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Effective Lifeguard Scanning: A Review

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Effective Lifeguard Scanning: A Review

Cover Page Footnote

This Scientfic Literature Review was conducted by the authors as members of the American Red Cross Scientific Advisory Council (SAC), Aquatic sub-council. This review was peer reviewed and approved by the membership of the SAC.

American Red Cross Scientific Advisory Council:
Effective Lifeguard Scanning Scientific Review

Abstract

The purpose of this scientific review was to address the question of what evidence-based visual surveillance/scanning skills exist in the peer-reviewed scholarly literature. It is well known that lifeguards spend a majority of their on-duty time surveying bathers and swimmers in the water. Lifeguards need to quickly distinguish among swimmers in distress and drowning persons from other bathers in order to rapidly come to their aid to prevent drowning. To be able to accomplish this task, Signal Detection Theory reveals that lifeguards need specific and extensive training in identifying the behavioral patterns associated with drowning persons and swimmers in distress. A typical drowning is not what has been popularized in the press and movies that shows a person calling for help and waving his or her arms about. Instead, drowning victims usually demonstrate the instinctive drowning response in which they are in a vertical position in the water, unable to call out because the mouth is underwater and arm and leg movements are ineffective in keeping them near the water's surface. The literature revealed that expert lifeguard observation, scanning, and surveillance skills need to be acquired through planned systematic practice to identify the presence of the instinctive drowning response among bathers.

Keywords: observation, surveillance, scanning, vigilance, lifeguarding, drowning prevention

Questions to be addressed:

- What evidence-based visual surveillance/scanning skills exist based on peer-reviewed scholarly literature?
- How should visual surveillance/scanning skills be taught and learned by American Red Cross certified lifeguards so that they competently perform their surveillance duties?

Introduction/Overview:

Ever since the completion of the U.S. Lifeguard Standards Coalition Report, it has been apparent that Red Cross Lifeguard Training in visual surveillance needs to be examined so that lifeguard candidates can rapidly detect individuals who are in danger of drowning.

Introduction/Overview Plain Language (for advisory):

Lifeguards spend a majority of their on-duty time surveying bathers and swimmers in the water. Lifeguards need to quickly identify swimmers in distress and drowning persons in order to rapidly come to their aid to prevent drowning. To be able to

accomplish this task, lifeguards need specific and extensive training in identifying the behavioral patterns associated with drowning persons and swimmers in distress. A typical drowning is not what has been popularized in the press and movies that shows a person calling for help and waving his or her arms about, but instead is usually unable to call out because the mouth is underwater and employs arm movements that press down on the water's surface.

Search Strategy and Literature Search Performed

Key Words Used

PubMed: ("Visual Perception" OR "guided visual search" OR "inefficient search strategy" OR "Attention/physiology" OR "Signal Detection, Psychological" OR "signal detection theory" OR "Task Performance and Analysis"

Embase: ('visual search' OR 'guided visual search' OR 'inefficient search strategy' OR 'visual scanning' OR 'signal detection theory' OR 'surveillance' OR 'psychomotor vigilance task'

Inclusion Criteria (time period, type of articles and journals, language, methodology): 1980-2020, scholarly peer reviewed journal articles in English.

Exclusion Criteria (only human studies, foreign language, etc…)

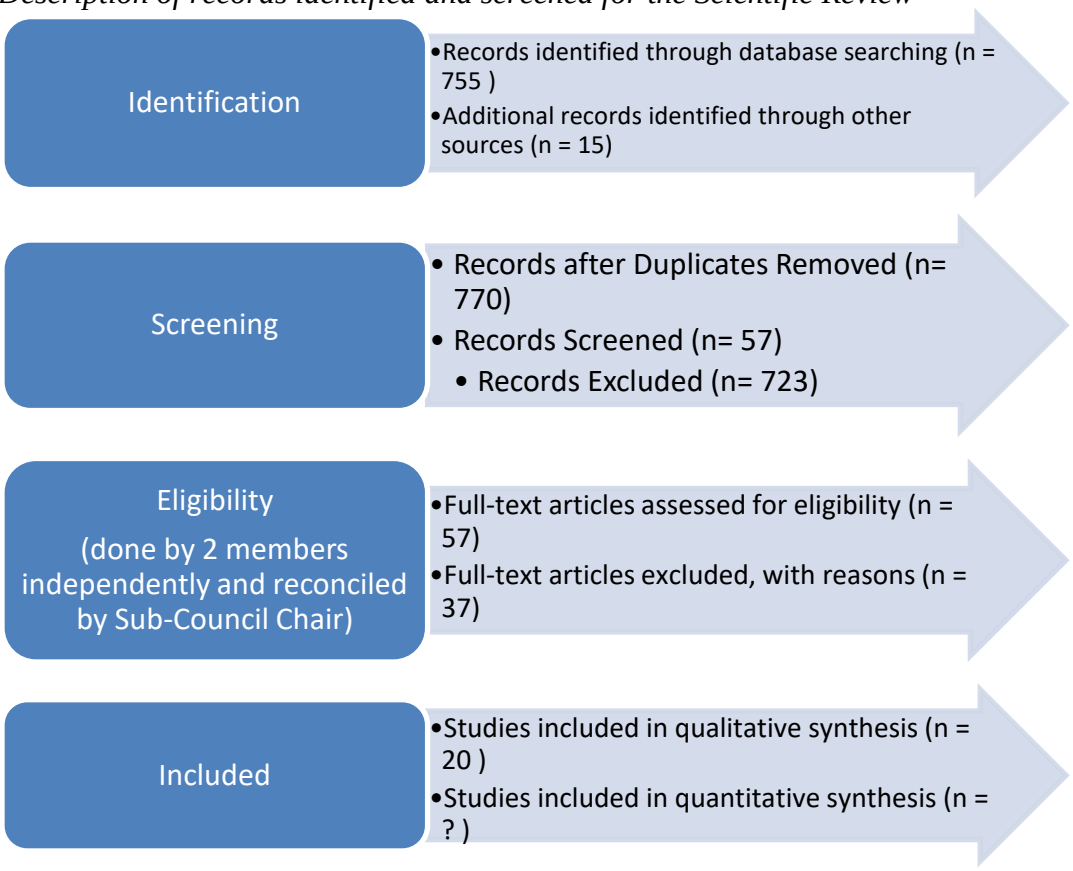
Only human studies in peer reviewed scholarly journals full text English languarge

Databases Searched and Additional Methods Used (references of articles, texts, contact with authors, etc...)

Used PubMed, Embase, and Summon

Table 1

Description of records identified and screened for the Scientific Review



Scientific Foundation:

Provide a summary of the science and other documents reviewed including biases and limitations which may be present. Include values and preferences if applicable (such as while the evidence was low were very concerned about the risk of… or while evidence was low the potential benefit was great in the setting of low to no risk…). Describe any environment or personnel decisions, opinions or considerations (such as this may not be appropriate for general first aid but would apply to wilderness first aid or while not appropriate for lay responders would be needed for emergency medical responders,…)

This scientific review of the literature related to keywords including visual perception, visual search, guided visual search, inefficient search strategy, attention/physiology, signal detection, theory, task performance and analysis, visual scanning, surveillance, psychomotor vigilance task involved an enormous number of peer reviewed journal articles. Fortunately, those papers relating more

directly to visual search, scanning, or surveillance that could apply to lifeguard training were more limited as described on the previous page.

Generally, the work on the topic of visual surveillance or scanning falls within the broad theoretical area of *human information processing*. Basic information processing (IP) models use a computer metaphor to explain how the human cognitive processes work. Models describe either three or four "stages" of process. A typical IP model includes a stimulus (e.g., visible light spectrum) being captured by the eye and retina in the sensory memory (input processes) stage, being held briefly in short-term memory, and encoded in long-term memory that leads to output processes such as a physical response. While long term memory is characterized by having almost limitless capacity and a lengthy time frame for storage, both sensory memory and short-term memory have much more limited capacity and shorter time frames.

An important related theoretical construct to information processing theory applied to lifeguarding is *detection* or *signal detection theory*. The signal detection theory (SDT) acknowledges the vast amounts of stimuli including visual stimuli that bombard humans constantly. Its goal is to measure the ability of humans to differentiate between stimuli ("signals") that are information-bearing from random background patterns ("noise"). This process is at the heart of a lifeguard's role while on duty: detecting a "signal" (i.e., a person in distress or drowning) from all the other visual, auditory, and tactile stimuli in the environment. In signal detection theory, a lifeguard on duty can have four possible outcomes: 1) a hit (i.e., there is a person in distress or drowning and the lifeguard detects and recognizes the situation and responds); 2) a miss (i.e., there is a person in distress or drowning and the lifeguard does not detect them); 3) a false alarm (there is no person in distress or drowning, but the lifeguard believes she detects a person in distress); and 4) a correct rejection (i.e., there is no person in distress and the lifeguard correctly does not respond). Hits (1) and correct rejections (4) are good outcomes; misses (2) and false alarms (3) are bad (although a miss is much more serious to a lifeguard than a false alarm).

Table 2

Lifeguard decisions/actions based on Signal Detection Theory (SDT) outcomes

		Existence of a drowning person	
		Yes	No
Lifeguard detects victim	Yes	Hit	False alarm
	No	Miss	Correct rejection

A majority of a lifeguard's time is spent not responding to an absence of a drowning (i.e., correct rejections). As a consequence, a lifeguard's vigilance can suffer because the signal detection process requires attentional focus and is perceptually fatiguing. The challenge in training new lifeguard candidates is for them to be able to recognize a correct signal of a distressed or drowning individual (a hit). In signal detection theory, it is important to identify criterion judgment values to identify whether a target signal (i.e., a distressed or drowning victim) is present or not. We want lifeguards to correctly respond to such critical signals and not miss any person drowning or in distress, but also not waste time and energy reacting to false alarms.

The issue being addressed in this scientific review was the identification of information that related directly to information processing and signal detection theory that should be applied to American Red Cross Lifeguard Training. The review illustrated the need for a stronger focus on training experiences in visual scanning for lifeguard candidates. In particular, the Lifeguard Training class must devote much more substantial online (hybrid) resources to providing training in identification of drowning behavior patterns among persons in the water in a variety of aquatic contexts (e.g., pools, beaches at lakes and rivers). Two of the studies identified that convenience samples of U.S. lifeguards often were not better at recognizing drowning events than non-lifeguards (Lanagan-Leitzel, 2012; Lanagan_Leitzel & Moore, 2010. Studies from the U.K. found that British lifeguards were in fact superior to non-lifeguards (Harrell & Boisvert, 2013; Luxton & Crundall, 2018; Page et al, 2011) in scanning and identifying drowning events although even experienced lifeguards frequently missed passive drowning.

One strong trend revealed in a number of studies (Biggs, et al., 2013; Bowden & Loft, 2016; Nordfang & Wolfe, 2018; Page et al., 2011; van der Gijp et al., 2018) was the importance of experience and expertise in scanning. Among persons with expertise in various types of visual scanning or surveillance (e.g., radiologists, air traffic controllers, athletic referees), the experience gained either from specific training, education, or experiential/trial-and-error time-on-task always provided faster and more reliable and consistent results than non-experts or those with limited experience. These studies further reinforced the theme from the previous paragraph that the Red Cross Lifeguard Training class must provide more extensive training and practice in identifying drowning persons than is done currently.

Several lifeguard training programs in the U.S. have advocated specific types of temporal or spatial search patterns (e.g., A, B, geometric patterns). The evidence-based literature did <u>not</u> support such artificial devices or strategies because they in fact distracted observers from the primary target (i.e., distressed or

drowning persons) as a result of requiring internal perceptual processes (Annerer-Walcher, et al., 2019). Indeed, lifeguards must be taught to store in long term memory those behavior patterns in the water that indicate a person in distress or drowning (e.g., the instinctive drowning response, a vertical body position, lateral downward pressing of arms, failure to swim to safety).

A number of studies reinforced the difficulties associated with visual scanning and surveillance and the factors that detracted from successful performance. For example, misplaced errors associated with selective attention (Conci & vonMahlenen, 2011), inattentional blindness (Eitam et al., 2015), expectation violations (Foerster & Schneider, 2015), and vigilance degradations (Sebastian et al., 2020) detracted from performance on scanning tasks suggesting an increase in critical "misses" of distressed or drowning persons by lifeguards. These findings all suggested a closer review of current lifeguard practices (e.g., length of on-duty time which causes a severe decrement in attention and visual performance searches).

Finally, two studies identified visual assessment instruments that might be employed effectively in the training and monitoring of lifeguards. Deering et al. (2018) published a 3-minute revision (from the original 10-minute instrument) of the Psychomotor Vigilance Test (PVT) that might be a useful instrument to employ in training lifeguard candidates and perhaps as part of field audits. Sanchez-Lopez et al. (2019) described the use of eye-gaze contingent attentional training (ECAT) that also showed promise in maintaining performance through improved attention.

The scientific review of the questions, "What evidence-based visual surveillance/scanning skills exist?" and "How should visual surveillance/scanning skills be taught and learned by American Red Cross-certified lifeguards so that they can competently perform their surveillance duties?" discovered evidence-based information especially drawn from the psychological and visual perception literature. That information has implications for the next revision of the American Red Cross Lifeguard Training program as well as the day-to-day activities of lifeguards. The identification of distressed or drowning person behavioral patterns (e.g., the instinctive drowning response) need to have a much stronger focus and more visual practice needs to be provided. It is well understood that vigilance is a mentally and physically fatiguing process which means that aquatic managers should be made aware of the need to maintain optimal attention and vigilance by lifeguards (e.g., give much more frequent breaks especially under heavy bather loads; use shifts in physical posture; avoid distractions). Several articles did identify future needs in lifeguard training especially in what we still need to know about effective visual scanning and surveillance.

Scientific Foundation Plain Language (for Advisory):

The reviewed scientific literature demonstrated that lifeguards need to be knowledgeable and skilled in effective visual scanning of persons in the water. They need to accurately and reliably identify a drowning or distressed person by recognizing distinctive behavioral patterns (e.g., instinctive drowning response, vertical posture in water, lateral downward pressing of arms, lack of capacity to swim to safety). The literature illustrated that expertise in visual scanning results from both structured training and sufficient experience with constructive feedback.

The capacity to visually scan effectively depends on both knowledge and training plus sufficient attention, vigilance, and lack of internal and external distractions. This information has implications for aquatic facilities and aquatic managers to make certain lifeguards are alert and attentive so they can be certain to recognize distressed or drowning people.

Recommendations and Strength (completed during Sub-council conference call or meeting but not by authors prior to meeting):

Overview of recommendation

Human information processing and signal detection theories indicate that human behavior such as visual scanning has definite limits that are impacted by degree of training, experience, and expertise as well as fatigue, inattention, distractions, and amount of extraneous environmental noise. The literature indicated that novice lifeguards were less skilled than more experienced guards, indicating a need to enhance visual scanning training experiences during the lifeguard training course.

During updated Lifeguard Training, lifeguard candidates require structured and intensive online training (using video) to acquire visual scanning skills. A revised Red Cross Lifeguard Training course needs to employ a large set of videos illustrating different drowning scenarios and contexts that the candidates can use to train their visual scanning during the online hybrid portion of the course. In addition, the challenges to attention and vigilance in the literature emphasizes the need to provide strategies for maintaining attention (e.g., more frequent breaks, changing physical posture, avoiding distractions such as cell phone usage).

Overview of recommendation Plain Language (for Advisory)

Visual scanning to detect distressed or drowning persons requires a degree of experience that can be attained by trial and error over years or through hours of structured training. The American Red Cross must provide structured training in visual scanning and detection of behavioral drowning patterns to lifeguard candidates to better prepare them for identifying distressed and drowning persons.

Specific Recommendations and Strength

The strength of all recommendations and conclusions is related to the scientific evidence upon which they are based. All recommendations therefore derive from critical review of the available literature and the strength of their design, standard reference material, textbooks, and expert opinion. All recommendations are weighted based upon the source and strength of the scientific evidence and are classified into one of three groups - Standards, Guidelines, or Options.

Standards *represent the strongest recommendations and have a high degree of scientific certainty. These recommendations result from strong evidence obtained from well designed, prospective, randomized controlled studies.*

Guidelines *provide a moderate degree of scientific certainty and are based on less robust evidence such as non-randomized cohort studies, case-control studies, or retrospective observational studies.*

Options *result from all other evidence, publications, expert opinion, etc. and are the least compelling in terms of scientific evidence.*

Standards:

- n.a.

Guidelines:

- Novice lifeguards should receive sufficient structured online video training and practice to acquire effective visual scanning to readily identify typical behavioral patterns of drowning persons.

Options:

- Lifeguards should receive training to avoid inattention and distractions (e.g., talking to patrons, using cell phone, daydreaming) while on duty. They also should be schooled in simple ways to improve attention (e.g., get enough rest, perform simple physical change of posture movements).
- Aquatic facility managers need to understand the seriousness of inattention and lack of vigilance by on-duty lifeguards and techniques for mitigating it.

Knowledge Gaps and Future Research:

There is still a great deal that has not been studied about effective visual scanning and surveillance by lifeguards and how it can be improved by educational training. More research evidence is needed to describe common behavioral patterns associated with drowning.

Implications for ARC Programs:

As indicated above, during the subsequent revision of the American Red Cross Lifeguard Training course, substantial enhancements in visual scanning training and practice need to be introduced to produce lifeguard candidates with improved visual scanning skills to recognize movement patterns associated with distressed and drowning persons.

Attach Any Lists, Tables of List of Recommendations Created as Part of This Review

(Please include any tables, lists of items or procedures and tables which you as part of the review)

Table 2. SDT outcomes

		Existence of a drowning person	
		Yes	No
Lifeguard detects victim	Yes	Hit	False alarm
	No	Miss	Correct rejection

Instructor or Educational Program Issues/Question/Topic

Provide a summary of the issues and/or topics to be addressed in this instructor info followed by any specific questions to be addressed. This can be taken from earlier in this document but does not have to be in exactly same language as this is targeted to instructor.

During an updated Lifeguard Training, lifeguard candidates require structured and intensive online training (using video) to acquire visual scanning skills. A revised Red Cross Lifeguard Training course needs to employ a large set of videos illustrating different drowning scenarios and contexts that the candidates can use to train their visual scanning during the online hybrid portion of the course.

In addition, the challenges to attention and vigilance in the literature emphasizes the need to provide strategies for maintaining attention (e.g., more frequent breaks, consuming caffeine, changing physical posture, avoiding distractions such as cell phone usage).

Introduction and Summary of SAC Documents and Recommendations

Describe why the scientific review has raised an issue for educational programs and/or instructors. Summarize, targeted for an instructor, the key scientific foundation. Include the Standard, Guideline and/or Options which are relevant. This section should summarize the key points which need to be communicated to instructors.

Human information processing and signal detection theories indicate that human behavior such as visual scanning has definite limits that are impacted by degree of training, experience, and expertise as well as fatigue, inattention, distractions, and amount of extraneous environmental noise. The literature indicated that novice lifeguards were less skilled than more experienced guards, indicating a need to enhance visual scanning training experiences during the lifeguard training course.

Implications for Program Design, Modification and/or Delivery

This section should summarize as precisely as possible what are the implications for ARC program design, modification and delivery that re relevant and important to communicate to instructors.

During the next revision of the Lifeguard Training course, extensive online training videos displaying a wide variety of drowning incidents in multiple aquatic contexts need to be designed. A to-be-determined module needs to be designed that allows for practice and feedback in visual training during the hybrid portion of the course.

In addition to enhanced visual scanning training, the importance of adequate rest and breaks for lifeguards to maintain attention and vigilance need to be emphasized in the course and communicated to aquatic managers and facilities perhaps as part of the facility audit program.

Summary of Key Articles/Literature Found and Level of Evidence/Bibliography:

Author(s)	Full Citation	Summary of Article (provide a brief summary of what the article adds to this review including which question(s) it supports, refutes or is neutral)	Method-ology	Bias Assess-ment	Indirect-ness/ Impre-cision/ Incon-sistency	Key results and magnitude of results	Support, Neutral or Oppose Question	Level of Evi-dence (Using table below)	Quality of study (excellent, good, fair or poor) and why
Annerer-Walcher,S., Korner,C., & Benedek, M.	Eye behavior does Not adapt to expect-ed visual distraction during internally directed cognition. *PLOS One*, 2018, *13*(9)	Participants performed mental multiplications (e.g. 26 x 7) that required attention turned inward. Participants were told whether or not distractors could appear during the calculation period, thereby potentially allowing them to prepare for the distractors. Their eye behavior was tracked to mark perceptual decoupling and workload. Turning attention inward showed evidence of perceptual decoupling for five of six eye parameters: blink rate, increased saccade & microsaccade rate, gaze was less constricted to the center, and pupils dilated.	Experi-mental	None	None PLoS One	Participants perceived distractors as challenging, but performance & eye behavior markers were unaffected. Results support perceptual decoupling as an automatic mechanism: Focusing inward on a task reduces attention to external events despite external distraction	Support	1b	Excellent
Biggs, A.T.; Cain, M.S.; Clark, K.; Darling, E.F.; Mitroff, S.R.	Assessing visual search performance differences between Transportation Security	Some visual searches depend upon accuracy (e.g., radiology, airport security screening). It is important to understand what factors best predict performance. The current study administered a visual search task to both professional and non-professional searchers to examine group differences	Experi-mental	None	None	Non-professional and inexperienced searchers were slower during searches while experienced professionals were more consistent	Support	1b	Excellent

	Administration Officers and nonprofessional visual searchers, *Visual Cognition*, 2013, *21*(3), 330-352	in which factors predict accuracy. These results inform cognitive theory by indicating differences due to experience.				(less variable) from search to search.			
Bowden,V.K. & Loft, S.	Using memory for prior aircraft events to detect conflicts under conditions of proactive air traffic control and with concurrent task requirement. *Journal of Experimental Psychology Applied*, (2016). *22*(2), 211-224.	In 2 experiments we examined the impact of memory for prior events on conflict detection in simulated air traffic control under conditions where individuals proactively controlled aircraft and completed concurrent tasks. Strong evidence existed that positive transfer was not impacted by dividing participant attention.	Experi-mental	None	None	Individuals were faster to detect conflicts that had repeatedly been presented during training (positive transfer).	Support	1b	Good
Chua, K.W., Richler, J.J., & Gauthier, I.	Holistic processing from learned attention to parts, *Journal of Experimental Psychology General*, (2015), *144*(4), 723-729.	Attention helps focus on what is most relevant to goals, and prior work has shown that aspects of attention can be learned. Learned inattention to parts can abolish holistic processing of faces, but it is unknown whether learned attention to parts is sufficient to cause a change from part-based to holistic processing with objects.	Experi-mental	None	None	These results demonstrated a novel link between learned attentional control and the acquisition of holistic processing.	Support	1b	Good

Conci, M., & vonMahlenen, A.	Limitations of perceptual segmentation on contextual cueing in visual search, *Visual Cognition* (2011), *19*(2), 203-233	In visual search, detection of a target in a repeated layout is faster than search within a novel arrangement, demonstrating that contextual invariances can implicitly guide attention to the target location Seven experiments showed that grouping by colour and by size reduces contextual cueing. In sum, all experiments show an influence of grouping on contextual cueing. This influence is larger for variations of spatial (as compared to surface) features and is consistent with the view that learning of contextual relations critically interferes with processes that segment a display into segregated groups of items.	Multi-experi-mental	None	None	Selectively attending to a relevant subgroup of items preserved context-based learning effects. Reduction of contextual cueing by means of grouping affected both the latent learning and the recall of display layouts.	Support	1b	Fair
Deering, S., Amdur, A., Borelli, J., Headapohl, W., &Stepnowsky, C.J.	A three-minute mobile version of the psychomotor vigilance task. *Sleep* (2018), *41*: A391-A392	Introduction: The Psychomotor Vigilance Task (PVT) is a timed test where participants respond to visual stimuli as quickly and accurately as possible. The standard PVT is computer-based and 10 minutes long. A 3-minute version has been demonstrated to be sensitive to sleep deprivation and improvements when regular sleep is restored. The results demonstrate that a mobile PVT can potentially collect large amounts of useful and informative data that can provide insights into individuals' sleep habits and daytime functioning.	Exper-imental	None	None	The shortened Psychomotor Vigilance Task (PVT) would be a valuable tool to use in lifeguard vigilance and surveillance training	Neutral	1b	Fair

Eitam, B., Shoval, R., & Yeshurun, Y.	Seeing without knowing: Task relevance dissociates between visual awareness and recognition, *Annals of the N.Y. Academy of Sciences*, (2015), *1339*: 125	We demonstrate that task relevance dissociates between visual awareness and knowledge activation to create a state of seeing without knowing-visual awareness of familiar stimuli without recognizing them. While people can indicate the orientation of the illusory rectangle with great ease (signifying that they have consciously experienced the illusion's inducers), almost 30% of them could not report the inducers' color. Thus, people can see, in the sense of phenomenally experiencing, but not know, in the sense of recognizing what the object is or activating appropriate knowledge about it.	Exper-imental	None	None	We discuss these findings in relation to the existing theories of consciousness and to attention and inattentional blindness, and the role of cognitive load, object-based attention, and the use of self-reports as measures of awareness.	Support	1b	Good
Foerster, R.M., & Schneider, W.X.	Expectation violations in sensorimotor sequences: Shifting from LTM-based attentional selection to visual search. *Annals of the N.Y. Academy of Sciences*, (2015), *1339*: 45	Long-term memory (LTM) delivers important control signals for attentional selection. LTM expectations have an important role in guiding the task-driven sequence of covert attention and gaze shifts, especially in well-practiced multistep sensorimotor actions. We investigated questions in a computerized version of the number-connection test.	Exper-imental	None	None	Expectation violations in a well-learned sensorimotor sequence cause a regression from LTM-based attentional selection to visual search beyond deviant-related actions and locations.	Neutral	1b	Good
Gerardin, P., Nicolas, J.,	Increasing Attentional Load Boosts Saccadic	Visual exploration relies on saccadic eye movements and attention processes. Saccadic adaptation mechanisms, which calibrate the	Exper-imental	None	None	These results indicate that increasing the level of attention	Neutral	1b	Good

Farne, A., & Pelisson, D.	Adaptation. *Investigative Ophthalmology & Visual Science*, (2015), *56*(11), 6304-6312	oculomotor commands to continuously maintain the accuracy of saccades, have been suggested to act at downstream (motor) and upstream (visuoattentional) levels of visuomotor transformation. Conversely, whether attention can directly affect saccadic adaptation remains unknown. To answer this question, we manipulated the level of attention engaged in a visual discrimination task performed during saccadic adaptation.				to the perceptual processing of otherwise identical targets boosts saccadic adaptation, and suggests that saccadic adaptation mechanisms and attentional load effects may functionally share common neural substrates.			
Nordfang, M., & Wolfe, J.M.	Guided search through memory. *Visual Cognition*, (2018), *26*(4), 285-298	In hybrid search, observers search a visual display for any of several targets held in memory. It is known that the contents of the memory set can guide visual search (e.g., if the memorized targets are all animals, visual attention can be guided away from signs). It is not known if the visual display can guide memory search (e.g., if the memory set is composed of signs and animals, can a visual display of signs restrict memory search to just the signs?). In three hybrid search experiments, participants memorized sets of items that belonged to either one or several categories. Participants were then presented with visual displays containing multiple items, also drawn from one or several categories.	Experi-mental	None	None	Study replicated the finding that visual search can be guided by the contents of memory. We found weaker, novel evidence that memory search can be guided by the contents of the visual display.	Support	1b	Good

		Participants were asked to determine if any of the items from their current memory set were present in the visual display.							
Sanchez-Lopez, A., Everaert, J., Van Put, J., De Raedt, R., & Koster, E.H.W.	Eye-gaze contingent attention training (ECAT): Examining the causal role of attention regulation in reappraisal and rumination. *Biological Psychology*, (2019). *142*: 116-125	This study used a novel eye-gaze contingent attention training (ECAT) to test the prediction that attention regulation is involved in reappraisal and rumination. Sixty-six undergraduates were randomly assigned to either the control or the active training condition of the ECAT. Active ECAT comprised training in allocating attention toward positive words to efficiently create positive interpretations while receiving gaze-contingent feedback. Participants in the control condition freely generated interpretations without receiving gaze-contingent feedback.	Experi-mental	None	None	Active ECAT resulted in: 1) more sustained attention on positive information, in turn predicting greater reappraisal success to down-regulate negative emotions, and 2) larger reductions in state rumination after viewing negative scenes. Findings provide a step towards use of personalized attention training.	Support	1b	Good
Sebastiani, M., Di Flumeri, G., AricÃ², P., Sciaraffa, N., Babiloni, F., & Borghini, G.	Neurophysiological vigilance characterisation and assessment: Laboratory and realistic validations involving professional air	Vigilance degradation usually causes significant performance decrement. The present study aimed to characterise and assess the vigilance level by using electroencephalographic (EEG) measures. The first study, involving 13 participants in laboratory settings allowed to find out the neurophysiological features mostly related to vigilance decrements. Those	Experi-mental	None	None	The results demonstrated a significant performance decrement related to vigilance reduction.	Support	1b	Fair

	traffic controller. *Brain Sciences*, (2020). *10*(1)	results were also confirmed under realistic ATM settings recruiting 10 professional ATCOs.							
van der Gijp, A., Ravesloot, C.J., Jarodzka, H., van der Schaaf, M.F., van der Schaaf, I.C., van Schaik, J.P.J., & Ten Cate, T.J.	How visual search relates to visual diagnostic performance: a narrative systematic review of eye-tracking research in radiology. *Advances in Health Sciences Education: Theory and Practice*. (2018). *22*(3), 765-787	For educational purposes, it is important to identify visual search patterns that are related to high perceptual performance and to identify effective teaching strategies. This review of eye-tracking literature in the radiology domain aims to identify visual search patterns associated with high perceptual performance. One study investigated teaching of visual search strategies and did not find a significant effect on perceptual performance. Eye tracking literature in radiology indicates several search patterns are related to high levels of expertise, but teaching novices to search as an expert may not be effective. Experimental research is needed to find out which search strategies can improve image perception in learners.	Scientific Review			Expert search was found to be characterized by a global-focal search pattern, which represents an initial global impression, followed by a detailed, focal search-to-find mode. Specific task-related search patterns, like drilling through CT scans and systematic search in chest X-rays, were found to be related to high expert levels.	Support	5	Excellent
Koon, W.A., Gates, R.M., Scoggins, S., Andrus, P., & Futoran, J. A.	(2020). The ocean lifeguard intervention continuum: A cognitive aid for surf lifeguard education. *International Journal of Aquatic*	Ocean lifeguards are constantly engaged in beach risk analysis, required to efficiently evaluate a variety of environmental and other factors quickly in order to triage and prioritize who needs help. Teaching these skills is a challenge for introductory training programs. We sought to improve new lifeguards' understanding of the	Scienti-fic Review	None	None	We developed a two-part cognitive aid for introductory ocean lifeguard education depicting individual and interacting elements of a beach goer's risk of	Support	5	Excellent

	Research and Education, *12*(4), Art. 11. https://doi.org/10.25035/ijare.12.04.11	interaction of various risk components in the beach environment and aid decision-making related to when a lifeguard should intervene in a situation. This new cognitive aid represented an advancement in the presentation of complex material in introductory training programs for those involved in aquatic rescue.				drowning or injury and the process by which that risk increases with associated lifeguard interventions on a continuum from low risk and no distress to drowning.			
Lanagan-Leitzel, L.K., & Moore, C.M.	(2010). Do lifeguards monitor the events they should? *International Journal of Aquatic Research and Education*, 4(3), Art. 4. https://doi.org/10.25035/ijare.04.03.04	Lifeguard training texts suggest that lifeguards should continually scan their zone of coverage, carefully examining patrons whose behavior is consistent with drowning or distress. The current study examined whether lifeguard performance is consistent with these specifications and whether these behaviors have enough visual interest to attract the gaze of non-lifeguards looking for drowning behaviors ("trained") or those who were given no specified target ("naïve"). Participants viewed video clips of natural swimming taken from three aquatic locations while an eye-tracker recorded their eye position.	Experi-mental	None	None	Lifeguard performance was to some extent consistent with the specifications above, although on many measures it was not statistically better than briefly-trained participants. Implications for future research and training are considered.	Support	1b	Good
Lanagan-Leitzel, L.K.,	(2012) Identification of critical events by lifeguards, instructors, and	Lifeguards are instructed to respond both to dangerous behavior and to distress/ drowning events. Variability in lifeguard effectiveness may result from variability in how individual lifeguards define what events are important to	Experi-mental	None	None	All participant groups (instructors included) had very few events that were consistently	Support	1b	Good

	non-lifeguards. *International Journal of Aquatic Research and Education*, 6(3), Art. 5. https://doi.org/10.25035/ijare.06.03.05	monitor ("critical events"). The variability in defining critical events was examined in the current study by presenting videos of normal aquatic activity to lifeguards (*N* = 17), lifeguard instructors (*N* = 10), non-lifeguards (*N* = 20), and students enrolled in a lifeguarding course (*N* = 12). Participants were asked to identify the events that they thought were important for a lifeguard to monitor and provide an explanation as to why they were critical.				reported, and many of the events that the instructors or lifeguards reported were well-reported by non-lifeguards. These results suggest a lack of agreement in the identification of critical events.			
Lanagan-Leitzel, L.K., Skow, E. & Moore, C.M.	(2015). Great expectations: Perceptual challenges of visual surveillance in lifeguarding, *Applied Cognitive Psychology*, *29*: 425–435 https://doi.org/10.1002/acp3121	This article examines the visual components of the lifeguard's job, discussing some of the major challenges they face during surveillance. These include optical challenges (turbidity and turbulence of the water, light refraction, and glare), scene challenges (elevated set size affecting clutter and perceptual 'blindnesses'), stimulus challenges (searching for multiple targets that are complex, dynamic, ill-defined, and rare), and attentional challenges, including but not limited to vigilance issues. The differences between basic laboratory research and the lifeguarding task are explored, with recommendations for future study.	Experi-mental	None	None	The differences between basic laboratory research and the lifeguarding task are explored, with recommendations for future study.	Support	1b	Excellent
Lanagan-Leitzel, L.K.	(2019). Examination of the	Lanagan-Leitzel (2012) found that lifeguards do not consistently report incidents when free-viewing aquatic	Experi-mental	None	None	It is proposed that lack of report in Lanagan-Leitzel	Support	1b	Good

	severity of aquatic incidents. *International Journal of Aquatic Research and Education, 10*(4), Art. 7 https://doi.org/10.25035/ijare.10.04.97	scenes and miss some incidents that should be considered critical. This could have been because they did not know what incidents were critical to monitor or because they were busy monitoring other incidents. In the current study, lifeguards and non-lifeguards were presented with video clips of isolated incidents and rated the severity of each on a scale of 0–7. The lifeguards reported greater mean and maximum incident severity than non-lifeguards. Further analyses of lifeguard responses revealed that severity ratings were only moderately correlated to the report rate in Lanagan-Leitzel (2012). Some of the incidents, though under-reported in Lanagan-Leitzel (2012), were given high severity ratings when isolated in the current study.				(2012) may have occurred due to attention being diverted to other critical incidents. Future research should utilize eye-tracking to assess the relationship between severity and monitoring.			
Luxton, V. & Crundall, D.	(2018). The effect of lifeguard experience upon the detection of drowning victims in a realistic dynamic visual search task. *Applied Cognitive Psychology*, *32*: 14–23.	Lifeguard surveillance is a complex task that is crucial for swimmer safety, though few studies of applied visual search have investigated this domain. This current study compared lifeguard and non-lifeguard search skills using dynamic, naturalistic stimuli (video clips of confederate swimmers) that varied in set size and type of drowning. Set size effects revealed a dip in reaction speeds at an intermediate set-size level, suggesting a possible change in visual search strategies as the array	Experi-mental	None	None	Lifeguards were more accurate and responded faster to drowning targets. Differences between drowning targets were also found: Passive drownings were responded to less often, but more quickly than	Support	1b	Excellent

	https://doi.org/10.1002/acp.3374	increases in size. The ability of the test to discriminate between lifeguards and non-lifeguards offers future possibilities for training and assessing lifeguard surveillance skills.				active drownings, highlighting that passive drownings may be less salient but are highly informative once detected.			
Harrell, W.A., & Boisvert, J.A.	(2003). An information theory analysis of duration of lifeguards' scanning. Perceptual and Motor Skills, 97(1, 129-134. https://doi.org/10.2466/pms.2003.97.1.129	Observers recorded the duration of scanning by six lifeguards in three indoor swimming pools. Duration of scanning was significantly predicted by the absolute numbers of child swimmers (< 17 years) in the pools and when numbers of child swimmers were represented in terms of bits of information. Duration of scanning increased as a linear function of both numbers of children and child bits of information. These results are interpreted in terms of the Hick-Hyman law of information theory.	Observa-tional	None	None	Lifeguards appear to simplify the task of information processing and decision-making by concentrating on children as a more at-risk group of swimmers. Duration of scanning was not significantly related to changes in number of adult swimmers.	Neutral	3b	Good
Page, J., Bates, V., Long, G., Dawes, P., & Tipton, M.	(2011). Beach lifeguards: Visual search patterns, detection rates and the influence of experience. *Ophthalmic and Physiological Optics, 31*(3), 216-224. https://doi-org/10.1111/j.1475	This study determined the rates of detection of a 'drowning' individual by beach lifeguards, and whether scanning patterns differed between groups of lifeguards (experienced/less experienced, male/females, surf/non-surf). It was hypothesized that (1) Experienced lifeguards would perform better and produce less fixations of longer duration than inexperienced; (2) A greater detection rate would be seen in a 'biased' compared to a 'non-	Experi-mental	None	None	Experienced lifeguards were five times ($p < 0.05$) more likely to detect drowning individual than inexperienced lifeguards. No significant differences between visual search patterns of	Support	1b	Excellent

	-1313.2011.00824.x	biased' condition; (3) There would be no differences between the surf compared to non-surf lifeguards, and male compared to female lifeguards with regard to scanning patterns or detection rates. Some lifeguards may have fixated on, but not processed, relevant visual data ('looked at but not seen'). 25% (biased) and 36% (non-biased) of the lifeguards did not fixate in the location of the person disappearing, but were able to identify their disappearance				the groups between 2 and 10 min. existed. Detection rates averaged 16% in non-biased condition & 29% in biased conditions ($p < 0.1$). Visual search patterns by lifeguards can be altered by instruction & detection rates improve. Peripheral vision is used effectively by some lifeguards, but may be problematic for others.			

Level of Evidence	Definitions (See manuscript for full details)
Level 1a	**Experimental and Population based studies** - population based, randomized prospective studies or meta-analyses of multiple higher evidence studies with substantial effects
Level 1b	**Smaller Experimental and Epidemiological studies** - Large non-population based epidemiological studies or randomized prospective studies with smaller or less significant effects
Level 2a	**Prospective Observational Analytical** - Controlled, non-randomized, cohort studies
Level 2b	**Retrospective/Historical Observational Analytical** - non-randomized, cohort or case-control studies
Level 3a	**Large Descriptive studies** – Cross-section, Ecological, Case series, Case reports
Level 3b	**Small Descriptive studies** – Cross-section, Ecological, Case series, Case reports
Level 4	**Animal studies or mechanical model studies**
Level 5	**Peer-reviewed Articles** - state of the art articles, review articles, organizational statements or guidelines, editorials, or consensus statements

Level 6	**Non-peer reviewed published opinions -** such as textbook statements, official organizational publications, guidelines and policy statements which are not peer reviewed and consensus statements
Level 7	**Rational conjecture** (common sense); common practices accepted before evidence-based guidelines
Level 1-6E	**Extrapolations** from existing data collected for other purposes, theoretical analyses which is on-point with question being asked. Modifier E applied because extrapolated but ranked based on type of study.