Cognition-Informed Training for International Nuclear Safeguards

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Abstract:

Each year, the International Atomic Energy Agency (IAEA) spends a significant amount of resources on training incoming nuclear safeguards inspectors. A significant portion of this training is accomplished through the Introductory Course on Agency Safeguards (ICAS). While ICAS and other IAEA safeguards trainings are highly effective, lessons from cognitive science could be applied to safeguards training modules to enhance the successful application of learned skills in various operational environments. In this paper, we review and explain relevant cognitive science literature and provide safeguards-specific recommendations for explaining new concepts, practicing skills, developing effective training environments, reinforcing information, and performing effectively under stress. Many of these recommendations could be implemented with minimal disruption to current curriculum and training approaches. While our recommendations are tailored for safeguards training environments, many are broadly applicable to teaching and training environments spanning the nuclear materials management domain.

Keywords: international nuclear safeguards, cognitive science, human factors, training

1. Introduction

The International Atomic Energy Agency (IAEA) allocates a significant amount of resources to train incoming nuclear safeguards inspectors. One of the primary means of training new inspectors is the Introductory Course on Agency Safeguards (ICAS), a months-long, comprehensive course that seeks to give inspectors all the information and skills they will need to be successful safeguards inspectors. . It is crucial that inspectors be able to transfer new skills from a training environment to the field. While ICAS is highly effective at training safeguards inspectors, lessons and best practices from cognitive science could further enhance the effectiveness of transferring skills learned in training to the field environment, and can also apply to other training within the IAEA Department of Safeguards.

Transfer of training occurs when learned skills are applied successfully in the workplace. Here, we focus on training design and delivery mechanisms to enhance learning, memory, and ultimately transfer of training to the field. We review relevant cognitive science literature on best practices for explaining new concepts, incorporating practice into training, providing realistic training environments, presenting materials in a compelling and memorable way, supporting proper mindset through encouragement of students, and using

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technologies measuring physiological responses to gain deeper understanding of student learning and attention. For each of these areas, we provide distinct lessons relevant for international nuclear safeguards and provide explicit and actionable recommendations that could be considered to support safeguards training. Our intention is not to replace comprehensive reviews in these areas; for a more thorough review on the translation of cognitive and educational psychology practices into classroom strategies, see [1], [2], [3].

The length, depth, and classroom-style format of ICAS makes it a good candidate for implementing our recommendations to promote the transfer skills learned in a training environment to the workplace. Notwithstanding, safeguards inspectors and other safeguards staff participate in classroom-based trainings throughout their IAEA careers, and many of our recommendations are relevant for those training activities. However, this study does not include a comprehensive overview of safeguards training activities. While we did read relevant literature and interview several subject matter experts in IAEA safeguards training, we did not have access to full training materials or protocols that would have allowed us to provide specific recommendations to change current procedures. Instead, we offer recommendations that we hope the safeguards training community finds relevant, some of which may currently be employed

The paper is organized as follows. Each section provides a high-level concept: explaining, practicing, training environments, presenting materials, encouraging students, and measuring responses. For each section, we provide specific training recommendations with references to cognitive psychology literature and highlight how these recommendations could be applied in safeguards training environments.

2. Explaining New Concepts

Explaining new concepts refers to how trainers present new material to students. It primarily refers to oral explanations, such as classroom lectures. Cognitive psychology research has identified specific strategies that strengthen students' ability to remember new information, understand abstract concepts, and mentally organize new information. Some strategies for enhancing the explanation of new concepts include interleaving related material, relating explanations to in-field duties, providing cues for what is important, and cross-training members of a team.

2.1 Interleave related topics and practice opportunities during instruction to help students identify similarities and differences between concepts.

Interleaving is a strategy in which an instructor switches back and forth between related topics or between example problems and practice problems in a lecture. Interleaving helps students mentally organize information, discriminate between different types of problems or information, and understand the differences between concepts [4, 5]. Instructors can incorporate interleaving by making comparisons between a current topic of focus and a related topic studied previously [5]. In addition, studies have shown that students learn quicker when example

problems are interleaved with practice problems [6]. Interleaving teaches students to discriminate between different types of problems or information and understand the differences between them [4, 5]. However, there is little evidence that switching between completely different subjects (such as between mathematics and language arts) is effective for learning; instead, interleaving focuses on similar problem types or solved example problems and practice problems when studying.

Safeguards training recommendations:

- Include intermittent practice opportunities in a lecture, for example with hands-on use of non-destructive assay methods that are being explained.
- Encourage discussion of similar concepts together, for example to compare different safeguards seals and the appropriate application and examination methods for each.

2.2 Explain the "why" or "how" of new information to develop a deeper understanding of new concepts.

Also referred to as elaborative interrogation or explanatory questioning, elaboration is the process of asking and explaining the "why" or "how" of a newly learned concept [5]. Researchers have proposed several possible explanations for the effectiveness of elaboration. One explanation is that elaboration improves learning by promoting the development of connections between new information and existing knowledge, which helps students mentally organize the information [5, 3, 1]. In the classroom, instructors may consider conducting elaboration exercises, in which they ask students to attempt to explain new concepts to themselves (such as writing down an explanation) or to their peers in small groups. However, elaboration is only effective if students' explanations of new concepts are accurate, so it is important that instructors monitor student discussions and provide correct information about new concepts following elaboration exercises [5]. Elaboration may also cause students to slow down while reading and pay more attention to the information being presented [3].

Safeguards training recommendations:

- Continue to present new information within relevant context of its importance to a particular technical objective or to the overall safeguards regime.
- Offer opportunities for safeguards inspectors to engage in explaining concepts as a form of learning and knowledge-check (i.e., correction by trainer if the explanation is incorrect). Self-check opportunities can also be used to provide feedback without pressuring inspectors in front of their colleagues.

2.3 Relate training activities to in-field duties.

Training is more effective when students perceive that what they learn during training will help them perform their jobs or improve their job performance and that the training is relevant to actual workplace tasks. Helping students understand how a training activity relates to job tasks will motivate them to learn the target skill or apply it in the workplace. Training programs could begin with information about how and why the training

is relevant to motivate students to pay attention and apply trained skills [7, 8].

Safeguards training recommendations:

- Relate training information to in-field and other safeguards verification tasks by providing context for the overall safeguards mission area.

2.4 Provide examples to explain difficult or abstract concepts.

Illustrating abstract concepts with specific examples helps students understand new ideas [6]. Examples can convey information more concisely and concretely than abstract concepts [5]. Associating an abstract concept with a concrete example can help students recall information, especially with the use of concrete examples that accurately illustrate the concept being taught to avoid confusion.

Safeguards training recommendations:

- Provide specific safeguards scenarios or examples as illustrations of difficult concepts. For example, when discussing the protocol for taking environmental swipe samples, describing the ramifications that would result from cross-contamination of swipe samples could facilitate learning.

2.5 Present materials in multiple formats.

Contrary to popular belief, teaching to an individual's preferred "learning style" (visual, auditory, verbal, and kinesthetic) does not result in better learning outcomes. Instead, all students benefit from being presented material in multiple formats [9, 10, 11, 12]. This concept is related to dual-coding theory, in which words are combined with visuals or other sensory information to enhance learning and memory [12]. Text is most often combined with visuals since images are easier to remember and they convey information more succinctly than text [5, 13, 14]. Dual-coding can help students understand complex processes or systems that would be difficult to understand with only a verbal description. Furthermore, delivering instructional materials in multiple formats can eliminate potential monotony from lectures and maintain audience attentiveness, thereby increasing the ability of students to sustain attention on the lecture [15]. Multiple formats might also support a diverse population of students with varying levels of proficiency in the presentation language.

Safeguards training recommendations:

- Safeguards trainers may consider providing examples in various media forms, such as images, text, video, spoken words, and physical objects, if applicable.
- Present safeguards training information in mixed-media formats, with a focus on audio supported by text.

2.6 Use multimedia elements effectively to reinforce learning.

One way to present in multiple formats is by incorporating multimedia elements such as slideshows, images, and videos into lectures to help students organize information, see examples, and understand processes. Multimedia instruction often involves presenting information in more than one modality at once, but excessive amounts of information presented simultaneously can result in cognitive overload and inhibit learning. Reinforce auditory information with complementary visuals to avoid overloading the audience with text. For example, an

animation that also includes on-screen text descriptions overloads visual channels as the student must split their attention between the animation and the text. Swapping on-screen text for auditory narration can reinforce, rather than undermine, learning taking place through visual channels [16, 17].

Safeguards training recommendations:

- Break presentations into segments to allow inspectors time to process and organize information. For example, present information in text form and then show an illustrative animation or image on the next slide [16, 17]. The ideal split will be driven by the concepts to be learned: diagrams with short text labels may be helpful for learning the components of a system, whereas animations with spoken descriptions may be more helpful for learning a new process [18, 19].
- Present corresponding material for a specific safeguards concept together, but do not add extraneous information in the process. Remove irrelevant examples, large amounts of text from slideshows, background music, and text descriptions that do not match narration in videos [16].
- Use human voices rather than computer-generated voices when presenting information, as people learn better from real human voices than from synthesized voices [17, 20].

2.7 Provide students with information about components of a system prior to teaching the system.

When learning about new systems, it is important that students learn the functions of the individual components comprising that system before trying to understand how those components work together to make the system work. For example, it would benefit a student to learn the name and function of computer parts before they attempt to build a computer. Pre-training allows students to understand causal links and complex processes [16].

Safeguards training recommendations:

- Provide reading, videos, or other content to safeguards inspectors to preview prior to the start of related class sessions.
- Introduce new concepts with reminders about the component pieces and how they fit into a broader safeguards concept.

2.8 Provide cues about how to select and organize important information.

Indicate what information is important and how new information fits with previously learned information to help students prioritize and organize knowledge. For example, include an agenda or table of contents to show how information is categorized, use headings to indicate main ideas, highlight the most important points or reiterate them using more than one modality (e.g., through text and narration), write main ideas on a board, or provide an outline of the most important topics [16, 17].

Safeguards training recommendations:

- Provide notes pages with main topics and important safeguards definitions already included.
- Describe learning objectives at the start and end of safeguards training modules to ensure key concepts are identified.

2.9 Present examples or instructions conversationally, in relation to the student.

Using conversational language helps students learn and remember information because such language personally connects the student with new material. For example, say, "When you use this piece of equipment, you have to calibrate it first to make sure your readings will be accurate," instead of, "This piece of equipment must be calibrated prior to operation to ensure accurate readings" [17]. An overview of studies indicated broad findings that that content presented in a conversational style compared to a formal style increased performance for information retention and transfer [21].

Safeguards training recommendations:

- Use a conversational, but professional, tone.
- Present material in the first or second person ("I" and "you"), as opposed to the third person ("one, he, she").

2.10 Teach members of a team about their teammates' roles and responsibilities to create more communicative and effective teams.

Cross-training is a training strategy in which every member of a team is trained in the duties of their teammates such that each team member understands the others' roles, tasks, and responsibilities [22]. The goal of cross-training is to create teams that can communicate, coordinate, anticipate each other's needs, and assist each other effectively. Studies have found that two- and three-person cross-trained teams outperformed non-cross trained teams by engaging in more teamwork behavior, communicating more effectively, having higher success rates on team based-tasks [23, 24], and developing shared mental models [25].

Safeguards training recommendations:

- Train all members of inspection teams on all tasks that might be required.
- Training across safeguards tasks could also be considered for non-inspector participants in safeguards verification activities, such as analysts or technicians that support inspection efforts.

3. Practicing

Practicing refers to opportunities for students to apply their new knowledge or skills in a supervised way. The repetition and course-correction that occurs while students practice target skills increases students' ability to perform effectively outside of training environments. Practicing can include hands-on activities, practicums, or applications, as well as classroom discussions. It can also include more formal mechanisms of practice such as quizzes and exams.

3.1 Provide opportunities to practice information recall.

Retrieval occurs when a student recalls a piece of information. Practicing retrieval by drawing information from long-term memory into working memory strengthens knowledge of that information [5]. For this reason, tests and quizzes can enhance one's knowledge while checking for successful retention of information [26]. Students tested more than one time retain more information long-term than those that are tested only once [27]. To enhance this effect, instructors could give students a series of quizzes prior to a final exam to give students multiple opportunities

to practice retrieval. Furthermore, providing feedback on quizzes and tests promotes learning because students have an opportunity to review and learn from mistakes [26].

Safeguards training recommendations:

- Encourage self-testing, such as by creating flashcards, for inspectors to practice retrieval and discover what they know and what they do not know. Best practice for self-testing with flashcards includes practicing with both sides of the cards (concept and definition, for example), and shuffling after each run-through of the deck.
- Provide low-stakes opportunities for inspectors to practice retrieving information, such as through quizzes or discussions that include feedback, so they can identify concepts to review. The use of game-like elements to support learning objectives has also been shown to increase learning outcomes (though, typically only small increases) and could provide low-stakes and engaging opportunities for practice [28].

3.2 Give students opportunities to observe and practice skills.

Observation and practice are critical for learning and remembering new information and skills [7]. During training, explanations of the behaviors to be learned can help students understand new behaviors and skills. This could include the trainer displaying effective and ineffective implementation of target skills (i.e., what to do and what *not* to do) and providing students with opportunities to practice and receive feedback on those skills.

Safeguards training recommendations:

- Demonstrate correct and incorrect execution of desired safeguards skills.
- Provide opportunities for safeguards inspectors to practice new skills with oversight and feedback from trainers.

3.3 Space practice over time.

Spaced practice involves revisiting previously learned information multiple times over the course of several days, weeks, or months. Distributing learning over several days significantly increases the amount of information that a student will retain compared to presenting the information in one learning session [27]. Spaced practice results in longer-term retention of information, likely because revisiting information at different times strengthens a student's ability to retrieve that information from memory [5]. Practice can also continue once the training period is over, for example through opportunities for continued learning, skill maintenance, and long-term goal setting, that will help students maintain their skills.

Safeguards training recommendations:

- Review prior, related content at the start of new lesson modules to provide multiple spaced exposures to safeguards information.
- Provide homework or external assignments that require inspectors to draw on prior information.
- Interleaving safeguards concepts (e.g., differences between seal types) can give inspectors multiple opportunities to learn concepts within a lesson.

3.4 Allow students to make and correct mistakes during training.

Error management is a strategy in which students are permitted to make mistakes during training. Instructors help students learn from their mistakes by correcting them, informing them of other errors that could occur, and describing the negative consequences of errors. Error management facilitates transfer of knowledge by teaching students how to anticipate issues before they arise and to manage problems if they occur [7].

Safeguards training recommendations:

- Provide opportunities for supervised practice, which can include reinforcement or corrections on a new skill. This could include supervised practice using safeguards equipment, applying or examining safeguards seals, or other important inspection tasks.
- Include low-stakes opportunities for inspectors to practice and fail in order to correct skill performance or recall through additional support from trainers. These low-stakes opportunities include supervised practice opportunities, self-testing, and working with small peer groups in which participants can support each other in mastering a skill.

3.5 Train critical skills for high anxiety scenarios repeatedly.

Increased anxiety (e.g., time pressure, threat of personal harm) in a situation can change decision-making, causing people to make faster and less accurate decisions [30]. This has been found in settings as varied as parachute jumps, piloting an aircraft, simulated firefighting (reviewed in [31]) and simulated police settings [29]. In high stress situations, people tend to fall back on overlearned strategies that they can pull from long term memory [31]. While experts often perform better under high stress situations [32, 33], both experts and novices have been shown to have degraded performance in high stress situations that require a creative response.

Safeguards training recommendations:

- Anticipate high stress scenarios and provide extra training on critical skills needed to mitigate those scenarios. This could include things like safeguards equipment troubleshooting, safety procedures, or emergency protocols.

Other training procedures to support stressful environments are covered in Section 4.

4. Training Environments

IAEA safeguards inspectors are likely to experience moderate levels of stress during inspections. They may face fatigue from lengthy travel and jetlag, discomfort from heat or noise within a facility, and high workload and time pressure from a long list of inspection tasks. Despite the presence of stress, inspectors must perform at consistently high levels. Training to prepare for stress may support this high-performance requirement.

4.1 Train in environments that resemble the field.

Trained skills are more likely to transfer to the workplace when the training environment closely resembles it. Having the training environment mirror the workplace helps students contextualize scenarios in which new

skills may be applied in the workplace. Methods to create realistic training environments include the provision of training opportunities in the field and the incorporation of field-relevant environments (such as location, noise, or time pressure) [7].

Safeguards training recommendations:

- Continue to provide in-field training opportunities at realistic or operational nuclear facilities.
- For classroom-based training, include field-relevant environments related to time constraints, space restrictions, operator negotiation, or other relevant elements. These elements could be as simple as introducing timed practice for seal examination and application exercises, or more complex and realistic scenario-based training.

4.2 Educate students on factors that may impact their performance in the field such as performing repetitive tasks, multi-tasking, and sleep deprivation.

When people must perform a low-effort, sustained monitoring task over a long period of time, performance of that task declines [34]. However, some promising work has shown that briefly switching to a different mental operation can offset these detrimental effects [35]. One theory is that the ability to pay attention to one task over time can be "reset" by this brief task-switch. It is also well known that trying to multi-task, or perform multiple similar operations at once, can hurt task performance. This is true both in simple laboratory tasks [36] as well as in real-world situations, like using a cell phone while driving [37]. For a review of factors that could affect the performance of safeguards practitioners, see [38].

Safeguards training recommendations:

- Include a training module on factors influencing safeguards inspection performance, and support inspectors on being able to assess their own state-of-being.
- Provide information on mitigation strategies for performance inhibitors that are common for safeguards inspections such as jetlag, multitasking, or time pressure.

4.3 Educate students on the effects of environmental stressors and mitigation techniques.

The environment in which someone is working can significantly impact their performance. Environmental stressors like noise [39, 40] and temperature (extreme heat [41] or cold [42, 43]) can degrade performance on certain tasks. In some cases, individuals can take action to reduce environmental stressors that can improve their own performance. For example, studies of noise and performance have found that reducing noise levels in work settings improves productivity [44] and reduces human error [45], accidental damage to material and absenteeism [46], and workplace accidents [47, 48].

Safeguards training recommendations:

- Include education on environmental stressors and their impacts on performance, with the aim to help inspectors identify when they are in scenarios of potentially compromised performance. This will allow inspectors to

better judge their own ability to complete tasks and request help from their inspection team as needed.

- Include potential mitigation strategies for safeguards inspection environmental stressors, such as using disposable ear plugs, orienting tasking according to temperature (e.g., working outdoors early on a hot day, and moving to indoor tasks during hotter parts of the day, and vice versa for cold climates), and knowing what accommodations they can seek from facility operators regarding environmental conditions.

4.4 Expose students to field-relevant stressors during training.

Stress inoculation training (SIT; also sometimes called stress exposure training) is a targeted three-phase training approach intended to teach individuals about stress and how to manage it [49]. SIT is organized into three phases: In Phase 1, students learn about stress effects and stressors they are likely to encounter in the workplace; in Phase 2, students learn techniques to cope with stress; in Phase 3, students practice using coping skills in increasingly stressful environments [50]. The objectives of SIT are to increase students' familiarity with stressors and stress symptoms, teach them skills to overcome stress effects, and build confidence in their ability to perform at a high level despite stress [50]. SIT has been shown to improve performance in real-life high-pressure situations, such as law enforcement settings [51].

Safeguards training recommendations:

- Implement aspects of SIT into safeguards inspection training. Headquarters-based training could include Phases 1 and 2, to identify stressors and learn techniques to cope with them. Field activities, such as APEX training, are good candidates for Phase 3 practice (and to the authors' understanding, is currently being used this way).

4.5 Create immersive training environments via augmented reality (AR) and virtual reality (VR) to replicate settings that would be too unsafe, costly, or otherwise untenable for in-person training.

Augmented reality (AR) refers to an immersive visual environment in which digital displays are superimposed over images of the participant's actual environment; virtual reality (VR) refers to a fully immersive 3D display, generally blocking out all elements of the real world. The use of AR/VR in training environments could have many potential benefits, including offering immersive, safe, and low-cost ways to expose people to high-risk or otherwise difficult-to-replicate environments during training, under the assumption that training in such environments will enhance transfer of the learned skills to the real-world environment (for review, see [52]). Some potential drawbacks of AR/VR for training include the cost of equipment and development of the virtual training environment, the inability to collaborate with others in real time, and the limited range of motion permitted by many AR/VR setups. Additionally, the quantitative benefits of AR/VR training to real-world performance remain unclear. In a recent

meta-analysis, Kaplan et al. [53] found equally good task performance in real-world settings following AR/VR training and traditional training across a variety of cognitive and physical tasks.

Safeguards training recommendations:

- Have new inspectors practice performing inspection tasks in a simulated environment first, such as a new unfamiliar facility, or a more complicated facility than one they have previously visited. Having the opportunity to practice inspection tasks in these varied environments may help them to learn and/or remember the steps better than simply reading about it in the classroom or watching a video.
- Replicate stressful aspects of the real environment that inspectors may encounter via AR/VR, following the research that learning under stressful environments likely improves recall in a real-world stressful environment. In these cases, environmental stress could be caused by issues such as equipment malfunction, uncooperative facility operators, or a safety incident.

5. Encouraging Students

Motivation refers to a student's desire to learn a new skill or reach a goal. Motivation is closely linked to self-efficacy, which is a person's confidence in their abilities. Students with higher self-efficacy believe that they can learn new skills and that learning new skills will result in positive outcomes or benefit them in the workplace [7]. Building appropriate self-efficacy supports student learning.

5.1 Promote trainees' confidence in their abilities.

A student's belief in their ability to learn and apply new skills is strongly linked to positive training outcomes. Students with higher confidence in their abilities are more likely to persevere despite challenges, while those with lower confidence are likely to be discouraged by challenges and reduce effort. Self-efficacy can be developed through skill mastery (practicing a skill to increase comfort level), modeling (watching others perform a skill so that it becomes more predictable and makes sense in context), encouragement, instruction, feedback from instructors, and post-training goal setting [7, 54, 8]. Giving positive feedback when students perform a skill correctly reinforces the skill and can increase trainees' beliefs about their competency with a skill [55]. Goal setting can also increase self-efficacy by giving students specific benchmarks to work toward and the ability to self-monitor their progress. Strong goals are specific to the trained skill, and are challenging but attainable [56].

Safeguards training recommendations:

- Give positive feedback and supportive corrections to inspectors as warranted by their performance.
- Provide multiple opportunities for inspectors to practice, fail, and correct their performance through hands-on activities and classroom exercises.

5.2 Encourage peer support.

Peer support has been found to be just as impactful on student development as supervisor support [7, 8]. Peers can provide each other with encouragement, feedback,

coaching, and behavior modeling, and play a significant role in a student's transfer of training to the workplace.

Safeguards training recommendations:

- Encourage inspectors to work together on problem-solving.
- Provide opportunities for inspectors to recognize the strengths and accomplishments of their peers.

6. Measuring Physiological Response

Specialized techniques can be used to assess learning and/or enhance training by collecting physiological data during task performance. Physiological data refers to data collected about the body (e.g., heart rate, brain activity) that can be used to infer something about cognition. These physiological measures can provide a way to study aspects of cognitive processing during performance, without asking the individual to stop and respond to questions. When collected together with behavioral data, these measures can be used to both understand and enhance training and performance. Selected technologies are described below based on their relatively easy implementation in operationally relevant environments. Because the technologies discussed below require cognitive science expertise to execute in the proper experimental settings and interpret the data appropriately, we do not recommend these technologies for immediate implementation for international safeguards training. Instead, we highlight these techniques to demonstrate that it is possible to measure trainees' stress levels, cognitive load, learning, and focus during training. This data could be used in the future by safeguards trainers to identify challenging or stressful training tasks that may require additional practice.

- **Electrodermal activity (EDA)**, a physiological measurement of the electrical conductance of skin, can give insights about a person's psychological state in response to a stressor [57, 58]. EDA could be used in safeguards training to identify training scenarios that produce stress in trainees for the development of stress-reducing interventions.
- **Heart rate (HR**) and **heart rate variability (HRV)** can be used to measure cognitive workload and fatigue [59, 60, 61, 62]. For safeguards training, HR and HRV measurements could be used to assess workload demands of a particular tool or procedure.
- **Eye-tracking** is used to measure the eye gaze location of people performing visual tasks, such as reading, viewing an image, or using an interface [63, 64, 65, 66]. Novice safeguards inspectors could study the eye gaze behaviors of senior inspectors to identify task-relevant areas to focus their attention on and learn which cues experts use to guide their attention during difficult tasks.
- **Electroencephalogram (EEG)** is the measurement of brain electrical activity using electrode sensors placed on the scalp, and event-related potentials (ERPs) are portions of the EEG signals that are time-locked to specific stimulus events [67, 68]. EEG and ERP data could help trainers

identify safeguards tasks that produce higher cognitive workload – and are therefore more difficult to learn – and design trainings that give extra practice time for more challenging tasks.

7. Conclusion

In this work, we highlighted specific training techniques that cognitive psychology research has identified as having positive effects on the transfer of training and described how these techniques could be applied to international nuclear safeguards training environments. Many of these techniques could be implemented in existing training programs like ICAS for minimal cost and could significantly increase students' knowledge retention and transfer of training from the classroom to the field. In particular, giving students opportunities to practice target skills, spacing exposure to materials over time, delivering material in multiple formats, and exposing safeguards staff to some stressors during training could significantly improve learning and knowledge retention. By making small changes to the ways that they explain information, present materials, and set up training environments, trainers can improve the effectiveness of their trainings and set up students for greater success in the workplace.

Other valuable contributions that support learning and human performance could come from domains such as social psychology and anthropology. Future studies should address lessons from these domains, as well as deeper analysis of current safeguards training practices to provide the most actionable recommendations.

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9. References

[1] Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving Students' Learning with

Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology. *Psychological Science in the Public Interest, 14*(1), 4-58.

[2] Hempel, B., Kiehlbaugh, K., & Blowers, P. (2020). Scalable and Practical Teaching Practices Faculty Can Deploy to Increase Retention: A Faculty Cookbook for Increasing Student Success. *Education for Chemical Engineers; 33,* 45-65.

[3] Roediger, H. L., & Pyc, M. A. (2012). Inexpensive Techniques to Improve Education: Applying Cognitive Psychology to Enhance Educational Practice. *Journal of Applied Research in Memory and Cognition*, 1, 242-248.

[4] Kang, S. H., & Pashler, H. (2012). Learning Painting Styles: Spacing is Advantageous when it Promotes Discriminative Contrast. *Applied Cognitive Psychology, 26,* 97-103.

[5] Weinstein, Y., Madan, C. R., & Sumeracki, M. A. (2018). Teaching the Science of Learning. *Cognitive Research: Principles and Implications; 3*(2), 1-17.

[6] Pashler, H., Bain, P. M., Bottge, B. A., Graesser, A., Koedinger, K., McDaniel, M., & Metcalfe, J. (2007). *Organizing Instruction and Study to Improve Student Learning.* National Center for Education Research.

[7] Grossman, R., & Salas, E. (2011). The Transfer of Training: What Really Matters. *International Journal of Training and Development, 15*(2), 103-120.

[8] Burke, L. A., & Hutchins, H. M. (2007). Training Transfer: An Integrative Literature Review. *Human Resource Development Review, 6*(3), 263-296.

[9] Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest, 9*(3), 105-119.

[10] Kirschner, P. A. (2017). Stop Propagating the Learning Styles Myth. *Computers & Education, 106,* 166-171.

[11] Clark, R. E. (1982). Antagonism Between Achievement and Enjoyment in ATI Studies. *Educational Psychologist*, *17*(2), 92-101

[12] Massa, L. J., & Mayer, R. E. (2006). Testing the ATI Hypothesis: Should Multimedia Instruction Accommodate Verbal-Visualizer Cognitive Style? *Learning and Individual Differences*; *16,* 321-335.

[13] Paivio, A., & Csapo, K. (1973). Picture Superiority in Free Recall: Imagery or Dual Coding? *Cognitive Psychology*, *5,* 176-206.

[14] Stenberg, G. (2006). Conceptual and Perceptual Factors in the Picture Superiority Effect. *European Journal of Cognitive Psychology*, *18*(6), 813-847.

[15] Hancock, P. A., & Warm, J. S. (1989). A Dynamic Model of Stress and Sustained Attention. *Human Factors*; *31*(5), 519-537.

[16] Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist*, *38*(1), 43-52.

[17] Mayer, R. E. (2017). Using Multimedia for E-Learning. *Journal of Computer Assisted Learning*, *33,* 403-423.

[18] Castro-Alonso, J. C. (2021). Five Strategies for Optimizing Instructional Materials: Instructor- and Learner-Managed Cognitive Load. *Educational Psychology Review*.

[19] Mutlu-Bayraktar, D., Cosgun, V., & Altan, T. (2019). Cognitive Load in Multimedia

Learning Environments: A Systematic Review. *Computers & Education, 141.*

[20] Liew, T. W., Tan, S., Gan, C. L, Kew, S. N. (2023). A Human or a Computer Agent: The Social and Cognitive Effects of an e-Learning Instructor's Identity and Voice Cues. In *Learning and Collaboration Technologies: 10th International Conference, 25th HCI International Conference* (pp. 292-304). Copenhagen: Springer-Verlag.

[21] Ginns, P., Martin, A. J., & Marsh, H. W. (2013). Designing Instructional Text in a Conversational Style: A Meta-Analysis. *Educational Psychology Review, 25,* 445-472.

[22] Blickensderfer, E., Cannon-Bowers, J. A., & Salas, E. (1998). Cross-Training and Team Performance. In *Making Decisions Under Stress* (pp. 299-311). Washington DC: American Psychological Association.

[23] Volpe, C. E., Cannon-Bowers, J. A., Salas, E., & Spector, P. E. (1996). The Imapct of Cross Training on Team Functioning. *Human Factors, 38,* 87-100.

[24] Cannon-Bowers, J. A., Salas, E., Blickensderfer, E. L., & Bowers, C. A. (1998). The Impact of Cross-Training and Workload on Team Functioning: A Replication and Extension of the Initial Findings. *Human Factors, 40,* 92-101.

[25] Marks, M. A., Sabella, M. J., Burke, C. S., & Zaccaro, S. J. (2002). The Impact of Cross-Training on Team Effectiveness. *Journal of Applied Psychology*, *87*(1), 3-13.

[26] Trumbo, M. C., McDaniel, M. A., Hodge, G. K., Jones, A. P., Matzen, L. E., Kittinger, L. I., . . . Clark, V. P. (2021). Is the Testing Effect Ready to be Put to Work? Evidence from the Laboratory to the Classroom. *Translational Issues in Psychological Science*, *7*(3), 332-355.

[27] Roediger, H. L., & Karpicke, J. D. (2006). Test-Enhanced Learning: Taking Memory Tests Improves Long-Term Retention. *Psychological Science*, *17*(3), 249-255.

[28] Sailer, M., & Homner, L. (2020). The Gamification of Learning: A Meta-Analysis. *Educational Psychology Review, 32,* 77-112.

[29] Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed Practice in Verbal Recall Tasks: A Review and Quantitative Synthesis. *Psychological Bulletin*, *132*(3), 354-380.

[30] Nieuwenhuys, A., Cañal-Bruland, R., & Oudejans, R. R. (2012). Effects of Threat on Police Officers' Shooting Behavior: Anxiety, Action Specificity, and Affective Influences on Perception. *Applied Cognitive Psychology*, *26*(4), 608-615.

[31] Wickens, C. D. (1996). Designing for Stress. In *Stress and Human Performance* (pp. 279-295). Lawrence Erlbaum Associates, Inc.

[32] Matthews, G., Davies, D. R., Westerman, S. J., & Stammers, R. B. (2000). Stress, Arousal, and Performance: An Introduction. In *Human Performance: Cognition, Stress, and Individual Differences* (pp. 161-176). New York: Taylor & Francis.

[33] Matthews, G., Davies, R. D., Westerman, S. J., & Stammers, R. B. (2000). Divided Attention and Workload. In *Human Performance: Cognition, Stress, and Individual Differences* (pp. 87-106). New York: Taylor & Francis.

[34] Davies, D. R., & Parasuraman, R. (1982). *The Psychology of Vigilance.* Academic Press.

[35] Ariga, A., & Lleras, A. (2011). Brief and Rare Mental "Breaks" Keep You Focused: Deactivation and Reactivation of Task Goals Preempt Vigilance Decrements. *Cognition, 118*(3), 439-443.

[36] Pashler, H. (1994). Dual-Task Interference in Simple Tasks: Data and Theory. *Psychological Bulletin*, 116(2), 220-244.

[37] Strayer, D. L., & Drews, F. A. (2007). Cell-Phone-Induced Driver Distraction. *Current Directions in Psychological Science, 16*(3), 128-131.

[38] Gastelum, Z., Mattes, A., Matzen, L., & Stites, M. (2020). Cognition-Informed Safeguards: Lessons and Recommendations for Safeguards Practitioners from Cognitive Science Research. *ESARDA Bulletin: The International Journal of Nuclear Safeguards and Non-Proliferation, 61*, 39-53.

[39] Levy-Leboyer, C. (1989). Noise Effects on Two Industrial Tasks. *Work and Stress, 3,* 315-322.

[40] Hockey, G. R. (1970). Signal Probability and Spatial Location as Possible Bases for Increased Selectivity in Noise. *Quarterly Journal of Experimental Psychology, 2,* 37-42.

[41] Caldwell, J. L., Caldwell, J. A., & Salter, C. A. (1997). Effects of Chemical Protective Clothing and Heat Stress on Army Helicopter Pilot Performance. *Military Psychology, 9,* 315-328.

[42] Ramsey, J. D. (1983). Heat and Cold. In *Stress and Fatigue in Human Performance*. Chichester: Wiley.

[43] Enander, A. E., & Hygge, S. (1990). Thermal Stress and Human Performance. *Scandinavian Journal of Work, Environment, and Health, 16*(1), 44-50.

[44] Weston, H. C., & Adams, S. (1932). The Effects of Noise on the Performance of Weavers. *Medical Research Council Industrial Health Research Board Report* (65).

[45] Broadbent, D. E., & Little, E. A. (1960). Effects of Noise Reduction in a Work Situation. *Occupational Psychology, 34,* 133-140.

[46] Noweir, N. H. (1984). Noise Exposure as Related to Productivity, Disciplinary Actions, Absenteeism, and Accidents Among Textile Workers. *Journal of Safety Research, 15*, 163-174.

[47] Kerr, W. A. (1950). Accident Proneness of Factory Departments. *Journal of Applied Psychology, 34,* 167-170.

[48] Cohen, A. (1974). Industrial Noise and Medical, Absence, and Accident Record Data on Exposed Workers. In *Proceedings of the International Congress on Noise as a Public Health Problem.* Washington, DC: US Environmental Protection Agency.

[49] Meichenbaum, D. (2003). Stress Inoculation Training. In *Cognitive Behavior Therapy: Applying Empirically Supported Techniques in Your Practice* (pp. 407-410). Hoboken: John Wiley & Sons Inc.

[50] Driskell, J. E., & Johnston, J. H. (1998). Stress Exposure Training. In *Making Decisions Under Stress* (pp. 191-217). Washington, DC: American Psychological Association.

[51] Heusler, B., & Sutter, C. (2020). Gaze Control and Training for High-Stress Situations in Law Enforcement: A

Systematic Review. *Journal of Police and Criminal Psychology*, 35, 401-413.

[52] Xie, B., Liu, H., Alghofaili, R., Zhang, Y., Jiang, Y., Lobo, F. D., . . . Yu, L. F. (2021). A Review on Virtual Reality Skill Training Applications. Frontiers in *Virtual Reality, 2.*

[53] Kaplan, A. D., Cruit, J., Endsley, M., Beers, S. M., Sawyer, B. D., & Hancock, P. A. (2021). The Effects of Virtual Reality, Augmented Reality, and Mixed Reality as Training Enhancement Methods: A Meta-Analysis. *Human Factors, 63*(4), 706-726.

[54] Bandura, A. (1982). Self-Efficacy Mechanism in Human Agency. *American Psychologist, 37*(2), 122-147.

[55] Gist, M. E. (1989). The Influence of Training Method on Self-Efficacy and Idea Generation Among Managers. *Personnel Psychology, 42,* 787-805.

[56] Gist, M. E., Stevens, C. K., & Bavetta, A. G. (1997). Effects of Self-Efficacy and Post-Training Intervention on the Acquisition and Maintenance of Complex Interpersonal Skills. *Personnel Psychology, 44,* 837-861.

[57] Boucsein, W., Fowles, D. C., Grimnes, S., Ben-Shakhar, G., Roth, W. T., & Dawson, M. E. (2012). Publication Recommendations for Electrodermal Measurements. *Psychophysiology, 49*, 1017-1034.

[58] Sharma, M., Kacker, S., & Sharma, M. (2016). A Brief Introduction and Review on Galvanic Skin Response. *The Journal of Medical Research, 2.*

[59] Lohani, M., Payne, B. R., & Strayer, D. L. (2019). A Review of Psychophysiological Measures to Asses Cognitive States in Real-World Driving. *Frontiers in Human Neuroscience, 13*(57).

[60] Dawson, M. E., Schell, A. M., & Filion, D. L. (2007). The Electrodermal System. In *Handbook of Psychophysiology* (pp. 200-223). Cambridge: Cambridge University Press.

[61] Topoglu, Y., Watson, J., Suri, R., & Ayaz, H. (2020). Electrodermal Activity in Ambulatory Settings: A Narrative Review of Literature. In *Advances in Neuroergonomics and Cognitive Engineering* (pp. 91-102). Springer.

[62] Schmidt, E. A., Schrauf, M., Simon, M., Fritzsche, M., Buchner, A., & Kincses, W. E. (2009). Drivers' Misjudgment of Vigilance State During Prolonged Monotonous Daytime Driving. *Accident Analysis & Prevention, 41*(5), 1087-1093.

[63] Duchowski, A. T. (2002). A Breadth-First Survey of Eye-Tracking Applications. *Behavior Research Methods, Instruments, & Computers, 34*(4), 455-470.

[64] Rayner, K. (1998). Eye Movements in Reading and Information Processing: 20 Years of Research. *Psychological Bulletin, 124*(3), 372-422.

[65] Tien, T., Pucher, P. H., Sodergren, M. H., Sriskandarajah, K., Yang, G. Z., & Darzi, A. (2014). Eye Tracking for Skills Assessment and Training: A Systematic Review. *Journal of Surgical Research, 191*(1), 169-178.

[66] Van der Gijp, A., Ravesloot, C. J., Jarodzka, H., Van der Schaaf, M. F., Van der Schaaf, I. C., van Schaik, J. P., & Ten Cate, T. J. (2017). How Visual Search Relates to Visual Diagnostic Performance: A Narrative Systematic Review of Eye-Tracking Research in Radiology. *Advances in Health Sciences Education, 22,* 765-787.

[67] Keil, A., Debener, S., Gratton, G., Junghöfer, M., Kappenman, E. S., Luck, S.

J., . . . Yee, C. M. (2014). Committee Report: Publication Guidelines and Recommendations for Studies Using Electroencephalography and Magnetoencephalography. *Psychophysiology, 51*(1), 1-21.

[68] Fabiana, M., Gratton, G., & Coles, M. (2000). Event-Related Brain Potentials: Methods, Theory. *Handbook of Psychophysiology, 3,* 53-84.

[69] Borghini, G., Astolfi, L., Vecchiato, G., Mattia, D., & Babiloni, F. (2014). Measuring Neurophysiological Signals in Aircraft Pilots and Car Drivers for the Assessment of Mental Workload, Fatigue, and Drowsiness. *Neuroscience & Biobehavioral Reviews, 44*, 58-75.

[70] Paller, K. A., Kutas, M., & Mayes, A. R. (1987). Neural Correlates of Encoding in an Incidental Learning Paradigm. *Electroencephalography and Clinical Neurophysiology, 67*(4), 360-371.

[71] Niso, G., Romero, E., Moreau, J. T., Araujo, A., & Krol, L. R. (2023). Wireless EEG: A Survey of Systems and Studies. *NeuroImage, 269.*

[72] Dehais, F., Duprès, A., Blum, S., Drougard, N., Scannella, S., Roy, R. N., & Lotte, F. (2019). Monitoring Pilot's Mental Workload Using ERPs and Spectral Power with a Six-Dry-Electrode EEG System in Real Flight Conditions. *Sensors, 19*(6).

[73] Nitsche, M. A., & Paulus, W. (2000). Excitability Changes Induced in the Human Motor Cortex by Weak Transcranial Direct Current Stimulation. *The Journal of Physiology, 527*(3).

[74] Coffman, B. A., Clark, V. P., & Parasuraman, R. (2014). Battery Powered Thought: Enhancement of Attention, Learning, and Memory in Healthy Adults Using Transcranial Direct Current Stimulation. *Neuroimage, 85*, 895-908.

[75] Giordano, J., Bikson, M., Kappenman, E. S., Clark, V. P., Coslett, H. B., Hamblin, M. R., . . . Calabrese, E. (2017). Mechanisms and Effects of Transcranial Direct Current Stimulation. *Dose-Response, 15*(1).

[76] Thair, H., Holloway, A. L., Newport, R., & Smith, A. D. (2017). Transcranial Direct Current Stimulation (tDCS): A Beginner's Guide for Design and Implementation. *Frontiers in Neuroscience, 11.*

[77] Rogowsky, B. A., Calhoun, B. M., & Tallal, P. (2020). Providing Instruction Based on Students' Learning Style Preferences Does Not Improve Learning. *Frontiers in Psychology, 11,* 1-7.

[78] Miyatsu, T., Nguyen, K., & McDaniel, M. A. (2018). Five Popular Study Strategies: Their Pitfalls and Optimal Implementations. Perspectives on *Psychological Science, 13*(3), 390-407.

[79] Blume, B. D., Ford, K. J., Baldwin, T. T., & Huang, J. L. (2010). Transfer of Training: A Meta-Analytic Review. *Journal of Management, 36*(4), 1065-1105.

[80] Colquitt, J. A., & Noe, R. A. (2000). Toward an Integrative Theory of Training Motivation: A Meta-Analytic Path Analysis of 20 Years of Research. *Journal of Applied Psychology, 85*(5), 678-707.

[81] Cannon-Bowers, J. A., Salas, & Eduardo. (1998). Individual and Team Decision Making Under Stress: Theoretical Underpinnings. In *Making Decisions Under Stress* (pp. 17-38). Washington DC: American Psychological Association.

[82] Hunter, L. W., & Thatcher, S. M. (2007). Feeling the Heat: Effects of Stress,

Commitment, and Job Experience on Job Performance. *Academy of Management Journal, 50*(4), 953-968.

[83] Salas, E., Driskell, J. E., & Hughes, S. (1996). Introduction: The Study of Stress and Human Performance. In *Stress and Human Performance* (pp. 1-45). Mahwah: Erlbaum.

[84] LePine, J. A., Podsakoff, N. P., & LePine, M. A. (2005). A Meta-Analytic Test of the Challenge Stressor-Hindrance Stressor Framework: An Explanation for Inconsistent Relationships Among Stressors and Performance. *Academy of Management Journal, 48*, 764-775.

[85] Stokes, A. F., & Kite, K. (2001). On Grasping a Nettle and Becoming Emotional. In *Stress, Workload, and Fatigue.* Mahwah: Erlbaum.

[86] Wickens, C. D. (2000). Designing for Stress. *Journal of Human Performance in Extreme Environments, 5*(1), 98-106.

[87] American Psychological Association. (2023, March 8). *Stress Effects on the Body.* Retrieved July 25, 2023, from https://www.apa.org/topics/stress/body

[88] Razmjou, S. (1996). Mental Workload in Heat: Toward a Framework for Analyses of Stress States. *Aviation, Space, and Environmental Medicine, 67*, 530-538.

[89] Staal, M. A. (2004). *Stress, Cognition, and Human Performance: A Literature Review and Conceptual Framework.* Moffett Field: NASA Ames Research Center.

[90] Duffy, E. (1957). The Psychological Significance of the Concept of "Arousal" or "Activation". *Psychological Review, 64*, 265-275.

[91] Falk, J. L., & Bindra, D. (1954). Judgment of Time as a Function of Serial Position and Stress. *Journal of Experimental Psychology, 47*(4), 279-282.

[92] Easterbrook, J. A. (1959). The Effect of Emotion on Cue Utilization and the Organization of Behavior. *Psychological Review, 66,* 187-201.

[93] Wilkinson, R. T. (1963). Interaction of Noise with Knowledge of Results and Sleep Deprivation. *Experimental Psychology, 66,* 332-337.

[94] Selye, H. (1956). *The Stress of Life*. New York: McGraw-Hill.

[95] Jones, D. M. (1983). Loud Noise and Levels of Control: A Study of Serial Reaction. In *Proceedings of the Fourth International Congress on Noise as a Public Health Problem.* Stockholm: Swedish Council for Building Research.

[96] Matthews, G., Davies, D. R., Westerman, S. J., & Stammers, R. B. (2000). Thermal Stress and Other Physical Stressors. In *Human Performance: Cognition, Stress, and Individual Differences* (pp. 193-206). New York: Taylor & Francis.

[97] Saunders, T., Driskell, J. E., Hall, J., & Salas, E. (1996). *The Effect of Stress Inoculation Training on Anxiety and Performance.* U.S. Army Research Institute for the Behavioral and Social Sciences.

[98] Hourani, L. L., Kizakevich, P. N., Hubal, R., Spira, J., Strange, L. B., Holiday, D. B., . . . McLean, A. N. (2011). Predeployment Stress Inoculation Training for Primary Prevention of Combat-Related Stress Disorders. *Journal of Cybertherapy & Rehabilitation, 4*(1), 101-116.

[99] Pallavicini, F., Argenton, L., Toniazzi, N., Aceti, L., & Mantovani, F. (2016). Virtual Reality Applications for Stress Management Training in the Military.

Aerospace Medicine and Human Performance, 87(12), 1-10.

[100] Serino, S., Triberti, S., Villani, D., Cipresso, P., Gaggioli, A., & Riva, G. (2014). Toward a Validation of Cyber-Interventions for Stress Disorders Based on Stress Inoculation Training: A Systematic Review. *Virtual Reality, 18,* 73-87.

[101] Clark, J. M., & Paivio, A. (1991). Dual Coding Theory and Education. *Educational Psychology Review, 3*(3), 149-210.

[102] Ramsey, J. G. (n.d.).

[103] Ellis, H. D. (1982). The Effects of Cold on Performance of Serial Choice Reaction Time and Various Discrete Tasks. *Human Factors, 24,* 589-598.

[104] Finley, J. R., Benjamin, A. S., & McCarley, J. S. (2014). Metacognition of Multitasking: How Well Do We Predict the Costs of Divided Attention? *Journal of Experimental Psychology, 20*(2), 158-165.

[105] Smith, S. M., & Vela, E. (2001). Environmental Context-Dependent Memory: A Review and Meta-Analysis. *Psychonomic Bulletin & Review, 8,* 203-220.

[106] Al-Shargie, F., Tariq, U., Mir, H., Alawar, H., Babiloni, F., & Al-Nashash, H. (2019). Vigilance Decrement and Enhancement Techniques: A Review. *Brain Sciences, 9*(8).

[107] Rosch, J. L., & Vogel-Walcutt, J. J. (2013). A Review of Eye-Tracking Applications as Tools for Training. *Cognitive, Technology & Work, 15,* 313-327.

[108] Luck, S. J., & Kappenman, E. S. (2017). Electroencephalography and Event-Related Brain Potentials. In *Handbook of Psychophysiology* (pp. 74-100). Cambridge: Cambridge University Press.

[109] Zhao, H., Qiao, L., Fan, D., Zhang, S., Turel, O., Li, Y., . . . He, Q. (2017). Modulation of Brain Activity with Noninvasive Transcranial Direct Current Stimulation (tDCS): Clinical Applications and Safety Concerns. *Frontiers in Psychology, 8.*

[110] Koriat, A. (2007). Metacognition and Consciousness. In *The Cambridge Handbook of Consciousness* (pp. 289-325). New York: Cambridge University Press.

[111] Mann, D. T., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-Cognitive Exercise in Sport: A Meta-Analysis. *Journal of Sport and Exercise Psychology, 29*(4), 457-478.

[112] Schroeder, S., Hyönä, J., & Liversedge, S. P. (2015). Developmental Eye-Tracking Research in Reading: Introduction to the Special Issue. *Journal of Cognitive Psychology, 27*(5), 500-510.

[113] Merali, N., Veeramootoo, D., & Singh, S. (2017). Eye-Tracking Technology in Surgical Training. *Journal of Investigative Surgery.*

[114] Gil, A. M., Birdi, S., Kishibe, T., & Grantcharov, T. P. (2022). Eye Tracking Use in Surgical Research: A Systematic Review. *Journal of Surgical Research, 279,* 774-787.

[115] Heusler, B., & Sutter, C. (2020). Gaze Control and Training for High-Stress Situations in Law Enforcement: A Systematic Review. *Journal of Police and Criminal Psychology, 35,* 401-413.

[116] Martinez-Marquez, D., Pingali, S., Panuwatwanich, K., Stewart, R. A., &

Mohamed, S. (2021). Application of Eye Tracking Technology in Aviation, Maritime, and Construction Industries: A Systematic Review. *Sensors; 21*(13).

[117] Vickers, J. N. (2016). The Quiet Eye: Origins, Controversies, and Future Directions. *Kinesiology Review; 5*(2), 119-128.

[118] Vine, S. J., Moore, L. J., & Wilson, M. R. (2014). The Acquisition, Refinement, and Resilient Performance of Targeting Skills. European *Journal of Sport Science; 14*(1), 235-242.

[119] Vine, S. J., & Wilson, M. R. (2010). Quiet Eye Training: Effects on Learning and Performance Under Pressure. *Journal of Applied Sport Psychology; 22*(4), 361-376.