 71 | 91 | 60 | 101 | 72 | 74 | 86 | 92 | 84 |

The EyeSi simulator has a function that awards participants zero out of a possible 100 for any stage of an operation if any dangerous parameters are crossed. This is a function decided by the algorithm in advance and discussed with the RCOphth and fed into the scoring mechanism and cannot be altered locally. These "catastrophic errors", which would have resulted in significant morbidity in patients in a real-life situation, were scored at zero, although for the following stages of the operation, the catastrophic error was "restored" so that the other stages could be completed without trace of the incident being in evidence and in that way a poor performance in one stage would not jeopardise the rest of the operation. In reality of course, this is not the case, and catastrophic errors do not magically repair themselves for the remainder of the operation. Trainees suffered on average 3.8 catastrophic errors over all six cases (Standard Deviation

**Table 4** Consultant Candidates' Heart Rate, Systolic and Diastolic Blood Press. Cases 2, 4 and 6 are distraction cases. Cases 1, 3 and 5 are non-distraction cases

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Case 1** | BP 1 Systolic | 154 | 142 | 137 | 146 | 154 | 152 | 145 | 168 | 143 | 123 |
| | BP 2 Diastolic | 95 | 100 | 73 | 86 | 90 | 108 | 94 | 50 | 83 | 82 |
| | HR 1 | 90 | 88 | 109 | 79 | 89 | 97 | 65 | 96 | 64 | 76 |
| | BP 2 Systolic | 149 | 130 | 145 | 164 | 167 | 148 | 144 | 172 | 134 | 136 |
| | BP 2 Diastolic | 101 | 88 | 88 | 91 | 101 | 92 | 85 | 103 | 77 | 83 |
| | HR 2 | 83 | 99 | 107 | 78 | 88 | 84 | 96 | 95 | 62 | 78 |
| | BP 3 Systolic | 146 | 130 | 128 | 153 | 166 | 126 | 120 | 156 | 130 | 143 |
| | BP 3 Diastolic | 89 | 80 | 89 | 93 | 102 | 77 | 82 | 110 | 82 | 89 |
| | HR 3 | 85 | 89 | 101 | 73 | 89 | 77 | 56 | 97 | 64 | 89 |
| **Case 2** | BP 1 Systolic | 174 | 132 | 122 | 152 | 89 | 147 | 145 | 142 | 146 | 138 |
| | BP 1 Diastolic | 151 | 85 | 86 | 85 | 61 | 85 | 88 | 93 | 78 | 84 |
| | HR 1 | 87 | 105 | 101 | 76 | 95 | 82 | 61 | 96 | 70 | 91 |
| | BP 2 Systolic | 147 | 133 | 130 | 162 | 157 | 143 | 147 | 160 | 155 | 160 |
| | BP 2 Diastolic | 107 | 89 | 70 | 89 | 77 | 79 | 93 | 94 | 90 | 81 |
| | HR 2 | 97 | 102 | 109 | 72 | 90 | 80 | 71 | 105 | 70 | 91 |
| | BP 3 Systolic | 135 | 139 | 107 | 145 | 159 | 139 | 150 | 160 | 138 | 142 |
| | BP 3 Diastolic | 81 | 86 | 74 | 83 | 66 | 85 | 93 | 100 | 80 | 90 |
| | HR 3 | 92 | 109 | 99 | 73 | 87 | 81 | 64 | 90 | 65 | 99 |
| **Case 3** | BP 1 Systolic | 154 | 128 | 124 | 147 | 140 | 140 | 137 | 163 | 128 | 139 |
| | BP 1 Diastolic | 92 | 86 | 68 | 86 | 75 | 98 | 91 | 105 | 76 | 75 |
| | HR 1 | 98 | 92 | 104 | 75 | 90 | 79 | 67 | 92 | 63 | 87 |
| | BP 2 Systolic | 157 | 124 | 127 | 163 | 161 | 154 | 139 | 161 | 130 | 152 |
| | BP 2 Diastolic | 92 | 85 | 85 | 90 | 83 | 65 | 96 | 102 | 80 | 87 |
| | HR 2 | 94 | 97 | 104 | 76 | 96 | 84 | 75 | 97 | 65 | 86 |
| | BP 3 Systolic | 129 | 129 | 106 | 146 | 126 | 152 | 140 | 155 | 122 | 150 |
| | BP 3 Diastolic | 82 | 88 | 68 | 83 | 80 | 104 | 81 | 99 | 80 | 86 |
| | HR 3 | 100 | 96 | 83 | 76 | 86 | 78 | 73 | 97 | 66 | 88 |
| **Case 4** | BP 1 Systolic | 163 | 142 | 121 | 139 | 154 | 159 | 149 | 162 | 132 | 138 |
| | BP 1 Diastolic | 95 | 92 | 85 | 92 | 86 | 101 | 87 | 105 | 80 | 78 |
| | HR 1 | 92 | 102 | 94 | 77 | 95 | 80 | 68 | 99 | 80 | 90 |
| | BP 2 Systolic | 154 | 119 | 126 | 150 | 154 | 153 | 147 | 163 | 135 | 156 |
| | BP 2 Diastolic | 81 | 86 | 86 | 87 | 89 | 98 | 93 | 109 | 78 | 99 |
| | HR 2 | 94 | 103 | 97 | 77 | 94 | 87 | 66 | 98 | 66 | 87 |

(*Continued*)

**Table 4** (Continued).

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | BP 3 Systolic | 156 | 126 | 119 | 157 | 143 | 158 | 139 | 168 | 117 | 145 |
| | BP 3 Diastolic | 88 | 89 | 90 | 90 | 87 | 106 | 84 | 93 | 75 | 83 |
| | HR 3 | 98 | 98 | 95 | 76 | 91 | 84 | 122 | 93 | 66 | 81 |
| **Case 5** | BP 1 Systolic | 162 | 122 | 117 | 149 | 144 | 153 | 140 | 158 | 127 | 134 |
| | BP 1 Diastolic | 99 | 88 | 84 | 84 | 81 | 107 | 89 | 102 | 60 | 89 |
| | HR 1 | 88 | 96 | 94 | 77 | 95 | 79 | 64 | 95 | 65 | 77 |
| | BP 2 Systolic | 148 | 132 | 123 | 156 | 150 | 150 | 136 | 152 | 126 | 138 |
| | BP 2 Diastolic | 92 | 91 | 80 | 92 | 89 | 87 | 87 | 104 | 75 | 90 |
| | HR 2 | 94 | 90 | 95 | 76 | 83 | 80 | 66 | 94 | 66 | 81 |
| | BP 3 Systolic | 140 | 133 | 127 | 146 | 146 | 152 | 147 | 159 | 123 | 145 |
| | BP 3 Diastolic | 83 | 90 | 86 | 94 | 87 | 85 | 86 | 102 | 64 | 85 |
| | HR 3 | 93 | 88 | 86 | 84 | 88 | 83 | 68 | 92 | 65 | 82 |
| **Case 6** | BP 1 Systolic | 145 | 129 | 117 | 147 | 141 | 116 | 133 | 164 | 126 | 136 |
| | BP 1 Diastolic | 91 | 85 | 82 | 85 | 87 | 71 | 89 | 103 | 76 | 76 |
| | HR 1 | 85 | 102 | 85 | 77 | 91 | 80 | 71 | 90 | 67 | 88 |
| | BP 2 Systolic | 148 | 125 | 125 | 139 | 135 | 149 | 156 | 154 | 119 | 138 |
| | BP 2 Diastolic | 85 | 83 | 84 | 81 | 88 | 92 | 93 | 102 | 78 | 87 |
| | HR 2 | 84 | 101 | 95 | 74 | 91 | 81 | 70 | 98 | 66 | 78 |
| | BP 3 Systolic | 168 | 119 | 124 | 140 | 148 | 156 | 142 | 155 | 119 | 138 |
| | BP 3 Diastolic | 123 | 82 | 88 | 84 | 69 | 62 | 99 | 92 | 75 | 83 |
| | HR 3 | 88 | 97 | 92 | 73 | 88 | 81 | 79 | 91 | 66 | 78 |

4.39), while consultants suffered an average of 9.9 catastrophic errors across all six cases (Standard Deviation 4.65). This difference between the groups had a statistically significant *t*-test result with a p value of 0.0074. This result is arguably the most important result of this study. There was no statistical difference in either trainee or consultant group for catastrophic errors with distraction cases, non-distraction cases or in a specific stage of the five-stage operation. The catastrophic errors were spaced evenly in both distraction and non distraction cases and across all five stages of the cataract operation.

## Summary of Results

The most important result of this study was that consultants performed statistically worse than trainees, though this was not its primary aim, which was to explore the effects of distraction as a stressor on surgical performance and on the surgeon in both trainee cataract surgeons and consultants undertaking cataract surgery. The primary aim was met in that the data gleaned did not demonstrate a statistically significant effect of distraction upon either the surgical performance of trainees or consultants, either for the better or worse. Additionally, heart rate, systolic blood pressure and diastolic blood pressure were not statistically significantly affected by distraction in either trainees or consultants, for the better or worse. Additionally, the consultants as a group suffered a statistically significant increase in the rate of catastrophic EyeSi

simulator errors that awarded zero points for a cataract stage compared to the trainee group. The data also showed a statistically significant increase in diastolic blood pressure across the consultant group relative to the trainee group, although again this was a comparison of the group as a whole rather than being related to the effects of distraction upon diastolic blood pressure. No other relationships were noted to be significant.

## Discussion

The main finding of note is that consultants performed more poorly than trainees overall, with the effect of distraction itself being a distraction from this very important and wholly unexpected discovery. The primary reason for undertaking this study was to see if distraction had an effect on the mental workload and cognitive load experienced by either trainees or consultants, measured both by EyeSi scores and biometric measurements in the form of blood pressure and pulse rates and did not reveal a statistically significant effect.

The consultant group performed worse than trainees in the distraction group and also performed worse than trainees overall. This is unexpected as the consultants have by definition performed many times more cataract surgeries than trainees and should be performing better, if the simulator is a genuine representation of real cataract surgery. Published EyeSi research indicates that surgical simulation increases surgical performance and decreases complication rates.[26–29,31,37] There is indeed a wealth of information of varying quality that demonstrates or attempts to demonstrate that EyeSi simulation training in novice surgeons increases surgical prowess, but none that attempt to demonstrate that experienced surgeons perform better automatically at simulated EyeSi cataract surgery compared to novice surgeons that are not experienced in real cataract surgery but are experienced at simulated surgery.[32] If the EyeSi simulator was truly representative of reality, then it would be reasonable to expect consultant ophthalmic surgeons to be better at simulated surgery by virtue of their surgical skills being honed in real patients over many years. The trainees experienced an average of 3.8 catastrophic errors over all five stages of all six cases, while the consultants suffered 9.9, with a p value on the *t*-test of 0.0074. A Hedges' g calculation reveals a result of 1.113 indicating a difference of at least one standard deviation in how trainees and consultants both performed as a group. This would suggest that the simulator is different enough from reality that a separate learning curve is required, which would explain why trainees are so much better at simulated surgery than consultants. If this is indeed the case it would indicate that consultants should not expect to be automatically skilled at simulated surgery and that if experience at real surgery does not indicate increased prowess at the simulator, then the suggestion that real surgery is made better by simulated surgery needs to be openly questioned. Indeed, a Cochrane review suggests that much of the evidence is affected by bias or potential bias.[32] This is the first study, however, to demonstrate that experienced cataract surgeons without simulator experience are significantly worse at simulated cataract surgery than real-life surgery novices. Clearly, this result would indicate that more work is needed to understand the role of simulation in advancing cataract surgery skills, particularly when the RCOphth is continually advancing the role of simulated surgery in training, and the purchasing of expensive simulation equipment is now advocated on an ever-increasing scale.[33]

There are other explanations for poor performance as well. Studies of cataract surgeons in Wales and the UK have suggested that a significant minority are stressed with almost a fifth admitting to being willing to give up surgery altogether if this was offered to them.[1,2] It might well be true therefore that the EyeSi simulator is in fact a truthful simulation of real-life cataract surgery and the consultants simply were in fact worse performers. Perhaps, consultant cataract surgeons are not as skilled as trainees at performing surgery due to factors such as age, deteriorating hand eye coordination and presbyopia. The study of stress amongst Welsh consultant staff indicated that younger consultants were in fact more stressed than their older counterparts, so these age-related factors might not be the root cause of the poor performance but rather confounding factors. The National Ophthalmic Database kept as a rolling audit by the RCOphth does indeed show a clear correlation between numbers of surgeries undertaken a year and decreasing complication rates. Perhaps, the overall number of cataracts performed per unit time in the recent past is more relevant, which is not something that was explored in this study.

It is not uncommon for consultant cataract surgeons to perform less surgery compared to trainees for several reasons. Trainees are required to perform a total of 350 cataract surgeries during their training and often strive for many. Consultants have no minimum number and commonly give trainees most or even all the operations on their list to undertake so that the trainees can learn and the consultant's time can be spent undertaking other pressing activities.

Trainees have no subspecialty interests that can be developed as part of the current RCOphth training programme while consultants sub-specialise in conditions such as glaucoma or retinal surgery, only rarely undertaken by trainees and not a college mandated requirement for completion of surgical training. Consultants also have an administrative and managerial role within their departments that can mean less time is present to devote to increasing their number of completed cataract operations. It is therefore possible that consultant ophthalmic surgeons are indeed worse performers in real life as well as in simulated surgery and the simulator is in fact representative of reality.

The low sample size is a limitation of this study, though the power calculation would indicate that only six more participants would be required to reduce the chance of a type 2 error significantly. The biggest limitation was not performing a task load index exercise, such as the NASA-TLX tool, on participants after the simulated cataract surgery list had ended. This would have given a real insight into the mental workload and cognitive stress both trainees and consultants were suffering during the testing, and although it is perhaps a subjective measure not as strong as the direct objective EyeSi score or the biometric readings, it would have added valuable insight into how the other results could be interpreted and made the outcome more robust. Another limitation with this study is the inconsistency with the distractions between participants, with no two experiences being exactly alike. The nature of the distraction, chosen to be as realistic as possible, also has the flaw that candidate responses alter slightly the way the distraction progresses and this does leave the study open to bias in which distractions proceed differently and therefore a more consistent means of providing a realistic distraction would be desirable for future studies. This may take the form of a much tighter script or a recorded distraction that can be played at specific pre-determined intervals.

Another consideration that may have limited the study findings is the motivation of the study participants. Consultants, having more experience than the Trainees, may have been less motivated given this was a simulated environment and not performed on a real patient. An evaluation form looking into potential candidates' motivation could be useful in future studies.

In view of the importance of this issue, it would be proper for the RCOphth to lead a UK-wide study of this issue. This would involve several sites and due to the increase in bias that such a change might entail an appropriately increased number of participants would also be required. In Wales, we recruited towards the very upper limit of eligible people we can reasonably expect for this sort of study, but on a UK-wide basis with many more potential applicants an additional form of bias would have to be accounted for when the consultants and trainees volunteering are by their very nature confident of their skills and happy to demonstrate them, whereas the unconfident and anxious might be expected to avoid participating. Whilst questionnaires might well limit this effect to an extent, it is always a risk when the potential pool of applicants has expanded greatly. Additionally, the amount of time involved in undertaking the study, for both investigators and participants, is such that a form of inducement for both would have to be at least considered, though this would introduce its own form of bias.

The mandate for change would be greater still if a UK-wide study was conducted under the auspices of the RCOphth. Whilst the primary aim of this study, what might now be called a pilot study, was to investigate the effects of cognitive load on surgical performance with a view to improving training through reducing distraction-based cognitive load, this was not proven to be the case though perhaps hints at a much more important problem of how cataract surgery training is conducted not just in the United Kingdom but around the world.

## Conclusion

The primary aim of this study was to determine the effects of distraction as a stressor on surgical performance and on the surgeon in both trainee cataract surgeons and consultants undertaking cataract surgery. The primary hypothesis was that increased cognitive load affected mental workload and as such decreased surgeon performance and increased stress, as measured by simulator scores and biometric measurements. Distraction as a stressor was found in the event not to have a statistically significant effect on either simulator scores or biometric parameters, either in trainees or consultants. Otherwise, the main finding of this study was that consultants performed worse than trainees overall and suffered more serious errors. This could be either due to the simulation device not being a true representation of live cataract surgery or that there really is an issue with some segments of the consultant population performing poorly at cataract surgery. Either way, this is an important finding which needs further research, the results of which would be instrumental in planning the

training of the next generation of cataract surgeons and consequently is critical to patient safety in cataract surgery in the future. This study is important as it has highlighted an important signal that needs further exploration. Future studies need much wider participation, RCOphth sponsorship and the addition of stress-based questionnaires to explore the issue in greater detail.

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