



Evaluating the Effects of Stress and Fatigue on Police Officer Response and Recall: A Challenge for Research, Training, Practice and Policy[☆]



Lorraine Hope^{*}

University of Portsmouth, United Kingdom

Armed police officers frequently respond to evolving, dynamic, and potentially dangerous incidents. Given the challenging and often controversial nature of this response context, understanding the impact of officer stress and fatigue on performance in incidents involving use of force is important for trainers, investigators, legal professionals, and policy-makers. The psychological literature on human performance is broadly informative with respect to the potential effects of stress and fatigue on response performance (e.g., shooting accuracy) and the reliability of accounts provided by officers. Unsurprisingly, stress and fatigue typically impair performance, although further research is needed to (i) delineate the precise nature of the effects of stress and fatigue on response performance and memory, and (ii) explore relevant contextual and boundary conditions. This article considers what current research can contribute to training and practice in use of force contexts, and outlines key methodological challenges for researchers and consumers of research in this field.

Keywords: Memory, Stress, Police, Law enforcement, Eyewitness, Fatigue

Police officers frequently respond to evolving, dynamic, and potentially dangerous incidents. Unlike bystanders, these “operational witnesses” are variously required to act to preserve life, protect members of the public, and neutralise violence. Ultimately, an officer’s role is to take effective and efficient action to intervene, de-escalate, and resolve such incidents. An officer’s response in such circumstances depends not only on their operational mandate but also on a variety of contextual factors at the level of the individual (e.g., level of stress or anxiety, perceived risk, previous experience, fatigue, training), and at the level of the incident (e.g., presence of weapons, number of perpetrators, location, availability of back-up). Following an incident, officers are typically required to describe and justify their response and, like any witness, provide information about their own and others’ actions. The manner in which such accounts are elicited, and the scrutiny under which legal professionals, the public, media, and professional standards agencies place them, varies significantly across jurisdictions.

This article explores the effects of two contextual or “estimator” factors on officer performance in operational-response

contexts involving use of force. Given the challenging and often controversial nature of this response context, understanding the potential impact of officer stress and fatigue on performance in incidents involving use of force is important for trainers, investigators, legal professionals, and policy-makers. The psychological literature on human performance can provide insights about two important aspects of this context: first, the nature of the response, and second, the reliability of accounts provided by officers.

Focusing on stress and fatigue, this article briefly examines (i) the extent to which psychological research in these domains is ready to inform practice, training, and policy; and (ii) methodological challenges facing researchers attempting to inform practice and policy in this domain.

Effects of Stress and Fatigue on Operational Response

Armed police officers responding in unpredictable, dangerous, high-risk environments produce physiological responses that are consistent with elevated stress levels (Armstrong, Clare,

Author Note

[☆] Please note that this paper was handled by the current editorial team of JARMAC.

^{*} Correspondence concerning this article should be addressed to Lorraine Hope, University of Portsmouth, United Kingdom. Contact: lorraine.hope@port.ac.uk

& Plecas, 2014; Meyerhoff et al., 2004). Performing well under stressful, high-pressured circumstances is challenging, and decrements in performance in such settings are well documented across the wider applied literature (e.g., Hancock & Szalma, 2008). Broadly, stress or negative arousal is thought to increase cognitive load and impair cognitive and perceptual-motor performance on capacity-demanding tasks. This impairment also occurs in police use-of-force contexts. Despite the fact that officers achieve shooting accuracy rates of over 90% in static shooting tests, the average shooting accuracy for real-life incidents is between 15 and 50% (e.g., Morrison & Vila, 1998). Research using police samples and realistic shooting exercises involving an element of threat has documented negative effects of anxiety on police shooting performance including a reduction in goal-directed attention, increased speed of shooting an approaching suspect, and reduced shooting accuracy (e.g., Nieuwenhuys, Canal-Bruland, & Oudejans, 2012; Nieuwenhuys & Oudejans, 2010; Nieuwenhuys, Savelsbergh, & Oudejans, 2012; for overview see Nieuwenhuys & Oudejans, 2012).

Fatigue as a result of either a short-term stressor (e.g., chasing a fleeing suspect on foot) or a longer-term behaviour pattern (e.g., shiftwork) can also impair performance. Exercise-induced fatigue following dynamic action (i.e., heavy exertion) negatively affects shooting accuracy (Vickers & Williams, 2007) and alters behavioural choices in a shooting context (e.g., decisions to stop running earlier and shoot from a greater distance to the target; Nibbeling, Oudejans, Canal Bruland, van der Wurff, & Daanen, 2013; Nibbeling, Oudejans, Ubink, & Daanen, 2014). In a similar vein, fatigue as a result of sleep disruption has been shown to impair professional performance across a range of time-critical, high pressured, decision-making occupations in aviation (Caldwell, 2012), healthcare (Lockley et al., 2004) and military (Miller, Matsangas, & Shattuck, 2007) settings. In policing contexts, where extended shifts and shiftwork are normal features of the work routine, it is unsurprising that surveys of police officers indicate that sub-optimal sleep is associated with increased self-reported error and safety violations (Rajaratnam et al., 2011; Vila, Kenney, Morrison, & Reuland, 2000).

That stress and fatigue might negatively affect officer performance in a response context is not a controversial assertion given observations in the wider applied human performance literature. Less well understood, however, are (i) the specific nature of performance decrements (e.g., likelihood of differential effects on shooting accuracy versus effects on decision-making accuracy), and (ii) the psychological factors underpinning impaired performance across different operational contexts. Further research is also needed to disentangle the combined effects of stress and fatigue on police use-of-force performance.

It is also worth bearing in mind that, to date, there is little evidence that officers are less susceptible to the effects of stress than other citizens. Recent research suggests that interventions to reduce officer stress response as part of a resilience training programme may be effective (see Andersen et al., 2015; McCraty & Atkinson, 2012) but further work is necessary to empirically establish the efficacy of such interventions.

Effects of Stress and Fatigue on the Reliability of the Accounts Provided by Officers

Officer accounts about use of force incidents can form a crucial part of subsequent investigations and court proceedings. However, scepticism over these accounts is well documented and generally highlights concerns relating to the potential for police collusion or corruption (Heaton-Armstrong & Wolchover, 2009). Although the deliberate fabrication of evidence is beyond the scope of the current article, there are less controversial explanations for at least some inaccuracies in the “honestly held” accounts provided by officers. The deleterious effect of acute stressors on memory is well-established in animal and human laboratory research (e.g., De Quervain, Roozendaal, Nitsch, McGaugh, & Hock, 2000; Kuhlmann, Piel, & Wolf, 2005; Salehi, Cordero, & Sandi, 2010) and also in research conducted in police and military training environments (e.g., Morgan et al., 2004; Taverniers, Taylor, & Smeets, 2013). In applied research contexts, individuals exposed to stressors typically report significantly fewer details than those in control conditions (e.g., Hulse & Memon, 2006; Stanny & Johnson, 2000) and can show increased susceptibility to misinformation and error (e.g., Hope et al., 2016; Morgan, Southwick, Steffian, Hazlett, & Loftus, 2013).

The complex factors underpinning memory impairment as a result of stress and arousal can be difficult to delineate in applied contexts. Generally, emotionally arousing events are remembered better than neutral events (e.g., Payne et al., 2006) with neurobiological research suggesting that stress hormones can enhance memory consolidation (McGaugh, 2000, 2013; Roozendaal, 2000). Although arousal may activate the amygdala working to enhance memory (Adolphs, Tranel, & Buchanan, 2005; Phelps, 2006), higher levels of stress disrupt hippocampus function and impair memory performance (Shackman et al., 2006; see also Davis & Loftus, 2009). Therefore, in applied contexts, impaired memory likely reflects the level of stress and task complexity (Deffenbacher, Bornstein, Penrod, & McGorty, 2004; Diamond, Campbell, Park, Halonen, & Zoladz, 2007; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007; for review see Finsterwald & Alberini, 2014).

High levels of stress might account for the memory impairments reflected in incomplete witness accounts, irrespective of whether that witness is a bystander or a police officer. However, an active response role in a use-of-force incident may exacerbate these effects. To date, only one study has attempted to directly examine the effects of officer response role on memory for an incident. In Hope et al. (2016), officers were assigned an active witness role (requiring them to respond as they would while on duty) or an observer role during a live scenario involving an armed perpetrator. Active responders, who experienced higher heart rates during the scenario than the observers, provided significantly fewer correct details in their accounts and reported significantly more errors pertaining to weapons (although overall accuracy rates were not compromised).

A similar pattern of recall impairments has been associated with exercise-induced fatigue. Although the wider literature suggests low-to-moderate exertion might improve cognitive

performance, including recall, high levels of exertion are likely to have a detrimental effect on memory performance (Lambourne, Audiffren, & Tomporowski, 2010; Lambourne & Tomporowski, 2010). Examining exercise-induced effects on memory for a police response context, Hope, Lewinski, Dixon, Blocksidge, and Gabbert (2012) found that officers who had been physically exerted before encountering a suspect in a live scenario recalled less information about the suspect than non-exerted officers and were less likely to correctly identify the target from a lineup.

That stress and fatigue might impair subsequent recall of an incident is, again, not a particularly controversial observation in light of the wider research literature. However, research assessing the performance of police officers in realistic use of force response contexts is limited to a small number of studies conducted by a small number of labs. Thus, replication and extension of this applied literature is important (see “Methodological and contextual challenges” section). Nonetheless, research to date demonstrates that memory accounts provided by operational witnesses are vulnerable to error and the omission of relevant information. Thus, the evaluators of accounts provided by officers following stressful or exerting incidents should be aware that officer memory may be impaired for details of the incident and that errors do not necessarily reflect a deliberate attempt to deceive, cover-up, or deflect blame (see also Grady, Butler, & Loftus, 2016).

What Can Research Contribute to Training and Practice?

The observation that both stress and fatigue can impair (i) cognitive and perceptual-motor performance during response and (ii) subsequent recall of an incident highlights the need for consideration of these factors in training, practice, and policy. To date, research has identified a number of potential avenues for improving current approaches, three of which are examined below.

Realistic Training Environments

Police use of force training focuses on physical, technical, and tactical performance and typically neglects the effects of factors such as stress or anxiety. As a result, many training practices do not adequately simulate the conditions likely to be experienced by officers in real-world encounters (see Andersen, Pitel, Weerasinghe, & Papazoglou, 2016; Morrison & Vila, 1998 for similar critique). The physiological stress response observed in “high realism scenario-based training” (p. 5) is consistent with the stress response observed in real use-of-force encounters (Andersen et al., 2016). Unsurprisingly, similar physiological responses are not observed in classroom-based training.

Given the documented physiological effects of realistic training environments and in light of effects of stress and anxiety on shooting performance (e.g., Nieuwenhuys et al., 2012) and literature suggesting that practice is more effective when test conditions are adequately replicated (for reviews, see Oudejans & Nieuwenhuys, 2009; Pinder, Davids, & Renshaw, 2011), police training should involve simulations that facilitate realistic shoot/no-shoot decisions and allow realistic shooting responses,

as distinct from static target practice. Although unlikely to be a panacea, training with threat-induced anxiety (e.g., “shoot back” opponents during simulations) may improve performance under pressure (e.g. Nieuwenhuys & Oudejans, 2011; Oudejans, 2008; Oudejans & Pijpers, 2009; but see also Nieuwenhuys, Savelsbergh, & Oudejans, 2015). Importantly, as noted by Andersen et al. (2016), training with high realism scenarios provides officers with an opportunity to experience how physiological arousal impacts their own response performance and affords an opportunity to improve performance under such conditions. Similarly, Bennell, Jones, and Corey (2007) endorse the use of high fidelity simulators in police training to facilitate “the development of schemas that are sufficiently flexible to deal with the unpredictability inherent in naturalistic settings” (p. 48). Thus, even though further research is needed, enhanced use-of-force training using realistic, anxiety-provoking scenarios and realistic response options is an important direction for police practice and education.

Method of Obtaining Accounts from Officers

The way in which accounts are obtained from officers following use-of-force incidents varies between jurisdictions. In some instances, officers are interviewed by investigators (who may be drawn from other units, forces, or agencies); elsewhere officers prepare written statements. Where interviews do take place, they should be conducted in line with best-practice investigative interviewing by experienced interviewers using, for example, the Cognitive Interview (Fisher & Geiselman, 1992; see Vrij, Hope, & Fisher, 2014 for a review). However, officers charged with writing their own statements should also benefit from basic retrieval support techniques associated with best practice interviewing when providing their accounts, such as the use of mental context reinstatement, open questions, and non-leading cues and prompts (see meta-analysis by Memon, Meissner, & Fraser, 2010). Tools incorporating these techniques already exist to support the provision of written accounts by witnesses (e.g., the self-administered interview; Hope, Gabbert, & Fisher, 2011). Furthermore, opportunities to experience memory impairment during training (e.g., attempting to provide a comprehensive statement following a training scenario) and an understanding of why this might occur should prepare officers for involvement in future incidents and eliminate dangerous but well-intentioned attempts to seek out other, potentially unreliable, sources of information.

Timing of Obtaining Accounts from Officers

Although practices vary internationally, several jurisdictions subscribe to a blanket period of enforced rest (typically 36–48 h) before requiring officers to provide a detailed statement of their experiences following a use of force incident. The basis for this mandatory rest period is unclear. There is some (self-report) evidence that a high proportion of officers who have been involved in use of force incidents experience sleep disturbance after the incident (Honig & Sultan, 2004). However, it is not clear why a mandatory rest period should be applied to officers but not other types of victims or witnesses who may have been involved in

violent or stressful incidents. Furthermore, extending the delay between a witnessing experience and subsequent recall increases the likelihood that (i) some detail may be forgotten and (ii) memory for the event may become contaminated by exposure to post-event information (Frenda, Nichols, & Loftus, 2011). For an officer who has been involved in a use-of-force incident, the timing of the account should take into account several factors, such as number of hours on shift, need for practical care and welfare, and the fact that the biological response to the psychological and physiological stress is unlikely to have receded in the immediate aftermath (see Wolchover, Heaton-Armstrong, Hope, & Gabbert, 2014). Some research suggests sleep may be important for memory consolidation, particularly for stressful incidents (Genzel, Spoormaker, Konrad, & Dresler, 2015), thus, it is possible that witnesses might benefit from rest before providing a statement. However, work by Payne et al. (2009) and, more recently, Calvillo, Parong, Peralta, Ocampo and van Gundy (2016) suggests that periods of sleep may be associated with increased susceptibility to memory distortion. As the exact nature of the relationship between stress, fatigue, and memory consolidation has not been elucidated in the eyewitness context, further research is necessary before recommendations pertaining to the timing of accounts can be made (see also Grady et al., 2016).

Methodological and Contextual Challenges

In this domain, a key question for researchers (and, indeed, consumers of research) is the extent to which police officers represent a “special case” for consideration. Beyond the effects of professional experience or training, there is no evidence to suggest that officers’ memories, or other cognitive processes, perform substantively differently to those of any other human (see also Vredeveltdt & van Koppen, 2016). Indeed, many of the findings outlined above pertaining to stress and fatigue might also apply to the accounts of witnesses or victims who chose to intervene, fight, or flee. However, unlike lay witnesses, officers are explicitly tasked with deriving an appropriate response strategy, planning the effective execution of that strategy, and then taking action accordingly (see Eyre & Alison, 2007). Therefore, conducting meaningful research in this field requires consideration of the extent to which the phenomenon under examination is likely to be affected by factors such as active responding, training and previous experience.

A second consideration is the degree of ecological validity in the design and execution of the research necessary to adequately assess a real-world phenomenon. Clearly, in the case of high-stress encounters, low-level laboratory manipulations (e.g., gory photographs) or third-party materials (e.g., vignettes, videos) are unlikely to generate comparably high levels of arousal or facilitate realistic levels of engagement. While research can never simulate the “life or death” nature of a use-of-force incident, better quality research in this domain seeks to replicate basic research findings working with realistic, live, training-type scenarios while attempting to control relevant features of the interaction, context, and environment. Of course, applied research must be held to the same high methodological

standards as laboratory work, including (i) recruitment of adequate samples sizes to test well-defined, theory-driven hypotheses; (ii) inclusion of relevant control groups; (iii) implementation of controlled, replicable scenarios; (iv) systematic manipulation of independent variables; and (v) use of appropriate statistical analyses. As end-users may not always be best placed to assess the methodological quality of applied research, there is a critical role for rigorous peer review by appropriately qualified experts in both academic and practitioner outlets.

The extent to which research findings in this domain are likely to be accepted or adopted by end-users is also reliant on the use of credible methodologies. Police, legal professionals, and policy makers are, unsurprisingly, critical of work purporting to make significant contributions to understanding of professional performance if it involves undergraduate samples, over-simplistic scenarios or naïve manipulations. In many instances, this is a fair criticism as the results of such research are often simply not ready for wider application or implementation. For example, an important topic deliberately not covered in the current article is the effect of racial bias in the use of force and how this might interact with factors such as stress. Although there is a significant laboratory-based literature on this topic, most research has yet to incorporate important contextual factors (e.g., threat, experience, training, cultural factors) and reflects many of the deficits outlined above (i.e., non-professional samples, laboratory-based methodologies, press-button responding). This critique is not intended to denigrate this line of research—establishing the nature of response biases and developing the necessary theoretical frameworks within which to understand them constitutes a critical first step in examining this challenging issue. However, such research is not yet ready to inform policy, practice, or the courts with respect to use of force contexts (see Cox, Devine, Plant, & Schwartz, 2014 for a related critique; also Mekawi & Bresin, 2015).

Finally, researchers should be aware of the potential politicisation of their research in this field and recognise that their results may be used (and abused) in unanticipated ways—including both the overstatement and oversimplification of their findings by a variety of commentators, so-called experts and agencies with vested interests. Often there is little a researcher can do to avoid this, but presenting the findings objectively and cautiously while avoiding hyperbolic claims about potential impact or premature policy recommendations is prudent.

Conclusions

Using a variety of methodological approaches, both basic and applied research literatures have identified human performance vulnerabilities when stress or fatigue is present. Results are broadly consistent and not entirely surprising—humans compromised by stress or fatigue are likely to suffer impairment in terms of response and memory performance. Although training may offset some performance decline, police officers are also vulnerable to such impairment, perhaps more so as a function of the additional cognitive load associated with responding to and resolving incidents. However, more research is necessary to unpack the relative importance of key contextual factors

affecting performance, including interactions between those factors. Future research also requires increased collaboration between researchers and end-users to ensure that the questions asked and methodologies adopted can make a meaningful contribution to our understanding of police performance in use of force incidents.

References

- Adolph, R., Tranel, D., & Buchanan, T. W. (2005). Amygdala damage impairs emotional memory for the gist but not the details of complex stimuli. *Nature Neuroscience*, 8, 60803, 512–518. <http://dx.doi.org/10.1038/nn1413>
- Andersen, J. P., Pitel, M., Weerasinghe, A., & Papazoglou, K. (2016). Highly realistic scenario-based training simulates the psychophysiology of real world use of force encounters: Implications for improved police officer performance. *Journal of Law Enforcement*, 5. ISSN 2161-0231 (Online)
- Andersen, J. P., Papazoglou, K., Koskelainen, M., Nyman, M., Gustafberg, H., & Arnetz, B. B. (2015). Applying resilience promotion training among special forces police officers. *SAGE Open*, 1–8 <http://dx.doi.org/10.1177/2158244015590446>
- Armstrong, J., Clare, J., & Plecas, D. B. (2014). Monitoring the impact of scenario-based use-of-force simulations on police heart rate: Evaluating the royal Canadian mounted police skills refresher program. *Western Criminology Review*, 15, 51–59.
- Bennell, C., Jones, N. J., & Corey, S. (2007). Does use-of-force simulation training in Canadian police agencies incorporate principles of effective training. *Psychology, Public Policy and Law*, 13, 35–58. <http://dx.doi.org/10.1037/1076-8971.13.1.35>
- Caldwell, J. A. (2012). Crew schedules, sleep deprivation, and aviation performance. *Current Directions in Psychological Science*, 21, 85–89. <http://dx.doi.org/10.1177/0963721411435842>
- Calvillo, D. P., Parong, J. A., Peralta, B., Ocampo, D., & van Gundy, R. (2016). Sleep increases susceptibility to the misinformation effect. *Applied Cognitive Psychology*, <http://dx.doi.org/10.1002/acp.3259>
- Cox, W. T. L., Devine, P. G., Plant, E. A., & Schwartz, L. L. (2014). Towards a comprehensive understanding of officers' shooting decisions: No simple answers to this complex problem. *Basic and Applied Social Psychology*, 36, 356–364. <http://dx.doi.org/10.1080/01973533.2014.923312>
- Davis, D., & Loftus, E. F. (2009). Expectancies, emotion and memory reports of visual events: Applications in the legal system. In J. R. Brockmole (Ed.), *The visual world in memory* (pp. 178–214). Psychology Press.
- Deffenbacher, K. A., Bornstein, B. H., Penrod, S. D., & McGorty, E. K. (2004). A meta-analytic review of the effects of high stress on eyewitness memory. *Law and Human Behavior*, 28, 687–706. <http://dx.doi.org/10.1007/s10979-004-0565-x>
- De Quervain, D. J., Roozendaal, B., Nitsch, R. M., McGaugh, J. L., & Hock, C. (2000). Acute cortisone administration impairs retrieval of long-term declarative memory in humans. *Nature Neuroscience*, 3, 313–314. <http://dx.doi.org/10.1038/73873>
- Diamond, D. M., Campbell, A. M., Park, C. R., Halonen, J., & Zoladz, P. R. (2007). The temporal dynamics model of emotional memory processing: A synthesis on the neurobiological basis of stress-induced amnesia, flashbulb and traumatic memories, and the Yerkes-Dodson Law. *Neural Plasticity*, <http://dx.doi.org/10.1155/2007/60803>
- Eyre, M., & Alison, L. (2007). To decide or not to decide: Decision making and decision avoidance in critical incidents. In D. Carson, R. Milne, F. J. Pakes, K. Shalev, & A. Shawyer (Eds.), *Applying psychology to criminal justice* (pp. 211–232). Chichester: Wiley. <http://dx.doi.org/10.1016/j.nlm.2013.09.017>
- Finsterwald, C., & Alberini, C. M. (2014). Stress and glucocorticoid receptor-dependent mechanisms in long-term memory: From adaptive responses to psychopathologies. *Neurobiology of Learning and Memory*, 112, 17–29. <http://dx.doi.org/10.1016/j.nlm.2013.09.017>
- Fisher, R. P., & Geiselman, R. E. (1992). *Memory enhancing techniques for investigative interviewing: The cognitive interview*. Springfield, IL: Charles C. Thomas.
- Frenda, S. J., Nichols, R. M., & Loftus, E. (2011). Current issues and advances in misinformation research. *Current Directions in Psychological Science*, 20, 20–23. <http://dx.doi.org/10.1177/0963721410396620>
- Genzel, L., Spoormaker, V. I., Konrad, B. N., & Dresler, M. (2015). The role of rapid eye movement sleep for amygdala-related memory processing. *Neurobiology of Learning and Memory*, 122, 110–121. <http://dx.doi.org/10.1016/j.nlm.2015.01.008>
- Grady, R. H., Butler, B. J., & Loftus, E. F. (2016). What should happen after an officer-involved shooting? Memory concerns in reporting procedures. *Journal of Applied Research in Memory and Cognition*, <http://dx.doi.org/10.1016/j.jarmac.2016.07.002>
- Hancock, P. A., & Szalma, J. L. (2008). *Performance under stress*. Hampshire, GU: Ashgate Publishing Ltd.
- Heaton-Armstrong, A., & Wolchover, D. (2009, January). Conferring at the crossroads. *Counsel*, 18.
- Honig, A. L., & Sultan, S. E. (2004). Reactions and resilience under fire: What an officer can expect. *The Police Chief*, 71(December), 54–60.
- Hope, L., Blocksidge, D., Gabbert, F., Sauer, J. D., Lewinski, W., Mirashi, A., & Atuk, E. (2016). Memory and the operational witness: Police officer recall of firearms encounters as a function of active response role. *Law and Human Behavior*, 40, 23–35. <http://dx.doi.org/10.1037/lhb0000159>
- Hope, L., Gabbert, F., & Fisher, R. (2011). From laboratory to the street: Capturing witness memory using the self-administered interview. *Legal and Criminological Psychology*, 16, 211–226. <http://dx.doi.org/10.1111/j.2044-8333.2011.02015.x>
- Hope, L., Lewinski, W., Dixon, J., Blocksidge, D., & Gabbert, F. (2012). Witnesses in action: The effect of physical exertion on recall and recognition. *Psychological Science*, 23, 386–390. <http://dx.doi.org/10.1177/0956797611431463>
- Lambourne, K., Audiffren, M., & Tomporowski, P. D. (2010). Effects of acute exercise on sensory and executive processing tasks. *Medicine and Science in Sport and Exercise*, 42, 1396–1402. <http://dx.doi.org/10.1249/MSS.0b013e3181cbee11>
- Lambourne, K., & Tomporowski, P. D. (2010). The effect of acute exercise on cognitive task performance: A meta-regression analysis. *Brain Research Reviews*, 1341, 12–24. <http://dx.doi.org/10.1016/j.brainres.2010.03.091>
- Lupien, S. J., Maheu, F., Tu, M., Fiocco, A., & Schramek, T. E. (2007). The effects of stress and stress hormones on human cognition: Implications for the field of brain and cognition. *Brain and Cognition*, 65, 209–237. <http://dx.doi.org/10.1016/j.bandc.2007.02.007>
- Hulse, L., & Memon, A. (2006). Fatal impact? The effects of emotional arousal and weapon presence on police officers' memories for a simulated crime. *Legal and Criminological Psychology*, 11, 313–325. <http://dx.doi.org/10.1348/135532505X58062>
- Kuhlmann, S., Piel, M., & Wolf, O. T. (2005). Impaired memory retrieval after psychosocial stress in healthy young men. *Journal of Neuroscience*, 25, 2977–2982. <http://dx.doi.org/10.1523/JNEUROSCI.5139-04.2005>

- Lockley, S. W., Cronin, J. W., Evans, E. E., Cade, B. E., Lee, C. J., Landrigan, C. P., ... & Czeisler, C. A. (2004). Effect of reducing interns' weekly work hours on sleep and attentional failures. *New England Journal of Medicine*, 351, 1829–1837. <http://dx.doi.org/10.1056/NEJMoa041404>
- McCraty, R., & Atkinson, M. (2012). Resilience training program reduces physiological and psychological stress in police officers. *Global Advances in Health and Medicine*, 1, 42–64.
- McGaugh, J. L. (2000). Memory: A century of consolidation. *Science*, 287, 248–251. <http://dx.doi.org/10.1126/science.287.5451.248>
- McGaugh, J. L. (2013). Making lasting memories: Remembering the significant. *Proceedings of the National Academy of Sciences of the United States of America*, 110, 10401–10407. <http://dx.doi.org/10.1073/pnas.1301209110>
- Mekawi, Y., & Bresin, K. (2015). Is the evidence from racial bias shooting task studies a smoking gun? Results from a meta-analysis. *Journal of Experimental Psychology*, 61, 120–130. <http://dx.doi.org/10.1016/j.jesp.2015.08.002>
- Memon, A., Meissner, C. A., & Fraser, J. (2010). The cognitive interview: A meta-analytic review and study space analysis of the past 25 years. *Psychology, Public Policy, & Law*, 16, 340–372.
- Meyerhoff, J. L., Norris, W., Saviolakis, G. A., Wollert, T., Burge, B., Atkins, V., & Spielberger, C. (2004). Evaluating performance of law enforcement personnel during a stressful training scenario. *Annals New York Academy of Sciences*, 1032, 250–253. <http://dx.doi.org/10.1196/annals.1314.031>
- Miller, N. L., Matsangas, P., & Shattuck, L. G. (2007). Fatigue and its effect on performance in military environments. In P. A. Hancock, & J. L. Szalma (Eds.), *Performance under stress* (p. 400). Ashgate Publications.
- Morgan, C. A., III, Hazlett, G., Doran, A., Garrett, S., Hoyt, G., Thomas, P., & Southwick, S. M. (2004). Accuracy of eyewitness memory for persons encountered during exposure to highly intense stress. *International Journal of Law and Psychiatry*, 27, 265–279. <http://dx.doi.org/10.1016/j.ijlp.2004.03.004>
- Morgan, C. A., III, Southwick, S., Steffian, G., Hazlett, G. A., & Loftus, E. F. (2013). Misinformation can influence memory for recently experienced, highly stressful events. *International Journal of Law and Psychiatry*, 36, 11–21. <http://dx.doi.org/10.1016/j.ijlp.2012.11.002>
- Morrison, G. B., & Vila, B. J. (1998). Police handgun qualification: Practical measures or aimless activity? *Policing: An International Journal of Police Strategies & Management*, 21, 510–533. <http://dx.doi.org/10.1108/13639519810228804>
- Nibbeling, N., Oudejans, R. R. D., Canal Bruland, R., van der Wurff, P., & Daanen, H. A. M. (2013). Pursue or shoot? Effects of exercise-induced fatigues on the transition from running to rifle shooting in a pursuit task. *Ergonomics*, 56, 1877–1888. <http://dx.doi.org/10.1080/00140139.2013.847213>
- Nibbeling, N., Oudejans, R. R. D., Ubink, E. M., & Daanen, H. A. M. (2014). Effects of anxiety and exercise-induced fatigue on shooting accuracy and cognitive performance in infantry soldiers. *Ergonomics*, 57, 1366–1379. <http://dx.doi.org/10.1080/00140139.2014.924572>
- Nieuwenhuys, A., Canal Bruland, R., & Oudejans, R. R. D. (2012). Effects of threat on police officers' shooting behavior: Anxiety, action specificity and affective influences on perception. *Applied Cognitive Psychology*, 26, 608–615. <http://dx.doi.org/10.1002/acp.2838>
- Nieuwenhuys, A., & Oudejans, R. R. D. (2010). Effects of anxiety on handgun shooting behavior of police officers: A pilot study. *Anxiety, Stress, and Coping*, 23, 225–233. <http://dx.doi.org/10.1080/10615800902977494>
- Nieuwenhuys, A., & Oudejans, R. R. D. (2011). Training with anxiety: Short- and long-term effects on police officers' shooting behavior under pressure. *Cognitive Processing*, 12, 277–288. <http://dx.doi.org/10.1007/s10339-011-0396-x>
- Nieuwenhuys, A., & Oudejans, R. R. D. (2012). Anxiety and perceptual-motor performance: Toward an integrated model of concepts, mechanisms, and processes. *Psychological Research*, 76, 747–759. <http://dx.doi.org/10.1007/s00426-011-0384-x>
- Nieuwenhuys, A., Savelsbergh, G. J. P., & Oudejans, R. R. D. (2012). Shoot or don't shoot: Why police officers are more inclined to shoot when they are anxious. *Emotion*, 12, 827–833. <http://dx.doi.org/10.1037/a0025699>
- Nieuwenhuys, A., Savelsbergh, G. J. P., & Oudejans, R. R. D. (2015). Persistence of threat-induced errors in police officers' shooting decisions. *Applied Ergonomics*, 48, 263–272. <http://dx.doi.org/10.1016/j.apergo.2014.12.0>
- Oudejans, R. R. D. (2008). Reality based practice under pressure improves handgun shooting performance of police officers. *Ergonomics*, 51, 261–273. <http://dx.doi.org/10.1080/00140130701577435>
- Oudejans, R. R. D., & Nieuwenhuys, A. (2009). Perceiving and moving in sports and other high-pressure contexts. *Progress in Brain Research*, 174, 35–48. [http://dx.doi.org/10.1016/S0079-6123\(09\)01304-1](http://dx.doi.org/10.1016/S0079-6123(09)01304-1)
- Oudejans, R. R. D., & Pijpers, J. R. (2009). Training with anxiety has a positive effect on expert perceptual-motor performance under pressure. *Quarterly Journal of Experimental Psychology*, 62, 1631–1647. <http://dx.doi.org/10.1080/09658210500139176>
- Payne, J. D., Jackson, E. D., Ryan, L., Hoscheidt, S., Jacobs, J. W., & Nadel, L. (2006). The impact of stress on neutral and emotional aspects of episodic memory. *Memory*, 14, 1–16. <http://dx.doi.org/10.1080/09658210500139176>
- Payne, J. D., Schacter, D. L., Propper, R. E., Huang, L. W., Wamsley, E. J., Tucker, M. A., Walker, M. P., & Stickgold, R. (2009). The role of sleep in false memory formation. *Neurobiology of Learning and Memory*, 92, 327–334.
- Phelps, E. A. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual Review of Psychology*, 57, 27–53. <http://dx.doi.org/10.1146/annurev.psych.56.091103.070234>
- Pinder, R. A., Davids, I., & Renshaw, D. A. (2011). Representative learning design and functionality of research and practice in sport. *Journal of Sport & Exercise Psychology*, 33, 146–155.
- Rajaratnam, S. M., Barger, L. K., Lockley, S. W., Shea, S. A., Wang, W., Landrigan, C. P., ... & Czeisler, C. A. (2011). Sleep disorders, health and safety in police officers. *Journal of the American Medical Association*, 306, 2567–2578. <http://dx.doi.org/10.1001/jama.2011.1851>
- Rozenendaal, B. (2000). Glucocorticoids and the regulation of memory consolidation. *Psychoneuroendocrinology*, 25, 213–238. [http://dx.doi.org/10.1016/S0306-4530\(99\)00058-X](http://dx.doi.org/10.1016/S0306-4530(99)00058-X)
- Salehi, B., Cordero, M. I., & Sandi, C. (2010). Learning under stress: The inverted U-shape function revisited. *Learning and Memory*, 17, 522–530. <http://dx.doi.org/10.1101/lm.1914110>
- Shackman, A. J., Sarinopoulos, I., Maxwell, J. S., Pizzagalli, D. A., Lavric, A., & Davidson, R. J. (2006). Anxiety selectively disrupts visuospatial working memory. *Emotion*, 6, 40–61. <http://dx.doi.org/10.1037/1528-3542.6.1.40>
- Stanny, C. J., & Johnson, T. C. (2000). Effects of stress induced by a simulated shooting on recall by police and citizen

- witnesses. *American Journal of Psychology*, 114, 359–386. <http://dx.doi.org/10.2307/1423364>
- Taverniers, J., Taylor, M. K., & Smeets, T. (2013). Delayed memory effects after intense stress in special forces candidates: Exploring path processes between cortisol secretion and memory recall. *Stress*, 16, 311–320. <http://dx.doi.org/10.3109/10253890.2012.721824>
- Vickers, J. N., & Williams, A. M. (2007). Performing under pressure: The effects of physiological arousal, cognitive anxiety, and gaze control in biathlon. *Journal of Motor Behavior*, 39, 381–394. <http://dx.doi.org/10.3200/JMBR.39.5.381-394>
- Vila, B. J., Kenney, D. J., Morrison, G. B., & Reuland, M. (2000). *Evaluating the effects of fatigue on police patrol officers*. Washington, DC: Police Executive Research Forum.
- Vredeveldt, A., & van Koppen, P. J. (2016). The thin blue lineup: A comparison of eyewitness performance by police and citizens. *Journal of Applied Research in Memory and Cognition*, <http://dx.doi.org/10.1016/j.jarmac.2016.06.013>
- Vrij, A., Hope, L., & Fisher, R. P. (2014). Eliciting reliable information in investigative interviews. *Policy Insights from Behavioral and Brain Sciences*, 1, 129–136. <http://dx.doi.org/10.1177/2372732214548592>
- Wolchover, D., Heaton-Armstrong, A., Hope, L., & Gabbert, F. (2014). Notebook challenge: No conferring. *Criminal Law and Justice Weekly*, 178.

Received 28 April 2016;
received in revised form 4 July 2016;
accepted 5 July 2016