Journal of Human Performance in Extreme Environments

Volume 7 | Issue 2 Article 12

Published online: 10-1-2003

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Recommended Citation
Smith, Kip (2003) "The Adverse Impact of Remote Command and Control under Live Fire," *Journal of Human Performance in Extreme Environments*: Vol. 7: Iss. 2, Article 12.
DOI: http://dx.doi.org/10.7771/2327-2937.1037

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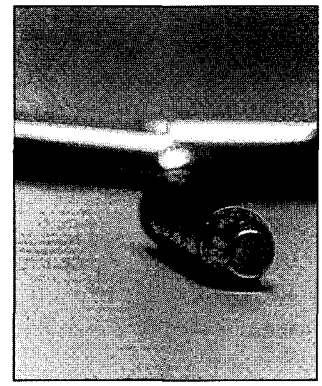
The Adverse Impact of Remote Command and Control under Live Fire



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The US Army is planning a shift in the mode of command and control between soldiers and their battlefield leaders. Soldiers will receive orders from afar through electronic means of communication. This practice is known as remote command and control. Reliance on remote command and control has the potential to erode trust between soldiers and their leaders and should, we hypothesize, slow soldiers' response times to commands to move and to shoot. We have conducted two field experiments to test this hypothesis (Pangburn, Freund, Pangburn, & Smith, 2003). Our laboratory was a paintball assault lane. While a paintball lane is not actual combat, we have found that its live but non-lethal fire makes it an effective and ethical laboratory for studying the behavioral and cognitive effects of stress induced by live fire. Participants were exposed to two conditions of communication mode, leader-present (face to face) and leader-remote (two-way radio). The contrast between participants' response times to commands to move and to shoot was statistically significant and was consistent with the predicted decrement in the remote command-and-control condition.

To use a term coined during the recent invasion of Iraq, trust emerges because the leader has been 'embedded' in the unit.

Introduction

The pervasive specter of death makes the battlefield a prototypical extreme environment. Troop survival requires vigilant and efficient teamwork, effective leadership, and the sporadic madness of heroism. The effectiveness of a battlefield leader is a direct function of the trust felt by the members of the fighting unit. Trust in the leader makes the battlefield feel less extreme, promotes teamwork, and encourages heroism.

The link between a battlefield unit and its immediate leader has traditionally been verbal and direct. Face-to-face contact and mutual hardship have long been the forge of trust. To use a term coined during the recent invasion of Iraq, trust emerges because the leader has been 'embedded' in the unit.

For soldiers in the U. S. infantry and their immediate leaders, this foundation of trust is about to disappear. The battlefield environment will soon become even more extreme.

The fundamental change is in the mode of communication between soldiers on the battlefield and their immediate leaders. One of the cornerstones of the U. S. Army's plan for modernizing the infantry is to have soldiers on the battlefield receive orders from afar through electronic means of communication. This practice is known as 'remote command and control.' The soldiers who will operate under this plan will no longer take their battle commands from a leader standing within visual range. The only connection with their commanding officers will be their radios or other electronic information devices.

We suspect that this fundamental organizational change is likely to do more than remove the leader from the battlefield. It will also erode the development of common ground (Clark, 1996) between soldiers and their leader. We expect the erosion of common ground to have profoundly negative implications for the development of trust and for the effectiveness of the fighting unit.

Common ground is special form of intentional thinking (e.g., Dennett, 1997). You have an intentional thought whenever you think about another person's (or group's) thinking. You and another (person or group) have common ground whenever you both know what each other knows and you both know that each other knows it (Clark, 1996).

http://dx.doi.org/10.7771/2327-2937.1037

This mutual knowledge of a shared representation of information is the essence of common ground. The military works troops hard during basic and more advanced training so that they may develop common ground through mutual hardship and interdependence. Common ground has traditionally been the glue that holds a fighting unit together.

We believe that common ground works to support the development of trust in a leader and in the leader's authority. A leader who is (and has always been) in the field with his troops should have more credibility than an absent or remote leader. Accordingly, the use of remote communication can be expected to degrade or eliminate the mutual knowledge of a shared representation of information and, as a result, the leader's ability to exercise authority. We hypothesize that the lack of a basis for common ground will be reflected in slower reaction times when commands are given remotely via electronic devices than when they are given face-to-face.

In the two experiments presented here, we test this hypothesis in an ecologically valid simulation of the battlefield environment, namely, a paintball assault lane.

Method

Participants

Forty-two college students, five women and 37 men, drawn primarily from an introductory psychology class, volunteered to spend a Saturday afternoon playing paintball on our simulated assault lane. The average and median age was 19 with a range of 18 to 26. All signed informed consent forms and liability releases. All participants were treated according to APA guidelines.

Design, Measures, and Task

We manipulated leader presence at two levels (present and remote) in a within-subjects design. We measured the participant's response time to the leader's commands to move and to shoot. We predict slower response times in the leader-remote condition. We expect that the effect of leader presence will not be strong under normal circumstances, but that it will emerge in the relatively extreme environment of simulated combat.

The simulated combat environment in this study is a paintball assault lane, Figure 1. The lane consisted of eight protective stations behind which the participants could hide. At the end of the lane was a fortified position where a sniper was positioned. The sniper's task was to shoot participants as they moved up the lane. The participants advanced through the lane one at a time. Each participant had two tasks. The first task was to move from station to station up the lane in response to the command to move. The second task was to shoot targets in response to the command to shoot. Statistical analysis used a within-subjects t test of the mean difference in response times between the leader-remote and leader-present conditions. The response times to commands to move and shoot were recorded by an observer using a stopwatch.

For the first experiment, the US Army provided access to the 25 ft x 200 ft building at Range 52, Fort Riley, Kansas, home of the US Army 1st Infantry and an active training center for artillery. We set up our paintball assault lane in this building. As shown in Figure 1, the lane consisted of a staggered series of eight 'stations' behind which the participant could take cover. At the far end of the lane, a 'sniper' hid behind a screen of netting and protective cover. As this experiment was conducted inside a

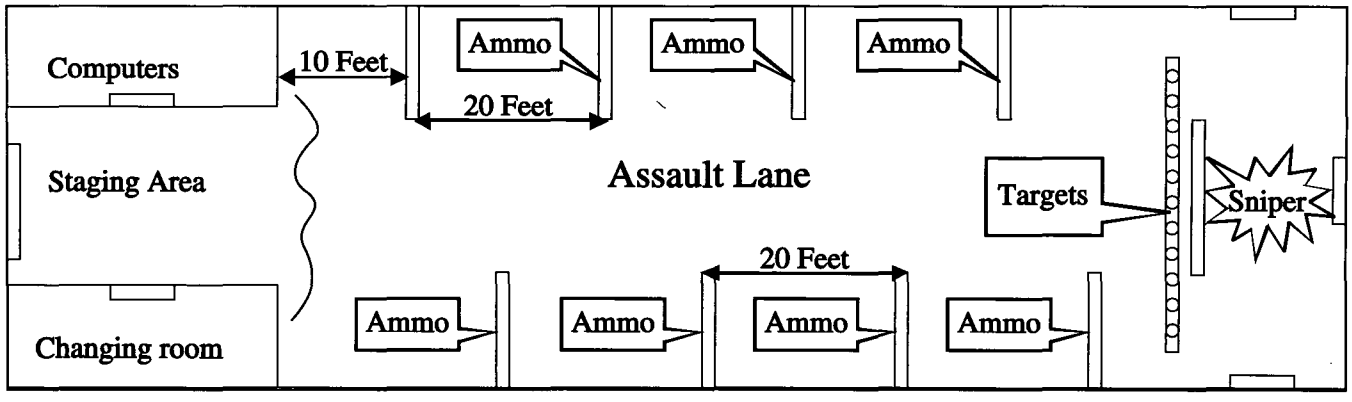

Figure 1. The layout of the paintball assault lane.

building with many windows, the leader in the remote condition was able to be completely out of the participant's sight while still able to view the assault lane.

Twenty students participated in the first experiment. Attendance was limited because a one-way trip to Fort Riley took 45 minutes and required passing through a security gate and a variety of active firing range complexes. All told, the experiment took at least four hours of the participants' time. In the interest of time and efficiency, we moved the second experiment to an on-campus facility (Quinlan Gardens). The setup was exactly the same as the lane in Figure 1 with one exception. The lane was set up in a small field rather than in a building. Twenty-two students participated in the second experiment.

The change in setting from inside to outdoors made the leader-remote condition in Experiment 2 less remote. In the leader-remote condition, the leader was approximately 100 yards behind the lane but still visible if the participant chose to look. In both experiments, all communication in the remote condition was by two-way radio.

Materials

Participants were given one paintball marker (gun), one set of US Army fatigues, a set of elbow and kneepads, and a paintball face shield. In the leader-remote condition, participants were also given a two-way radio and instructions on its use.

Procedure

When participants arrived at the lane, a uniformed soldier presented them with a standard battle-dress uniform and asked them to put the uniform on. The participants were then introduced to their leader, an army officer. The leader briefed them using the official military Operations Order format and addressed them by their last names. They were then told to assemble in a staging area where they could hear the activity in the assault lane while they waited their turns. All of this was purposefully done to immerse the participant in the experiment and to heighten the sense of realism and their anxiety.

While waiting, participants were instructed on the safety and use of the paintball markers and read a briefing. Participants were sent down the lane individually. Whenever the participants took aim at the targets or moved between stations, they exposed themselves to the sniper's fire. Participants were instructed to attempt to shoot enemy targets without hitting friendly targets. No measures were made of firing accuracy because our hypothesis concerns the participant's reaction time to commands given by the leader and says nothing about their marksmanship. The shooting task was created only to give focus to the participant's activity and to enhance the feel of a combat environment.

A small container with five paintballs was placed at each of the eight stations. The 40 paintballs in the eight containers were the participant's only ammunition. The participant started at one end of the lane, shown by the X in Figure 1. At this station and all subsequent stations, the leader gave the participant the command "Fire" when he judged it to be safe to do so. The time elapsed from the issue of the command to the first shot fired is the first dependent measure.

When the participants ran out of paintballs, they reported "Out of ammo" to the leader, who then gave the command "Move" when he judged it safe to do so. The participants had to move across the lane to the next station and immediately pick up its container of five paintballs. The time elapsed between the issue of the command to move and the time the participant's hand first touched the new supply of ammunition was the second dependent measure. When the participants finished loading, they reported "Loaded" to the leader who then started the cycle over again with the command "Fire." To measure reaction time, an observer would shadow the participant and record elapsed time with a stopwatch. Although we assume this method was accurate and effective, in the future we hope to record these data using biometric telemetry.

In the leader-present condition, the leader was one station behind the participant. In the leader-remote condition the only contact between the leader and the participant was by two-way radio.

Every participant ran through the lane twice, once with the leader physically present and giving orders, and once with the leader viewing the lane from a remote location and giving orders through a two-way radio. The order of conditions was counterbalanced across participants.

The study was intended to generate some anxiety so that the measures would more readily generalize to the battlefield. The major sources of stress were the fear of being shot and actually being hit by paintballs. The pain associated with being struck by a paintball is slight but sudden and intense. Protective gear minimizes the risk of injury. A registered nurse received remuneration for being on site throughout the experiment.

Results

The purpose of this study was to test whether we can observe any effect of leader presence on command and control in a simulated combat environment. The participants were exposed to two conditions, leader-present (face-to-face) communication, and leader-remote (two-way radio) communication.

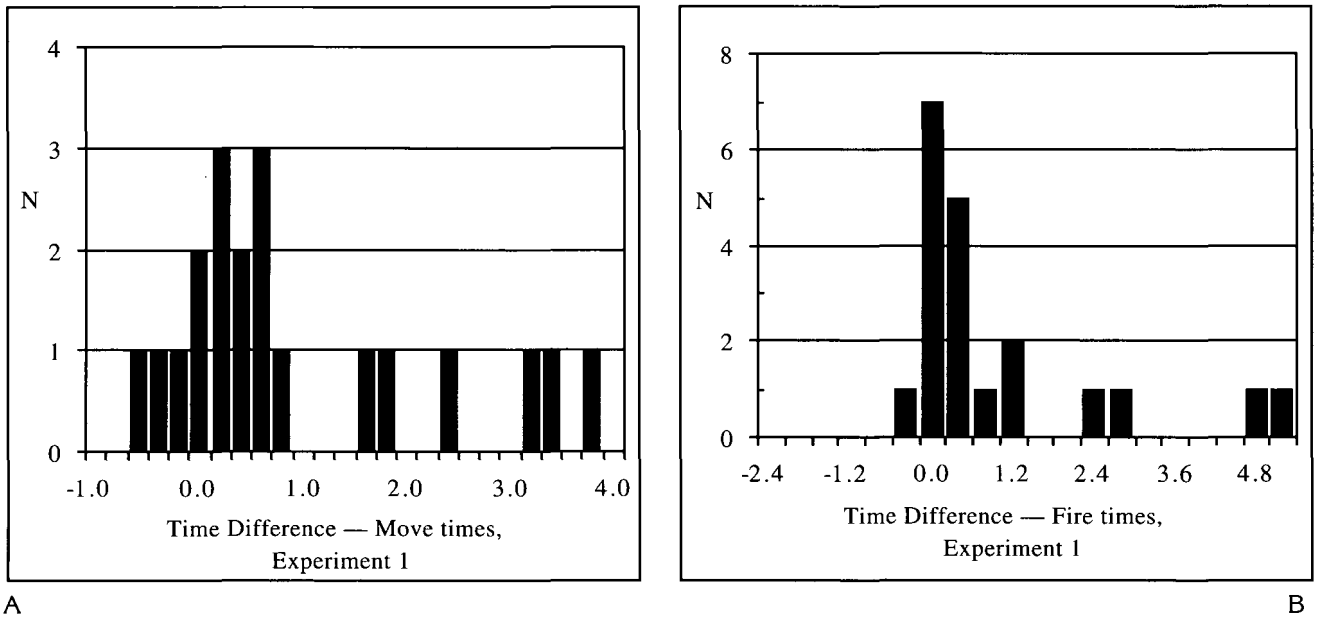

Figure 2. *(a) Histogram of the average differences in participants' response times to the command to move in Experiment 1. Data are calculated as the time to move from one station to the next in the leader-remote condition less the time in the leader-present condition. (b) Histogram of the average differences in participants' response times to the command to fire In Experiment 1.*

Experiment 1

Figure 2a is a histogram of the within-subject difference in response times to the command to move for the participants in Experiment 1. The difference is calculated by subtracting the average of the times observed in the leader-present condition from the averages of the times observed in the leader-remote condition. Of the 20 participants, 15 took longer to move in the leader-remote condition than in the leader-present condition. A within-subjects t test for these data, $t(19) = 2.958$, $p < .004$, indicates that response times to the command to move were significantly longer in the leader-remote condition.

Figure 2b is the histogram of the within-subjects difference in response times to the command to shoot. The data are, once again, calculated by subtracting the time observed in the leader-present condition from the time observed in the leader-remote condition. Of the 20 participants, 12 took longer to shoot in the leader-remote condition than in the leader-present condition. A within-subjects t test for these data, $t(19) = 2.317$, $p < .016$, indicates that response times to the command to shoot were significantly longer in the leader-remote condition.

Experiment 2

Figures 3a and 3b are histograms of the within-subjects difference in response times to the commands to move and to shoot, respectively, for the participants in the second experiment. The data are calculated in the same way as those shown in Figure 2. Of the 22 participants, 16 took longer to move in the leader-remote condition than in the leader-present condition. A within-subjects t test for the move data indicates that the difference is significant $t(21) = 2.798$, $p < .006$. Of the 22 participants, 15 took longer to shoot in the leader-remote condition than in the leader-present condition. A within-subjects t test for the fire data indicates that the difference is significant $t(21) = 2.211$, $p < .020$.

Given the similarity of the two experiments' results, it appears the subtle difference in the degree of remoteness of the leader across the two experiments did not have a significant impact on response times. The similarity also allows us to aggregate the data. The test on the composite move data is significant $t(41) = 4.122$, $p < .0001$. The test on the composite shoot data is also significant $t(41) = 3.218$, $p < .0013$. These results support our hypothesis. Participants were faster to react to the leader's commands when the leader was present than when the leader was remote.

Discussion

The two experiments reported here are the first in a planned series of studies on leader presence and com-

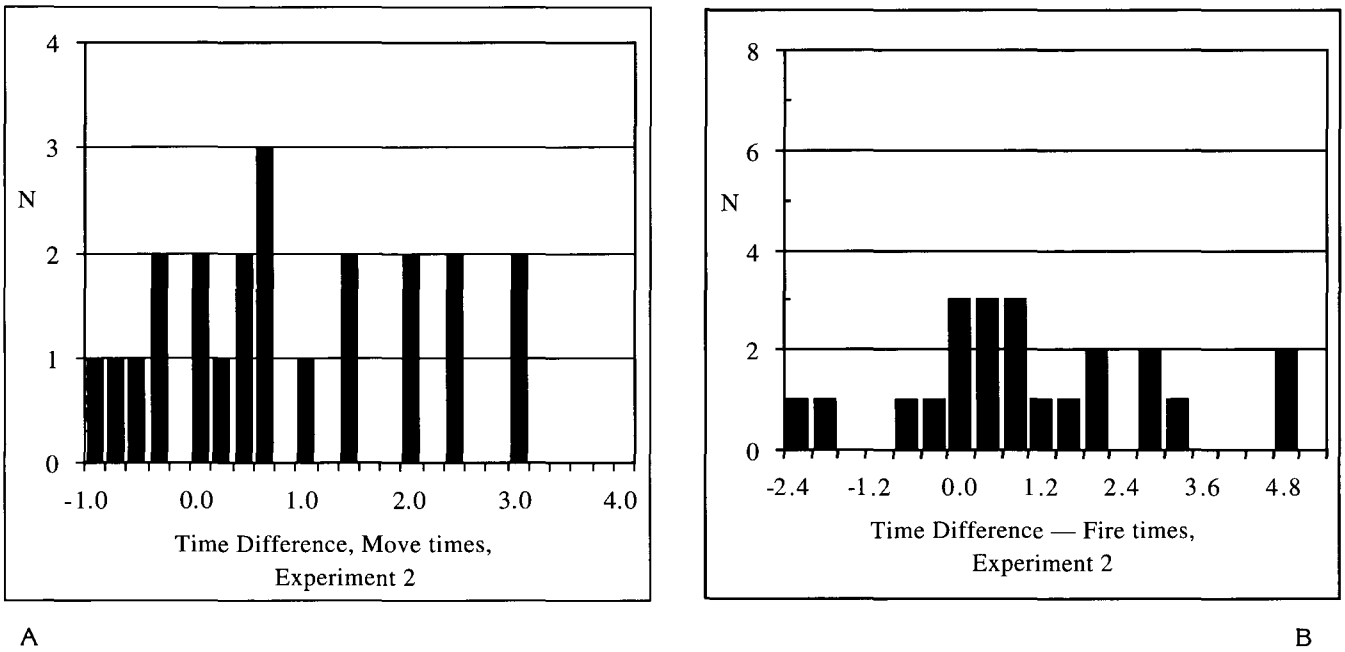

Figure 3. *(a) Histogram of the average differences in participants' response times to the command to move in Experiment 2. (b) Histogram of the average differences in participants' response times to the command to fire In Experiment 2.*

mon ground. Common ground is the foundation for the development of trust not only between troops and their leader but also among individuals. The battlefield is an extreme environment that serves as a metaphor for (too much of) everyday life. Understanding the impact of the erosion of common ground on the battlefield may suggest constraints for the design of tools and information devices that facilitate the development of common ground and, eventually, trust. This is our long-term goal. In the short term, data acquisition is continuing in a paintball assault lane in Sweden. We are now using automated biometric telemetry to eliminate the possibility of observer error in the measurement of response times and to assess psychophysiological indicators of stress.

In Praise of the Paradigm

It is simply not possible to simulate a combat environment in a laboratory. Our desire for ecological validity forced us to work outside the normal laboratory setting. For the first experiment, our assault lane was set in a building on an active Army base. The lane in the second experiment was set up in a lightly wooded field on campus.

Embedding experimental controls in a simulated combat environment is a new concept in human factors research. To attain ecological validity, we immersed participants into a pseudo-military environment by providing military uniforms, speaking in military command style, and by keeping the age group in line with that of the military. This procedure gives us the ability to generalize the results of the experiments to real-world battlefield settings.

Admittedly, paintball is not actual combat and our assault land cannot be said to be a truly extreme environment. Unlike a battlefield, the paintball assault lane allows us to exercise experimental control. However, it retains viable levels of several battlefield stressors including interactive hostility and the unannounced onset of sharp pain. The presence of these and other stressors makes the paintball lane an excellent natural laboratory for investigating the extreme environment faced by battlefield soldiers.

In addition to its face validity, the paintball paradigm has two highly desirable features. First, the availability of commercial paintball facilities make it possible for others to replicate and expand upon these and future experiments. Second, because paintball is a recreational activity (for the young), it has an ethical neutrality that makes it acceptable (if not palatable) to most members of Institutional Review Boards. This in itself is a coup. Paintball opens research on battlefield stressors to the scientific community at large.

Author Note

The views expressed in this work are those of the author and do not necessarily reflect official Army policy. This work was supported by the DOD Multidisciplinary University Research Initiative (MURI) program administered by the Army Research Office under grant DAAD 19-01-1-0621. Dr. Elmar Schmeisser is the project monitor. The credit for conceiving these experiments and for their success goes to 2nd Lt. Keith Pangburn.

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