When a Flashlight Looks Like a Threat: A Multifaceted Human Factors Approach in the Accident Reconstruction of a Police Officer Shooting

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Abstract: This case study presents a forensic human factors investigation into a nighttime officer-involved shooting that occurred during a police response to a residential burglary alarm in Midland, Texas. The homeowner, awakened by his spouse and alarm system cues, discharged a firearm at an officer who had entered the residence through an unlocked front door. The primary question investigated was whether the homeowner had sufficient visual information to identify the officers before firing his weapon. Through a combination of validated photography, photometric testing, motion capture, and laser scanning, the analysis recreated the precise lighting, and biomechanical conditions present at the time of the incident. Texturized privacy glass, minimal ambient lighting, and the intense luminance contrast of a high-powered flashlight contributed to a visual environment in which no discernible features of the officers were visible. These conditions, combined with documented high-stress cognitive effects such as tunnel vision and expectation bias, formed the basis for concluding that the homeowner likely perceived ambiguous stimuli as threatening intruders. To further communicate these findings, ESi developed six 3D virtual animations integrating synchronized bodycam and security footage, biomechanical reenactments, and photometrically accurate lighting conditions. These animations were used in litigation to support expert opinions and clarify the timeline and perceptual limitations at play. This case underscores the importance of human-centered analysis in high-consequence environments, particularly where sensory limitations and cognitive load converge under duress. It also highlights how scientific visualization and human factors methodology can be integrated to inform legal determinations regarding perception and intent.

Keywords: Human Factors, Low-Light Perception, Luminance Contrast, Forensic Animation, Motion Capture, Validated Photography

1. Literature Review

The human visual system functions best under clear and relatively high levels of illumination. Under low-illumination levels, the ability to visually detect relevant information is reduced. To navigate safely under low-illumination conditions, the human visual system must rely on artificial lighting and degraded visual information that would otherwise be fully available with higher levels of illumination. This degraded information affects the manner in which humans perceive and respond to the stimuli presented in low-illumination environments. For instance, when driving during nighttime conditions, our visual systems depend more on a particular set of information sources, such as contrast and expectancy.

Contrast is of high importance for object detection. In order for an object to become detectable, it must have greater luminance than its background – i.e., luminance contrast (Krauss and Olson, 2015). Luminance contrast can be described as the difference in 'brightness' between a given object and its background. Luminance contrast plays a critical role in the detection and discrimination of visual information under lower illumination levels or poor visibility conditions, where other cues such as color, texture, and extended sightlines may be lessened or unavailable (Sprague et al, 2019).

2. Incident Reconstruction

This case study presents a forensic human factors investigation into a nighttime officer-involved shooting that occurred during a police response to a residential burglary alarm in Midland, Texas. The homeowner, awakened by his spouse and alarm system cues, discharged a firearm at an officer who had entered the residence through an unlocked front door. The primary question investigated was whether the homeowner had sufficient visual information to identify the officers before firing his weapon. Through a combination of validated photography, photometric testing, motion capture, and laser scanning, the analysis recreated the precise lighting, and biomechanical conditions present at the time of the incident.

2.1 Data Gathering

ESi performed an inspection of the subject premises and gathered various data– i.e., precise geometry of the subject residence via laser scanning, realistic human motion of the relevant human involved in the incident captured using Xsens motion capture system, and validated photography for an accurate representation of low-illumination conditions present during the subject incident. During the inspection, ESi documented the premises via photography and laser scanning, captured human motion data, and performed visual testing during low-illumination conditions to generate validated photography. The purpose of ESi's inspection and analysis was to gather sufficient data to answer the question of whether the homeowner had sufficient visual information to detect and identify the presence of the officers prior to the homeowner shooting his gun.

ESi utilized two FARO Focus laser scanners to capture precise 3-dimensional geometry of the subject premises. Laser scanners are used to document and preserve incident sites and scenes. The laser scanner provides a three-dimensional point cloud of the scene geometry. In this process, each point is assigned an X, Y, and Z coordinate in a known coordinate system. The FARO S350 has a 3-dimensional position accuracy of 2 millimeters up to 10 meters (FARO Technologies, 2016). The laser scanner also has the capability to take color photos of the scene and assigns a color to each of these data points. Numerous scans were conducted to capture data for the subject site location. This technique is widely accepted in the scientific community and has broad applications, including in virtual reality and accident investigation (Danhof, Müller, Meier, & Schneider, 2015; Eyre, 2015a; Eyre, 2015b; Webber-Youngman et al., 2019). This data was incorporated into ESi's analysis and 3-dimensional virtual animations.

ESi recreated the biomechanical motions of male and female homeowners and the male and female responding officers observed in the reviewed video evidence (Figure 1). The available video evidence allowed ESi to break down each step and motion with respect to time. To document the recreated motions, ESi utilized human surrogates and a motion capture system (Xsens Technologies, 2021). This allowed ESi to incorporate realistic human motion into the full analysis and 3-dimensional virtual animations (Metzler et al, 2007). Figure 2 shows a snippet of the human surrogates in motion capture suits. In addition, ESi documented and tested an exemplar flashlight of the same make and model as the one used by the responding officer during the subject incident (see Figure 3). The exemplar flashlight was sent to a photometry laboratory to capture its photometric distribution, and the resulting lighting pattern was provided as a ".ies" (IES) data file. IES files are in a format developed by the Illuminating Engineering Society and are commonly used in many industries and by most 3D animation software tools to simulate realistic lighting for a myriad of lighting situations. This was later integrated into the full analysis and 3D animations.

Figure 1. Frame extracted from synchronized video. This shows the moment Officer 1 directed a powered flashlight at the front door of the subject residence.

Figure 2. ESi team of investigators documenting biomechanical motions for the involved individuals within the home.

Figure 3. Exemplar flashlight the responding officers used.

3. Data Analysis

3.1 Validated Photography

The validated photography scientific methodology incorporates a calibrated gray scale chart to match the scene observations of a human observer. The chart used for this testing contained a set of circular targets in a calibrated gray scale, shown in Figure 4. The amount of illumination falling on the chart and the distance between the observer and the chart determines the number of circles visible to the observer. The observer then notes the number of circular targets observable, along with general observations of the surrounding environment (e.g., background illumination, the appearance of surrounding structures and/or nature). A set of bracketed photographs is captured at the time of the observations, providing for a set of nominal, underexposed, and overexposed digital images. Subsequently, the photographs with the exposure that match the actual observations made by the observer as closely as possible are selected. It is important to note: The validated photographs included in this report may not reflect the actual features and exposure levels of the original photographs. For instance, if viewed electronically via an uncalibrated computer monitor and/or under different brightness levels than those used to calibrate the photographs, these validated photographs may display different features and exposure levels (i.e., darker or brighter) from those originally intended, thereby resulting in a different perceived experience to an observer. Similarly, if viewed on a printed version, an uncalibrated printer may yield photographs that do not accurately represent the intended exposure of the photographs.

This type of photography allowed ESi to document all relevant light sources that would have contributed to the homeowner's ability to detect and identify objects under low-illumination conditions during the subject incident. For instance, Figure 5(A) shows the view that the homeowner would have had as he exited the master bedroom and walked past the living room. The only significant light source illuminating the nearby space would have been the relatively small "nightlight" plugged

into the lower portion of the wall on the left side of the photograph. The nightlight only partially illuminated the living room and small portions of the dining room. The rest of the hallway and portions of the house would have been under darker lighting conditions. Figure 5(B) shows the same view of the hallway as it would have been illuminated by the officer's flashlight.
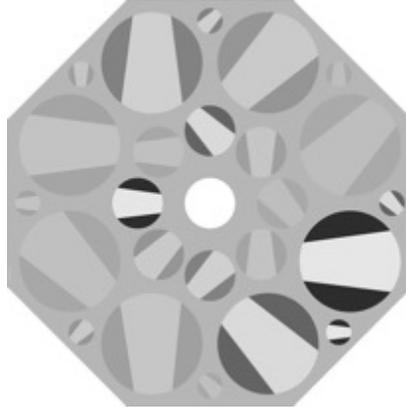

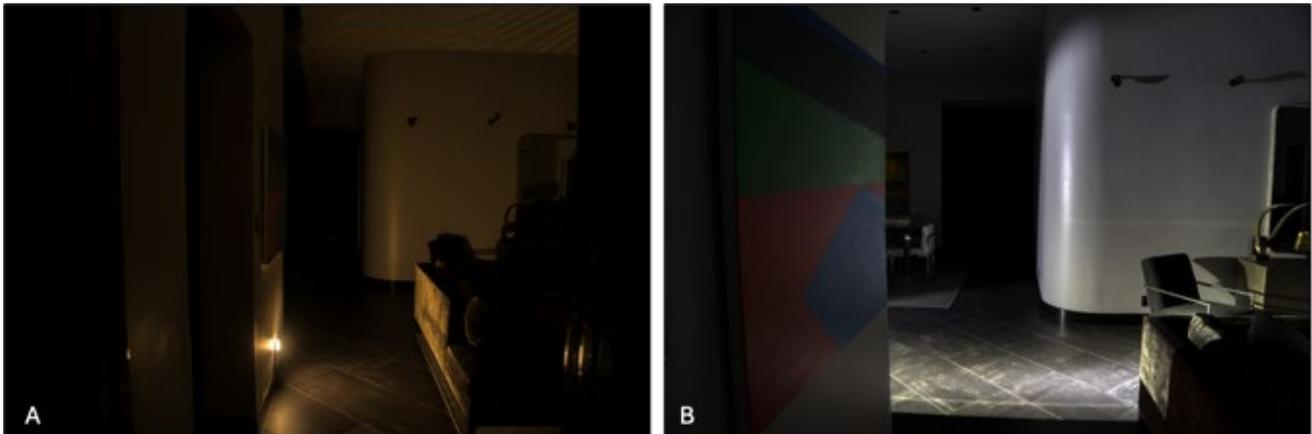Figure 4. Contrast-sensitivity chart used for validated photography.

Figure 5. Validated photograph of illumination available just outside the master bedroom (A). Validated photograph of illumination available just outside the master bedroom with light from exemplar flashlight added (B).[1]
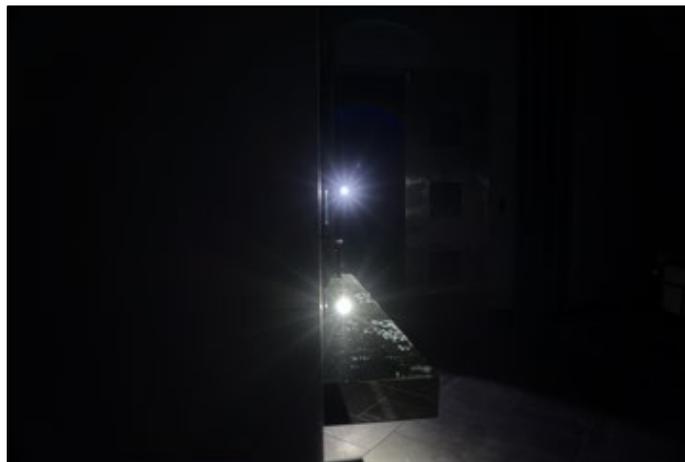

Figure 6. Validated photograph of the homeowner's view as he turned around the wall and prepared for shooting his gun.

3.2 Virtual Reconstruction and Animation

ESi developed a series of virtual animations. The purpose of these animations was to show a cohesive timeline of the event that occurred just prior to the shooting and to present an accurate representation of the visual information that would have been available to the homeowner prior to the subject shooting. A 3D animation of the events leading up to the male responding officer entering the subject home was created using the software program 3D Studio Max, which is developed and sold by Autodesk corporation. This animation was shown from several different camera views, some of which were compared to matching security camera views and was supplemented with an animated tutorial of the floor plan of the home.

The process of creating the animated visualizations began by creating a 3D computer aided design (3D CAD) model of the interior and exterior of the home. FARO Focus laser scans gathered during the site inspection of the home were converted to a polygonal mesh 3D CAD model and loaded into 3D Studio Max (3DS). This polygonal model was used as a template to create parametric 3D models of objects such as the walls, floors, ceilings, doorways, furniture, sidewalks, fences, foliage, etc., inside and outside the subject home. Site inspection photographs, police photographs, and aerial photos of the site available online were used to provide realistic colors and materials (such as carpet, concrete, etc.) for objects inside and outside the home.

3D CAD avatars were created to represent the male and female responding officers and the male and female homeowners in the animation. Anthropomorphic data supplied was used to make sure each avatar was the correct height and weight. The various security cameras, police photos, and body cam footage were used to approximate the clothing worn by each avatar. Motion capture data gathered by the ESi site inspection team was then used to assign motion to each avatar throughout the sequence of events. Events visible in both the interior and exterior security cameras were used to synchronize the motion of the police officers outside the home to the motion of the homeowners inside the home.

Virtual animated cameras were created in 3DS to match the views provided by the home's security cameras. This was done using the camera match utility inside 3DS. To do this, five or more points in the FARO Focus laser scans are assigned matching points in the security camera footage as seen from the camera being matched. 3DS then uses equations similar to those used by an optometrist determining the shape of corrective lenses to calculate the virtual lens parameters for the matching virtual camera. These parameters were given further adjustments in the camera editing interface to achieve a more exact camera match. These virtual cameras were then used to refine the motion of the avatars so that the motions more exactly matched the motions of the officers and the Wilsons in the security camera footage. The MotionBuilder software module for 3D Studio Max was used to edit the data received from the motion capture system to refine the match.

Since the security cameras that captured the events at the subject home were infrared, it was necessary to use other means to represent the lighting viewed by the officers and the homeowners on that night. To do this, virtual lights were positioned inside and outside the home model in 3DS to match their physical locations. The validated photographs and videos gathered by the ESi site inspection team were used to adjust the parameters of these lights to create matching virtual lighting. The IES file that was provided by the photometry laboratory was then loaded into 3DS and placed in the 3D CAD model representing the flashlight held by the responding officer.

In addition to the virtual security cameras already mentioned, an additional virtual camera was placed on the front porch to provide a wider view of the events recorded by the security cameras. Another virtual camera was placed outside and above the home to aid in providing a guided tour of the yard and entrance points to the home. Inside the home, an additional virtual camera was placed to provide a top-down view of the living room. Finally, an additional virtual camera was placed at the eye point of the avatar representing David Wilson to provide a realistic virtual view from his perspective.

3D Studio was then used to calculate, or render, 30 frames per second for each virtual camera described above for the sequence of events shown in the security cameras in addition to the virtual tour of the homes. Adobe After Effects was used to combine the frames for each camera into a movie file and to add any text or highlight graphics. In some cases, the infra-red security camera footage was edited together as an inset view with the realistic lighting view provided by the virtual camera. Final adjustments to the color and amount of light emitted by the virtual lights were then made to more completely match the light-balanced photos and videos supplied. Each animation was compressed and exported to a .mp4 movie file.

4. Findings and Results

ESi built a total of 6 virtual animations:

1. **Front Sidewalk View** shows a video of the events from outside the house looking towards the front door.
2. **Heidelberg v Wilson Overall** shows a chronological order of the event timeline from different perspectives.
3. **Living Room Cam with Security Footage** shows an overlay of animation and the subject security footage from the Wilson's residence.
4. **Mr. Wilson View** shows a view of the events from David Wilson's perspective.
5. **Overhead View** shows a bird's eye view of the subject events.
6. **Porch Cam with Inset** shows an overlay of animation and video from corresponding footage from the surveillance camera located at the front porch.

These animations were built based on the data gathered by ESi – i.e., precise geometry of the subject residence via laser scanning, realistic human motion of the relevant human involved in the incident captured using Xsens motion capture system, and validated photography for an accurate representation of low-illumination conditions present during the subject incident. The virtual animations developed by ESi show a cohesive timeline of the events that occurred just prior to the shooting and present an accurate representation of the visual information that would have been available to the homeowner prior to the subject shooting. From the resulting analysis, it was concluded that the incident occurred during nighttime conditions and under overall low-illumination conditions. The design of the subject front door included a series of windows with texturized glass that did not allow for the transmission of sharp outside images. Changes in light intensity and fuzzy shadows or silhouettes would have been the only stimuli transmitting through such windows. Such ambiguous stimuli would've been perceived and interpreted in a manner that heightened the homeowner's fear and further reinforced the belief that there was a threat, and Prior to shooting his gun, the homeowner would have not been able to detect and identify that the individuals at his front door were police officers due to the disparity in luminance contrast between the officer's flashlight and the dark outside environment.

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