Diagnosing Critical Incidents during Army Battle Drills

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ABSTRACT

Critical incidents such as injury, friendly fire, and non-lethal fratricide may occur in military training environments. While these incidents present valuable learning opportunities, quantitative performance data is often insufficient for understanding the root cause of such incidents. In-depth case studies can help overcome this issue by providing valuable qualitative, actionable data. The present study collected Army squad performance, firing, and communication data during a dry-fire battle drill as part of a larger research effort to measure, predict, and enhance Soldier and squad close combat performance. Soldier-worn sensors revealed that some of the top-performing squads committed friendly fire and a fratricide. Therefore, case studies were conducted to determine what contributed to these incidents. This paper provides insight into squad performance beyond quantitative ratings and underscores the benefits of more in-depth analyses in the face of critical incidents during training. Squad communication data was particularly valuable in diagnosing incident root causes. For the fratricide incident, the data revealed a communication breakdown between individual squad members stemming from a non-functioning radio. The specific events leading up to the fratricide incident and the squad's response will be discussed along with squad communication patterns among high and low-performing squads in the context of various critical incidents. We will examine how the conditions surrounding critical incidents and the underlying causes of those incidents can be recreated and manipulated in a simulated training environment, allowing instructors to control the incident onset and provide timely feedback and instruction.

ABOUT THE AUTHORS

Michael King, Ph.D., is a Human Factors Engineer II at Quantum Improvements Consulting. He has three years of experience managing a research lab in a university setting, focusing on the relationship between cognition and human skill and performance. Michael earned his Ph.D. in Experimental Psychology at Case Western Reserve University, where he researched the cognitive and perceptual factors that influence human performance, such as memory, attention, and learning. Michael has conducted field research on virtual reality training technologies for the Air Force, interfaced directly with industry clients to incorporate gamification elements aimed at increasing customer motivation, and conducted usability testing on a mobile application that promotes self-directed learning. Michael's research interests center around human performance, training, and the predictors of success in defense settings.

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INTRODUCTION

In high-pressure combat situations, the key to success for the Army often depends on successful team functioning, with communication being a vital prerequisite (Orasanu and Salas, 1993, Adelman et al., 1998, Entin and Serfaty, 1999, Svnesons and Anderson, 2006). Studies of team communication in relation to performance have a long history (e.g., Williges et al. 1966). This research shows that communication requires a concerted effort from all active team members to succeed. How well a communication system functions depends on its coordination potential and how it is implemented since these aspects of communication make information sharing possible. An effective communication system will maintain situational awareness to reach common task goals (Rafferty, Stanton, and Walker, 2010).

Critical incidents such as injuries, friendly fire, and fratricide are often difficult to understand in military high-intensity performance environments. Team communication becomes even more important when critical incidents occur, both on the battlefield and during training (Rafferty, Stanton, and Walker, 2010, Webb and Hewett, 2011). It is important to analyze why these incidents happened and intervene appropriately to help prevent them in the future. Fratricide is likely the most critical incident in the U.S. Army. An analysis of U.S. Army incidents during the Global War on Terror found teamwork and communication issues as prevalent causes of fratricide (Webb & Hewett, 2011). Therefore, analyzing team member communications surrounding critical incidents during realistic battle drill scenarios is expected to provide insight into their causes to inform human performance, training, and technological interventions.

Our team collected and analyzed squad communication data during two battle drills as part of the U.S. Army Combat Capabilities Development Command's (CCDC) Small Unit Performance Analytics (SUPRA) initiative. SUPRA and its parent program Measuring and Advancing Soldier Tactical Readiness and Effectiveness (MASTR-E) focus on enhancing Soldier lethality and maximizing tactical performance. Gathering audio data during battle drill iterations and analyzing squad communication in the context of performance metrics has provided valuable insights into squad behavior down to a granular level. It has allowed for an investigation of critical incidents during the drill, including a fratricide incident. The fratricide incident was broken down by shot data, communications, and anecdotal evidence to fully understand why the incident occurred and how it may be prevented in training and, ultimately, in the field.

METHODS

Performance Context

Data were collected in the context of Army squads executing Battle Drill 2A: React to Contact, which involves the squad locating and suppressing the enemy, establishing supporting fire, and assaulting the enemy position using fire and maneuver. The drill commences when the Alpha team, also known as the Support-by-Fire team, makes contact with the enemy. As soon as this occurs, the Alpha team is to produce suppressive fire that forces the enemy to keep their heads down, preventing that enemy from executing their mission. Suppressive fire presupposes a specific volume of coordinated firing from the Alpha team's M4s and Squad Automatic Weapons (SAW). There should be a continuous volley of shots fired toward the enemy's general direction at all times, forcing them to take cover (see point 1 in Figure 1). While the enemy is suppressed, the Bravo (i.e., Assault team) moves in (see point 2 in Figure 1) to flank either side of the enemy position (see point 3 in Figure 1). Before the Bravo team's assault, the Alpha team must shift their fire away from the direction of the intended assault and lift fire once the Bravo team moves in for the assault (see dotted line in point 1 in Figure 1). After the Bravo team has swept through the enemy position, the Alpha team follows to ensure the enemy has been eliminated.

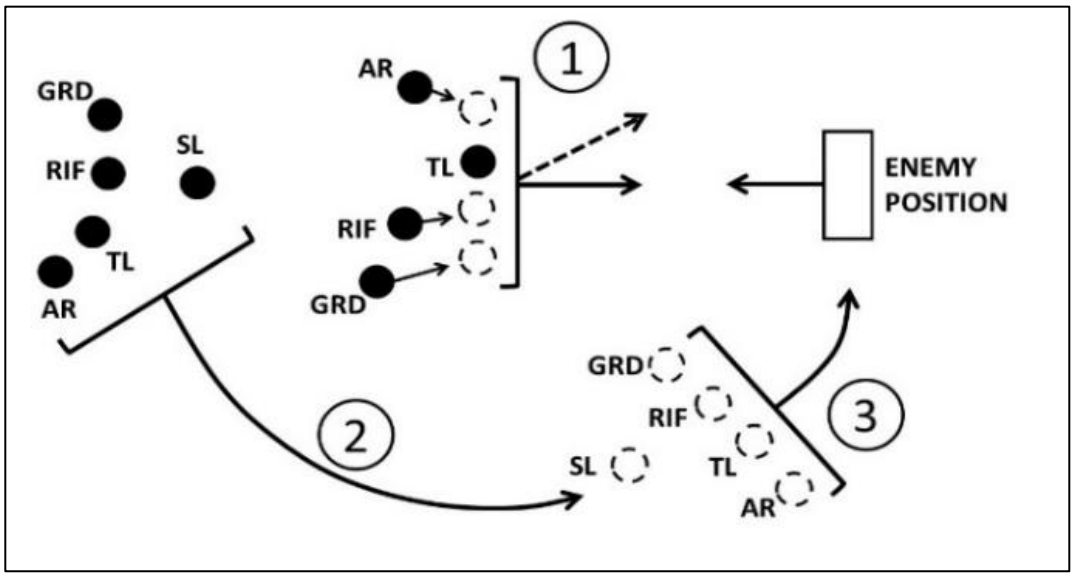

Figure 1. Depiction of BD2A.
For both Alpha and Bravo teams, SL: Squad Leader, TL: Team Leader, AR: SAW gunner, GRD: Grenadier, RIF: Rifleman (Alpha team is directly in front of the enemy position)

There are four main stages of BD2A: 1) Enemy initiates direct fire contact, 2) Alpha Team suppresses the enemy; Bravo Team prepares for movement, 3) Bravo Team maneuvers on the objective; Alpha Team supports by fire, and 4) Bravo Team conducts assault; Alpha Team conducts second wave assault. Based on a task analysis that involved a review of doctrine, training publications, research literature, and subject matter expert (SME) discussions, we extracted specific communication actions associated with each squad position during BD2A.

Participants

A typical Army Infantry squad comprises nine members, consisting of a squad leader, a Support-by-fire (SBF) team, and an Assault team, each of which has a team leader (TL), automatic rifle gunner (SAW), grenadier (GRN), and rifleman (RIF). Data from seven squads and their performance over three iterations of BD2A was collected. For this paper, we will focus on the analysis of one squad's iteration of this drill, which we will denote as Squad X to maintain anonymity. Squad X was selected because it was rated as the highest-performing squad among all seven squads and because a critical incident occurred during the squad's second iteration of the drill. The contrast between the squad's high-performance level and the critical incident occurrence made Squad X a particularly interesting case study.

Data Collection Methods

The data collection focused on the verbal communications of squad members. These communications were recorded by emplacing throat microphones on Soldiers connected to a recorder attached to their body armor. Recorders were synched by ensuring all recorders were started simultaneously and blowing a whistle to indicate drill start. The synching of recordings is essential so that communications from each squad member can be compared and pieced together while on the same drill timeline. The squad and the opposition forces (OPFOR) used blanks and wore multiple integrated laser engagement system (MILES) equipment that captured how often they were shot at and how lethal those shots were. Observer Controller (OC) subject matter experts (SMEs) evaluated squad performance during BD2A based on established criteria.

Data Processing Methods

Audio files were trimmed, cleaned, processed through speech-to-text software. Speech-to-text outputs were organized into an Excel sheet based on squad position and time. Two researchers then listened to the audio while reading along with the speech-to-text output and either confirmed or edited each line of dialogue to ensure an accurate transcription

for each squad member. Once each line of dialogue for each squad member was verified for accuracy, transcriptions were combined to create one flow of communication for the entire squad.

CRITICAL INCIDENT ANALYSIS

Squad X was initially interesting due to their high-performance scores. Squad X was rated as the highest-performing squad in terms of Training and Evaluation Outlines (T&EO) and subject matter expert (SME) observation ratings. However, we looked closer at their Multiple Integrated Laser Engagement System (MILES) data and saw that they were the only squad that recorded a fratricide event. This occurred during their second drill iteration, their second-highest-rated performance score among all three iterations, and the fourth-highest-rated iteration out of 21 iterations among seven squads. Our question was, how could this have happened to such a high-performing squad? What went wrong during this drill that was otherwise a textbook performance? To answer these questions, we took an in-depth case study approach to understand better how and why this incident occurred, what lessons could be learned from this, and how this can be applied to future training initiatives. The first step was to understand Squad X's performance from a high level.

Performance Analysis

The metrics used to determine the highest performing squads are Average OC Weighted Points Scored, Squad Talking the Guns Ratio, and Squad Firing Rate. The Average OC Weighted Points Scored is a weighted aggregate of scores on 13 constructs by all the SMEs who assessed the squad from different viewpoints. Constructs include communication, control, cover and conceal, fire effectiveness, information exchange, leadership, planning, rehearsals, security, simplicity, speed, surprise, violence, and weapons handling. Talking the Guns Ratio measures a squad's indirect coordination during firing. It is the ratio of time that squad members are actively firing their weapon over the time that squad members are not firing due to inactivity. The idea behind this metric is that to maintain fire superiority over the OPFOR; the squad should be laying suppressive fire with as minimal inactivity as possible. While one squad member reloads their weapon or fixes a malfunction, the other squad members should be firing to maintain the constant fire. This measures the squad's implicit coordination of fire. Squad Firing rate is the combined average firing rate of all squad members measured in rounds per minute.

Squad X completed the battle drill in 17 minutes and 57 seconds in their 2nd iteration. See Table 1 for a breakdown of the duration of each battle drill stage for Squad X.

Table 1. Squad X, 2nd Iteration Drill Stage Times

Stage	Duration
Approach to Contact	00:00-08:56
Contact to Assault	08:56-12:20
Assault on the Objective	12:20-14:45
Post-assault	14:45-17:57

The SMEs rated Squad X as the highest-performing squad, based on the Average OC Weighted Points Scored, compared to the six other squads. On their second iteration, Squad X had the fourth-highest overall drill rating out of 21 total drills across all seven squads. Squad X had the highest average Talking the Guns score among all seven squads, with an average of 15.79 (SE = 4.7). For every 1 minute of inactivity from the squad in terms of firing, they had 15.79 minutes of firing time. Squad X had a Talking the Guns score of 18.94 in their second iteration, the highest score out of 21 iterations among seven squads. Squad X had an average firing rate of 250.52 rounds per minute, the third highest among all seven squads. Squad X had a firing rate of 282.79 rounds per minute in their second iteration, which is the second highest firing rate in an iteration out of all 21 iterations among seven squads.

Communication Analysis

Taking all performance metrics into account, Squad X was the highest-performing out of all seven squads. However, the performance metrics and other quantifiable scores provide only partial information and do not reveal what team processes and behaviors contribute to this performance. The squad transcriptions from the battle drill iterations give a "play-by-play" of the drill events and how each squad member reacted in their own words. The transcripts reveal

trends and patterns that further explain performance differences among squads. The drill can be broken down by stage, problems during each stage can be identified, and the squad's response to these problems can be analyzed. Breaking down the transcriptions in terms of drill stage can expose where squads have communication breakdowns and help trainers understand where an intervention may be most beneficial.

The in-depth analysis of Squad X uncovered a fratricide incident during their second BD2A iteration. Despite Squad X being the highest-performing squad, friendly fire and fratricide are critical mistakes that, if not addressed in training, can have dire consequences in the field. During this iteration, the Squad Leader (SL) had significant issues with their radio, particularly while trying to communicate with the Bravo Team Leader (BTL). A critical action of this drill occurs when the firing team shifts their fire away from the OPFOR to allow the assaulting team to assault through and eliminate any remaining OPFOR. The period of the drill where the shift fire occurs is dangerous, as the flanking team is moving towards where the support by the fire team is laying suppressive fire. The fire team must shift their fire away from where the flanking team is moving in. The SL attempts to radio the shift fire command to the BTL, whose team is laying suppressive fire. The SL could not communicate with the BTL via radio to inform them that the assaulting team was beginning their assault and that the firing team needed to shift their fire. The comms eventually reached the BTL, but not until late in the movement, and a member of the Alpha Team was shot in the back as a result. Fortunately, this was just a dry fire exercise, and no one was actually shot or killed though the implications for training are still major.

The communication data from Squad X allowed the research team to analyze how and why the fratricide incident occurred. During this drill iteration, the SL designated the Alpha Team as the flanking team and the Bravo Team as the SBF team. This designation is notable because it was one of the few times across the 21 drill iterations that the Alpha Team was not the SBF team. It is unclear why exactly the SL made this decision from the transcriptions. It also appears that the SL was traveling with the Alpha Team on their maneuver based on the radio communications between the BTL and SL We can see from early in the drill that the SL and the BTL were having communication issues (see Figure 2).

Position	Timestamp	Comms
SL	[00:10:23	Bravo be advised Alpha flanking New York New York. How copy over.
SL	[00:10:31	He can't hear me.
BTL	[00:10:31	[NAME] pick up rate of fire
SL	[00:10:32	Stay down, stay put. Keep fire on them
ATL	[00:10:35	Keep shooting at them!
ASAW	[00:10:38	I see him!

Figure 2. Squad X Communication Issues Between the SL and BTL

At 10:23 in the drill, the SL attempts to communicate the Alpha Team flanking plan, but the communication is either not received or not acknowledged by the BTL. When the squad is ready to shift fire, the SL again has issues communicating with the BTL (see Figure 3). The Alpha Team is moving toward the objective, the point in the drill when the Bravo Team must shift their fire away from the Alpha Team. The BTL does not receive the SL's shift fire call [12:20] until the SL yells it [12:29] after failing to communicate via radio nine seconds after the initial call. The Bravo Team echoes the BTL's shift fire call, with the BGRN shifting fire two seconds after hearing it from the BTL, at which point the BGRN hits the ASAW in the back with a fatal simulated shot.

SL	[00:12:20	Bravo, bravo shift fire shift fire? How copy over?
BSAW	[00:12:23	I'm black!
BRIF	[00:12:23	I got eyes on!
SL	[00:12:29	Shift fire!
BTL	[00:12:29	Shift fire shift fire
BRIF	[00:12:30	Shift fire!
AGRN	[00:12:31	Malfunction!
BSAW	[00:12:31	Shift fire shift fire!
BGRN	[00:12:31	Shift fire shift fire!
ASAW	[00:12:33	Someone see who shot?
BTL	[00:12:33	left left left
AGRN	[00:12:36	Shift fire.
SL	[00:12:38	Shift fire!

Figure 3. Squad X Shift Fire Communications

When the fratricide occurred, the Bravo Team was providing suppressive fire while the Alpha Team was flanking the OPFOR, ready to assault through the objective. The firing data (Figure 4) and MILES data at 733 seconds into the drill (12:32) reveal that the BGRN shot the ASAW. Nobody but the Bravo team shot between 720 seconds and 747 seconds. The incident occurred when the Alpha Team was on its feet, moving through the objective.

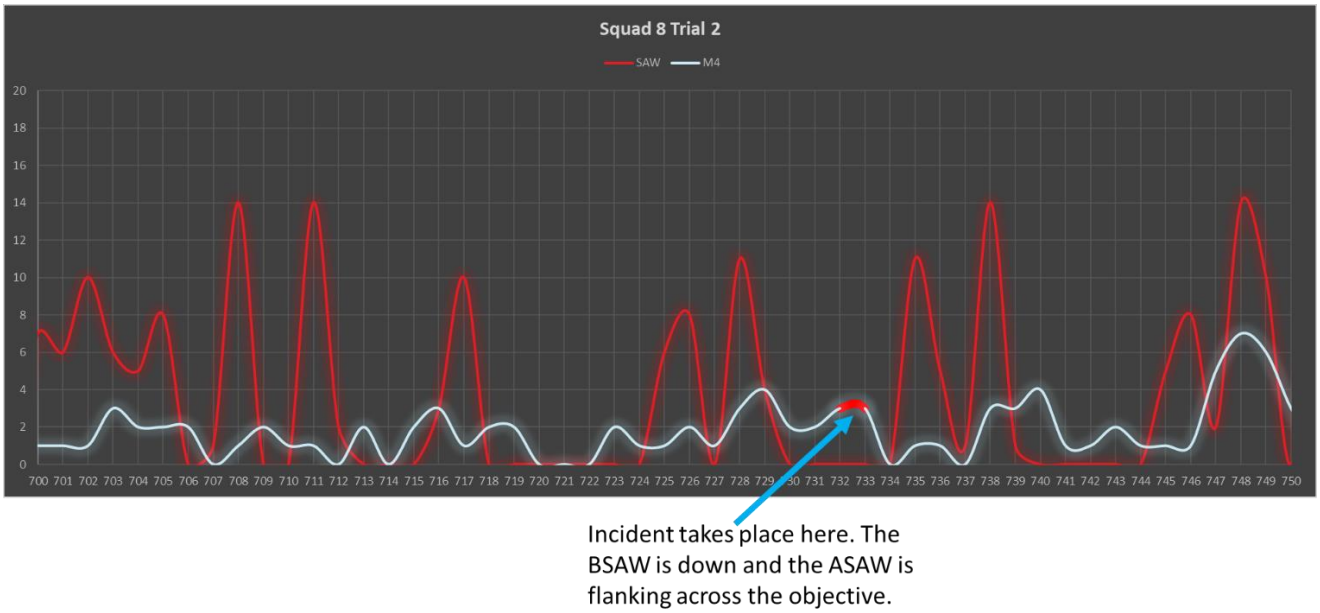

Figure 4. Squad X Firing Data. The red lines represent the SAWs firing rate over time, and the white lines represent the M4s firing rate over time.

The BTL, BRIF, and BGRN all shot at 733 seconds into the drill, but the BGRN was the only one to shoot the ASAW. The BGRN does not shoot again until six seconds later, at 739 seconds into the drill. Only the BSAW and the BTL shot for the next six seconds after the incident occurred.

DISCUSSION

Squad performance can be a complex construct to evaluate using typical performance metrics alone (SME ratings, firing rate, etc.). Examining the communication flow among the team can provide additional information about how a team performed and why some events occurred during the drill. Squad communications can provide valuable insight

into squad member actions and decisions, especially when incidents occur. The squad analyzed in this paper was an interesting case given the contrast of being the highest performing squad while also committing fratricide in the dry fire exercise. Using transcriptions from the recordings taken during the drill, the research team could analyze the fratricide event, understand how it occurred, and possibly where this otherwise high-performing squad went wrong.

The in-depth analysis of squad communications has proven effective for evaluating squad functioning and analyzing incidents that occur during training. By collecting and analyzing squad-level communications, we can better understand why incidents occur, even among the most elite of squads. Ideally, the insights prevent such incidents from happening again in training and, most importantly, in the field. Getting to the root cause, such as a malfunctioning radio, of critical incidents can inform training and human factors solutions. In this case, a remedy of communication checks at key points in the drill or radio status indicators may have been effective. Knowing how squad members communicate can inform squad composition to facilitate optimal communication, teamwork, and performance.

The present study highlights the need for training to assess squads beyond the surface level of performance in the field. Squad X was a high-performing squad based on their battle drill performance. If this were a training event outside of the SUPRA study confines, the review of Squad X would likely have ended at the initial performance evaluation and the critical fratricide incident would not have been uncovered. Squad X would have appeared as well-trained and ready. The rich data collected in this study underscores the importance of looking past the quantitative results of a training event and diving deeper into the data to uncover underlying issues that can cause extreme incidents.

Murphy's Law states that "anything that can go wrong will go wrong." The results of this study highlight the importance of training and preparation to deal with the things that can go wrong. Simulating the performance environment and replicating conditions in live or virtual training is an effective way to prepare Soldiers for dealing with unexpected, challenging situations. In a live training environment, like the SUPRA study, instructors may take a passive approach, letting the scenarios and challenges play out naturally, capturing the data, and tailoring feedback based on the outcomes. In a virtual environment, instructors can take a more active approach, exerting more control and manipulating the scenario, scheduling incidents, analyzing the team's response, and providing feedback accordingly. One benefit of the active approach is that it allows for more tailored training that adapts to the squad based on their experience level and performance. Instructors can control incident onset and intensity, providing appropriate scaffolding commensurate with the squad's experience level. A communication incident like the one described above can be introduced to challenge a high-performing team like Squad X. Conversely, the virtual scenarios can lack the realism of live scenarios with naturally occurring incidents. Regardless of the approach, Squads need to train on reacting to unforeseen adverse events, and instructors need access to actionable data surrounding those events.

By incorporating communication data into training and squad composition decisions, instructors will be better equipped to analyze Soldier behavior and potentially decrease the frequency of incidents, especially those as dire as fratricide. Future work will focus on continuing to collect and analyze communication data during squad battle drill exercises to build a more robust set of critical incident cases and inform training and performance improvement interventions. The present study can inform future research on team processes and effectiveness in real-world performance environments.

ACKNOWLEDGEMENTS

This research was sponsored by the U.S. Army Combat Capabilities Development Command - Soldier Center (CCDC SC). The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of CCDC-SC or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation hereon. The authors would like to thank Ms. Meghan O'Donovan and Mr. Lee Hancock for their support and vision in executing this project.

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