Journal of Police and Criminal Psychology
https://doi.org/10.1007/s11896-021-09439-w

Misplacing Memory: Examining the Phenomenon of Cognitive Offloading During an Officer-Involved Use-of-Force Scenario

Brittany Blaskovits[1] · Bryce Jenkins[1] · Andrew Brown[1] · Simon Baldwin[1] · Craig Bennell[1]

Accepted: 18 February 2021

Abstract
People are known to offload memory processing tasks to devices, such as cameras. We examined whether body-worn cameras (BWCs) are used in this way by police officers. Fifty officers responded to a simulated domestic dispute that resulted in lethal force. Half the sample was provided a BWC and told their footage would be available to assist with post-event recall, but it was later feigned that there was a technological issue. The remaining officers were not equipped with a BWC and thus were aware they would not have any footage to rely on. The amount, accuracy, and type of details reported by officers were coded and subjected to analysis. The results revealed that wearing a camera did not promote cognitive offloading in officers, suggesting that the training officers receive, or other factors that might be unique to policing, may mitigate an effect that has been observed in other contexts.

Keywords Cognitive offloading · Police · Body-worn cameras · Use of force

In a high-stress situation, like an officer-involved use-of-force event, an officer's memory can be negatively affected such that they fail to properly attend to and encode important details of the event (Bremner 1999; Fortin et al. 2002). In extreme cases, officers may experience tunnel vision and/or auditory exclusion whereby perceptual narrowing occurs to such a degree that numerous (potentially important) cues are ignored (e.g., weapons, bystanders; Artwohl 2002; Grossman and Christensen 2007). This restriction in one's field of view leaves them vulnerable to memory errors and/or gaps in their recall (Grossman and Christensen 2007; van der Kolk Fisler 1995). However, even moderately stressful tasks appear to impact memory processes, interfering with one's ability to both encode and retrieve information (see Shields et al. 2017).

To compensate for the potential memory deficits resulting from stress, body-worn cameras (BWCs) have been revered as a tool to enhance officers' ability to recall details from encounters with members of the public (Jennings et al. 2014). When an officer watches their BWC footage, certain details might prompt them to better remember what transpired during the encounter, as well as aspects of their risk assessment (i.e., why they made the decisions they did during the encounter; Dawes et al. 2015). From a policing perspective, the hope is that by enhancing officers' recall, citizens will better understand police-public interactions, and perceptions or accusations that officers are intentionally being deceptive following an incident (should their recall be discrepant; Schultheis et al. 2015) will be mitigated.

Interestingly however, new research has found that having access to saved information about an event (e.g., via photographs or video) may actually have a negative effect on memory for that same event (Henkel 2014; Risko and Gilbert 2016; Sparrow et al. 2011) and that this "photo-taking impairment effect" could be due to cognitive offloading (Henkel 2014; Soares and Storm 2018). When we use recording devices in the physical environment (e.g., a camera, phone, or notepad) in an effort to change the processing requirements of a task (i.e., recording information to act as a cue for later recall), we are said to be "offloading" information to a prosthetic "memory" bank (Risko and Gilbert 2016; Soares and Storm 2018). Doing so can reduce cognitive load in the encoding environment, which theoretically "frees up resources" for other tasks, such as better communication, problem-solving, decision-making, and motor tasks. Yet, it could also leave us reliant on the source of the saved information—why remember, when we can later rely on a recording device?

✉ Brittany Blaskovits
brittanyblaskovits@cmail.carleton.ca

[1] Department of Psychology, Carleton University, 1125 Colonel by Drive, Ottawa, ON K1S 5B6, Canada

Moreover, the literature suggests that individuals are more apt to relinquish their cognitions to a tool when it is difficult to recall pertinent information, such as when they are stressed, experiencing interruptions during encoding, or being exposed to an overwhelming amount of information (Gilbert 2015; Risko and Gilbert 2016). The police are, of course, a population that is exposed to complex, often stressful events that require them to multi-task (e.g., communicating with a subject, making tactical decisions, using intervention options); leaving them particularly vulnerable to engage in offloading (e.g., to their BWCs). Unfortunately, officers do not always have access to their recorded footage. There may be human or technological errors that prevent recording, the footage may not always be useable (e.g., if it is of poor quality), or the footage could be used as hold-back evidence against officers involved in critical incidents (Office of the Privacy Commissioner of Canada 2015; Reporters Committee 2019). If officers offload encoding responsibilities to their BWC only to find that the source of the saved information is unavailable, their recall could be compromised. Therefore, determining the degree to which officers in high-stress use-of-force encounters offload encoding responsibilities to their BWC is important.

The Potential Impact of Stress on Police Officer Memory

Use-of-force events involving police officers are rare. For example, in Canada, 99.9% of all police-public interactions are resolved without the use of force (Baldwin et al. 2018; Butler and Hall 2008; Hall et al. 2013), and in the USA, it is estimated that less than 2% of interactions involve use of force by the police (MacDonald et al. 2009). Nevertheless, the unpredictable nature of policing, and the potential for injury or death, undoubtedly contributes to stress in officers (Andersen et al. 2016; Anderson et al. 2002). While the stress response has implications for one's overall body function and health (e.g., Anderson et al. 2002), it also appears to impact psychological processes including memory and learning.

It has been argued that a certain amount of stress can improve subsequent recall, since the perceptual narrowing that occurs under stress allows individuals to ignore irrelevant information and attend to that which is most pertinent (Lewinski 2008). This is consistent with the "weapon focus effect," whereby individuals tend to remember weapons better than other, less salient details (Steblay 1992). Alternatively, some research has found that stress, particularly high or chronic stress, can restrict one's attention to such an extent that important information fails to be properly encoded, consequently impairing recall (e.g., Artwohl 2002; Grossman and Christensen 2007). A recent meta-analysis of 113 studies aimed at clarifying the effect of stress on memory found that while stress can enhance certain memory processes, it also appears to disrupt others (Shields et al. 2017). For example, Shields et al. (2017) found that post-encoding stress improved memory, unless the stressor and study materials were in different physical locations. In contrast, stress that occurred prior to or during encoding and/or retrieval impaired episodic memory (i.e., memory for specific events, situations, or experiences), albeit such effects depended on a variety of factors such as the emotional valence of the study material and the delay time between stressor and encoding.

The debilitating effect of stress on encoding and retrieval is supported by the "executive control account" of memory (Shields et al. 2017; Schwabe et al. 2010). This theory assumes that stress targets "executive functions" (i.e., those that support effective encoding and retrieval; Blumenfeld and Ranganath 2007; Gagnon and Wagner 2016; Levy and Anderson 2002), consequently impairing "…working memory, selective attention, and cognitive flexibility" (Shields et al. 2017, p. 639). The impairment of these functions is particularly concerning for officers involved in high-risk incidents in which they are forced to make sound judgements under high levels of stress. Working memory, for example, temporarily stores information so that cognitive tasks such as problem-solving can be accomplished (Baddeley 1983). In other words, it allows one to remember something (e.g., such as where to go to respond to a call for service), while also engaging in something else (e.g., communicating with dispatch). Should one's working memory become overwhelmed or otherwise short-circuited, breakdowns in short- and long-term memory may occur (Taverniers et al. 2011, 2010; Wine 1971).

The impact of stress on memory is not necessarily surprising considering that one of the areas of the brain most affected by the stress response is the hippocampus, a structure that plays a major role in the encoding and retrieval of autobiographical event details (Bremner 1999; Dusek and Eichenbaum 1997; Fortin et al. 2002). Under a moderate level of stress, the hippocampus works to encode important information about a stressor and may even improve threat detection by facilitating the comparison of a current dangerous situation to prior dangerous situations (Bremner 1999). However, exposure to extreme or prolonged stress has the potential to overwhelm the hippocampus, and even damage it (Arbel et al. 1994; Bachevalier and Meunier 1996; Fortin et al. 2002). It has been suggested that hippocampal dysfunction may represent, "…the anatomic basis for alterations in memory, such as fragmented or delayed recall of traumatic memories…" (Bremner 1999, p. 798).

Body-Worn Cameras as Tools for Intention Offloading

Following a use-of-force event, most agencies require their officers to explain what happened in a report (Alpert and Smith 1999; Garner et al. 2018; Laming 2019). Yet, tense interactions with members of the public, particularly those that involve the application of force, clearly represent situations where an officer would be stressed and thus vulnerable to certain memory issues. It has been argued that BWCs may be able to enhance officers' ability to recall details about their encounters with the public, ensuring reports are completed as fully and accurately as possible (Dawes et al. 2015; Jennings et al. 2014), similar to a "walk-through" of a crime scene (Geiselman 2010; Honig and Lewinski 2008). Because BWCs have the potential to record full events, they should, theoretically, capture idiosyncrasies of use-of-force encounters that might otherwise be forgotten or distorted. More specifically, if officers have the opportunity to refer to their BWC footage while writing their reports, any loss of information resultant from stress should be allayed.

Similar to the use of reminders, alarms, and notes, using a BWC to assist in "remembering" an event is arguably a form of intention offloading. When one offloads, they are effectually relinquishing their cognitions "into the world" to enhance their prospective memory (i.e., trigger a later intention; Risko and Gilbert 2016). Interestingly, research suggests that we offload often and may even attempt to do so more than is necessary (Risko and Dunn 2015; Risko and Gilbert 2016). For example, in a study conducted by Risko and Dunn (2015), participants chose to offload (i.e., write down the to-be-remembered items), even when the memory load was so minimal that performance did not improve with offloading. This propensity to offload, despite the lack of benefit on performance, may be attributable to "…(i) an undetected performance benefit, (ii) a bias against cognitive effort…and/or (iii) an erroneous metacognitive belief that the offloading will in fact benefit performance" (Risko and Gilbert 2016, p. 681). However, offloading is even more likely to occur when our mental capacities are exhausted, such as when we are stressed or the information is complex or overwhelming—a state typical of officers who find themselves in a precarious interaction with an assailant.

Successful offloading allows us to reallocate our mental resources elsewhere (Risko and Gilbert 2016; Storm and Stone 2015). For instance, if an officer were to rely on a BWC to store information that would have otherwise been executed by their working memory, space is theoretically "freed up" for other cognitive (e.g., communication, problem-solving, decision-making) and motor tasks (e.g., unholstering, aiming, and deploying an intervention option). It is argued that offloading is underpinned by one's own metacognitive awareness of their limitations (Redshaw et al. 2018; Risko and Gilbert 2016). The notion is similar to transactive memory, a theory that describes how individuals in close partnerships develop mnemonic systems whereby one person can rely on the other (and vice versa) to recall shared information (e.g., Wegner et al. 1991). Knowing that we might have difficulty remembering later on, we surrender certain information to external support systems (e.g., Gilbert 2015; Redshaw et al. 2018).

As research demonstrates, it is clear that offloading comes at a price. When one redistributes their cognitions to a device, like a camera, less effort is dedicated to encode and retain that information (i.e., the trade-off for increased mental capacity is some loss of information; e.g., Henkel 2014; Marsh and Rejaram 2019; Risko and Gilbert 2016). In other words, knowing that the instance is being saved in some other form appears to give us permission to forget it. Indeed, recent research has revealed that having constant, easy access to saved information (often in the form of photos and/or video) negatively affects memory (Henkel 2014; Risko and Gilbert 2016; Sparrow et al. 2011). Sparrow et al. (2011), for instance, conducted a series of four studies showing that when people expect to have future access to information (like via the internet), they tend to have lower rates of recall. In one study, participants were asked to type various statements and told that half the statements they wrote would be deleted and the other half would be saved. In a subsequent recall test, participants were significantly more likely to remember those they believed had been erased. This suggests that we may be less motivated to encode and retain information that will be saved in another form. Relatedly, Henkel (2014) found that when individuals take photos of objects, they are less likely to remember those objects and recall fewer details about them, compared with if they had only observed them; a phenomenon referred to as the photo-taking impairment effect. In fact, even when participants were provided additional time to view the objects prior to taking a photo they displayed impaired recall.

It is unclear if the impaired recall for saved information is a direct by-product of cognitive offloading, although it seems likely. Marsh and Rejaram (2019), for example, argue that it makes sense to rely on external sources (like the internet) as memory stores—"…it is unlimited in its capacity, almost always available, fast, and relatively unlimited in scope. There is no point memorizing an address when one can look it up quickly, from anywhere" (p. 6). Henkel (2014), however, notes that cameras may act as a cue to "dismiss and forget," similar to what seems to occur in studies examining directed-forgetting (e.g., Bjork and Woodward 1973; Golding and MacLeod 1998). In such studies, individuals have tended to dismiss information they are explicitly told to forget and better recall that which they are told to remember. Likewise, a camera may signal that the information being captured is either unimportant and can be disregarded, or that it is being stored elsewhere.

Soares and Storm (2018) argue that other processes, specifically attentional disengagement, may better explain the problematic recall for photographed objects. They conducted a within-subject study wherein participants took photos of a group of paintings with the messaging application Snapchat.[1] They also took photos of paintings that would not be deleted (i.e., with a regular camera). Finally, participants simply viewed a group of paintings. The findings revealed a photo-taking impairment effect for the paintings that were photographed, regardless of whether they were saved in a permanent form or not (i.e., via Snapchat). The findings were replicated in another study by the same authors where participants were aware that they would have to physically delete the photos they took of the paintings. Given that offloading depends on one's ability to rely on an external source to "remember for them," Soares and Storm note that it may not fully explain the impairment in recall observed. In any case, we appear to dismiss information when a camera is present. While this effect is concerning in a general sense (see Carr's (2008) article "Is Google making us stupid?"), it would be even more alarming if it were to occur amongst police officers tasked with accurately recalling life or death events.

Purpose

If officers can rely on BWCs to "hold" a memory for them, offloading may be beneficial, given its ability to overcome capacity limitations and minimize computational effort (Risko and Gilbert 2016). However, officers do not always have access to their footage. There may be problems with the recording if, for example, they forget to turn on the camera prior to an event or the camera malfunctions. Alternatively, the footage itself may be of poor quality (if the image is obstructed, freezes, or if the camera is damaged during an altercation), or officers may simply not be allowed to view it if it is being used as holdback evidence (e.g., Reporters Committee 2019). Consider an officer who offloads to a BWC, and as a result does not adequately encode important information during an encounter (consistent with Henkel's (2014) photo-taking impairment effect). If they then turn to the source of the "saved information" only to find that it is unavailable, their ability to recall and articulate their actions could be compromised.

In a courtroom trial about a use-of-force event, discrepancies and/or memory failures may be perceived negatively, as if an officer is withholding evidence, or acting deceptively (Schultheis et al. 2015). Given that memory deficits are already likely to occur under stress (Shields et al. 2017), and that various problems with BWC footage appear quite likely (Blaskovits et al. 2017; Remsberg 2016), determining the degree to which officers in use-of-force encounters offload encoding responsibilities to BWCs (potentially exacerbating memory deficits) is important. Therefore, the aim of the current research is to examine how BWCs impact the amount, accuracy, and type of details reported by officers during a simulated use-of-force event.

Hypotheses

Hypothesis 1A. Consistent with research in other domains (e.g., Henkel 2014; Sparrow et al. 2011), it is expected that officers who are led to believe that they will be able to view their BWC footage following their involvement in a simulated use of event, but later are prevented from doing so due to a feigned technological issue (i.e., the primed group), will report significantly fewer details about the event when prompted to do so, relative to officers who are not wearing a camera (and aware that they will not have the opportunity to view any footage prior to completing their statement about the event; i.e., the control group).

Hypothesis 1B. Consistent with prior research that found associations between high levels of stress and deleterious effects on memory (Dawes et al. 2015), it is further hypothesized that stress may act as a covariate, such that officers will provide fewer details about the use-of-force event they were involved in if they were primed to believe that they could rely on the footage from their BWC, particularly if they were highly stressed.

Hypothesis 2A. Given natural biases to fill in gaps in memory with what we believe to have happened (e.g., based on prior experience; Dawes et al. 2015; Lacy and Stark 2013), it is expected that the statements provided by the primed group of officers will be significantly less accurate compared with the control group.

Hypothesis 2B. Moreover, much of the literature suggests that, as stress increases, memory impairments become more pronounced (e.g., Dawes et al. 2014, 2015; Morgan et al. 2006). Therefore, it is further hypothesized that stress may act as a covariate such that statements provided by those in

[1] Snapchat is a multimedia messaging application whereby individuals can share photos that automatically disappear after a short period of time (e.g., within 1 to 10 s).

the primed condition will be less accurate, particularly for those experiencing higher stress.

Research Question. Lastly, the current study aims to explore the type of details recalled by officers. Specifically, it investigates the extent to which officers include more details related to certain aspects of the event, like the perpetrator, relative to others. Given that few studies have examined the type of details recalled in statements made by police officers, no hypotheses regarding this were made a priori.

Method

Participants

A total of 50 operational police officers were recruited from a training center in Canada.[2] Approximately 88% ($n = 44$) of the sample was male, and 12% ($n = 6$) were female, relatively consistent with the dispersion of most police organizations in North America (Conor 2018; Data USA 2019). Participants were 37.10 (SD = 8.21) years of age, on average, and had 10.66 (SD = 6.66) years of overall police service, 10.22 (SD = 6.17) of which were operational. Independent sample *t* tests indicated that female participants had significantly more years of overall service ($M = 16.88$, SD = 7.45) relative to males ($M = 9.81$, SD = 6.16), $t\,(48) = 2.57$, $p = 0.013$. They also had significantly more years of operational service ($M = 16.42$, SD = 7.53) compared with males ($M = 9.38$, SD = 5.54), $t\,(48) = 2.80$, $p = 0.007$. More than half the sample reported that they were married (52%, $n = 26$), and the same amount reported that they had children. Approximately 30% ($n = 15$) of participants had a college diploma or certificate, and 28% ($n = 14$) had a bachelor's degree. The majority of the sample were Constables (74%, $n = 37$) or Corporals (12%, $n = 6$), and did not have use-of-force instructor training[3] (71.4%, $n = 35$). Most had never been involved in a lethal force encounter (86%, $n = 43$), although 10% ($n = 5$) had been witness to one, and 4% ($n = 2$) had been involved as a subject officer (i.e., the officer responsible for an individual's death).

Given that the current study was not clinical in nature, participants were not medically examined prior to participating. However, in order to participate, all officers needed to be considered "fit for duty" by their police agency and currently be on active duty. Moreover, they were asked to report if they had cardiovascular disease and whether they were taking any medications that could affect their heart rate (HR). None of the participants reported that they had cardiovascular disease, and only 6% ($n = 3$) indicated that they took medication affecting their HR. An independent sample *t* test indicated that these three participants' beats per minute (bpm) above-resting (which was used as a covariate in every analysis) did not differ significantly from the other participants, $t\,(45) = -0.02$, $p = 0.982$.

Across participants, the average maximum HR during the scenario (i.e., calculated from the time at which participants received the simulated dispatch call until the time they were de-equipped) was 149.46 bpm (SD = 21.82), which is consistent with HRs from officers in the field (Baldwin et al. 2019). Participants' average resting rate was 70.03 bpm (SD = 9.68), which is similar to the baseline reported by Andersen and Gustafsberg (2016) and consistent with the normal resting HR for adults (Laskowski 2018). The average bpm above-resting was also calculated to better account for individual differences in HR variability. This ensured that if multiple officers displayed a maximum HR of 145 bpm, for example, those with a lower resting rate would show a larger relative increase (Anderson et al. 2002). Consistent with Anderson et al. (2002), Andersen et al. (2016), Baldwin et al. (2019), and Andersen and Gustafsberg (2016), bpm above-resting was calculated by subtracting participants' average resting rate from their maximum HR.[4] The average bpm above-resting across participants was 80.72 (SD = 17.92). This rate is notably higher than that reported by Anderson et al. (2002) who recorded officers' HR while on shift where they engaged in various activities including fighting, handcuffing, and pursuing subjects. It is consistent with that reported by Andersen et al. (2016) and Andersen and Gustafsberg (2016).

Independent sample *t* tests and chi-squared tests indicated that there were no significant differences between males and females on any of these items (i.e., marital status, presence of children, level of education, rank, training, involvement in a lethal force encounter, maximum HR, or bpm above-resting).

[2] The current sample of participants is a subset of a larger pool of 123 participants that was collected for other research purposes.

[3] "Use-of-force instructor training" was a dichotomous yes/no item. If participants had instructor level training, then they could expand on the type of training they had in an open-text box if they chose to. Types of training that participants reported delivering included firearms, emergency response team, use of force, active threat, conducted energy weapon, among others.

[4] Participants' resting HR was calculated by acquiring 1 min of their lowest bpm. This approach aimed to avoid using potential artifacts (i.e., excessive and/or irregular low beats) as the resting rate. Although we acknowledge that a more accurate measure of resting HR might be acquired from officers immediately upon waking (Plowman and Smith 2013), similar approaches to ours have been used in prior research (e.g., Anderson et al. 2002; Andersen and Gustafsberg 2016; Baldwin et al. 2019). The average of the lowest 1-min observed HR was used in the calculation for participants' bpm above-resting.

Measures

Demographics. Each participant completed a demographic questionnaire comprised of 16 questions that asked them their age, rank, and years of service, among other qualities.

Heart Rate. Salivary cortisol, heart rate variability (HRV), and heart rate (HR) have all been used to measure stress reactivity in police officers (Anderson et al. 2002; Burke et al. 2007; McCraty and Atkinson 2012). However, readings of salivary cortisol may be confounded by the time of day that they are taken and HRV is argued to be inconsistent and susceptible to error when collected while participants are moving (Dickerson and Kemeny 2004; Heathers and Goodwina 2017). Alternatively, HR, averaged over time, is a robust, ecologically valid measure that is likely to be more appropriate for the continuous monitoring of officer stress during an active-duty shift, such as that simulated in the current study (Andersen and Gustafsberg 2016; Arble et al. 2019; Vrijkotte et al. 2000). Increases in sympathetic activity caused by real or perceived threats are associated with HR increases, whereas relative increases in parasympathetic activity, causing one to become calmer and more relaxed, are associated with HR decreases (Thayer et al. 2012). Therefore, given the dynamic nature of the scenario participants were exposed to, HR was used as a proxy for stress.

Standard Use-of-Force Report. Following an application of force, most police organizations require that their officers complete a statement about the encounter (Alpert and Smith 1999; Garner et al. 2018; Laming 2019). To assess recall, the standard use-of-force report from the organization from which the sample of officers was recruited was used in the current study. This particular report is completed online and contains 25 drop-down questions that request information about the subject's behavior at the time of the event and various situational factors (e.g., weather conditions, time of day, intervention method[s] used [e.g., pistol, Taser, Oleoresin Capsicum spray]). There are two open text boxes where officers are asked to elaborate on the subject's known history and behavior, and a final incident narrative where officers describe in full what occurred. Such reports are generally completed as an articulation and oversight tool, ensuring an officer's actions are lawful and have been appropriately articulated should they ever be questioned. However, these reports may also be used as a method for analysts to infer trends that could inform policy, training, and the procurement of equipment.

Other research (e.g., Soares and Storm 2018; Sparrow et al. 2011) has asked participants a pre-determined set of questions to assess their recall, which may not capture the full extent of their memory about an object or situation. Thus, while the current study used a standard use-of-force report that prompted participants by asking some close-ended questions similar to prior research, they were also asked to freely recall what they could about the event. Free recall appears to enhance episodic memory and may provide a better indication of individuals' complete memory for an event (see research related to the cognitive interview; e.g., Aschermann et al. 1991; Fisher et al. 1989; Memon and Bull 1991).

Equipment

Heart Rate. In order to measure the extent to which the scenario elicited stress in officers, all participants were equipped with a Polar H7 Chest Strap Heart Rate Monitor® and two Polar V800 Heart Rate Monitor Watches®. In combination, the devices can be used to obtain a live, accurate reading of HR and corresponding R-R intervals[5] (Giles et al. 2016). Previous research has validated the use of this technology (e.g., Barton et al. 2000; Hope et al. 2016; Kayihan et al. 2013), and has shown that it may be a useful alternative to other technologies (e.g., electrocardiograms (ECG)) for obtaining measures of HR during periods of activity, such as when officers are participating in high fidelity training scenarios (Baldwin et al. 2019; Giles et al. 2016; Hope et al. 2016). Moreover, similar to other research, participants were also equipped with FirstBeat Bodyguard 2 Heart Rate Monitors© to reduce the likelihood of lost or corrupted HR data, and to ensure a secondary source from which to verify the accuracy of the data collected (Parak and Korhonen 2013; Ramey et al. 2016).

StressVest™. Since it is not feasible to systematically assess the impact of stress on memory during actual use-of-force events due to the irregularity and low base rate of these incidents, ethical standards, and the lack of control required to adequately measure the variables of interest consistently across officers, specialized training technology was incorporated into the design of the study. One type of technology utilized was the StressVet™ system. The actors in the scenario, and every participant, wore a StressVet™ along with a StressVet™ PRO belt. They were also provided a standard issue pistol that was equipped with SecuriBlank Loud 9-mm simunition and had been converted with laser barrels, which emitted infrared light when discharged. When a participant is "shot" while wearing the StressVet™ system, the wearer

[5] In brief, R-R intervals can be described as the distance between the peaks of two waves comprising a heart rhythm. A faster HR, as would be expected under stress, is associated with a shorter interval between the two peaks (Tarvainen et al. 2014; Thayer et al. 2012).

receives a localized shock to the abdomen through the belt (Setcan Corporation 2019). The shock (and/or potential for a shock) is argued to induce stress similar to that which an officer would experience in a genuine use-of-force encounter (Staller et al. 2017). The system provides the added benefits of safety (e.g., non-projectile based weapons are used) and other forms of fidelity (e.g., participants can communicate with each other freely since they are not wearing safety gear such as face masks).

Body-Worn Cameras. Half of the sample was equipped with an Axon Body 2 BWC. It was attached to the front of the officers' uniform as per the manufacturer's instruction and turned on prior to the start of the scenario.

Surrounding Cameras. In addition to the BWCs, participants also wore Applied Science Laboratories (ASL) Mobile Eye-5 Glasses© (i.e., eyetracker) and GoPRO HERO4 Silver© cameras were mounted in central locations around the facility where the scenario took place. Given potential issues with BWCs (e.g., limited field of view), these additional cameras were installed to record the officers' activities from other angles. The videos were also reviewed to verify statements made by the officers in their reports about what occurred.

Procedure

Police officers were recruited from a large Canadian police organization either via email or by signing up for the study in-person during in-service training at a training facility. Upon arrival, participants were provided a consent form, cleansed of their live intervention options, and provided with inert options. All participants were then equipped with the eyetracker and HR monitors. They completed a demographic form and a series of questionnaires not relevant to the current study. Upon completing the questionnaires, participants were equipped with a StressVet™ and StressVet™ PRO belt.

Approximately half the sample (52%, $n = 26$) was selected to wear a BWC.[6] An explicit statement was made to this group informing them that they would have the opportunity to view their BWC footage prior to completing their statement about the event. This primed group of participants, who were under the impression that they could rely on their footage, was expected to offload elements of their cognition (i.e., certain encoding tasks) to their cameras. The remaining half of the participants (48%, $n = 24$) were not assigned to wear a BWC and were thus aware that they would not have any footage to rely on. Since they would not have the opportunity to look back on any footage, this control group was expected to put in significantly more effort to attend, encode, and ultimately retain event details. All participants were then exposed to a realistic domestic disturbance call.

The scenario was developed in collaboration with several use-of-force subject matter experts and instructors. It was piloted with 12 officers, after which modifications were made to enhance the scenario's realism and ensure that it remained standardized regardless of the various ways a participant could react. The scenario aimed to include stressors known to increase arousal including time pressure, task load, threat, ambiguity, novelty, noise, and performance pressure (Driskell and Salas 1996; Wollert et al. 2011).

In brief, the scenario required that participants respond to a call in an upstairs apartment where a male subject was reported to be in breach of his probation conditions. The apartment had a combined living and dining area, as well as a separate bedroom, adorned with a couch, coffee table, television, dining room table, and bed. There were also numerous items (e.g., clothing, magazines, posters), including weapons (e.g., sledgehammer, knives), placed around the residence to add to the complexity of the scenario. Empty bottles of alcohol were displayed around the room; a radio was blaring loud music, and a scent training system (AirAware®) released the smell of marijuana.

The scenario was designed such that while initially the subject simply refused to leave the residence on account of his breach, it quickly evolved into a mental health–related call (i.e., the subject threatens suicide by holding a knife to his throat). Depending on a participant's response, the scenario could progress from there into a physical altercation between the subject and another male witness who was also in the residence. Eventually, the subject grabbed a gun and began shooting at the participant while the witness grabbed a cellphone to record the incident. The scenario concluded when participants returned fire on the subject, made an arrest, and applied first aid while waiting for back-up and emergency response.[7]

Post-scenario, participants were de-equipped and asked to complete a second series of questionnaires unrelated to

[6] Note that while every effort was made to ensure the random assignment of participants to the primed versus control conditions, the groups were counterbalanced to ensure each group had a relatively equal number of participants in them. Some participants were also assigned to a certain condition as the result of limited time, equipment, and/or availability. Therefore, while the study cannot be said to have true random assignment, the lack of demographic differences between the groups suggest that it is unlikely any pre-existing differences contributed to the results.

[7] Note that the same actors played in every scenario. They followed a standard script that was flexible enough to ensure they could adapt to whatever decisions a participant made. The scenario room was re-adjusted after every participant so that it appeared the same for each participant.

the current study.[8] Participants then completed a standard use-of-force report about the event. None of the participants were allowed to see their BWC footage before writing their statement. Those who had been assigned to wear a camera were told that there was an error with their footage and that they would need to complete the statement without any aid. When they finished their statement, they were debriefed by the researchers as well as by a use-of-force instructor and given the opportunity to withdraw their data. None of the participants chose to withdraw. The entire study took approximately 1 h and 15 min to complete, and each officer received a $50 gift card as compensation for their time. The study was approved by the Carleton University Ethics Committee for Psychological Research (CUREB-B Clearance # 108,733) as well as the Human Resources Research Review Board (2018–04) from the agency in which the officers were recruited.

Analytical Approach

Qualitative Coding. All 50 use-of-force reports were coded into their smallest component parts. If, for instance, an officer wrote "When I knocked, there was a blonde male," the sentence was broken down to acquire three details pertaining to (1) a behavior enacted by the officer (i.e., them knocking), (2) the hair color of the witness (i.e., blonde), and (3) the gender of the witness (i.e., male). The details were counted to obtain the total number of details recalled by each participant. The majority of the details came from the free recall portion of the report, although there were approximately 25 drop-down questions that could be counted toward the total (depending on what information a participant provided and/or what they chose to answer). A trained research assistant independently coded a random subset (25%) of the reports. The intraclass correlation (ICC) for the total number of details reported was 0.84, which is considered a "good" degree of agreement (e.g., Hallgren 2012; Koo and Li 2016; McHugh 2012).

Each detail was then compared with ground truth[9] to determine accuracy (i.e., if the participant reported that the witness was blonde, is he, in fact, blonde?). The ICC for the determination of accuracy was 0.85, indicating good reliability across raters. The reports were then subjected to a deductive content analysis. The deductive method is driven by prior knowledge or models; categories and subcategories are created a priori, and then, the data is coded according to them (Elo and Kyngas 2008). Given that use-of-force reports are a standard tool in the agency from which the officers were recruited, making them familiar to most officers, there is a general understanding about the type of information that needs to be included. As such, the reports tend to be similar (i.e., officers typically provide a description of the call, subject[s], weapons, their response, and the outcome). Predetermined categories based on this general model of what a typical use-of-force report includes, were thus created.

Details were categorized as those which related to the (1) context, (2) subject, or (3) officer. Statements about the lighting conditions or descriptions of the witness, for example, were classified into the category related to context, whereas statements about the subject's appearance were slotted into the subject category. Any statements about the participant's response to the scenario, including behavior and/or statements they made, were coded into the officer-related category. While an unconstrained matrix was adopted, which allowed for the addition of extra categories should new themes emerge that were not anticipated a priori, none were established. The ICCs for classification into the above categories were predominately above 0.65, which is considered "moderate" agreement (Bobak et al. 2018; Koo and Li 2016).

Assumptions. The coded data was subjected to analysis of covariance (ANCOVA). Assumptions relevant for ANCOVA were assessed prior to analyses. Four cases had standardized residuals that exceeded ± 3 standard deviations, suggesting they were outliers. Further exploration determined they were legitimate responses and that winsorizing them did not alter the results. To reduce the potential for bias introduced by winsorizing, they were left as is (Aguinis et al. 2017; Ghosh and Vogt 2012; Liao et al. 2016). Linear relations were observed between participants' bpm above-resting and each of the dependent variables (total number of details, accurate details, inaccurate details, confabulated details, number of subject-related details, accuracy of subject-related details, number of context-related details, accuracy of context-related details, number of officer-related details, accuracy of officer-related details) for both conditions, as assessed by visual inspection of scatterplots. There was homogeneity of the regression slopes as all interaction terms were $p > 0.05$. Standardized residuals for the experimental condition were nearly all normally distributed at $p > 0.05$, as assessed by Shapiro–Wilk's test. However, Shapiro–Wilk's test was violated in several instances in the control condition. Therefore,

8 These questionnaires asked participants about the stress they experienced as a result of the scenario, and whether or not they experienced any cognitive distortions (e.g., tunnel vision, auditory exclusion). Importantly for the current study, the questionnaires provided a brief time interval before participants were asked to recall what occurred, more closely resembling the time gap likely to occur after a real-life critical incident (i.e., before an officer would have the opportunity to complete their notes).

9 Ground truth was established by watching a combination of BWC, GoPRO©, and eyetracker footage.

Table 1 ANCOVA examining differences in the total amount of details recalled by officers and the accuracy of those details

	Primed group[a]		Control group[a]			
	M	SD	*M*	SD	*p*	n_p^2
Number of details	93.48	32.29	89.17	31.18	0.700	0.003
Accurate details	81.78	29.13	77.22	27.14	0.637	0.005
Inaccurate details	6.13	3.43	6.30	3.32	0.812	0.001
Confabulated details	4.52	3.04	4.61	3.94	0.949	0.000

Technological errors with the HR monitors resulted in the loss of three participants' data, and one participant's recall was irretrievable when the online use-of-force reporting program closed unexpectedly. Analyses were thus conducted on a total of 46 participants. Above-resting bpm was used as a covariate in every analysis. Reported are the estimated marginal means while controlling for the covariate

[a]N = 23

histograms and Q-Q plots were examined, and skew and kurtosis values were calculated. The visual tests appeared relatively normal, and skew and kurtosis were within an acceptable range (Field 2009; Kline 1998, 2005). Since ANCOVA is robust to violations of normality and there were an approximately equal number of cases in both groups, the data were left untransformed. Homoscedasticity was evident as assessed by inspecting the standardized residuals plotted against the predicted values for each dependent variable. The assumption of homogeneity of variances, as assessed by Levene's test, was met on all but one analysis.[10] The result of that analysis did not change when the data was transformed. For ease of interpretation, the untransformed result is reported.

Results

Demographic Differences

Independent sample *t* tests were conducted to determine whether there were any pre-existing mean differences between the primed and control group on the continuous demographic variables age, years of service, and operational years of service, as well as average maximum HR during the scenario and bpm above-resting. None of the tests were significant, suggesting that the groups were relatively equally distributed on these items. Chi-squared analyses were conducted to examine differences between the primed and control group on the categorical items gender, education level, rank, prior involvement in a lethal force encounter, prior use-of-force instructor training, presence of dependents, and marital status. Once again, no differences were observed, reducing the likelihood that any differences between the groups were the result of demographic characteristics.[11]

Heart Rate

Data from the Polar H7 Chest Strap Heart Rate Monitor® and two Polar V800 Heart Rate Monitor Watches® were transferred into the Kubios© software where it was cleaned and spliced into phases, providing a measure of each participant's average maximum HR during the scenario (i.e., cut to start when participants received the simulated dispatch call until the time they were de-equipped). A paired sample *t* test was conducted to examine whether there was a significant difference in participants' average resting rate relative to the maximum rate elicited during the scenario. There was a significant difference between the two phases, $t(46) = 26.52$, $p < 0.001$, indicating that, on average, participants experienced significantly more stress during the scenario ($M = 149.46$, SD = 21.82) compared with when participants were at rest ($M = 69.97$, SD = 9.89). Participants' bpm above-resting was used as a covariate in every analysis to control for the effect of stress on recall.

Analyses Examining Overall Recall

The results indicated that, on average, participants recalled over 89 individual details about the interaction, which lasted, on average, 9.74 min (SD = 2.52). Those wearing a BWC (and who were expected to be offloading their cognitions) actually recalled slightly more details—93 details on average. However, an ANCOVA indicated that there was no significant difference in the amount recalled between those wearing a BWC and those without one. The majority of details that the participants reported were accurate. On average, participants wearing a BWC reported approximately 82

[10] The violation of Levene's test is noted when discussing the result below. Given the violation of homogeneity of variances for that analysis, the finding should be interpreted with caution.

[11] The researchers recognize the potential for inflation of type 1 errors due to the presence of many *t* tests and chi-squared analyses. Bonferroni adjustments were made to control for type I errors.

Table 2 ANCOVA examining the effect of HR on the total amount of details recalled by officers and the accuracy of those details

	Mean square	*df*	*F*	*p*	n_p^2
Number of details	677.85	1	0.67	0.418	0.015
Accurate details	583.06	1	0.73	0.397	0.017
Inaccurate details	7.24	1	0.63	0.432	0.014
Confabulated details	0.597	1	0.05	0.829	0.001

Technological errors with the HR monitors resulted in the loss of three participants' data, and one participant's recall was irretrievable when the online use-of-force reporting program closed unexpectedly. Analyses were thus conducted on a total of 46 participants

accurate details, whereas those without one recalled 77 accurate details. There was no significant difference in accuracy between the two conditions (see Table 1).

In order to ensure that those participants who reported very few details were not artificially inflating the accuracy count, a percentage was calculated by dividing the total number of each officers' details by the amount that they reported accurately; this number was then multiplied by 100. For those who were wearing a BWC, approximately 88.42% (SD = 3.73) of all the details participants reported were accurate. Similarly, 87.79% (SD = 4.85) of the details reported by participants who were not wearing a BWC were accurate. Not surprisingly, an ANCOVA indicated that there was no difference in the proportion of details recalled accurately by those who wore a BWC and those who did not, F $(1, 43) = 0.208$, $p = 0.651$, $n_p^2 = 0.005$.

To better understand participants' recall, the inaccuracies participants reported were also examined. Inaccuracies were those details that a participant reported incorrectly when compared against ground truth (e.g., the participant reported that the subject wore a black hoodie, when it was, in fact, white). On average, across both conditions, participants recalled approximately six inaccurate details. There was no significant difference between participants who wore a BWC and those without one on the number of inaccuracies recalled (see Table 1). The percentages indicated that, on average, 6.53% (SD = 2.40) of the details reported by participants wearing BWCs were inaccurate, whereas approximately 7.37% (SD = 3.71) of the details reported by participants without a BWC were inaccurate. There was no significant difference in the percentage of inaccurate details recalled by those who wore a BWC and those without one, F $(1, 43) = 0.844$, $p = 0.363$, $n_p^2 = 0.019$.

A distinction was made between details that were inaccurate, and those that were confabulated. Confabulated details were those that participants fabricated (i.e., they reported something that never actually occurred; French et al. (2009); Schacter et al. (1998). For example, if a participant reported that the subject was holding scissors when there was, in actuality, no scissors present, it counted as a confabulated detail. On average, across both conditions, participants confabulated approximately 4–5 details. There was no significant difference between the two conditions on the extent to which participants confabulated (see Table 1). The percentages indicated that, on average, 5.09% (SD = 3.47) of the details reported by participants wearing BWCs were confabulated. Alternatively, 4.84% (SD = 3.33) of the details reported by participants without BWCs were confabulated. Once again, there was no significant difference between the conditions in regard to the percentage of confabulations made by participants, F $(1, 43) = 0.089$, $p = 0.767$, $n_p^2 = 0.002$.

Participants' bpm above-resting was used as a covariate in every analysis to control for the effect of stress on recall. As outlined in Table 2, a series of ANCOVAs indicated that participants' bpm above-resting was not a significant covariate in any of the analyses that examined the total amount of details recalled and the accuracy of those details.

Analyses Examining the Type of Details Recalled

Recall that details were coded according to whether they related to the context, the subject, or the officer. A series of ANCOVAs were conducted to explore whether officers with BWCs recalled more about certain aspects of the event, and if this recall was more (or less) accurate, compared with those without BWCs. The results revealed that officers recalled the most about the context—the mean number of context-related details was approximately 45 for those wearing a BWC, and 44 for those without a camera. As outlined in Table 3, there was no significant difference between the two conditions on the number of context-related details recalled. The majority of those contextual details were also accurate. Again, there was no significant difference between the accuracy of the details recalled for those with BWCs relative to those without. More specifically, the percentages indicated that approximately 91.05% (SD = 5.92) of the context-related details recalled by those wearing a BWC were accurate, whereas 91.33% (SD = 5.78) were accurate for those without a BWC, F $(1, 43) = 0.010$, $p = 0.922$, $n_p^2 = 0.000$.

In regard to the amount and accuracy of details recalled that were related to the subject, the results showed that, on average, officers recalled over 20 details, and that the majority of those details were accurate. There appeared to be no significant difference in terms of the number of subject-related details recalled between the two conditions, or the accuracy of those details (see Table 3). The percentages indicated that 88.56% (SD = 4.92) of the subject-related

Table 3 ANCOVA examining the type of details recalled by officers and the accuracy of those details

	Primed group[a]		Control group[a]			
	M	SD	*M*	SD	*p*	n_p^2
Number of context-related details	45.09	18.59	43.91	17.52	0.870	0.001
Accurate context-related details	39.78	16.62	39.04	15.55	0.910	0.000
Number of subject-related details	23.17	5.01	21.70	6.48	0.443	0.014
Accurate subject-related details	20.61	4.99	18.30	5.76	0.186	0.040
Number of officer-related details	25.22	11.98	24.57	11.11	0.888	0.000
Accurate officer-related details	21.43	10.28	19.87	9.64	0.649	0.005

Technological errors with the heart rate (HR) monitors resulted in the loss of three participants' data, and one participant's recall was irretrievable when the online useof- force reporting program closed unexpectedly. Analyses were thus conducted on a total of 46 participants. Above-resting bpm was used as a covariate in every analysis. Reported are the estimated marginal means while controlling for the covariate

[a]N = 23

Table 4 ANCOVA examining the type of details recalled by officers and the accuracy of those details

	Mean square	*df*	*F*	*p*	n_p^2
Number of context-related details	135.09	1	0.41	0.526	0.009
Accurate context-related details	62.62	1	0.24	0.628	0.005
Number of subject-related details	38.40	1	1.15	0.290	0.026
Accurate subject-related details	58.65	1	2.07	0.157	0.046
Number of officer-related details	44.82	1	0.33	0.568	0.008
Accurate officer-related details	71.76	1	0.72	0.401	0.016

Technological errors with the HR monitors resulted in the loss of three participants' data, and one participant's recall was irretrievable when the online use-of-force reporting program closed unexpectedly. Analyses were thus conducted on a total of 46 participants

details recalled by those wearing BWCs were accurate, whereas 84.23% (SD = 9.93) of the details recalled by those without BWCs were accurate, F (1, 43) = 3.13, p = 0.084, n_p^2 = 0.068.[12]

Lastly, the amount and accuracy of details recalled that were related to the officer were calculated. The results revealed that, on average, participants recalled approximately 25 officer-related details. There was no significant difference in the amount recalled between those wearing BWCs compared with those without cameras (see Table 3). Of those details, most were accurate, and there was no significant difference in accuracy between the two conditions. For those wearing BWCs, on average, 84.99% (SD = 8.77) of the officer-related details recalled were accurate, while for those without cameras, 81.27% (SD = 13.05) of the details noted were accurate, F (1, 43) = 1.10, p = 0.299, n_p^2 = 0.025.

As outlined in Table 4, a series of ANCOVAs demonstrated that participants' bpm above-resting was not a significant covariate in any of the analyses that examined the type of details recalled, nor the accuracy of those details.

Discussion

As far as we are aware, the current study was the first to examine the phenomena of cognitive offloading in the policing context. The findings suggest that unlike other contexts (e.g., Henkel 2014; Soares and Storm 2018), officers do not appear to relinquish their cognitions to a camera. It was hypothesized that officers who were led to believe that they would have the opportunity to view their BWC footage following their involvement in the simulated use of event would report significantly fewer details about the event, and that those details would be less accurate, compared with those not wearing a camera (and aware that they would not have the opportunity to view any footage prior to completing a statement about the event). However, the results revealed no significant differences between the two groups. Moreover, the majority of the details (≈ 80%) were accurate, regardless of what condition participants were assigned.

Most of the details that participants recalled were in relation to the context in which the event took place (e.g., items they noticed in the residence, the layout of the building, and statements the witness made). Participants recalled a lesser amount of details about the subject (i.e., the main perpetrator's appearance, behavior, and statements he made) and about their own behavior. Although they were most accurate about the context, the majority of the details recalled about the subject and themselves were also accurate. The null findings seemed to hold even after controlling for the effect of stress on recall. Consistent with the few experimental studies that have examined memory in a use-of-force context (e.g., Hope et al. 2012, 2016; Morgan et al. 2006), it had been hypothesized that stress elicited during the scenario would impair recall. While we were able to elicit a significant amount of stress in participants (averaging a maximum HR of 149 bpm), stress (as measured via HR) was not a significant covariate in any of the analyses.

Failure to Offload

The findings in the current study support recent work conducted by Marsh and Rajaram (2019), although they are at odds with much of the research to date (e.g., Henkel 2014; Risko and Gilbert 2016; Sparrow et al. 2011). Marsh and Rajaram's (2019) online study did not find a significant difference in recall for statements participants were told would either be saved or deleted on their computers. They suggested that their findings could be the result of a pervasive belief that "…things cannot ever be completely purged from the internet" (Marsh and Rajaram 2019, p. 6). This may have made the "delete" manipulation implausible. Likewise, the priming in the current experiment may not have been entirely believable. BWCs remain a relatively new form of technology that officers might still distrust. There are various well-known issues related to

[12] This analysis violated Levene's test of homogeneity of variances. The finding should thus be interpreted with caution.

quality, for example, that can make the footage unusable (if, for example, something is blocking the lens and/or the camera angle fails to capture peripheral details; Blaskovits et al. 2017; Remsberg 2016). If participants assumed the BWC would be unreliable, then it would make sense that they would refuse to offload to it.

Indeed, some research indicates that officers may be cynical toward BWC technology (e.g., Gaub et al. 2016; Huff et al. 2018; Tankebe and Ariel 2016). For example, officers appear to be aware that BWCs fail to provide a complete understanding of an event (Pelfrey and Keener 2016). They have also voiced concerns about various logistical problems with BWCs, such as knowing when they are turned on and what to do should they have connection issues. It is thus possible that officers may defer to their own memory bank, rather than rely on a potentially fickle camera. Relatedly, the organization that the current sample of officers was recruited from is not issued BWCs for operational use. Therefore, they had little-to-no personal experience in regard to the camera's efficacy and never actually turned it on themselves during the study (i.e., the researcher attached each camera and turned it on). The limited deployment in their own agency may thus have led participants to be particularly cautious about the reliability of the technology, suggesting that cognitive offloading may actually be a learned behavior (i.e., that it might occur once officers do become more aware of the reliability of BWCs). Developing a better understanding of officers' beliefs about the utility of the BWC footage in relation to their own meta-cognitive abilities may therefore be an important avenue for future research.

Alternatively, the lack of an offloading effect may be explained, in large part, by the sample examined. Police officers are trained in ways that distinguish them from the wider population that have been participants in previous offloading research. For example, most officers are required to provide detailed notes after use-of-force incidents that may serve as an "aide memoire" for court purposes. Their familiarity with legally articulating their actions could result in an increase in the amount of information reported, compared with others without similar experience. Moreover, many agencies train their officers on indicators of risk and/or potential signs of danger (e.g., Kahn et al. 2018). note that such training ensures officers are sensitive to gestures, language, and attire that could indicate potential precursors to a threatening situation. It is possible that this type of training may mitigate cognitive offloading to some extent, since it encourages officers to attend to and encode a variety of cues in their environment. Officers, unlike most members of the public, are taught to be highly vigilant, consolidate the information they observe in a scene, and act accordingly (regardless of camera presence); in fact, they are required to, given their position in society (as members of authority that can enforce the law) and the critical lens used to examine their decisions.

Relatedly, the participants in the current study were exposed to different information than what has been examined in other relevant research to date, which is typically quite trivial information (Risko and Dunn 2015). Prior studies have looked at recall for objects in a museum (Henkel 2014), pictures in a studio (Soares and Storm 2018), and arbitrary information online (Sparrow et al. 2011). Considering individuals' preference to offload even simple information, it has been argued that they will be even more likely to offload when their mental capacities are strained (i.e., when there is a lot of information to retain or there are interruptions during encoding; Gilbert 2015; Risko and Gilbert 2016). However, previous findings do not account for information that might have personal implications for the participant. Offloading photographs, especially those exchanged via social media platforms like Snapchat, are so transient that they are arguably inconsequential (recall Soares and Storm's (2018) research). Offloading vital information, on the other hand, may be a risky cognitive short-cut. The current findings ask us to consider the type of information we offload and whether the effect could be assuaged for that which is personally relevant and/or of significant value.

Indeed, the current findings suggest that information pertinent to personal and public safety, for example, may be prioritized, despite having a camera capturing it. While the scenario participants experienced was obviously fabricated, it closely mimics the type of stress officers can expect to experience in the field (Andersen et al. 2016; Baldwin et al. 2019). In fact, scenario-based training has been revered as the gold standard in policing because it can be so realistic (e.g., Andersen et al. 2016; Fletcher 2009; Oudejans 2008). When exposed to realistic scenarios, officers are motivated to perform as they would in real life and seriously consider the decisions they make in the scenario as they could resemble those made in similar circumstances on the job (Staller and Zaiser 2015).

Interestingly, while the current findings are contrary to those reported by Soares and Storm (2018), they may lend credence to their argument that attentional disengagement might better explain the photo-taking impairment effect. Recall in their study that memory was impaired when participants took a picture, regardless of whether that photo was saved or deleted. Because offloading depends on one being able to rely on an external source to "remember for them," Soares and Storm suggested that individuals may not be offloading when they use cameras. Rather, their attention might be compromised during the act of photo-taking itself, resulting in disrupted encoding and a loss of information. Unlike in Soares and Storms' study, officers did not need to manipulate the BWC in any way during the current study. In fact, the camera was turned on for them and left to record throughout the entire experiment. Therefore, there was arguably less chance that participants would experience attentional disengagement, and as such, no impairment was observed. Camera and/or video manipulation may thus play a role in the photo-taking impairment effect and in intention offloading more broadly.

Lastly, it is interesting to note that while not significant, the results suggested that the officers wearing cameras actually recalled slightly more than those without a camera (i.e., the findings trended in the opposite direction than what was hypothesized). It is thus possible that the cameras actually acted as a cue to motivate participants, subconsciously or not, to ensure their recall was exceptional so as to avoid any potential issues that could arise if their recall was inconsistent with the cameras. Video and/or photographic evidence, in particular, tends to be heavily relied on in court (Dawes et al. 2015; Mezey 2013; Mnookin 1998); often, it is considered to portray the objective truth of an event, despite its numerous issues (e.g., perspective, frame rate, and the quality of footage can all impact how an event is portrayed on screen; Boivin et al. 2017; Dawes et al. 2015). Therefore, it is important to consider the contextual factors (e.g., personal or political pressure) at play in this research and their potential impact on offloading.

The Effect of Stress on Recall

The stressors embedded within the scenario, combined with the technological additions (e.g., the StressVest™), appeared to elicit an appreciable amount of stress in the current sample of participants. Their maximum HR during the scenario averaged 149 bpm, which is comparable with that elicited in other police research (e.g., Andersen and Gustafsberg 2016; Andersen et al. 2016; Federal Law Enforcement Training Center [FLETC] 2004). For example, in FLETC's (2004) study examining the effect of stress on cognition and performance during a shoot-out exercise, officers' average maximum HR reached nearly 140 bpm. Likewise, participants in Hope and colleagues' (2012) study displayed HRs averaging between 159 and 163 bpm. Moreover, participants' average increase from their resting rate was nearly 81 bpm—well above that reported in studies like Anderson and colleagues' (2002) and Baldwin et al.'s (2019), which captured officers' HR while on duty.

However, contrary to other studies examining the effect of stress on recall (e.g., Hope et al. 2012, 2016; Morgan et al. 2006), the variability in stress (i.e., bpm above-resting) did not affect recall. Research like Hope and colleagues' (2016) study found that stress mediated the effect of an officer's role (either as an active participant or as a witness) on recall. Those who were actively engaged in the scenario reported significantly fewer details about the scenario compared with witnesses, and this was explained, in part, by their higher levels of stress.

While it is unclear why the current findings did not replicate prior research, it could be that seemingly small differences in the amount of stress elicited (measured via HR increases) result in differential outcomes. Maladaptive stress arousal has been shown to disrupt cognitive functions (e.g., attention, perception; Driskell and Salas 1996; Vickers 2007), contributing to inattentional blindness (Eysenck et al. 2007; Nieuwenhuys and Oudejans 2011) and perceptual narrowing (Honig and Lewinski 2008; Vickers 2007). These deficits may result in individuals missing important details and being unable to recall various aspects of an event (Easterbrook 1959; Yuille et al. 1994; Hope et al. 2016). However, not all stress is maladaptive—indeed, the stress response is designed to improve many functions, thereby ensuring survival (Fenici et al. 2011; Tsigos and Chrousos 2002).

Under high levels of stress one can experience improved sensory awareness (Siddle 1995), performance (e.g., see Andersen and Gustafsberg 2016; Andersen et al. 2016), and memory consolidation (e.g., McGaugh 2000, 2013; Payne et al. 2006; Hope 2016). It is not until stress becomes chronic or maladaptive that hippocampus function is disrupted, and cognitive impairments appear (e.g., Davis and Loftus 2009; Hope 2016; Shackman et al. 2006). Thus, while there was a significant increase in HR during the scenario (relative to officers' resting rate), the surge may actually have put participants in the optimal range, allowing them to narrow their attention on important threat-related stimuli, ensuring encoding (and ultimately retrieval) remained unaffected. Moreover, recent research also suggests that stress may have less of an effect on cognition and movement that is rehearsed and/or automated (Arble et al. 2019; Renden et al. 2017; Vickers and Lewinski 2012). Given that officers are repeatedly exposed to certain skill sets (e.g., drawing a firearm) in training and on the job, they may recover quickly from stress. The scenario used in the current study (versus scenarios used by previous researchers) may have incorporated skill sets that were in fact fairly rehearsed and/or automated for this particular sample, either through training (which they were involved in at the same time as this study) or as a result of their on-the-job experiences.

Alternatively, it is possible that differences in coding (i.e., into context, subject, and officer-related themes) may distinguish the findings from prior research. For example, other studies where similar levels of stress have been elicited in the participants, but where impairments in recall were observed (e.g., Hope et al. 2016; Morgan et al. 2006), did not categorize officers' statements in the same way we did. Moreover, due to the complexity of the scenario, it was impossible to code for omissions in the current study (i.e., everything an officer could have seen but failed to recall in their statement). As was apparent from Shields et al. (2017) meta-analysis, slight changes in methodology can reveal differences in episodic memory. Nevertheless, the current findings suggest that individual variability in stress, as measured by HR, may not affect recall, but rather that officer memory may remain relatively well preserved despite the impact of stress, at least for those details that are recalled.

Limitations and Future Directions

Although the average maximum HR and average bpm above-resting during the scenario were comparable with other relevant research (e.g., Andersen and Gustafsberg 2016; FLETC 2004; Hope et al. 2012, 2016), it is difficult to mimic the sort of stress officers experience when exposed to a true life or death event. Mason (1968) argues that conditions, which involve (1) novelty, (2) unpredictability, (3) loss of control, and (4) threat to one's ego, tend to induce a stress response. The scenario in the current study was designed to incorporate these aspects in various ways and fully immerse participants in the event (i.e., they were not passively viewing objects and/or photos; Henkel 2014; Soares and Storm 2018). The inclusion of multiple actors and the presence of weapons were included to enhance realism; indeed, the scenario was designed to mimic the sorts of conditions that might significantly increase arousal in a naturalistic setting and included time pressure, task load, threat, novelty, coordination demands, performance pressure, and noise (Driskell and Salas 1996; Wollert et al. 2011). It also ensured that there was enough happening in the scenario that officer recall could be tested. The methodological differences between offloading studies make comparisons with other research challenging and do not guarantee that the scenario elicited stress that would promote maladaptive functioning.[13] However, it adds to the literature by providing a more applied examination of offloading than has been conducted to date. Should future research utilize more observational methodology (e.g., on-shift HR tracking), greater external validity may be achieved, thereby corroborating relations between stress and recall.

HR was used in the current study as a proxy measure for stress and has been used in prior studies examining the effect of stress on police officers (e.g., Andersen and Gustafsberg 2016; Andersen et al. 2016; Arble et al. 2019). While HR is argued to be a robust, ecologically valid, objective measure of stress reactivity (Vrijkotte et al. 2000), it is not an absolute measure of an individual's stress (Arble et al. 2019; Brisinda et al. 2015). The collection of additional biomarkers of stress, such as cortisol, was not feasible in the current study. However, they would provide additional evidence for the impact of stress on episodic memory processes, and are encouraged in future studies with police officers. Likewise, the equipment that was used to measure HR, while allowing for movement, is not as accurate as hospital-grade ECG testing. The findings must thus be interpreted in light of these limitations.

There are also some drawbacks related to when officers were asked to complete the use-of-force report. Similar to other memory-related research, all participants in the current study were asked to complete a filler task (a series of questionnaires) prior to providing their statement. While this sort of methodology, whereby participants are exposed to some distraction task prior to retrieval is relatively common, it could impact recall (e.g., see Shields et al. 2017). Moreover, certain policies (depending on the agency) may dictate that officers involved in real-life use-of-force events do not report anything for a specified period of time (e.g., 24–48 h or after a sleep cycle in an attempt to enhance memory consolidation) or after some investigative procedures have occurred (e.g., Grady et al. 2016; Seattle Police Department 2019; Siegel 2010). The lack of a more realistic time delay in the current study may thus affect the generalizability of the study. Therefore, future research exploring officer recall after various postponements is encouraged.

A final limitation relates to our inability to determine exactly what led to the lack of an offloading effect. As mentioned, one obvious possibility is that police training or officers' legal requirements to report their behavior mitigates offloading tendencies observed in other contexts. A second possibility is that because the organization the officers were recruited from does not currently use BWCs, participants were accustomed to reporting without the aid of seeing BWC footage. A third, related possibility is that the participants' attitudes towards technology more generally (e.g., that technology cannot be trusted) may have reduced their tendency to offload incident-related encoding to their cameras. Fourth, it is possible that despite the primed group being explicitly told they would be able to view their BWC footage, such information may have been dismissed or forgotten once the participants were focused on their scenario. Finally, a range of other individual difference variables may help explain the lack of offloading, given that certain personality traits (e.g., conscientiousness) are known to improve memory functioning (Elkana et al. 2018) and be common among some police personnel (Detrick and Chibnall 2006). Future research examining these possibilities should be conducted.

Conclusion

The current research aimed to investigate the impact of BWCs—a rapidly expanding technology—on human processing under conditions of stress. It is the first known study to examine the phenomena of intention offloading in an applied context, with a sample of police officers under stress. It appears that officers in the current sample do not

[13] While we acknowledge that there is a necessary difference between a simulated scenario and a true life-or-death event, many of the subject matter experts and use-of-force trainers involved in the current scenario reported that it was one of the most realistic and stressful scenarios they had ever encountered.

(yet) use BWCs as tools to offload. This lack of offloading may mean that officers are not "freeing up space" for other cognitions that could allow them to engage in better communication, decision-making, problem-solving, and motor skills (Risko and Gilbert 2016; Storm and Stone 2015). However, this also means that officers, regardless of the camera, are reliant on themselves to encode and retain event details, which is good news if their camera were to fail. Should these findings be replicated, concern among law enforcement agencies that BWC adoption could mean a reduction in accurate recall, may be alleviated.

Author Contribution Brittany Blaskovits, Craig Bennell, and Simon Baldwin conceptualized the study. Brittany Blaskovits, Bryce Jenkins, Andrew Brown, and Simon Baldwin conducted the study and were involved in coding and analyses. Craig Bennell provided counsel and supervised the process. Brittany Blaskovits drafted the paper, and all of the authors provided critical revisions. All of the authors approved the final version of the paper for submission.

Funding This research was funded by a Social Sciences and Humanities Research Council Insight Grant that was awarded to the last author (SSHRC# 435–2017-1354).

Data Availability The data has been deemed sensitive by the police agency that allowed us to conduct the research.

Declarations

Ethics Approval The study was approved by the Carleton University Ethics Committee for Psychological Research (CUREB-B Clearance # 108733) as well as the Human Resources Research Review Board (2018–04) from the agency in which the officers were recruited.

Conflict of Interest Two of the authors are employed with the police agency that provided various in-kind donations to support the research (e.g., access to a training facility).

References

Aguinis H, Cascio WF, Ramani RS (2017) Science's reproducibility and replicability crisis: international business is not immune. J Int Bus Stud 48(6):653–663

Alpert GP, Smith MR (1999) Police use-of-force data: where we are and where we should be going. Police Q 2(1):57–78

Andersen JP, Gustafsberg H (2016) A training method to improve police use of force decision making: a randomized controlled trial. Sage Open 6(2):1–13

Andersen JP, 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. J Law Enforc 5(4):1–13

Anderson GS, Litzenberger R, Plecas D (2002) Physical evidence of police officer stress. Policing: An Int J Police Strat Manag 25(2):399–420

Arbel I, Kadar T, Silbermann M, Levy A (1994) The effects of long-term corticosterone administration on hippocampal morphology and cognitive performance of middle-aged rats. Brain Res 657(1–2):227–235

Arble EP, Daugherty AM, Arnetz BB (2019) Differential effects of physiological arousal following acute stress on police officer performance in a simulated critical incident. Front Psychol 10(759):1–11

Artwohl A (2002) Perceptual and memory distortion during officer-involved shootings. FBI Law Enforcement Bulletin 71:18–24

Aschermann E, Mantwill M, Köhnken G (1991) An independent replication of the effectiveness of the cognitive interview. App Cogn Psychol 5(6):489–495

Bachevalier J, Meunier M (1996) Cerebral ischemia: are the memory deficits associated with hippocampal cell loss? Hippocampus 6(5):553–560

Baddeley AD (1983) Working memory. Philosophical Transactions of the Royal Society of London. Series B, Biol Sci 302(1110):311–324

Baldwin S, Hall C, Blaskovits B, Bennell C, Lawrence C, Semple T (2018) Excited delirium syndrome (ExDS): situational factors and risks to officer safety in non-fatal use of force encounters. Int J Law Psychiatry 60:26–34

Baldwin S, Bennell C, Andersen J, Semple T, Jenkins B (2019) Stress-activity mapping: physiological responses during general duty police encounters. Front Psychol 10:1–17

Barton J, Vrij A, Bull R (2000) High speed driving: police use of lethal force during simulated incidents. Legal Criminol Psychol 5(1):107–121

Bjork RA, Woodward AE (1973) Directed forgetting of individual words in free recall. J Exp Psychol 99(1):22–27

Blaskovits B, McGale H, Bennell C (2017) Everything is not as it appears: examining the quality of officer-involved body worn camera (BWC) footage. Paper presented at the annual meeting of the Society for Police and Criminal Psychology, San Diego, CA

Blumenfeld RS, Ranganath C (2007) Prefrontal cortex and long-term memory encoding: an integrative review of findings from neuropsychology and neuroimaging. The Neuroscientist 13(3):280–291

Bobak CA, Barr PJ, O'Malley AJ (2018) Estimation of an inter-rater intra-class correlation coefficient that overcomes common assumption violations in the assessment of health measurement scales. BMC Med Res Methodol 18(93):1–11

Boivin R, Gendron A, Faubert C, Poulin B (2017) The body-worn camera perspective bias. J Exp Crim 13(1):125–142

Bremner JD (1999) Does stress damage the brain? Biol Psychiat 45(7):797–805

Brisinda D, Fioravanti F, Sorbo AR, Venuti A, Fenici R (2015) Psychophysiological assessment of acute stress induced by high-pressure law-enforcement driving: a pilot study. Psychol Soc Behavior Res 2:36–50

Burke R, Waters JA, Ussery W (2007) Police stress: history, contributing factors, symptoms, and interventions. Policing: An Int J Pol Strat Manag

Butler C, Hall C (2008) Public–police interaction and its relation to arrest and use of force by police and resulting injuries to subjects and officers: a description of risk in one major Canadian urban city. Law Enforc Exec Forum 8(6):141–157

Carr N (2008) Is Google making us stupid? What the internet is doing to our brains. The Atlantic. Retrieved from https://www.theatlantic.com/magazine/archive/2008/07/is-google-making-us-stupid/306868/

Conor P (2018) Police resources in Canada, 2017. Statistics Canada. Retrieved from https://www150.statcan.gc.ca/n1/pub/85-002-x/2018001/article/54912-eng.htm

Data USA (2019) Police officers. Retrieved from https://datausa.io/profile/soc/police-officers#growth

Davis D, Loftus EF (2009) Expectancies, emotion, and memory reports for visual events. In: Brockmole JR (ed) The visual world in memory. Psychology Press, East Sussex, UK, pp 178–214

Dawes DM, Ho JD, Vincent AS, Nystrom PC, Moore JC, Steinberg LW, Miner JR (2014) The neurocognitive effects of simulated use-of-force scenarios. Forensic Sci Med Pathol 10(1):9–17

Dawes D, Heegaard W, Brave M, Paetow G, Weston B, Ho J (2015) Body-worn cameras improve law enforcement officer report writing accuracy. J Law Enforc 4(6):1–21

Detrick P, Chibnall JT (2006) NEO PI-R personality characteristics of high-performing entry-level police officers. Psychological Services 3(4):274–285

Dickerson SS, Kemeny ME (2004) Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. Psychol Bull 130(3):355–391

Driskell JE, Salas E (eds) (1996) Series in applied psychology: stress and human performance. Lawrence Erlbaum Associates Inc., Hillsdale, NJ

Dusek JA, Eichenbaum H (1997) The hippocampus and memory for orderly stimulus relations. Proc Natl Acad Sci 94(13):7109–7114

Easterbrook JA (1959) The effect of emotion on cue utilization and the organization of behavior. Psychol Rev 66(3):183–201

Elkana O, Bustanai NYK, Louzia-Timen R, Kodesh E, Franco M, Doniger GM (2018) Conscientiousness is associated with improvement in visuospatial working memory and mood following acute physical exercise: a randomized controlled trial. Personality Individ Differ 132:126–132

Elo S, Kyngäs H (2008) The qualitative content analysis process. J Adv Nurs 62(1):107–115

Eysenck MW, Derakshan N, Santos R, Calvo MG (2007) Anxiety and cognitive performance: attentional control theory. Emotion 7(2):336–353

Federal Law Enforcement Training Center (2004) Survival scores research project. Homeland Security

Fenici R, Brisinda D, Sorbo AR (2011) Methods for real-time assessment of operational stress during realistic police tactical training. In: Kitaeff J (ed) Series in applied psychology: Handbook of police psychology. Routledge/Taylor & Francis Group, New York, NY, pp 95–319

Field A (2009) Discovering statistics using SPSS, 3rd edn. Sage Publications Ltd., London, England

Fisher RP, Geiselman RE, Amador M (1989) Field test of the cognitive interview: enhancing the recollection of actual victims and witnesses of crime. J Appl Psychol 74(5):722–727

Fletcher JD (2009) Education and training technology in the military. Science 323(5910):72–75

Fortin NJ, Agster KL, Eichenbaum HB (2002) Critical role of the hippocampus in memory for sequences of events. Nat Neurosci 5(5):458–462

French L, Garry M, Loftus E (2009) False memories: a kind of confabulation in non-clinical subjects. In: Hirstein W (ed) Confabulation: Views from neuroscience, psychiatry, psychology, and philosophy. Oxford University Press, Oxford, UK, pp 33–62

Gagnon SA, Wagner AD (2016) Acute stress and episodic memory retrieval: neurobiological mechanisms and behavioral consequences. Ann N Y Acad Sci 1369(1):55–75

Garner JH, Hickman MJ, Malega RW, Maxwell CD (2018) Progress toward national estimates of police use of force. PLoS One 13(2):e0192932

Gaub JE, Choate DE, Todak N, Katz CM, White MD (2016) Officer perceptions of body-worn cameras before and after deployment: a study of three departments. Police Q 19(3):275–302

Geiselman RE (2010) Rest and eyewitness memory recall. Am J Forensic Psychol 28(2):65–69

Ghosh D, Vogt A (2012) Outliers: an evaluation of methodologies. Joint Statistical Meetings, Selection on Survey Research Methods, pp 3455–3460

Gilbert SJ (2015) Strategic offloading of delayed intentions into the external environment. Q J Exp Psychol 68(5):971–992

Giles D, Draper N, Neil W (2016) Validity of the Polar V800 heart rate monitor to measure RR intervals at rest. Eur J Appl Physiol 116(3):563–571

Golding JM, Macleod CM (eds) (1998) Intentional forgetting: interdisciplinary approaches. Erlbaum, Mahwah, NJ

Grady RH, Butler BJ, Loftus EF (2016) What should happen after an officer-involved shooting? Memory concerns in police reporting procedures. J Appl Res Mem Cogn 5(3):246–251

Grossman D, Christensen LW (2007) On combat: the psychology and physiology of deadly conflict in war and in peace. PPCT Research Publications, Belleville, IL

Hall C, Votova K, Wood D (2013) Prospective analysis of police use of force in four Canadian cities: nature of events and their outcomes. Defence Research and Development Canada. Retrieved from http://cradpdf.drdc-rddc.gc.ca/PDFS/unc127/p537864_A1b.pdf

Hallgren KA (2012) Computing inter-rater reliability for observational data: an overview and tutorial. Tutor Quant Methods Psychol 8(1):23–34

Heathers J, Goodwin M (2017). Dead science in live psychology: a case study from heart rate variability (HRV). https://doi.org/10.31234/osf.io/637ym

Henkel LA (2014) Point-and-shoot memories: the influence of taking photos on memory for a museum tour. Psychol Sci 25(2):396–402

Honig A, Lewinski WJ (2008) A survey of the research on human factors related to lethal force encounters: implications for law enforcement training, tactics, and testimony. Law Enforc Exec Forum 8(4):129–152

Hope L, Lewinski W, Dixon J, Blocksidge D, Gabbert F (2012) Witnesses in action: the effect of physical exertion on recall and recognition. Psychol Sci 23(4):386–390

Hope L, Blocksidge D, Gabbert F, Sauer JD, 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 Hum Behav 40(1):23–35

Huff J, Katz CM, Webb VJ (2018) Understanding police officer resistance to body-worn cameras. Policing: An Int J 41(4):482–495

Jennings WG, Fridell LA, Lynch MD (2014) Cops and cameras: officer perceptions of the use of body-worn cameras in law enforcement. J Crim Justice 42(6):549–556

Kahn KB, McMahon JM, Stewart G (2018) Misinterpreting danger? Stereotype threat, pre-attack indicators, and police-citizen interactions. J Police Crim Psychol 33(1):45–54

Kayihan G, Ersöz G, Özka, A, Koz M (2013) Relationship between efficiency of pistol shooting and selected physical-physiological parameters of police. Policing: An Int J Police Strat Manag 36(4):819–832

Kline RB (1998) Principles and practice of structural equation modeling. Guilford, New York, NY

Kline RB (2005) Principles and practice of structural equation modeling, 2nd edn. Guilford, New York, NY

Koo TK, Li MY (2016) A guideline of selecting and reporting intraclass correlation coefficients for reliability research. J Chiropr Med 15(2):155–163

Lacy JW, Stark CE (2013) The neuroscience of memory: implications for the courtroom. Nat Rev Neurosci 14(9):649–658

Laming E (2019) Police use of body worn cameras. Police Pract Res 20(2):201–216

Laskowsk E (2018) What's a normal resting heart rate? Mayo Clinic. Retrieved from https://www.mayoclinic.org/healthy-lifestyle/fitness/expert-answers/heart-rate/faq-20057979

Levy BJ, Anderson MC (2002) Inhibitory processes and the control of memory retrieval. Trends Cogn Sci 6(7):299–305

Lewinski B (2008) The attention study: a study on the presence of selective attention in firearms officers. Law Enforc Exec Forum 8(6):107–139

Liao H, Li Y, Brooks G (2016) Outlier impact and accommodation methods: multiple comparisons of type I error rates. J Mod Appl StatMethods 15(1)

MacDonald JM, Kaminski RJ, Smith MR (2009) The effect of less-lethal weapons on injuries in police use-of-force events. Am J Public Health 99(12):2268–2274

Marsh EJ, Rajaram S (2019) The digital expansion of the mind: implications of internet usage for memory and cognition. J Appl Res Mem Cogn 8(1):1–14

Mason JW (1968) A review of psychoendocrine research on the pituitary-adrenal cortical system. Psychosom Med 30(5):576–607

Memon A, Bull R (1991) The cognitive interview: its origins, empirical support, evaluation and practical implications. J Community Appl Soc Psychol 1(4):291–307

McCraty R, Atkinson M (2012) Resilience training program reduces physiological and psychological stress in police officers. Global Adv Health Med 1(5):44–66

McGaugh JL (2000) Memory—a century of consolidation. Science 287(5451):248–251

McGaugh JL (2013) Making lasting memories: remembering the significant. Proc Natl Acad Sci 110(Supplement 2):10402–10407

McHugh ML (2012) Interrater reliability: the kappa statistic. Biochemia Medica 22(3):276–282

Mezey N (2013) The image cannot speak for itself: film, summary judgment, and visual literacy. Valparaiso Univ Law Rev 48(1):1–39

Mnookin JL (1998) The image of truth: photographic evidence and the power of analogy. Yale J Law Humanit 10(1):1–74

Morgan CA III, Doran A, Steffian G, Hazlett G, Southwick SM (2006) Stress-induced deficits in working memory and visuo-constructive abilities in special operations soldiers. Biol Psychiat 60(7):722–729

Nieuwenhuys A, Oudejans RR (2011) Training with anxiety: short- and long-term effects on police officers' shooting behavior under pressure. Cogn Process 12(3), 277–288. https://www.priv.gc.ca/en/privacy-topics/surveillance/police-and-public-safety/gd_bwc_201502/

Office of the Privacy Commissioner of Canada. Guidance for the use of body-worn cameras by law enforcement authorities. Retrieved from https://www.priv.gc.ca/en/privacy-topics/surveillance/police-and-public-safety/gd_bwc_201502/

Oudejans RRD (2008) Reality-based practice under pressure improves handgun shooting performance of police officers. Ergonomics 51(3):261–273

Parak J, Korhonen I (2013) Accuracy of Firstbeat Bodyguard 2 beat-to-beat heart rate monitor. Whitepaper, 6–8

Payne JD, Jackson JD, Ryan L, Hoscheidt S, Jacobs WJ, Nadel L (2006) The impact of stress on neutral and emotional aspects of episodic memory. Memory 14(1):1–16

Pelfrey Jr WV, Keener S (2016) Police body worn cameras: a mixed method approach assessing perceptions of efficacy Policing: An Int J Police Strat Manag 39(3):491–506

Plowman SA, Smith DL (2013) Exercise physiology for health, fitness and performance, 4th edn. Lippincott Williams & Wilkins, Baltimore, MD

Ramey SL, Perkhounkova Y, Hein M, Chung S, Franke WD, Anderson AA (2016) Building resilience in an urban police department. J Occup Environ Med 58(8):796–804

Redshaw J, Vandersee J, Bulley A, Gilbert SJ (2018) Development of children's use of external reminders for hard-to-remember intentions. Child Dev 89(6):2099–2108

Renden PG, Savelsbergh GJ, Oudejans RR (2017) Effects of reflex-based self-defence training on police performance in simulated high-pressure arrest situations. Ergonomics 60(5):669–679

Remsberg C (2016) Should cops see body cam video before giving use of force statements? Force Science Institute. Retrieved from https://www.forcescience.org/2016/12/should-cops-see-body-cam-video-before-giving-use-of-force-statements/2016/12/should-cops-see-body-cam-video-before-giving-use-of-force-statements/

Reporters Committee (2019) Access to police body-worn camera video. Retrieved from https://www.rcfp.org/resources/bodycams/

Risko EF, Dunn TL (2015) Storing information in-the-world: metacognition and cognitive offloading in a short-term memory task. Conscious Cogn 36:61–74

Risko EF, Gilbert SJ (2016) Cognitive offloading. Trends in Cognitive Sciences 20(9):676–688

Schacter DL, Norman KA, Koutstaal W (1998) The cognitive neuroscience of constructive memory. Annu Rev Psychol 49(1):289–318

Schultheis E, Ellingwood H, Bennell C (2015) Is seeing believing? Public perception in the use of body worn video by police [Conference session]. Annual meeting of the Society for Police and Criminal Psychology, Atlanta, GA, United States.

Schwabe L, Wolf OT, Oitzl MS (2010) Memory formation under stress: quantity and quality. Neurosci Biobehav Rev 34(4):584–591

Seattle Police Department. (2019). 8.400 – Use of force reporting and investigation. *City of Seattle*. Retrieved from https://www.seattle.gov/police-manual/title-8---use-of-force/8400---use-of-force-reporting-and-investigation

Setcan Corporation (2019) StressVest overview. Retrieved from http://stressvest.com/products/system/stressvests/

Shackman AJ, Sarinopoulos I, Maxwell JS, Pizzagalli DA, Lavric A, Davidson RJ (2006) Anxiety selectively disrupts visuospatial working memory. Emotion 6(1):40

Shields GS, Sazma MA, McCullough AM, Yonelinas AP (2017) The effects of acute stress on episodic memory: a meta-analysis and integrative review. Psychol Bull 143(6):636–675

Siddle BK (1995) Sharpening the warrior's edge: the psychology & science of training. PPCT Research Publications, Millstadt, IL

Siegel J (2010) Officer involved shooting statements: wait. The Bill Blackwood Law Enforcement Management Institute of Texas. Retrieved from https://shsu-ir.tdl.org/bitstream/handle/20.500.11875/1745/1365.pdf?sequence=1

Soares JS, Storm BC (2018) Forget in a flash: a further investigation of the photo-taking-impairment effect. J App Res Mem Cognition 7(1):154–160

Sparrow B, Liu J, Wegner DM (2011) Google effects on memory: cognitive consequences of having information at our fingertips. Science 333(6043):776–778

Staller MS, Cole JC, Zaiser B, Korner S (2017) Representative training with less risk: the effects of non-lethal training and conventional ammunition in police use of force training on heart rate variability. Policing, 1–15

Staller MS, Zaiser B (2015) Developing problem solvers: new perspectives on pedagogical practices in police use of force training. J Law Enforc 4(3):1–15

Steblay NM (1992) A meta-analytic review of the weapon focus effect. Law Hum Behav 16(4):413–424

Storm BC, Stone SM (2015) Saving-enhanced memory: the benefits of saving on the learning and remembering of new information. Psychol Sci 26(2):82–188

Tankebe J, Ariel B (2016) Cynicism towards change: the case of body-worn cameras among police officers. Hebrew University of Jerusalem 16–42

Tarvainen MP, Niskanen JP, Lipponen JA, Ranta-Aho PO, Karjalainen PA (2014) Kubios HRV–heart rate variability analysis software. Comput Methods Programs Biomed 113(1):210–220

Taverniers J, Van Ruysseveldt J, Smeets T, von Grumbkow J (2010) High intensity stress elicits robust cortisol increases and impairs working memory and visuo-spatial declarative memory in Special Forces candidates: a field experiment. Stress 13(4):324–334

Taverniers J, Smeets T, Van Ruysseveldt J, Syroit J, von Grumbkow J (2011) The risk of being shot at: stress, cortisol secretion, and their impact on memory and perceived learning during reality-based practice for armed officers. Int J Stress Manag 18(2):113–132

Thayer JF, Åhs F, Fredrikson M, Sollers JJ III, Wager TD (2012) A meta-analysis of heart rate variability and neuroimaging studies: implications for heart rate variability as a marker of stress and health. Neurosci Biobehav Rev 36(2):747–756

Tsigos C, Chrousos GP (2002) Hypothalamic–pituitary–adrenal axis, neuroendocrine factors and stress. J Psychosom Res 53(4):865–871

Van der Kolk BA, Fisler R (1995) Dissociation and the fragmentary nature of traumatic memories: overview and exploratory study. J Trauma Stress 8(4):505–525

Vickers JN (2007) Perception, cognition, and decision training: the quiet eye in action. Human Kinetics, Champaign, IL

Vickers JN, Lewinski W (2012) Performing under pressure: gaze control, decision making and shooting performance of elite and rookie police officers. Hum Mov Sci 31(1):101–117

Vrijkotte TG, Van Doornen LJ, De Geus EJ (2000) Effects of work stress on ambulatory blood pressure, heart rate, and heart rate variability. Hypertension 35(4):880–886

Wegner DM, Erber R, Raymond P (1991) Transactive memory in close relationships. J Pers Soc Psychol 61(6):923–929

Wine J (1971) Test anxiety and direction of attention. Psychol Bull 76(2):92–104

Wollert TN, Driskell JE, Quail J (2011) Stress exposure training guidelines: instructor guide to reality-based training. Retrieved from http://www.virtualtacticalacademy.com/files/stress_exposure_training_manual_9–26B.pdf

Yuille JC, Davies G, Gibling F, Marxsen D, Porter S (1994) Eyewitness memory of police trainees for realistic role plays. J Appl Psychol 79(6):931–936