Introducing a Non-Vocal Parallel Feedback System into a Simulated Combat Situation

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The non-verbal signals which in direct face-to-face communication indicate a request for clarification are lost in vocal radio communication where every request must be expressed verbally. However, such an expression entails a social cost which reduces the number of requests. Our hypothesis states that this cost can be reduce by supplying a secondary, non-vocal channel. To test this we introduced a parallel non-vocal radio feedback channel in to a simulated combat situation. In the experiment we measured the number of requests for clarification and the number of mistakes. No significant difference was found, which we attributed to methodological issues, but we believe that there are good reasons for continuing research on this issue.

Introduction

Failure to communicate can be not only costly and time-consuming but actually lethal if such a failure should occur in a situation where a decision based upon said information could be the difference between life and death. Whether it be fire-fighters entering a burning building, soldiers in a combat zone or rescue workers co-ordinating a rescue operation, swift, efficient and error-free communication is of the utmost importance. Very often though such situations severely restrict the available modes of communication for various reasons, one of these is that direct contact is seldom possible. Because of this the most common medium today is vocal radio communication. Radio communication is a positively ancient form of communication compared to other modern communication forms and has not changed much in the last hundred years. Most vocal radio communication is still half-duplex and single channel, meaning that only one party may transmit at the time, but all other parties can listen. A number of issues are associated with this kind of vocal radio communication.

As shown by Kip Smith and Keith Pangburn (2004) distance to a leader decreases performance in simulated combat situations. This result may imply that a number of factors affecting performance are lost in transmission. Further evidence of this can be found in a article by Herbert H. Clark and Susan E. Brennan (1991) where the authors profess that a number of qualities of normal face-to-face conversations

fig 1. Entering the first room of the experiment

are not present in radio communication. These findings and many more which will be discussed in the theoretical background section have led us to believe that there are some inherent flaws in vocal radio communication but that there might be a way to compensate for this loss of information. Because of this we set out to design an experiment where we attempted to introduce a parallel non-vocal feedback channel.

Background

We have chosen to look more specifically at communication in a military context, a field that has a long and interesting history. Communicating orders rapidly to groups and individuals seems to have been a pressing matter even for the earliest armies. Whether is was by horse, runner or fire signal, getting the right information to the right person at the right time was vital, and still is. Radio, when it was invented in the 1890s, was a quantum leap in speed, range and accuracy of communication. At first only large units, ships and aeroplanes had radios but at the

start of the second world war the German army had supplied every single tank with a radio, bringing swift vocal radio communication down to the level of individual soldiers and small groups. This trend has continued on a steady course and most armies today use vocal radio communication as their main form of communication. In some armies this has even progressed to the extreme of giving every single soldier in a combat zone a small, short range personal radio.

This reliance upon vocal radio communication might be about to change. According to A. Cebrowski and J. Gartska (1998) ,who introduced the concept of network-centric warfare, many other modalities of communication will be used in the future. The armies of both Sweden and the United States have taken this to heart and developed models of future fighting forces with many similarities (Brehmer & Sundin, 2004; Department of the Army, 2002). This recent development in military research has been aimed at replacing the old hierarchical structure with a new more flexible system (Brehmer & Sundin, 2004; Department of the Army, 2002). The key concept is to make commanding officers less bound by geographical proximity to the people under their command. In this new army, instead of working with groups, the focus has been shifted to working with highly trained specialised individuals. This new type of soldier should be able to be inserted into ad-hoc temporary teams that are guided by a remote leader.

Also in the new army the old praxis of leaders training and forming a bond of trust through experiencing hardship with the men under their care is no more. What remains to fill the void is the knowledge that the people you work with are professionals and that they stand to loose as much yourself should something go awry. This sort of trust is defined as "Cognition based trust" (McAllister, 1995) A problem that arises from this is the fact that half of the premise for cognition based trust towards the commander is lost as he does not experience the full consequences of a flawed order. It has also been

fig 2. Faced with a tough decision

shown that cognition based trust is extremely fragile (McAllister, 1995) and that one bad decision on the commander's part can severely damage the relationship between the commander and the soldier if there is no other bond in place.

The large impact of a bad decision on the commanders part makes it crucial for the commander to be sure that the information is communicated clearly and on the soldiers side, fully understood. Unfortunately the most common communications medium in the military is still half-duplex radio. Half-duplex radio is according to Clark & Brennan (1991) and Olson & Olson (2000) a feature thin medium. Olson & Olson have chosen to classify a communications medium according to what sort of information it enables us to communicate, whereas Clark & Brennan are more focused on what sort of actions the medium enables us to take. These actions entail communication costs and due to the lack of supported actions in radio communication the time and effort it takes to detect and repair a misunderstanding is much higher than in other media such as face-to-face communication.

To make matters worse the organisational structures in many professions dealing with remote command are actually constructed in a way that makes it less likely for the people on the ground to request clarification once they've realised that something is amiss. Ryan, Pintrich and Midgley (2001) have shown that there are two different factors in play that interact to determine an individual's inclination towards seeking help once the person in question has realised that he is in need of help. The first factor concerns an individual's personality and is divided in to social- and goal oriented qualities. As these are generally randomly distributed they are hard to control, however these qualities interact and reinforce the properties of the context (the second factor). A military context is according to the definition by Ryan et al an achievement-goal structured environment where people depend on the competence and training of their brothers in arms and where it is the results that matter. An-

other quality that comes in to play when dealing with temporary military teams is the fact that the social/interpersonal climate is different. Seeking help from friends that you know well and who know you has been shown by Ryan et al to be much easier than asking it of strangers. This is because lack of understanding can be perceived as a sign of incompetence and weakness.

Hypothesis

Our research led us to believe that introducing a second non-vocal channel into the equation would enrich the communication medium and thereby facilitate the process of fault detection and reparation. The PFS allows for *Simultaneity, Rapid Feedback* and *Parallel Channels* (Ryan et al. 2001). Rapid feedback allows the receiver of an order to communicate a request instantly when confusion occurs and is a vital part of the process of reparation. By letting the parallel signal represent the paralinguistic signs that we use to communicate confusion we wanted to bring the action of making the commander aware of possible uncertainties concerning a given order closer to the subconscious. We were aware of the difficulties in explicating something previously implicit, however, we felt that the design of the PFS would serve to focus the receiver's concentration on the order that was given. Also, the fact that the receiver used a non-vocal mode of communication creates a feeling of anonymity, which serves to break through the barrier that is in place due to the structure of the context.

Our hypothesis in designing the experiment was that the PFS would make it easier for the participants to ask for help, and that this would reduce the number of misunderstandings and subsequently the number of mistakes. This hypothesis was based upon a number of premises, the first was that simultaneity would make it easier to ask for help. The assumption was that the participants would listen to the message transmitted by vocal radio communication and at any time when they felt the need for clarification they would indicate this using the PFS. The second premise was that using the PFS would be a smaller effort than using the radio to vocally ask for clarification. Because of this we designed the PFS as a

fig 3. In full gear

simple button which could easily be held and released at any time. A third and final premise was that asking for help is a difficult task, meaning that we expected that by making it easier to do so we would see more requests for clarification.

Experiment design

In order to maintain ecological validity we decided early on to keep the vocal radio communication and to make the non-vocal parallel feedback system (from here on referred to as the PFS) a secondary channel. We believe that half-duplex vocal radio communication will continue to be used for a long time.

In designing this experiment we were striving to make the experience of the experiment as close to a real combat situation as possible. As real guns were out of the question, paintball markers and indoor paintball balls were used. These are very safe but still create a sense of urgency in someone being fired upon. Being hit by a ball can be painful but the only real risk is of getting some light bruises. Nonetheless, all of our participants, as well as all the members of the research group who were in danger of being fired upon were required to wear face masks at all times during the experiment. All of our participants were students from Linköpings University who participated on voluntarily.

Before designing the experiment we decided that we wanted to measure two things, the number of mistakes and the number of requests for clarification. The first of these measurements required that it was possible to make mistakes so we designed a number of tasks that we could manipulate, given in the form of orders transmitted via

radio. These orders and the experimental environment were designed so that the orders could be performed correctly without asking for clarification but doing so would increase the likelihood of making a mistake.. The second measurement was sub-divided in to three categories: Vocal request in direct conjunction with the order given, vocal request not in direct conjunction with the order given and requests made using the PFS.

We chose a between-subjects design as the practice effect in a within-subjects design could have compromised the experiment. In the experiment a single participant was given orders via radio by a remote leader. The participant was not allowed to meet the leader beforehand or during the experiment and was never told where the leader was located. Before the experiment the participant was given instructions on how to use the marker and the communications equipment and allowed to try them out. The participants in the experimental group were also given instructions on how to use the transmitting part of the PFS. They were told that when receiving an order they were to hold down the button on the transmitter (thus transmitting on the chosen frequency) until either they felt that there was need for clarification or the order was transmitted in full. The transmitting part of the PFS was a single Danita SP-3380 PMR walkie-talkie.

In order to increase stress and make the situation as combat-like as possible a sniper, played by a member of the research group, harassed the participant with paintball fire during the experiment. The participant was given twelve orders in total during the experiment while following a course spanning three floors. Three of these orders were manipulated to promote mistakes. In figure 4 a floor-plan of the second floor of the experiment is shown, the arrows indicate the route given by the orders. The second arrow (starting from the topmost staircase symbol) represents a manipulated order. In this order the participant is ordered to enter a door which can not be seen from the starting point of the order since it is obscured by a nearby wall.

fig 5. The receiving part of the PFS

Two members of the research group, posing as civilians and wearing brightly coloured vests, observed the experiment and kept notes of any mistakes made. The orders were given from a closed room in the same house by another member of the research group, who played the leader, where the other part of the PFS was located. This part of the PFS (shown in figure 5) consisted of a radio, similar to the transmitting part, connected to a red diode which indicated if the button on the participants transmitter was depressed. The orders were given according to a script written before the experiment and clarifications, when requested, were based upon this material. As little improvisation as possible was used by the leader. All radio communication was recorded using an iRiver MP-590 MP3 player.

fig 4. Floor-plan of the second floor of the experiment

Following the experiment a short semi-structured interview was held to asses the participants feelings and impressions concerning the experiment.

Results

At first glance the data recorded during the experiments might seem curious, as there's no difference at all in the mean of either the requests for clarifications or the number of mistakes between the two different conditions. Upon closer inspection one can however see that the mistakes made and the calls for help occurred at different times for each test subject. This led us to con-
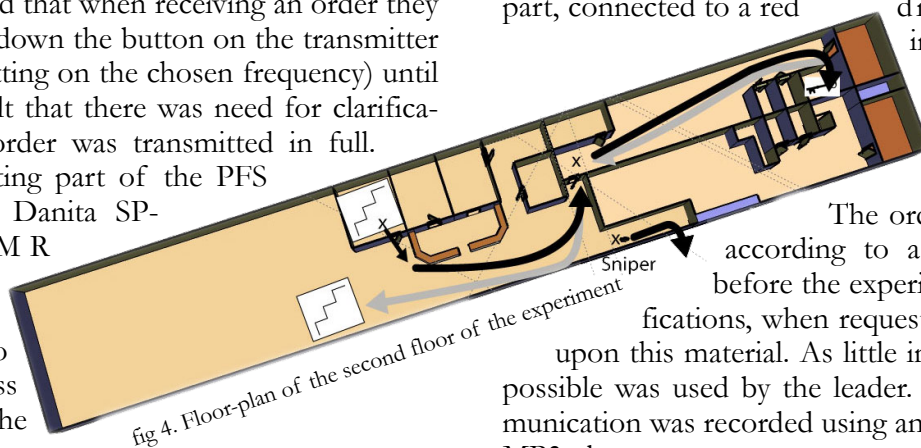
Table 1. Quantitative results of the experiment

Group	PFS Used	Direct Requests	Indirect Requests	Mistakes
Experimental	0	16	5	18
Control	N/A	14	7	18

clude that this quirk in the data is not the result of a fault in the design.

What is more concerning is the fact that not a single person in the experimental group used the PFS to indicate confusion while all used it to signal attention. One would think that there would at least be some positive data in the cases where requests for clarification had occurred in conjunction with the order as this indicates that the ambiguity had been detected during the time that the order was been given. Alas that was not the case. Our theory was founded on the idea that asking for help with the use of a non-vocal channel would lower the structurally imposed resistance to help seeking behaviour. As no help was sought through the non-vocal channel, it is not surprising that there was no significant difference between the means.

Discussion

During the analysis of the qualitative data recorded after each trial three predominant explanations as to why the PFS was not used surfaced. We were surprised to learn that a large number of participants claimed forgetfulness. When asked why they did not use the PFS to indicate uncertainty during the mission they reacted as if it was the first time they had heard that the equipment was supposed to fill this purpose. Many of the test subjects who displayed ignorance as to the primary purpose of the PFS after the experiment actually spontaneously repeated the functions of the device during the instructions before the experiment. In this they clearly showed that they had grasped the underlying concept of the device.

The second explanation might in some ways be connected with the first. Several participants reported that they felt uncertain as to how exactly the PFS worked. This confusion in conjunction with the strain that the stressful environment put on the participants made them fall back on their "tried and tested" vocal communication skills. One would be hard pressed to find any human skill that we have had more training in than using our voice to make ourselves understood. Because language is such a low level skill it takes up a small amount of the cognitive resources. It seems that the test subjects in an effort to free up resources for processing of environmental cues and threat assessment neglected the newly introduced communications channel in favour of the less costly vocal modality. If this is the case it was a profitable decision to maintain a high level of ecological validity. A less stressful environment might have had a considerably improved chance of isolating an effect, but this might also have led us to draw a misguided conclusion concerning the practical benefit of the PFS.

The third and last tendency we saw was that test subjects reported that they wanted to finish listening to what the leader said before deciding if the order was sound. They reasoned that when some part of the order sequence seemed odd more information would be given later that made things clearer. This is perhaps the strongest critique against the design of the our PFS.

fig 6. The leader with the recording equipment and radios

Methodological issues

With hindsight we realise that the instructions given before each trial might have been better scripted. While teaching the test subjects how to use the equipment the PFS was introduced as a dual function system where holding the button was supposed to communicate understanding and releasing it would indicate confusion. However, due to the wording some of the test subjects might have misunderstood the first function as indicating attention since they were taught to: "Hold the button while you are listening" (our translation from Swedish). This combined with the fact that the instructions were quite information heavy is a plausible explanation as to why they forgot about the second function of the PFS. The reasoning behind the dual function approach was that we wanted the use of the PFS to be focused on a positive action, that of understanding. Another approach would have been to abandon the dual function approach in favour of a single function. We feel however that this would focus the use of the PFS on a negative action and that this would increase the resistance against seeking help. On the other hand this approach would have enabled the test participants to use the PFS to indicate confusion after the order had been issued and thus nullifying the third detrimental explanation as to why the PFS was not used.

We also had some trouble with trials that had to be discarded because of errors in the data. A number of test subjects reported that they had great difficulty in holding the down button on the PFS. The radio we modified for the experiment was designed in such a way that the button was covered by a small rubber sheet that concealed the precise location of the button. The unit also had a depression on the side of the button that seemed to indicate where to put your finger. The depression however was half a centimetre away from the actual location which resulted in numerous slips and thus gave us some erroneous data.

Conclusions

In conclusion, even though we had some methodological issues we hope that others will continue this line of research and perhaps learn from our conclusions. We believe that that there are some important issues raised by our results that need to be addressed in any future communication media and in further research done on the subject. One of these is that it seems that any new media needs to be have a lower social and cognitive cost than those media which are already in use, especially when used in a high-stress situation. It also seems that one can not easily predict the use of a device such as the PFS in a high-stress situation.

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