# Body Worn Cameras: Comparing Human and Device to Ensure Unbiased Investigations

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## Abstract

*Law enforcement (LE) officers use of body worn cameras (BWCs) is rapidly increasing throughout the United States. The increased use is due to the belief that BWCs will improve professionalism, decrease complaints, and mitigate excessive force. Results from field trials support the effectiveness of BWCs for decreasing both the incidents of police use of force and citizen complaints. However, the few studies reviewing the effectiveness of BWCs have not addressed the human limitations and camera capabilities. Investigators should have knowledge in human factors science to protect against the bias BWC video may provide. This article highlights relevant human factors issues and provides a frame of reference for investigators to use when reviewing BWC video. The focus is on use-of-force applications captured on a BWC. The points discussed are the differences between what a human being perceives and is capable of remembering when compared to what a camera captures and reproduces. Human factors science can help investigators, LE executives, district attorneys, and judges understand that camera evidence is not a direct reproduction of what an officer experienced. BWC video should be viewed critically through the eyes of a human factors trained investigator to ensure unbiased opinions concerning the actions of the involved officer.*

Police body worn cameras (BWCs) have become the subject of an intense topic of discussion socially, politically, and within law enforcement. There is a general societal opinion that the BWCs will solve an empirically unsupported problem of widespread abuse by police officers (Adams et al., 1999; Eith & Durose, 2011; Langan, Greenfield, Smith, Durose, & Levin, 2001; Langton & Durose, 2013; Ross, Mesloh, Henych, & Thompson, 2009). Whether the societal perception will be altered through the use of cameras is still to be seen; however, law enforcement has recognized the benefits of BWCs through demonstrated decreases in officer use of force as well as through decreased citizen complaints (Ariel, Farrar, & Sutherland, 2015; Miller, Toliver, Yanda, & Fisher, 2014; White, 2014). While the few studies on BWCs focus on positive outcomes, there are many areas where further exploration is needed. One such area is the potential for BWCs to create bias—not only in society, but within the investigatory and prosecutorial processes of the criminal justice system. The bias may result from the lack of a frame of reference for the differences between what a camera captures and what a human sees and perceives. This is especially true when a BWC "captures" a law enforcement (LE) officer's use of force.

Dr. Jon Nordby (1992), a 30+ year Forensic Crime Scene Analyst, wrote a research article entitled, *Can We Believe What We See, If We See What We Believe? Expert Disagreement*. In the article, Dr. Nordby points out how powerful the visual experience can be for the observer. He discusses how an investigator's biased observation influences both the interpretation of evidence and the formulation of conclusions. He also points to inappropriate expectation-laden observations and a general lack of specified knowledge as creating judgment errors on multiple levels.

Prevention of BWC video bias can be garnered through an understanding of human visual capabilities and limitations. This new frame of reference should then be reasonably weighed against BWC footage and other evidentiary fact patterns. This evidentiary comparison coincides with the intent of human factors science and encompasses important aspects of human behavior to include perception, cognition, and memory. Ultimately, the capabilities of the human being must be weighed critically against the capabilities of a BWC for neutral investigatory decision making. Dr. Nordby's article, although written over 20 years ago, highlights the need for investigators to become educated in human factors science, so they might review BWC evidence critically and not draw inappropriate conclusions about what an officer perceived (saw, heard, reacted to, or remembers (J. Nordby, personal communication, July 7, 2015).

The introduction of the term *human factors* thus far has been cursory and requires more depth for a full understanding. One well-evolved definition states, "Human Factors is concerned with the application of what we know about people, their abilities, characteristics, and limitations to the design of equipment they use, environments in which they function, and jobs they perform" (Human Factors and Ergonomics Society [HFES], 2015, p. 1). It should be noted that the integration of human factors research in high-liability fields such as command and control, health care, air traffic control, oil and gas operations, and transportation (incomplete list) has been valuable in designing resilient systems, improving human performance, and mitigating errors. Unfortunately, law enforcement has not embraced human factors science with the enthusiasm one might expect considering the implications of human performance to many LE-related activities.

A review of the most powerful examples of current information, research, and studies on BWCs provided no evidence of any discussion on the differences in human capabilities (human factors) compared to that of the camera (Ariel et al., 2015; Ellis, Jenkins, & Smith, 2015; Goodall, 2007; Katz, 2012; Mesa Police Department [MPD], 2013; ODS Consulting, 2011). The lack of a discussion on human factors is concerning from an investigatory point of view. It is important to note that human factors/human behavior science was presented at the LE community's doorstep over 20 years ago in the form of officer performance during critical incidents (Siddle, 1995). The "knock" on law enforcement's door by human factors science since that time has only become more intense through research by professionals such as Dr. Alexis Artwohl, Dr. Bill Lewinski, and Lt. Col. Dave Grossman (to name a few). BWCs have created an additional critical concern requiring law enforcement and the criminal justice system to acknowledge human factors science to ensure the knowledge necessary for unbiased investigations. The consequences of not doing so may be extreme for officers exposed to uninformed use-of-force (UOF) investigators, LE executives, or triers of fact within the criminal justice system.

## Human Factors Science and Judging Reasonableness

The BWC is a unique and powerful evidentiary tool in a myriad of LE situations, but the most important implications revolve around an officer's use of force. The use of video evidence in this context is not entirely new as police vehicles have had mounted cameras for over 20 years. The uniqueness of the BWC is readily apparent in its allowance for a previously unavailable point of view. BWCs allow the investigator to feel directly engaged in the event as if they had experienced the situation themselves. This new first-person point of view may create a potential for the observational bias Dr. Nordby (1992) discussed. Most people understand the difficulty in overcoming the confirmation bias associated with seeing with one's own eyes. The difficulties found in confirmation bias through video review may be challenged by the science contained in this document which outlines the differences between human visual capabilities and a camera. The profound differences demonstrate that humans do not see like a camera, record like a camera, or play back like a camera.

## The *Graham* Standard

In order to appreciate this discussion, a review and scientific comparison of the bright line case law concerning use of force is provided. The U.S. Supreme Court in *Graham v. Connor* (1989) determined that an officer's use of force must be "objectively reasonable" in light of the facts and circumstances confronting them. The term *objective* is defined in part as "involving or deriving from sense perception or experience with actual objects, conditions, or phenomena" (Merriam-Webster, 2015). The correlation between this definition and the definition of human factors (listed above) provides a foundation for the inclusion of human factors science in the judgement of what is reasonable (Ross, 2013; Wallentine, 2007).

A major consideration in judging the "reasonableness" of a particular use of force is an assurance that the judgment is based (in part) upon the perspective of the officer at the moment in time force was used (*Graham v. Connor*, 1989). A key to defining this type of judgement is an understanding that an officer's perspective is individualized to that moment in time and impossible to recreate through the 20/20 hindsight provided by a BWC. A consideration of human factors science in relation to what an officer perceives and what a BWC provides is essential to mitigate the 20/20 hindsight/confirmation bias provided by video (*Graham v. Connor*, 1989; Miller, n.d.; Nordby, 1992; Ross, 2013). Investigators must consider that perspective is not only derived individually through vision, but is inclusive of previous training, life experience, and other environmental stimuli.

Dr. Nordby (1992) does not stand alone in his assessment of the need for specific and appropriate investigative skill sets applied to investigations in order to prevent unintentional bias. The Vice President and Senior Legal Advisor to Lexipol, the nation's leading provider of public safety risk management policy and resources, is quoted from an article discussing reasonable force and human factors science:

> *Anyone claiming to provide an objective evaluation of police use of force must gain the necessary educational foundation to even ask the right questions in order to reach reliable conclusions. Agencies must broaden the vision of training, experience and education for those who analyze force situations and pass judgment on the reasonableness of force.* (Wallentine, 2007, p. 1)

This statement is overwhelmingly powerful in its context and demands compliance from those within the criminal justice system.

Investigation of a UOF event without consideration of the relevant human factors issues has the potential to create bias due to common misconceptions about human visual and memory capabilities (Nordby, 1992; Zampini & Spence, 2012). In order to overcome potential bias caused by BWC video review, UOF investigators should come to understand the human factors component of the assessment criteria for objectively reasonable force (Ross, 2013; Ross et al., 2012). Topical understandings of the human factors that apply to cognition, attention, and memory, as well as the results of fear upon human physiology are critical (Ross, 2013). This science-based frame of reference is not intended to be a stand-alone justification for unreasonable uses of force, but, rather, it provides a comparative backdrop for the other facts and circumstances involved in conducting a complete investigation. Human factors science should be included with other evidentiary fact patterns to ensure an ethical, thorough, unbiased, and reasonable final result. Investigators' topical knowledge of human factors issues will enable them to reach out to a human factors specialist/expert in order to state their opinions.

Driving the point home, a recent Force Science (2015) newsletter discussed a UOF incident in which dash camera footage was internally reviewed. The video was initially reviewed by a first-line supervisor who stated, "The video tells all here" in his determination that a use of force was excessive (p. 1). Internal affairs investigators agreed with the supervisor's statement and findings concerning the use of force (excessive), and they recommended discipline. Ultimately, the top executive in the department reached out to an individual with human factors and video review training. That individual was able to determine that the use of force was in fact justified which potentially saved the officer's career.

## Point of View Versus Perspective of an Officer

Many BWC manufacturers, media outlets, and even some LE organizations often cite body camera recordings as being from the perspective of the officer (Body Vision, n.d.; President's Task Force, 2015; Santora & Stewart, 2014). Although their intent implies that BWC recordings are from the officer's point of view, the use of the word "perspective" could be damaging in consideration of *Graham v. Connor* (1989). The word *perspective* within the context of *Graham v. Connor* is unrelated to an officer's point or field of view (external) in comparison to a BWC's field of view (FOV). A clear delineation should be made in that regard when discussing BWC recordings and the officer's perspective. The lack of delineation between the two (officer perspective vs. BWC FOV) only furthers the potential bias created by BWC video.

The *Graham v. Connor* (1989) citation's use of the word *perspective* defines an internal cognitive assessment comprised from the consolidation of stimulus data points available to the officer during a rapidly evolving and violent confrontation (Merriam-Webster, 2015; Ross, 2013). The data points are the information the officer gathered at the time of the incident and are specific to him or her (Flosi, 2012; *Graham v. Connor*, 1989; Peters, 2015; Wallentine, 2007).

Cameras and the subsequent reproduction of events they provide are both fact and fallacy in regards to judging an officer's actions during a UOF event. They are *fact* because the events captured on film from a particular angle are an accurate reflection of a portion of the event from a particular point of view. The *fallacy* is found in the empirical human factors limitations an officer may experience in areas such as attention, vision, and cognition, as well as encoding and retrieval of memories (Artwohl, 2008; Chabris, Weinberger, Fontaine, & Simons, 2011; Honig & Lewinski, 2008; Hyman, Boss, Wise, McKenzie, & Caggiano, 2010; Jensen, Yao, Street, & Simons, 2011; Pinizzotto, Davis, & Miller, 2006; Ross, 2013; Ross et al., 2012; Staal, 2004; Vickers & Lewinski, 2012). On the most basic level, it is important to understand that a BWC is only capable of delivering a recorded portrayal of events from the restricted viewpoint of the lens. This viewpoint is from a relatively fixed position, whether head, chest, or lapel mounted.

## BWC Placement

A *point of view* is defined as a "position from which a thing is viewed" ("Point of View," 2015). The point of view definition provides for a fixated point upon which an aspect of the environment is looked upon, but it does not define what is seen or perceived. A point of view is factually ambiguous as it does not define the FOV capabilities of the device (mechanical or human) nor does it account for obstacles. These facts are important to keep in mind when considering where the BWC is mounted on the officer's person while determining the differences between what the BWC captured and what the officer saw.

Many models of BWCs provide a chest-mounted capability providing a point of view from the officer's torso that does not account for the wearer's head and eye movement. Video capture variations may occur when a camera is placed high upon the chest or lower toward the abdomen. A lapel- or shoulder-mounted BWC falls under a similar set of considerations as it also does not account for the wearer's head and eye movements and may have a point of view oriented more toward the right or left. No known empirical evidence has provided any consistency between these BWC positions and what an officer saw during an event or would be capable of seeing.

The head-mounted BWC has been erroneously described as having the ability to provide the point of view or perspective of the officer as its orientation is near the eye and will follow the head direction of the wearer. The head-mounted position does not account for eye movement, visual attention, saccades, fixations, or the differences between the BWC and the officer's FOV capabilities. Although mounting the BWC on an officer's head (e.g., side of head) may provide the closest representation of an officer's actual point of view, no empirical evidence known to the author supports the use of head-mounted BWCs over other mounting locations. Additionally, no known empirical evidence supports that head-mounted BWCs correlate with what an officer saw or is capable of seeing.

## The Human Visual System

BWC mounting positions, perspective, and point of view considerations are a preamble to a much deeper discussion on defining the differences between what an officer may see and what the BWC records. While the BWC can provide high-definition (HD) quality video at all viewable angle(s), the human eye falls far short in relative performance. The differences are based both in the biological structure of the eye as well as in the physiology behind the human visual system.

Vision is a complex process requiring cooperation between a myriad of components in both the eye and the brain. It is important to note that humans do not "see" with their eyes and that vision is a reproduction of how our brains piece together neurochemical signals (Anderson, 2009). The process begins when light travels through the pupil and falls on the retina located along the back wall of the eye (Cater, 2004). The human retina is a half-millimeter thick piece of tissue containing sensory neurons which convert light into electrical messages. These messages travel along the optic nerve to optic centers in the brain (Kolb, 2004). Several areas of the brain are involved in the complicated process of taking sensory input from the optic nerve and converting it to a visual experience (Anderson, 2009; Williams, Kitchener, Press, & Steele, 2004). What we perceive as vision is a construct of what our brain pieces together.

The sensory neurons or photoreceptor cells within the retina are separated into two distinct types called rods and cones (Anderson, 2009; Cater, 2004; Nave, 2015). There are approximately 120 million rod cells in the human eye. Rods are comparatively much more light- and motion-sensitive than cones but are not sensitive to color and provide a lower visual acuity. Rods provide a monochrome 20/200 level of vision in low intensity light environments (Anderson, 2009; Cater 2004; Geis, 2015).

The optimum level of vision available from our low-light-capable rods is only obtained after approximately 30 minutes of exposure to darkness (Nave, 2015)—an important issue when considering an officer moving from a light to dark environment. Rods are primarily responsible for our peripheral vision, and the reduced acuity provided by these receptors is important to remember when considering what an officer is capable of seeing in the periphery.

The 6 to 7 million color-sensitive cones contained within the retina provide human color vision and the highest level of visual acuity (Anderson, 2009; Nave, 2015). Cones adapt to changing light levels much faster than rods and are responsible for high resolution vision (Nave, 2015). As the discussion on human vision moves forward into spatial fields of vision, it will be important to note the limited high acuity allotted by the reduced number of cones within the eye (foveal FOV). This very small area of the eye, biologically speaking, is what provides humans with HD quality vision comparable to what a BWC provides in its entire FOV.

The spatial FOVs are categorized through the foveal, parafoveal, and peripheral regions of the eye (Calvo & Lang, 2005). It is important to note the visual capabilities of each area are related to the relative density of rods and cones contained therein. Cones are highly concentrated in the macula area of the eye, which is a layer of tissue located near the center of the retina encompassing both the foveal and parafoveal regions. Based on the biological makeup of the eye, these areas are consistent with the placement of rods and cones and further define the areas of limited high acuity FOV (Cater, 2004; Nave, 2015).

In the center of the macula is an area known as the *fovea centralis* which is densely packed with cones but contains no rods (Nave, 2015). The foveal region provides a 1 to 2$^{o}$ concentric high-acuity FOV based on its dense composition of rod cells (Cater, 2004; Nave, 2015; Rayner, White, Kambe, Miller, & Liversedge, 2003). The fovea provides a spatial focus of overt attention and is essential for the ability to attend (i.e., cognitively process, understand, and remember) to items within the environment (Calvo & Lang, 2005). In the simplest terms, the fovea is often unconsciously directed to the most salient visual stimulus perceived in the environment and is often the measurement device for the center of visual attention. The biology of the human visual system ensures the necessity to place the fovea on specific areas (consciously or unconsciously) in order to make sense of a visual stimulus and store the information for later retrieval (Read & Meyer, 2000). While humans have limited HD quality vision, we are able to construct (visually) a much larger representation of the environment through rapid eye movements or saccades (discussed in more detail later) (Henderson, 2003).

An appreciation of the foveal field and its involvement in attending to and processing information in our environment can be gained through the following demonstration: Using a page of type-written narrative as a backdrop, hold your thumb out to arm's-length and close one eye. Focus on your thumb nail, and you will notice the clarity found in just the nail (foveal view). Without looking away from your thumb nail, attempt to see the words on the page, just to the left and right of the thumb nail. The words will be blurry if not unreadable (Kline, Lynk, & Cooney, 2015; Rayner et al., 2003). This simple test shows the inadequacy of the eyes' very small range of 20/20 vision (foveal 1 to 2$^{o}$) compared to a camera's HD version, which provides 20/20 "vision" throughout its entire FOV (up to 180$^{o}$). The test also shows the limited amount of information potential for encoding (memory) during a single fixation.

The parafoveal belt defines a concentric ring surrounding the fovea which contains some rods but mostly cones. The parafoveal belt provides a 5$^{o}$ conical field of continued quality color vision (Rayner et al., 2003) but with less acuity than that found in the fovea. While the parafoveal FOV initiates the human capability of perception without a conscious focus of attention, there is controversy as to what type of information may be obtained from this visual angle (Calvo & Lang, 2005).

Beyond the 5° parafoveal area, vision is reduced to about 1/10th the detail found in the foveal region (Antunano, 2002; Geis, 2015; Keith, 2012). This peripheral area of vision encompasses most of the human FOV and, while limited in acuity, this area is necessary for noticing movement and monochromatic night vision. Peripheral vision is responsible for noticing movement and allowing for both the unconscious and conscious redirection of the fovea in order to obtain the HD quality vision necessary to "attend" to a specific stimulus in detail.

The limitations of peripheral vision can be demonstrated by fixating the FOV while attempting to define objects in the periphery without head or eye movements. From a distance of a few feet and while fixating at a central point, objects located more than 10° lateral to the fixation point are difficult to define in any detail (e.g., words, structures, intricacies). Vision becomes increasingly lower in acuity, moving outward to a point in the periphery where items disappear from vision completely.

## Visual Attention

*Visual attention* is defined as a "set of cognitive operations that mediate the selection of relevant and the filtering out of irrelevant information from cluttered visual scenes" (McMains & Kastner, 2009, p. 1). The environment in which a human functions is rich with complex and constantly flowing information, while the ability to attend (i.e., see, hear, process, retain in memory) to every aspect is impossible. Human visual attention requires momentary visual fixations to perceive and process specific stimuli—ensuring that quality multitasking is a myth (Napier, 2014). While rapid shifting of attention between various stimuli in the environment allows for a global perspective, this type of divided visual attention limits the ability to perceive and process, and to remember specific items not attended to (Geis, 2015; Napier, 2014). The more environmental stimulus requiring attention, the more opportunity for error (i.e., missing objectively important information) as attention moves and fixates between stimuli rapidly. During these shifts of attention, unattended items may not be perceived, processed, or stored in memory.

While a human being's high acuity vision covers a small 1 to 2° area, the ability to see the environment in detail is made available due to rapid eye movements or saccades. These movements take place about three times every second and allow the fovea to cover more of the environment for a better visual experience (Henderson, 2003). One critical fact concerning saccades is they must momentarily fixate for a minimum of 160 to 200 milliseconds on an object in order for the brain to perceive and attend to the stimulus (J. Vickers, personal communication, January 28, 2015). This momentary fixation of the foveal FOV on an object is often referred to as *overt visual attention* (Carrasco, 2011; Gould et al., n.d.). Overt visual attention is vital in considering if an officer saw and/or is able to recall events recorded on a BWC.

The concept of attention (i.e., processing sights, sounds, sensations) is critical for a UOF investigator's understanding of what an officer may or may not have perceived during a critical incident. Attention has been described as a "spotlight," which illuminates a portion of the environment and leaves other information dimmed or not available to be seen. Attention has great bearing upon what details an officer will respond to, make decisions upon, or remember later.

Human attention, and specifically visual attention, is important to UOF investigators due to the BWC's ability to record everything in its visual field and provide those details in perfect playback. When considering what an officer "sees," investigators must understand that officers will often selectively "visually attend" or "see" items based on their saliency (Henderson, 2002). *Saliency* can be determined either unconsciously in a reactionary form or consciously such as when an officer intentionally looks toward a subject's hands or the sights of a firearm. Investigators must also understand that visual saliency is based upon the perspective of the officer at that moment in time and not necessarily what the investigator believes is most important. The concept of selectively attending to an environment is the underlying empirical evidence supporting that an officer will never be able to see or remember all aspects of what is recorded on a BWC. The officer may selectively attend to what is salient to him at moments in time, and much of that attention will be captured at an unconscious level (Ruz & Lupianez, 2002).

*Selective attention* is the term generally used to define the filtering of visual information in order to adequately make sense of the overwhelming amount of information humans receive (Ruz & Lupianez, 2002). Consider the act of driving a car. The driving environment provides a massive amount of sensory stimuli, yet the driver mostly attends to only what is salient. The color of the vehicle in the next lane or the ballgame in the roadside park may not be attended to as they are not important in the task of driving. Conversely, honking horns or vehicles moving into the driver's lane will unconsciously divert attention to that stimulus for moments in time, ensuring a lack of attention to other potentially important aspects of driving (i.e., what is right in front of the driver). UOF investigators must recognize that although aspects of the environment are within an officer's FOV, salience often dictates attention; and without attention, there can be no recall (Anderson, 2009; Carassco, 2011; Carpenter, 2004). What is salient to an officer during rapidly evolving incidents may seem intuitive to an investigator, but it may be difficult to define specifically.

## Inattention Blindness

When human beings (officers) selectively attend to aspects in the environment, they may not perceive other information within their visual FOV. This lack of perception may add to potential discrepancies between officer performance and investigator bias when reviewing BWC video. Science has provided various names for attentional shifts and lack of awareness, including *inattentional blindness* and *change blindness* (Simons, 2000, 2007). Each term requires introduction as they define how "seeing" is not simply a capability based upon what stimuli are within the visual field but, rather, a consideration for the complex human mechanism involved.

Arien Mack and Irvin Rock introduced the term *inattention blindness* through their studies on visual perception (as cited in Simons, 2007). Inattention blindness defines how an individual may fail to see an unexpected object within his or her visual field due to a preoccupation with another task (Simons, 2007). Mack and Rock found their study participants, while they were visually fixated on a primary target, often did not notice an unexpected object even when it appeared in the center of their visual field (Carpenter, 2004). A powerful example of inattention blindness involved a 1999 study which asked 192 observers to watch a video in which two teams of three players would pass a basketball. One group of players was dressed in all white clothing and the other in black clothing. Observers were asked to count the total passes between the teammates within the group they were attending (black or white). During the video, an unexpected situation would present itself within the observer's FOV. Either a person wearing a full gorilla suit or a woman carrying an umbrella would walk through the groups passing the basketball. When queried afterward, 46% of the 192 observers did not notice the unexpected event (Simons & Chabris, 1999).

Another study involving inattention blindness in direct relation to law enforcement required participants to engage in a "foot pursuit" along a walking path. Located 26 feet off the walking path, but well within view, a fight between three people was staged. The participants who engaged in the foot pursuit were later questioned as to what they saw during the event. During night conditions, only 35% of participants noticed the fight. During daylight conditions, only 56% noticed (Chabris et al., 2011).

It should be noted that this experiment was conducted to support Boston police officer Kenneth Conley, who ran past a vicious beating while chasing a suspect. The officer claimed later he did not see the beating and was ultimately charged with perjury (Spiegel, 2011). Dick Lehr authored a text about the case and has been quoted as saying, "Common sense would say that he (Conley) had to see something" (as cited in Spiegel, 2011). Later, during trial, jurors assumed Conley was lying, ultimately convicting him of perjury and obstruction of justice (Spiegel, 2011). The bias demonstrated by Lehr is not uncommon and obviously translated to the investigators. The overriding point is that a BWC also may have "seen" the fight, providing the potential for additional bias and evidence against the officer without the consideration for human factors science.

## Change Blindness

*Change blindness*, although related to inattentional blindness, is distinctly different. While inattentional blindness is the failure to notice something that is otherwise clearly perceptible, change blindness involves not seeing a distinct change in the environment. Change blindness involves working memory and its involvement in scene comparison. The change of visual stimulus is usually predicated by a disruption to perception (e.g., eye movement, eye blinks).

For example, Levin and Simons (1997) conducted an experiment demonstrating change blindness while having participants view a film in which an environmental change occurred within their FOV. Each change (10 total) occurred within the standard refresh rate (60 Hz) of conventional recording and display video devices. Changes ranged from the removal of a bright-colored scarf worn by an actor to changing the color of a vehicle's license plate. Ultimately, of the 90 changes (overall) that occurred for all participants, only one individual noticed a single change.

A secondary experiment in the Levin and Simons (1997) study provided an even more powerful display of change blindness. In the second experiment, participants viewed a video in which the central focus revolves around the actions of the actor. As the film progresses, the actor involved is replaced by a completely different person. In this experiment, 27 of the 40 participants failed to notice the actor's identity had changed.

A third and more well-known study involved an experimenter approaching and asking pedestrians on a university campus for directions. During the 10 to 15 second exchange, two additional experimenters carrying a door rudely barge between the pedestrian and the experimenter, briefly obscuring the pedestrian's view of the experimenter. During this time, the experimenter who was asking for directions swaps places with the experimenter carrying the back of the door; the experimenter who carried the back of the door then continued the conversation with the pedestrian. Despite the fact that, compared to the initial experimenter, the replacement experimenter displayed clear differences in clothing, appearance, and voice, only seven of 15 pedestrians reported noticing the change, and those who did not report the change continued providing directions as if nothing had occurred (Levin & Simons, 1997).

Several opportunities can be found online that allow for a first-hand experience of both inattention and change blindness. One example is a video entitled *The More You Watch, the More You See*, which is an advertisement for Ireland television station TG4. In the video, a man walks through a crowded room with significant events occurring around him and within a normative human FOV; most, if not all, are missed by the unwary viewer (TG4, 2009). The second example is a video is entitled *Test Your Awareness: Whodunit?*, which is a superb demonstration of change blindness. In the video, 21 changes occur within 40 seconds, which the unwary viewer will often not see, but even those warned beforehand will not see them all (dothetest, 2008).

Considering both inattention and change blindness in the context of a UOF situation, it is appropriate for investigators to consider how an officer under a great deal of stress might not "see" a rapidly unfolding event in the same manner as a BWC will record or replay it. LE entities can potentially experience these phenomena by watching students progress through simulated UOF encounters in a Force Options Simulator (FOS).

For those unfamiliar with the FOS, it provides a life-sized video simulation of subjects in the context of a LE encounter. The subjects may require an officer to use some level of force in an interactive method. The author's personal observations of over 200 FOS trials have demonstrated the fact that officers experiencing the simulation first-hand often report they did not see things within their FOV that are readily apparent to others in the room. Two particular examples (see below) have been observed by the author.

### Scenario #1

A male and female are arguing inside a vehicle. The driver's door opens quickly and stays open for just under a second before a very large man gets out and begins to threaten the officer verbally. The man removes the clearly visible handgun (approximately 1 to 1.5 seconds visible before the suspect retrieves it) from a pouch on the driver's side door and shoots at the officers. The author has questioned the students about what they saw during this moment in time. A large majority (approximately 90%) do not see the handgun in the driver's side door and ultimately report that the weapon was retrieved from somewhere on the driver's body.

### Scenario #2

A suicidal male is found pacing in a parking lot with a large knife held to his own neck. The male walks back and forth, holding the knife to his neck while talking to himself for a period of time before quickly moving toward the officer. As the male moves toward the officer, he moves the knife down to his side rapidly and throws it to the ground. Most officers are in the process of aligning their weapons on the male or beginning to fire their weapons as the subject moves toward them and later are surprised when confronted with the fact that the male dropped the knife. The author has questioned the students about what they saw during this moment in time. At the time of this writing, 100% of officers do not see the knife being dropped and shoot the suspect multiple times as he approaches.

These two plausible examples of inattention/change blindness are interesting for several reasons. First, it is important to note that while the student officer overwhelmingly does not see the listed salient details, almost all of the students watching (audience) do see them. The student audience is often surprised by the inability of the officer to see what is clearly within their FOV. This is indicative of what an investigator might feel upon watching a BWC video and the subsequent bias created. Also of import is that the officers involved in the scenario examples have no reasonable cause to fabricate their experiences; this has become a common detractor from the application of theory in UOF settings.

While inattention/change blindness has not been empirically proven to effect officers under these exact situations, the powerful anecdotal evidence cannot be ignored. Clearly, visual attention/FOV science applicable to human error in many other fields (e.g., medical, aviation, and transportation) are similarly applicable to UOF situations. Human beings have been proven time and again to not see various stimuli within their FOV in a myriad of situations, both with and without the stress of a violent encounter. The need for further scientific study in this area is clear, but investigators and the rest of the criminal justice system would be injudicious not to accept the current empirical presentations of human visual limitations in regards to a BWC review. As human factors scientist Marc Green (2013) states, "[I]nattention blindness is not a mental aberration; it is the norm" (p. 1).

## Stress and Visual Performance

Any stimulus that draws attention in some degree is a stressor. This means that daily low stress environmental stimuli can cause a human to selectively attend to a visual aspect of the environment and, therefore, be inattentionally blind to other aspects within their FOV. The fear-based stress of a police UOF incident increases the effects of selective attention, inattention blindness, and change blindness (Artwohl, 2008; Godnig, 2003; Grossman & Christensen, 2008; Honig & Roland, 1998; Martinelli, 2010; McCraty, 2012; Ross et al., 2012; Staal, 2004; Vickers & Lewinski, 2008). UOF incidents are chaotic and violent, typically causing increasing levels of fear in those involved. Fear, within this context, activates the limbic system's "fight or flight" response, causing hormones and neurotransmitters to be released throughout the body (Akinola & Mendes, 2012; Martinelli, 2010; Ross et al., 2012; Staal, 2004; Taverniers, Smeets, Ruysseveldt, Syroit, & Grumbkow, n.d.).

These naturally occurring stimulants—cortisol, epinephrine, and norepinephrine—activate the sympathetic nervous system, a portion of the central nervous system responsible for instinctual survival (fight or flight). This survival mechanism causes physiological changes that enhance or degrade officer performance. Some of the "changes" include dilated pupils, increased heart rate, loss of fine motor skills, cognitive and memory impairment, increased gross motor skills, and hypervigilance (Geis, 2015; Martinelli, 2010; Ross et al., 2012; Staal, 2004). While involved in a critical incident, the increased effects of stress on an officer's performance, particularly to attention and visual capabilities, can be dramatic (Artwohl, 2008; Godnig, 2003; Grossman & Christensen, 2008; Honig & Roland, 1998; Martinelli, 2010; McCraty, 2012; Ross et al., 2012; Staal, 2004; Vickers & Lewinski, 2008).

Science has shown the sympathetic nervous system response to a fear-based stressor may cause extensive visual degradation (Artwohl, 2008; Godnig, 2003; Pinizzotto et al., 2006). In life-threatening situations, visual attention is reportedly increasingly narrowed toward the threat while peripheral information is blurred or blocked (Geis, 2015; Godnig, 2003; Staal, 2004). Evidence suggests the tunneling of vision can cause visual limitations comparable to the sight capabilities provided by the 1 to 2° capability contained in the foveal FOV (Geis, 2015; Godnig, 2003). In essence, this is similar to looking down a foot-long piece of PVC tubing while being absolutely unaware of other peripheral visual stimulus (Geis, 2015; Godnig, 2003). This high-level focus of attention on a threat is intended to ensure survival; however, it can be a hindrance for information retrieval and memory storage. This stress/arousal reaction is called *peripheral narrowing* and is often referred to as *tunnel vision* (Godnig, 2003). It is imperative to understand the extent of what might not be seen when vision tunnels and limits the available FOV (Geis, 2015; Godnig, 2003; Levin & Simons, 1997; Staal, 2004).

Several studies directly relating to the effects of stress on LE officers engaged in life or death confrontations have been conducted. The findings provide that a majority of officers (51 to 79%) experienced a tunneling of vision during an officer-involved shooting (OIS) event (Artwohl & Christensen, 2002; Honig, 1998; Pinizzotto et al., 2006). Some of the interviews conducted with officers experiencing tunnel vision support the involved officer's FOV decreasing to a point where only the sights of an officer's weapon or the barrel of the offender's weapon was all that was seen (Klinger, 2004; Pinizzotto et al., 2006)

## Human Field of View Compared to Body Cameras

In human vision, there is an area referred to as the useful or functional field of view (UFOV/FFOV). The FFOV is the visual area over which information can be extracted at a brief glance, without eye or head movements (Ball, Wadley, & Edwards, 2002). In simple terms, this is an area where our visual resources can notice a stimulus and then direct attention (selectively attend) to it. Outside this area and without conscious scanning or unconscious saccadic movement, officers may be blind to other visual stimulus (i.e., inattentional blindness). Several aspects can decrease the FFOV to include poor vision, difficulty dividing attention, visual clutter and/or ignoring distraction, and slower processing ability. Although the absolutes behind the depth of tunnel vision or decreases in FFOV have not been empirically defined, a tremendous amount of scientific literature supports its existence (Staal, 2004).

Under moderate foveal load, the FFOV in normal adults under the age of 60 years ranges between 35 and 50$^{o}$ (D. Roenker, personal communication, May 13, 2015). Science has provided empirical evidence that the FFOV can decrease to below 10$^{o}$ without high levels of stress (Harada, Hakoda, Kuroki, & Mitsudo, 2015). Ultimately, anecdotal evidence supports the claim that the FFOV can decrease to 1 to 2$^{o}$ provided by the fovea when life-threatening events occur (Artwohl & Christensen, 2002; Geis, 2015; Godnig, 2004; Honig & Roland, 1998; Pinizzotto et al., 2006).

In consideration of selective attention, FFOV, and tunnel vision, investigators should consider that BWCs have a FOV ranging from 95 to 170$^{o}$ (BodyCam, 2015; FirstVu, 2015; Vievu, 2015; Wolfcom, 2015) and have no similar deficits. A BWC will record all aspects within its FOV with HD clarity.

## Frame Rate

BWC frame rate settings and playback device frame rates should be important pieces of information for investigators. Due to the limitations of human short-term memory or working memory, the review of video at its normal playback rate can be problematic for in-depth discovery. Frame rates, commonly referred to as frames per second (fps), can provide an investigator with a true understanding of how much visual information can be gleaned in just 0.25 second. Investigators should understand that they are incapable of receiving all the visual information necessary (at full playback speed) for a complete investigation. Even constant replay and slowing down of a video may not provide all the salient details necessary for an in-depth investigation. The reason is based in human factors science, which provides that the human visual system can only individually process approximately 10 to 12 separate images per second (Read & Meyer, 2000). This fact, combined with knowledge that many BWCs have listed recording rates between 30 and 60 fps (BodyCam, 2015; FirstVu, 2015; Vievu, 2015) provides for an understanding that much can be missed in a full speed review.

Taking video played back at 60 fps, investigators should know there are 60 individual photographs that should be viewed in order to see exactly what occurred in just one second of time. As an example, Alexander Jason (2010) conducted a study on action/reaction for start/stop shooting times. Within the study, he determined that officers generally fire one round every 0.23 second (M = rapid fire). In the same study, he found that a human body will fall in approximately 1.1 seconds. Consider a BWC recording at both 30 and 60 fps in a situation in which an officer is engaged in an OIS that lasts just 1 second. At 60 fps, Jason's average shooting split time result provides that at least four rounds (faster shooters could fire more) could be fired during those 60 frames (1 second). Jason's findings suggest that a person incapacitated by those rounds may not have reached a full prone position during that time. The variation of movement in the falling body may provide important answers to an OIS investigation, but they will not all be evident at full playback speed. Additionally, information captured at 30 fps will not provide as many of those important details. Investigators should consider that a BWC running at 60 fps will capture a tremendous amount of information in just one second. Those resulting 60 photographs can be the difference between prosecutions or enhanced civil liability. Anything less than a frame-by-frame forensic analysis provides nothing more than speculation and potential basis for bias.

## Body Camera Footage Review

There are opposing views as to whether officers should be allowed to view BWC footage prior to making statements or writing reports. One perspective is that it is vitally important to capture an officer's perspective without potential interference created by inconsistencies between the officer's memory and the video (Daigle, 2015). This "do not view prior" perspective is also based on a social perception that an officer who reviews BWC footage will have an opportunity to fabricate testimony (Daigle, 2015; Stanley, 2015).

Another major consideration may come from the *Graham v. Connor* (1989) case law itself. The review of video may have unintentional effects upon recall. The officer may not intentionally be deceitful, but there is a possibility of a memory being altered through the visual stimulus and unintentional cues from investigators (Daigle, 2015; Loftus, 1997). Any unintended alteration of the officer's perspective during the event may be problematic for obvious reasons.

Chuck Tilby (personal communication, February 2015), a former police executive and current content writer for Lexipol, is a supporter of not viewing video prior to report writing. He believes it would be better to explain to a jury why an officer's recollection does not match the video perfectly as opposed to fight back discovery that an officer's recollection was based (at least partly) on the video and not actual observations.

The other side of the argument is that reviewing BWC footage allows the officers to provide the best account of what occurred (Miller et al., 2014). One of the most positive aspects of reviewing video is its ability to refresh the officer's recollection by opening memory pathways and linking events that the officer does remember (Geis, 2015). This is an invaluable necessity for the best memory retrieval and fullest account of an event. The process is similar in some ways to cognitive interviewing and how the procedures allow for deeper memory retrieval through developing "memory tracks" (Fisher & Geiselman, 2010).

The International Association of Chiefs of Police (IACP) has publicized its understanding of memory loss under stress and promotes post-OIS scene walk-throughs in order to increase memory between 20 to 40% (Tracy, 2015).

A review of the video, although not specifically addressed by the IACP, can seemingly offer all the positive outcomes of a scene walk-through in refreshing memory and can assist the officer in providing a more thorough statement of fact.

A recent guideline document published by the Police Executive Research Foundation (PERF) addressed this issue and provided support for officer review of video footage. PERF, along with the majority of police executives consulted for their document, are in favor of an officer's review of BWC footage prior to making statements for incidents in which they were involved (Miller et al., 2014).

## Conclusion and Recommendations

BWCs are the wave of the future and, in today's social environment, it is prudent that officers have point-of-view related evidence of their public encounters. However, it is just as important for investigators and all involved in the criminal justice field to understand the limitations of the human being wearing the BWC. Even a general introductory knowledge of these limitations would provide a frame of reference for appropriate investigatory video review or recognition of the need to seek assistance. This information is also necessary for the public to understand that what they see on YouTube and what the officer experienced may be very different.

Police officers are human beings, and their inherent abilities do not surpass that of the rest of the populace. No human will perceive everything in the environment, which ensures they will not recall it with 100% accuracy. For this reason, the criminal justice establishment can be assured that there will be variations between what officers see and what BWCs record. An acceptance of human factors science will ensure that the bias produced through "seeing is believing" is suppressed by empirical evidence denying that statement. The science will ensure criminal and civil cases are judged fairly while considering ALL of the pertinent facts and circumstances available at the time.

Nationally, law enforcement should embrace human factors science and apply it to policy, procedure, training, and core practices. The need for further research on BWCs as an evidentiary tool is important to ensure both law enforcement and society understand that video is not flawless evidence. A low cost and potentially effective method of study is to place BWCs on student officers using the Force Options Simulator. The students would have the camera on during their scenario and be debriefed at the conclusion. An experimental group of officers reviewing BWC footage could be compared to the recall ability and memory variations of those who do not review the footage. The findings would provide empirical evidence for direct application to policing.

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