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Taking Trust to the Field: Pilot Study on Trust and Communication in Teams

by

Barbara D. Adams and Lora Bruyn

Humansystems® Incorporated
111 Farquhar Street, Second Floor
Guelph, Ontario
N1H 3N4

Project Manager:
Barbara Adams
(519) 836 5911

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Defence Research and Development Canada
1133 Sheppard Avenue West
North York, Ontario

DRDC Scientific Authority
Carol McCann
(416) 635-2190

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HUMANSYSTEMS Incorporated

Author

Barbara Adams
Humans*ystems* Inc

Approved by

Carol McCann

Head/Command Effectiveness & Behaviour

Approved for release by

K.M. Sutton
Chair, Document Review and Library Committee

Abstract

This paper describes the results of a pilot study to explore trust in teams and team communication. A field trial involving 24 Canadian infantry soldiers in Fort Benning, Georgia was undertaken in conjunction with the Soldier Information Requirements Technology Demonstrator (SIREQ-TD). This trial involved 3 sections conducting at least 8 tactical assault missions over the course of several days. Teams were required to manoeuvre on assigned routes through a heavily wooded area, to dispatch an enemy sniper encountered enroute, and to overtake two enemies occupying a defensive position at the final destination.

After each mission was completed, trust within the team was measured using the Trust in Teams Scale (Adams & Bruyn, 2003). During each mission, all communications were logged using a radio system. All communications were analyzed into discrete transmissions, and coded by type (transfer, request for information, acknowledgement), function (related to location, status), and referent (friendly or enemy) according to a classification system developed by Entin et al. (1993). In addition, the content of communications was also analysed for trust relevant events, in accordance with our existing model of trust in small teams (Adams & Webb, 2002).

Results showed that generic communication coding schemes were of limited usefulness for understanding trust-relevant communication, but did seem to indicate some relationship between team trust and anticipation ratios. Moreover, the relative lack of clearly trust-relevant communication suggests that it will be important to create experimental situations that more strongly pull for trust, such as varying risk levels. It will also be important to use less constrained criteria and a more qualitative approach to analyzing team communication. The first iteration of the team trust scale seemed to perform relatively well, and we received positive feedback about the scale from participants. More importantly, the team trust scale did seem to capture team trust as it evolved over time, and there were some predictable matches between events that occurred during tactical assault missions and measures of team and leader trust. Several conceptual and pragmatic challenges of conducting future trust field research are noted, including linking trust as a psychological state and as a choice behaviour, the need for experimental control, tailoring of the experimental context to data collection (e.g. performance data) and the time intensity of content analysis. Recommendations for future work are explored.

Résumé

Le présent document décrit les résultats d'une étude pilote visant à explorer la confiance et la communication au sein d'équipes. Un essai pratique auquel participaient 24 fantassins canadiens se trouvant à Fort Benning, en Géorgie, a été mené parallèlement au Projet de démonstration technologique des besoins des soldats en matière d'information (SIREQ-TD). Cet essai mettait en cause 3 sections qui ont effectué au moins 8 missions d'assaut tactique au cours de plusieurs jours. Les équipes devaient manœuvrer sur un parcours assigné dans une zone densément boisée, amener un tireur d'élite rencontré en chemin et évincer deux ennemis occupant une position défensive à la destination finale.

Après chaque mission, on mesurait la confiance au sein de l'équipe à l'aide du barème de confiance dans les équipes (Adams & Bruyn, 2003). Durant chaque mission, toutes les communications étaient consignées au moyen d'un système radio. Puis, toutes ces communications étaient analysées dans des transmissions discrètes et codées par type (transfert, demande d'information, accusé de réception), fonction (par rapport à l'endroit, au statut) et référent (ami ou ennemi), selon un système de classification mis au point par Entin et al. (1993). En outre, nous analysions aussi le contenu des communications afin d'y déceler des activités liées à la confiance, conformément à notre modèle actuel de confiance au sein de petites équipes (Adams & Webb, 2002).

Les résultats ont révélé que des schémas de codage génériques des communications étaient peu utiles pour comprendre la communication applicable à la confiance, mais semblaient indiquer un certain lien entre la confiance de l'équipe et les rapports d'anticipation. De plus, l'absence relative de communication clairement applicable à la confiance suggère qu'il sera important de créer des situations expérimentales faisant plus directement appel à la confiance, comme des niveaux de risque variés. Il sera également important de recourir à des critères moins restrictifs et à une approche plus qualitative pour analyser la communication au sein de l'équipe. La première itération du barème de confiance au sein de l'équipe a semblé fonctionner relativement bien, et nous avons reçu des commentaires positifs des participants au sujet du barème. Fait encore plus important, le barème de confiance a semblé capter l'évolution de la confiance au fil du temps, et certains rapports prévisibles ont été constatés entre des événements qui se sont produits durant des missions d'assaut tactique et la mesure de la confiance de l'équipe et du chef. Plusieurs difficultés d'ordre conceptuel et pragmatique ont été notées pour la recherche future dans le domaine de la confiance, notamment l'établissement d'un lien entre la confiance en tant qu'état psychologique et comportement de choix, la nécessité d'un contrôle expérimental, l'adaptation du contexte expérimental à la collecte de données (p. ex., données sur le rendement) et l'intensité temporelle de l'analyse du contenu. Des recommandations de travaux futurs sont explorées.

Executive Summary

This pilot study had three goals. First, it explored trust and communication in small military teams and considers how best to analyze trust-relevant communication. Secondly, this work served as the first iteration of the earlier version of the Trust in Teams Scale (Adams, Bruyn and Chung-Yan, 2004). Lastly, we gained experience in both the conceptual and logistic challenges of conducting field research to study trust.

A 10-day field trial was undertaken in a heavily wooded area in Ft. Benning, Georgia from March 25 to April 10, 2002. Twenty-four regular force infantry soldiers undertook force-on-force tactical assault missions in heavily wooded terrain. For each mission, eight soldiers worked as an organic infantry Section (with two assault groups) to engage an enemy force of four soldiers occupying a defensive position in a heavily wooded area. Soldiers were required to manoeuvre on assigned routes through the wooded area, to dispatch an enemy sniper encountered enroute, and to overtake two enemies at the final destination. Weapons included blank firing and a laser target engagement system to simulate live weapons effects. Each mission was configured to standardize the experimental mission parameters between conditions, and consisted of three phases: mission briefing, planning and execution.

After each mission was completed, trust within the team was measured using the Trust in Teams Scale (Adams & Bruyn, 2003). During each mission, all communications were logged using a radio system. All communications were analyzed into discrete transmissions, and coded by type (transfer, request for information, acknowledgement), function (related to location, status), and referent (friendly or enemy) according to a classification system developed by Entin et al. (1993). In addition, the content of communications was also analysed for trust relevant events, in accordance with our existing model of trust in small teams (Adams & Webb, 2002).

Results showed that generic communication coding schemes were of limited usefulness for understanding trust-relevant communication, but did seem to indicate some relationship between team trust and anticipation ratios. Moreover, the relative lack of clearly trust-relevant communication suggests that it will be important to create experimental situations that more strongly pull for trust, such as varying risk levels. It will also be important to use less constrained criteria and a more qualitative approach to analyzing team communication. The first iteration of the Trust in Teams Scale seemed to perform relatively well, and we received positive feedback about the scale from participants. More importantly, the Trust in Teams Scale did seem to capture team trust as it evolved over time, and there were some predictable matches between events that occurred during tactical assault missions and measures of team and leader trust. Several conceptual and pragmatic challenges of conducting future trust field research are noted, including linking trust as a psychological state and as a choice behaviour, the need for experimental control, tailoring of the experimental context to data collection (e.g. performance data) and the time intensity of content analysis. Recommendations for future work are explored.

Sommaire

Cette étude pilote visait trois objectifs. Premièrement, elle explorait la confiance et la communication au sein de petites équipes militaires ainsi que la meilleure façon d'analyser la communication applicable à la confiance. Deuxièmement, ce travail constituait la première itération de la version antérieure du barème de confiance dans les équipes (Adams, Bruyn et Chung-Yan, 2004). Troisièmement, nous avons acquis de l'expérience sur le plan des difficultés à la fois conceptuelles et logistiques que présente la recherche sur le terrain dans le domaine de la confiance.

Un essai pratique de 10 jours a été mené dans une zone densément boisée à Fort Benning, en Géorgie, du 25 mars au 10 avril 2002. Vingt-quatre fantassins de la Régulière ont entrepris des missions d'assaut tactique de force à force sur un terrain densément boisé. Pour chaque mission, huit soldats formaient une section d'infanterie intégrée (avec deux groupes d'assaut) chargée d'engager une force ennemie de quatre soldats occupant une position défensive dans une zone densément boisée. Les soldats devaient manœuvrer sur un parcours assigné à travers une zone boisée, amener un tireur d'élite ennemi rencontré en chemin et évincer deux ennemis à la destination finale. Les armes comprenaient un système de tir à blanc et un système d'engagement d'objectif au laser qui simulaient les effets du tir réel. Chaque mission était configurée de façon à uniformiser les paramètres de mission expérimentale selon les conditions et comprenait trois phases : exposé, planification et exécution.

Après chaque mission, on mesurait la confiance au sein de l'équipe à l'aide du barème de confiance dans les équipes (Adams & Bruyn, 2003). Durant chaque mission, toutes les communications étaient consignées au moyen d'un système radio. Puis, toutes ces communications étaient analysées dans des transmissions discrètes et codées par type (transfert, demande d'information, accusé de réception), fonction (par rapport à l'endroit, au statut) et référent (ami ou ennemi), selon un système de classification mis au point par Entin et al. (1993). En outre, nous analysions aussi le contenu des communications afin d'y déceler des activités liées à la confiance, conformément à notre modèle actuel de confiance au sein de petites équipes (Adams & Webb, 2002).

Les résultats ont révélé que des schémas de codage génériques des communications étaient peu utiles pour comprendre la communication applicable à la confiance, mais semblaient indiquer un certain lien entre la confiance de l'équipe et les rapports d'anticipation. De plus, l'absence relative de communication clairement applicable à la confiance suggère qu'il sera important de créer des situations expérimentales faisant plus directement appel à la confiance, comme des niveaux de risque variés. Il sera également important de recourir à des critères moins restrictifs et à une approche plus qualitative pour analyser la communication au sein de l'équipe. La première itération du barème de confiance au sein de l'équipe a semblé fonctionner relativement bien, et nous avons reçu des commentaires positifs des participants au sujet du barème. Fait encore plus important, le barème de confiance a semblé capter l'évolution de la confiance au fil du temps, et certains rapports prévisibles ont été constatés entre des événements qui se sont produits durant des missions d'assaut tactique et la mesure de la confiance de l'équipe et du chef. Plusieurs difficultés d'ordre conceptuel et pragmatique ont été notées pour la recherche future dans le domaine de la confiance, notamment l'établissement d'un lien entre la confiance en tant qu'état psychologique et comportement de choix, la nécessité d'un contrôle expérimental, l'adaptation du contexte expérimental à la collecte de données (p. ex., données sur le rendement) et l'intensité temporelle de l'analyse du contenu. Des recommandations de travaux futurs sont explorées.

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1. Introduction

This pilot study involved tactical assault missions in a realistic field setting and had three aims. First, this work explored the relationship between trust in teams and team communication, and considered how best to analyze communication results. Second, this study was conducted at the very early stages of development for a Trust in Teams Scale, and served as the pilot test of the earliest version of the scale. Based on this work, we received informal feedback about the scale and format and about the kind of items to be used in the first formal iteration of the scale (explored in subsequent work, Adams, Bruyn & Chung-Yan, 2004). Third, this report also describes the challenges in measuring trust and communication within a field study, and considers the research implications for future work (both laboratory and field) exploring trust in teams.

2. Research Questions

This pilot work explores the relationship between trust and communication in the context of small ad-hoc military teams (infantry sections) who completed several tactical assault missions in an elaborate field study. This work addresses several key questions. First, this work explores trust within teams. Using the first iteration of a "trust in teams" scale, this work administered the scale several times to members of infantry teams. In so doing, we were able to not only assess how the scale performed at a descriptive level, but were also able to track levels of members' trust in other teammates over time.

In order to understand the relationship between trust and communication, the entire content of the sections' communication was recorded via a digital radio system. Analysis of this communication involved a complete transcription of communications, and a content analysis using a classification scheme created by Entin et al. (1993) and adapted for this research. This analysis was used to understand the frequency and content of communications and the anticipation ratios evident within the teams. In addition, the transcribed record of communication also allowed for exploration of "trust events", discrete events judged to relate to trust within the teams.

Lastly, this work addresses the practical difficulties inherent in doing trust work within this kind of setting. A field setting creates a number of challenges for exerting experimental control and for understanding both team communication and team performance. As such, we saw this pilot work as an important opportunity both to pilot and to think about the pragmatics of measurement that might be relevant to our long-term program of researching trust within teams.

It is important to note that this pilot study was conducted in the context of a SIREQ-TD (Soldier Information Requirements Technology Demonstrator) experiment exploring radio communications with and without a digital map. Pairing this study with an applied research project, in theory, allowed us access to a very realistic environment in which to explore our initial ideas about trust and communication. At the same time, however, piggybacking on an existing project also proved somewhat problematic, as the technical systems used in the project had many problems. The Xybernaut computers worn for the digital map display, for example, had persistent performance problems due to overheating. These (and many other problems) limited the number of missions that could be accomplished, thereby limiting the kind of conclusions that can be drawn from this work. As

a result, we took more of a descriptive than inferential approach. However, as the first step in thinking about doing trust research in a challenging field setting and in subsequent laboratory settings, we believe that this work was extremely informative and valuable.

Study Overview A 10-day field trial was undertaken in Ft. Benning, Georgia from March 25 to April 10, 2002. Twenty-four regular force infantry soldiers undertook force-on-force tactical assault missions in heavily wooded terrain. For each mission, eight soldier participants worked as an organic infantry Section, comprised of two Assault Groups, to engage an enemy force of four soldiers occupying a defensive position. Soldiers were required to manoeuvre on assigned routes through the wooded area, to dispatch an enemy encountered enroute, and to overtake two enemies at the final destination. Weapons included blank firing and a laser target engagement system to simulate live weapons effects. Each mission was configured to standardize the experimental mission parameters between conditions, and consisted of three phases: mission briefing, planning and execution.

Having manoeuvred to the objective area, the two Assault Groups began a coordinated assault on the objective. Each mission required the Assault Groups to approach and destroy the enemy from different directions (i.e. without line of sight between Groups) while being mindful of the likely location and status of the other Assault Group.

After each mission was completed, trust within the team was measured using the Trust in Teams Scale (Adams & Bruyn, 2003). During each mission, all communications were logged using a radio system. All communications were analyzed into discrete transmissions, and coded by type (transfer, request for information, acknowledgement), function (related to location, status), and referent (friendly or enemy) according to a classification system developed by Entin et al. (1993). In addition, the content of communications was also analysed for trust relevant events, in accordance with our existing model of trust in small teams (Adams & Webb, 2002).

3. Method and Measures

Twenty-four regular force, dismounted infantry soldiers were organized into 3 sections of 8. Section 1 completed 10 missions and the other two sections completed 8 each for a total of 26 missions.

Participant Data: Participants completed a questionnaire detailing their years in the infantry, rank, trade courses completed, and field experience in small Unit tactics, particularly urban operations and house clearing.

Trust in Team Scale: An early measure of the Trust in Teams Scale (Adams, Bruyn & Chung-Yan, 2003) was used. This scale included items related to competence, benevolence, integrity and predictability (see Appendix A). This allowed us to get informal feedback on the scale, as well as to see how well the scale performed in actual use and over the course of time.

Communications Measures: Using the data capture capabilities of the radio communications system and a review of mission activities, communications were first captured into discrete wav files. Two different analyses were then undertaken. As part of this work, the communications were transcribed by a typist with considerable military background. When the content of

communications was unclear, the lead experimenter assisted the typist to decipher the content. This transcription was then reviewed in detail, with the goal of identifying clearly trust-relevant communication or events. We defined trust events as specific and discrete instances involving either trust directly, or teammates' expectations with respect to the key factors of competence, benevolence, integrity or predictability which were either supported or violated. We adopted very conservative criteria for this judgement. Thus, transmissions were only classified as trust events only if they clearly had direct trust relevant content in the opinion of two trust experts.

Secondly, a more specific post-hoc semantic analysis of the content of each communication was undertaken.[1] Communications were sorted each classified by type, function and referent of communication (enemy or friendly). This approach to the content analysis of communication has been adapted from Entin et al. (1993).

- Types: Messages were first type classified as either a "Transfer" of information, a "Request" for information, an "Order" to perform some task, or an "Acknowledgement" of receipt of any of the three previous types.
- Functions: Each message was then classified by its information transfer function. Functions describe the purpose for transferring the information. Functional classifications included "Status", "Location", "Task Assignment", and "Planning/Problem Solving".
- Enemy / Friendly: For functions involving "Status" or "Location", the message was further classified as relating to "Enemy" or "Friendly" forces.

This analysis also allowed the calculation of anticipation ratios for each mission. Anticipation ratios reflect the ability of team members to anticipate the information needs of other members. Anticipation ratios provide some insight into teamwork and coordination behaviour by relating the number of information transfers to the number of requests (i.e., if transfers exceed requests then anticipation behaviour exists) (Sperry, 1995).

Performance Measures: Several performance measures including rounds taken (from the enemy), rounds used and the number of kills were also recorded as part of the primary experiment.

[1] This analysis was conducted as part of the primary SIREQ-TD study and was shared with this pilot study.

4. Results

Trust in Teams and Trust in Leader Scales

The version used in this research was the first iteration of a team trust scale under development. (see Appendix A).[2] This provided an opportunity to test the value of the scale, as it included items related to the competence, benevolence, integrity and predictability factors, in preparation for a broader effort to understand the psychometric properties of the scale. In addition, this scale also included several items related to trust in a leader (see Appendix A). Table 1 below shows overall scores on the team trust items and on the leader trust items in each of three sections on a 7 point scale ranging from completely disagree (1) to completely agree (7). Means above the midpoint (4) indicate that the members of a section are relatively trusting of each other and/or their leader, whereas means below the midpoint (4) suggest that they are not very trusting of each other and/or their leader.

Table 1: Trust in Teams Scale and Trust in Leader Scale Descriptives

Section #	TeamTrust Mean (StDev)	TeamTrust N	LeaderTrust Mean (StDev)	LeaderTrust N
1	5.0 ± 0.7	78	4.7 ± 0.8	78
5	5.3 ± 0.7	63	5.2 ± 1.0	63
6	5.0 ± 0.8	64	4.6 ± 0.7	64
All Grps	5.1 ± 0.7	205	4.8 ± 0.9	205

In general, these results indicate that members of a section are relatively trusting of each other, with all ratings at 5 or slightly above. Levels of trust were slightly lower for leaders, but not below the midpoint, with a mean of 4.8. Further, trust ratings are similar within the three sections. This suggests that trust in teams as a whole is slightly higher than trust in specific leaders.

Informal feedback from participants indicates that the measurement approach taken in this work does seem to have at least face validity with military participants. Whether or not the final scale will have the appropriate psychometric qualities is an empirical question to be answered with a larger sample.

Participants also completed single item ratings of trust in other team members, and trust in leader.[3] Assessing the relationship between these ratings and trust scale ratings may provide a sense of how

[2] It is important to note that this scale (attached as Appendix A – shown with trust in teams and trust in leaders combined) is the earliest version of trust in teams scale, and is different from the scale used in Adams, Bruyn and Chang-Yan (2004).

[3] We used the term "confidence" instead of trust, as we have noted that military participants are hesitant about using the term "trust" (Adams & Webb, 2003). Forthcoming results argue that the words "trust" and "confidence" appear to have been used to refer to the same concept in this pilot study.

well the trust items are tapping the dimension of interest. Table 2 shows the relationship between the single item trust ratings and the overall scale ratings of trust in team and leader.

Table 2. Relationship between trust scale indices and single trust items (team and leader).

	I have confidence in the members of my team	I have confidence in my leader	Team Trust	Leader Trust
Single Item: "I have confidence in the members of my team"	1.00			
Single Item: "I have confidence in my leader"	.55*	1.00		
Team Trust Scale	.82*	.65*	1.00	
Leader Trust Scale	.41*	.80*	.58*	1.00

* Marked correlations are significant at $p < .05$.

As a whole, the scale items as written in the Trust in Teams Scale do seem to uniquely capture confidence in other teammates as measured in the single items. This is indicated by the fact that confidence in team members is significantly related to the team trust scale indices. Moreover, the correlation between the single item tapping team trust and the trust in team index is stronger than is the correlation with the trust in leader items. The same is also true for the trust in leader single item, as the correlation between the leader items is stronger than the correlation with the team trust items. As such, the variables that one would expect to be most strongly correlated do show the expected pattern. Moreover, it is also clear that trust in the team, and trust in the team leader (as measured by the single items) are highly correlated, but not completely overlapping, $r=.58$, $p<.05$.

Communication Content

It is important, then, to explore the content of communications, and to see whether trust-relevant events underlie these findings. Were events evidenced in trust ratings meaningfully related to the actual content of communication?

Communications from all 26 missions were transcribed by an experienced typist and a content analysis was performed. In all, we coded a total of 5,129 discrete transmissions. At the first stage of analysis, the Entin et al. (1993) content analysis scheme was used. Obviously, with only 3 teams, it was impossible to explore the content of communication at anything other than a descriptive level. Figure 1 shows the type of communication as a proportion of the total transmissions.

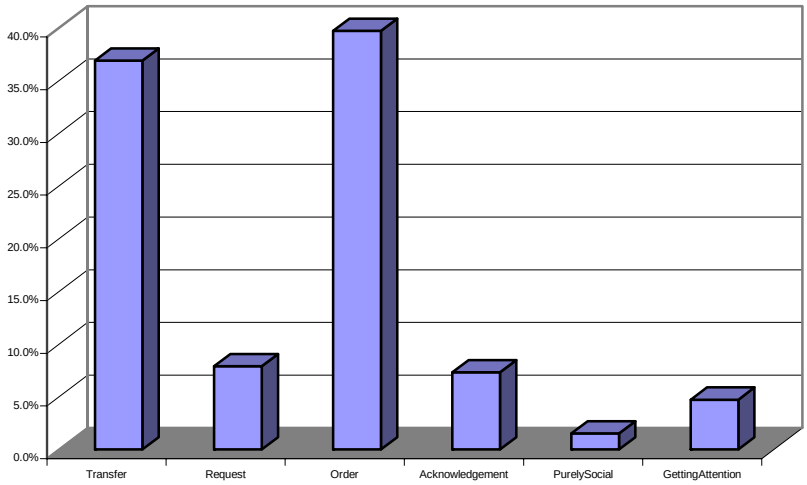

Figure 1: Type of communication over all missions

Orders were the most prominent form of communication, accounting for 37% of the total transmissions. Transfers of information were the next most common at 34%, followed by requests and acknowledgements at about 6%. Working to get the attention of other teammates, and purely social communications (those without any task-relevant content) were relatively uncommon.

It is also important to ask what function the communications served, as a percentage of all communications. This is shown in Figure 2.

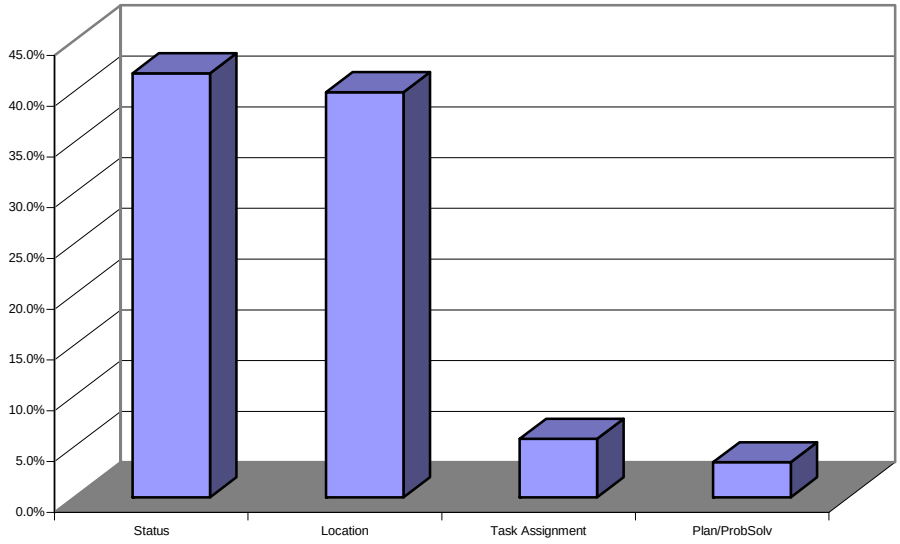

Figure 2: Function of communication over all missions

In general, then, the most frequent function of communication was related to information about one's status (general information relevant to one's own situation) or asking others to give their

status. Location was the next most prominent. Some communication had neither function and a small proportion was related to giving task assignments and planning/problem solving.

Trust Events

Having transcribed the entire content of communications, it was then possible for us to consider each mission, and to judge the discrete trust events that occurred during the mission.[4] At the first level of analysis, we exercised a conservative criterion, and first sought any direct references to trust or confidence. This analysis, not surprisingly, yielded no hits. The next screening process, undertaken by the lead trust experimenter, involved searching for incidents directly related to competence, benevolence, integrity or predictability that may have impacted on other teammates' views of trustworthiness, or which seemed related to trust-relevant behaviour. This analysis yielded a very low number of trust events. Each of these events is described in the rest of this section.

One of the trust events spoke directly to competence. Recall that a complete Section was broken up into two Assault Groups who worked toward a rendezvous point before beginning a final assault on enemy positions. At one point, a member of one assault group seemed to notice on his digital map display that the other assault group was off route, and was openly critical of the other assault group's navigation skills.

> *…obviously they can't read a map…what bearing we are on….so we will shake out…same thing…*

This kind of communication, although rare, indicates low trust in the competencies of the members of the other assault group.

Within another section, the first few missions undertaken by the section were completed in the regular way. During the fifth of this section's 10 missions, however, the section commander decided that in order to make the mission more of a learning experience, he would delegate navigational control to a more junior member of the assault group. At this point, the section commander addressed the rest of the assault group, and let them know that a new person was in charge of navigation using the digital map display.

> *You've got a junior leading…we've got to let these guys navigate with this….it'll give Jones good experience doing it*

In this communication, the section commander (SC) implicitly indicates trust in the junior navigator by giving over control. At the same time, however, the SC also reminds the team that this person is relatively new at performing this skill. As our previous work has demonstrated (Adams & Webb, 2003), showing concern for the professional development of a junior member of the team is one way that leaders build trust with the members of their team. In this sense, this action indicates a level of personal concern, as well as belief that the new person can perform the task well.

There is also evidence in the communications that at least one trust violation may have impacted trust within one of the infantry teams. This instance occurred in the third mission conducted by one of the sections. In this mission, Smith[5] was the navigator for the assault group that consisted of Jones, Wood, the SC and the second in command (2IC). Smith had navigated the group to a location that he believed was just before the rendezvous area, in order to meet the other assault

[4] This analysis addressed both trust and distrust.

[5] In order to protect confidentiality, all of the names in this document are pseudonyms.

group. At this point, a member of the other assault group (presumably looking at his digital map display) noticed that Smith had led his assault group the entirely wrong direction.

> *Person 4 from other AG: Smith…you're right the fuck out of it…on your nav…*
>
> *Smith: Point that way…until the rest come in…then we will reassure ourselves… in case you are wondering…I went off the path…because of that… …route*
>
> *Other Person: Come on let's move…*
>
> *Smith: Follow that road…right to the intersection…*
>
> *2IC: Ya we can bluff them into…ah…thinking that we're….you know… the whole…whole section…doing a frontal attack*
>
> *SC: Fuckin' Daniel Boon*

The 2IC mocks the navigator by laughably arguing that the navigation error may be an intentional bluff to deceive the enemy. The SC mocks further by drawing a contrast between the navigator and Daniel Boon (a skilled woodsman). Then, the 2IC, apparently having recognized that Smith is having trouble navigating decides to take a more active role in helping. Although the order of march (evident in other communications) has been Smith, Jones, 2IC, and Wood, the 2IC now decides that he wants to switch positions to occupy the 2nd position (closer to Smith), perhaps in order to monitor him (and his navigation of the assault group) more closely.

> *2IC: It's going to be in the exact same order that we just had…except that… myself and Jones are going to switch positions…so that I'm going to be in the middle…*

In the very next communication, the 2IC then reviews the information presented on the digital map display.

> *2IC: That green line going up…is the route... and then the T part of the line…that's going to be basically the assault…assault line…like the fire base…*

This impromptu review of the workings of the digital map display seems to be an effort to ensure that Smith is using the right information in order to guide the team. Although it is impossible to ascertain from only the content of the communication whether the 2IC did this specifically for Smith, this communication does appear to be a good example of defensive monitoring (McAllister, 1995). Other than to address the trust violation that just occurred, there appears little reason for this information to be reviewed at this point in the mission.

Although our intuition is that this incident is related to trust, an even more compelling argument could be made by considering this event in relation to trust scale ratings. If the event that occurred during this mission (Mission 3 for Section 1) did impact on trust within the team, this may be indicated in the trust in team scales completed at the end of every mission. Figure 1 below shows the trust scale ratings for each section across all of their missions.

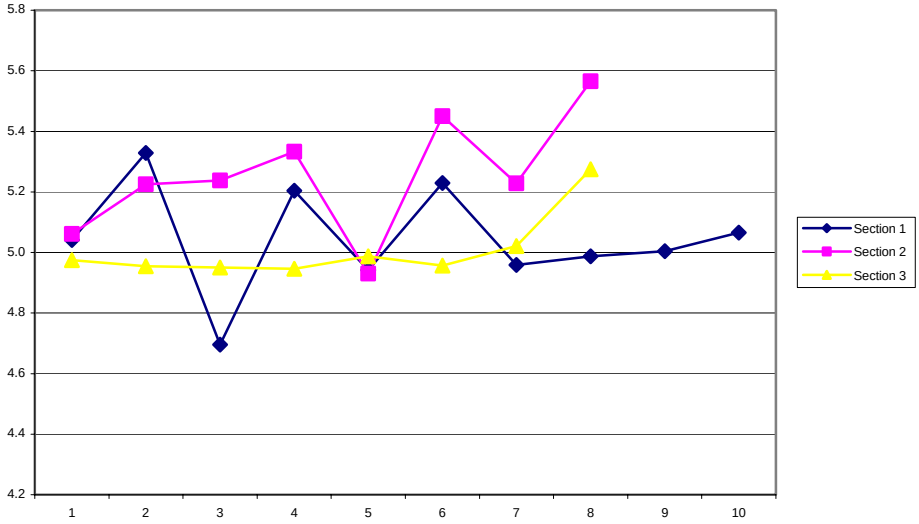

Figure 3. Trust in teams over time as a function of section

The ratings for Section 1 seem to support the argument that the error during Mission 3 caused a substantial drop in trust within the section. The Trust in Teams Scale ratings are the lowest of any mission, within all sections and in all missions.

As Figure 4 shows, the same was also true of the ratings of trust in the leader.

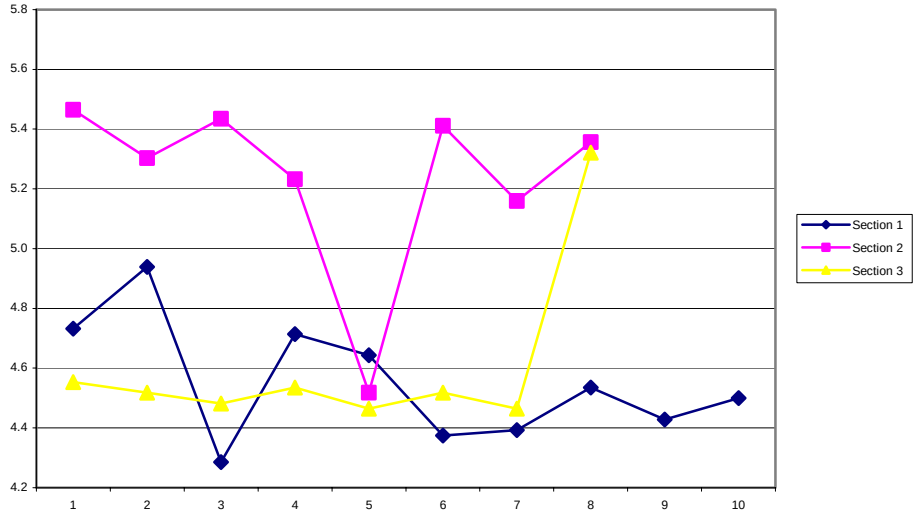

Figure 4. Trust in leader over time as a function of section

This suggests that the assault group leader may have been held at least partly responsible for the error. What is also interesting, however, is that trust ratings for both team and leader are considerably higher in the next mission, Mission 4. It is also important to note that the implications of this trust violation do not appear to be long lasting, and that trust in the team and in the team leader rebound quickly after the successful completion of the next mission. Whatever the impact of the error on trustworthiness, it does appear to have bounced back well after a successful mission. This trust event evidenced in team communications does seem to have been related to changes in measured trust in the team and in the team leader.

It is only fair to point out, however, that it is not always possible to understand changes in measured trust in teams or leaders by referring to the communication within them. In Section 3, for example, ratings of the leader are quite stable until Mission 8, wherein the ratings jump considerably. For Section 1, on the other hand, the ratings drop somewhat over the course of time, but are particularly low at the end of Mission 3. A somewhat similar pattern is evidenced for Section 2, showing a huge drop during Mission 5. Unfortunately, there is no clear content in the team communications during each of these missions that can explain these wide variations. It may have been that interactions outside of the experimental context may have influenced these shifts. For the future, it would be helpful to include an open ended section at the end of the team and leader trust scales, asking participants to indicate any factors that may have impacted on their trust during the course of a mission. It will be important to attempt to understand this issue better in the context of a more controlled environment.

Considering the large number of communications evidenced within the missions, the incidence of clearly trust-relevant communications is surprisingly low. Part of this, however, is likely due to the fact that when in doubt, we have used a very conservative criterion, in order to ensure that we have not over-interpreted the frequency of trust-relevant communications. In starting this work, we were concerned that coders should have to use as little extrapolation or inference as possible. In the future, this concern needs to be addressed by strict definitions, but ones that are somewhat less restrictive and conservative than the ones adopted in this work.

The difficulty that we had in clearly delineating trust events also speaks to how important it is to know the underlying psychological state of participants. Future work exploring the relationship between trust and communication, then, would benefit from also collecting online information about trust violations and positive trust events that occur during the course of a mission. The content of communication that is related to trust is much more implicit. This suggests that having more immediate access to the link between participants' experience of trust and related communications should be an important goal of future trust and communications work. Barring this, immediate post-mission interviews will be the next best tool in order to understand and interpret the intent behind the trust communications that are evident in the course of realistic simulations.

As informative as this work was in terms of helping us define our future requirements, there were very few clear trust events, and it would be disappointing to undergo such a huge focused effort in the future, only to generate a few clearly trust-relevant events. At the next stage of research, it will be important to create scenarios in which we are able to have more experimental control over the context, and be able to create a situation in which truly trust-relevant communication is likely to occur at a higher than current rate. This suggests that explicitly making trust an issue within the experimental context may well be one way by which to "pull" for more trust-relevant communication. This may, for example, be enacted through the use of varying levels of risk to make trust issues more likely to impact on team performance and process.

As a whole, analysis of all of the communications in this study suggests that although it was a very rich communication environment, the vast majority of transmissions are task-related, and reflect little on team dynamics and on issues of trust. Because of the sheer amount of communication that occurs at all stages of tactical assault missions, by definition, there will be very little communication that can be clearly categorized as directly relevant to trust. Not surprisingly, in the context of a tactical assault mission, soldiers do not explicitly discuss issues related to their coordination and levels of trust in working with others. With revisions to the methodologies employed in collecting the data, and in the content analysis scheme, however, we are confident that more can be learned about the relationship between trust and communication in future work.

Anticipation Ratios

As noted earlier, anticipation ratios (the proportion of transfers vs. requests for information) are an indirect indicator of the ability of team members to anticipate the needs of other team members, and to provide them with the information that they require in an efficient and timely fashion (Sperry, 1995). Anticipation ratios provide some insight into teamwork and coordination behaviour by relating the number of information transfers to the number of requests (i.e., if transfers exceed requests then anticipation behaviour exists).The ability to anticipate and predict other teammates is also likely to facilitate the growth of trust. Unfortunately, the correlation between trust within a team and its level of anticipatory communication, was relatively low and not significant ($r = -.14$ and $p > .05$). Within this sample then, there is little evidence that trust is related to the ability to anticipate other teammates. Though anticipation ratios are a common measure of teamwork (e.g. Sperry, 1995), we would argue that they may not capture the kind of reciprocal communication needed to build trust. A better way might be to match one-for-one each request with each transfer.

Despite this, however, there is some evidence that suggests that high levels of anticipation may be one way in which teams work to re-establish trust after a trust violation. Looking at anticipation ratios did yield an interesting pattern. As described earlier, within Section 1, the team navigator had made a significant navigational error during mission 3. Figure 5 shows anticipation ratios for Section 1 over the course of all their missions.

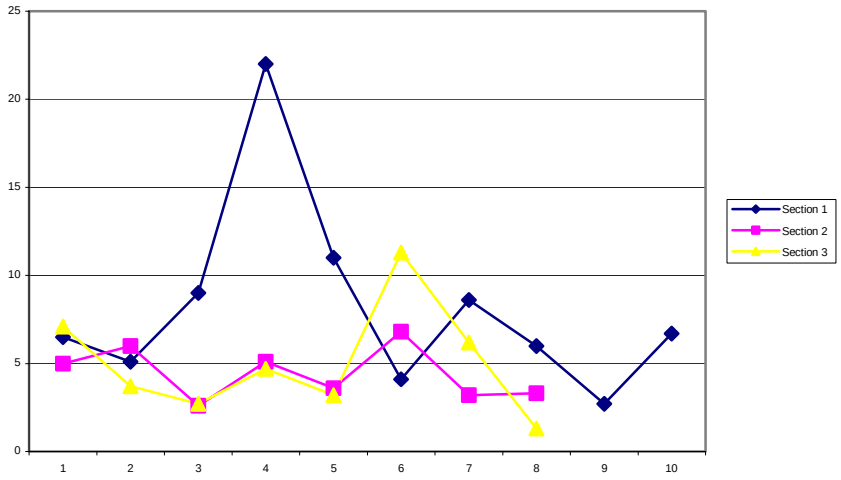

Figure 5. Anticipation ratios for all sections over time

As Figure 5 shows, in Mission 4, there was a sizeable increase in the anticipation ratio within Section 1 in the mission immediately following the error, as there were far more transfers than requests. We would speculate that this section might have attempted to "get back on track" after the error, by being more deliberate in ensuring constant and responsive communication. It is also important to note that trust clearly rebounded in Mission 4. One could argue that more responsive communication could have been used during the mission in order to re-establish trust. This result supports our hypothesis that teams showing higher rates of anticipatory communication will also have higher levels of trust.

Behavioural Measures

As noted earlier, another goal of this work was to explore potential behavioural measures that could be used in future work. Some of the measures used in this study were problematic, and alternatives would need to be found to get reliable performance data. Laser-tag like systems (called SIMLAS) are often used in tactical assault mission research, and, in theory, should allow for the collection of data for all of the engagements, and for the impact in terms of kills/rounds fired and taken, etc. Laser aimers are placed on guns and record all engagements. In addition, sensor vests worn by participants also record hits from opposing forces. This information would speak to the effectiveness and efficiency with which assault groups perform their designated tasks of neutralizing the enemy. Unfortunately, though data can be collected with this equipment, in practice, there was very little usable data that emerged from SIMLAS in this pilot study. Several types of problems with the system, including small knocks on a gun housing that mistakenly indicated a hit, cross-over data errors in the system caused by people by standing too close together, using guns in full automatic mode, and high variance in the accuracy of laser aimers made this data difficult to interpret with any confidence. Nonetheless, we are optimistic that new versions of SIMLAS recently acquired by CF may eliminate some (but perhaps not all) of these problems.

Future trust research may want to seriously consider the use of "Simunition"[6], as it offers several advantages. This ammunition provides the realism of a military weapon while discharging only pellets that do not typically break the skin. This form of ammunition offers a much more realistic experimental setting. Although simunition does cause mild pain and discomfort, this kind of context raises risk, vulnerability and uncertainty, and is more likely to give rise to issues of trust. This being said, it is important to acknowledge that the increased realism comes with considerably more expense, presents more challenges for ethical approval, and provides less flexibility in terms of employing participants in multiple missions.

In our a priori thinking about possible behavioural measures, we wondered if observer ratings using pre-defined definitions of coordination and cooperation may have been meaningfully related to trust. In this study, unfortunately, these measures could not be obtained for two reasons. First, it would have been difficult to get these measures without impacting negatively on the other measures that needed to be gathered for the primary experiment. Secondly, intensely difficult terrain navigation and the speed with which tactical assault missions were conducted in key parts of the missions made data collection of these kinds of behavioural measures impossible. For the

[6] http://www.simunition.com/index.php

future, however, the tailoring of both the kind of task and the terrain to enable observer ratings should be considered.

In future research assessing the relationship between trust in teams and team performance, other measures of performance are also possible. The first relates to mission timing. Timely completion of a mission is a direct indicator of team performance. In order for timings to have been accurate in the context of the current experiment, we would have needed to have experimental control, as well as to have fewer extraneous variables in play that might impact the ability of teams to complete the missions without interruptions, and, fewer technical difficulties.

Lastly, our work in this experiment has also indicated another possible measure of team performance. Within the primary digital map experiment, participants were equipped with global positioning systems (GPS) which were monitored by a mobile instrumented vehicle. In conjunction with software created by the Distributed Battlespace Lab in Fort Benning, Georgia, the entire wooded area was modelled, complete with topographic information, and the entire team movement was recorded by tracking of the GPS systems. This data can be stored in real-time files showing team movement and dispersion. Playback of these files could allow subject matter experts (SMEs) to rate the levels of coordinated movement etc., perhaps in relation to ratings of team trust from participants. This form of data collection, again, is likely to be relatively costly, and availability of SMEs is sometimes problematic. In general, however, this pilot study has provided a clear sense of both the possibilities and the challenges of behavioural measures for a future program of trust research.

5. Summary of Findings and Recommendations

A number of important conclusions follow from this pilot study. Understanding the relationship between trust and team process and performance will require making a clearer link between the psychological state that underlies trust and trust-relevant behaviours. The trust scale measures currently under development will provide critical access to team members' level of trust as a psychological state. However, this pilot work shows that it is very difficult to distinguish communication that is truly trust-related from that which serves other functions. Simply recording the entire communication within an infantry team will not be maximally helpful unless we have closer access to the underlying psychological state in conjunction with those communications. That is, we will not be certain whether trust relevant behaviours (such as communication) are a product of trust unless we can also show a temporal link with trust as a psychological state (e.g. on self-report measures).

There are many ways to address this issue. Perhaps the best solution is to have increased online access to team members' psychological states as they actually perform their duties. How this is done would need to be considered carefully, as stopping missions at several points to get participants to complete trust questionnaires multiple times has the potential to influence the dynamics of interest. Within the context used in the pilot experiment, this would also have been difficult. As the terrain in which the pilot study was conducted was very large, and as missions often moved very quickly, it would have been difficult for experimenters to maintain the level of surveillance needed to provide questionnaires at several different points. This suggests that the

experimental context needs to be more tailored to the needs of collecting communication data and to monitoring psychological state more closely. This would require a more constrained set of missions with the same kind of tasks, but with more opportunity for experimental control.

One of the ways to do this in the kind of mission scenario used in this pilot study would be to have a more portable data collection device (e.g. a PDA) that travels with participants, and which probes their trust judgements throughout the mission. This would allow us to be more confident that communications that seem trust-relevant actually are, as there is less of a "disconnect" between the time at which ratings of trust as a psychological state and trust-relevant behaviour (in this case, communication) are collected. The experimental context needs to be carefully considered, of course, and the PDA would need to be specially protected from damage in order to preserve data integrity. Such a mechanism could also allow participants to report relevant events that impact on their trust in other teammates or in the team leader.[7]

For the future, it would also be helpful to measure self-reported and objective rater trust-relevant events that occur during the course of a mission. In these scenarios, due to the complexity of the terrain, and the speed with which infantry teams move at different stages of the mission, it was impossible for observers to constantly have "eyes on" their respective assault groups. With traveling data collection, it may be possible to have participants indicate when trust-relevant events occur. In the context of tactical assault missions, however, it may not be realistic to suggest that people in the midst of such attacks will necessarily have the ability to report these events consistently.

With more experimental control (and with a more constrained workspace), it will be possible to depict the different phases of a mission, and to distinguish the true high risk phases from more instrumental phases (e.g. simple non-tactical movement). If trust is related to team communication, this is more likely to be the case in high risk than in low risk situations. It might be the case that trust only influences the content and frequency of communication in highly stressful contexts. One other issue that is possible to code, then, is the phase of the mission, and to indicate when progression from a low to high risk mode occurs. Another approach to this would be to simulate high and low risk situations within missions in order to explore how team trust changes as the result of these situations.

This preliminary research suggests that understanding the relationship between trust and communication will require contexts that elicit a higher rate of trust-relevant communication (e.g. high levels of risk), as well as considerable refinement of the content analysis of small team communication. It would be important to explore other coding schemes more relevant to understanding the relationship between trust and communication. For example, if competence, benevolence, integrity and predictability are the primary factors affecting trust, these themes may be reflected in the content of teams' communications. Observer ratings of fear or uncertainty etc., indicated by participant tone and loudness of voice, may also be informative. And, if we could get better access to trust as a psychological state, it would also be possible to use a less conservative and restrictive criteria to classify trust-relevant communications, as less extrapolation would be necessary.

Many of the limitations of this work stem from the experimental context that was available. This work piggybacked on an existing experiment studying the use of assault group radios and digital

[7] A PDA designed for military testing will be used by SIREQ in platoon tactical assault missions in Fort Benning in April/May 2004.

map displays in tactical performance and communications. As such, we did not have full experimental control. There were serious problems with the equipment, and the recorded audio communication spoke frequently to this problem. In light of these persistent problems, it is difficult to argue that this context was the ideal way to begin to understand the relationship between trust and communications. It was unclear, for example, the extent to which trust within a team on any given mission was influenced by interpersonal dynamics or the constant equipment malfunctions. It seems inevitable that trust in both teams and in leaders could have been impacted by trust in automation, a variable not of primary interest here.

For future work, we would argue that there are likely to be many benefits in switching to laboratory conditions to conduct early trust and communication research. One approach that could help to link communication to psychological state would be accessing participants' views about what they were thinking and feeling at specific points in the mission. This would be possible in the DRDC 1st person gaming lab that has been used in other Humansystems communication studies. In an environment with more experimental control, it would also be possible to understand the factors that influence changes in trust in other teammates and in team leaders.

At a more pragmatic level, this pilot study provides good evidence about what it will take to better understand the relationship between trust in teams and team communication. As a whole, this kind of work is extremely labour intensive, as it requires not only transcription of all communication, but also time consuming content analysis coding of the communications. In this study, the mission scenarios lasted about 20 minutes. Mission scenarios that are much shorter could provide ample opportunity for trust relevant communication to occur while limiting the effort needed to extract this information. What is critical, however, is experimentally controlling the context such that issues of vulnerability, risk and uncertainty can also be emphasized. Despite these difficulties, the initial goal of this work, exploring and articulating what it would take to measure team trust and communication in future work, was realized.

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Appendix A – Trust in Teams (and Trust in Leader) Scales

PARTICIPANT NUMBER : _____ SESSION NUMBER : _____

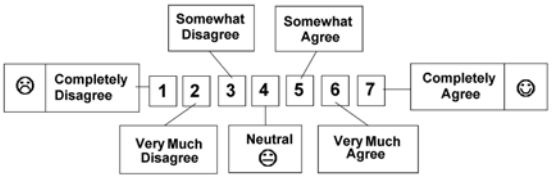
ASSAULT GROUP : _____ SECTION NUMBER : _____

CONDITION: RADIO: $ RADIO $ NO RADIO

MAP: $ DIGITAL MAP $ PAPER MAP

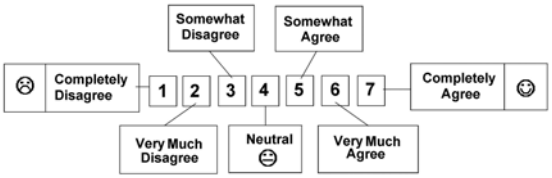
ROLE: $ RIFLEMAN $ 2IC $ SECTION COMD

USING THE SCALE PROVIDED, INDICATE THE EXTENT TO WHICH YOU AGREE WITH THE FOLLOWING STATEMENTS WITH RESPECT TO YOUR CURRENT TEAM.



	☹			😐			☺
	1	**2**	**3**	**4**	**5**	**6**	**7**
1. I am confident that my team is highly skilled.	○	○	○	○	○	○	○
2. No matter what, I can rely on the word of my team.	○	○	○	○	○	○	○
3. I can depend on the fairness of my leader.	○	○	○	○	○	○	○
4. I am confident about the integrity of my teammates.	○	○	○	○	○	○	○
5. My leader is capable when performing his/her job.	○	○	○	○	○	○	○
6. Even when things are risky, my team puts words into action.	○	○	○	○	○	○	○
7. The communication in my team is effective.	○	○	○	○	○	○	○
8. My teammates and I have common values.	○	○	○	○	○	○	○
9. My team has a hard time handling high risk situations.	○	○	○	○	○	○	○
10. In difficult situations, I never know what my teammates will do next.	○	○	○	○	○	○	○
11. In difficult situations, my team members are really just out for themselves.	○	○	○	○	○	○	○
12. Cohesion is a real problem in my team.	○	○	○	○	○	○	○
13. My leader shows ill will toward me.	○	○	○	○	○	○	○
14. In times of uncertainty, my team sticks to the plan.	○	○	○	○	○	○	○
15. My team cares personally about my survival.	○	○	○	○	○	○	○
16. I am suspicious of my teammates' motivations.	○	○	○	○	○	○	○
17. My team works like a well-oiled machine.	○	○	○	○	○	○	○

USING THE SCALE PROVIDED, INDICATE THE EXTENT TO WHICH YOU AGREE WITH THE FOLLOWING STATEMENTS WITH RESPECT TO YOUR CURRENT TEAM.



	☹			😐			☺
	1	2	3	4	5	6	7
18. In the worst of times, I know I can rely on my teammates.	○	○	○	○	○	○	○
19. I have confidence in the integrity of my leader.	○	○	○	○	○	○	○
20. I have faith that my team members are motivated to protect me.	○	○	○	○	○	○	○
21. My leader and I see the same things as important.	○	○	○	○	○	○	○
22. My team shows considerable skill in performing their job.	○	○	○	○	○	○	○
23. My team is highly skilled.	○	○	○	○	○	○	○
24. My team has a common understanding of what to do in high risk situations.	○	○	○	○	○	○	○
25. I have faith in the competence of my leader.	○	○	○	○	○	○	○
26. In difficult situations, my team works as individuals rather than as a unit.	○	○	○	○	○	○	○
27. My team protects each other in risky situations.	○	○	○	○	○	○	○
28. My teammates tend to say one thing yet do another.	○	○	○	○	○	○	○
29. I am confident that I can predict what my teammates are likely to do.	○	○	○	○	○	○	○
30. My teammates' actions are reliable.	○	○	○	○	○	○	○
31. When times are rough, my team sticks together.	○	○	○	○	○	○	○
32. My team makes me feel confident of success.	○	○	○	○	○	○	○
33. The way my leader behaves varies a lot from day to day.	○	○	○	○	○	○	○
34. Even when we run into hard times, I always know how my teammates are going to react.	○	○	○	○	○	○	○
35. If I really need them, my teammates are there for me.	○	○	○	○	○	○	○
36. I have faith in the integrity of my teammates.	○	○	○	○	○	○	○
37. I have faith in the abilities of my team.	○	○	○	○	○	○	○
38. I have confidence in the members of my team.	○	○	○	○	○	○	○
39. I have confidence in my leader.	○	○	○	○	○	○	○

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(U) This paper describes the results of a pilot study to explore trust in teams and team communication. A field trial involving 24 Canadian infantry soldiers in Fort Benning, Georgia was undertaken in conjunction with the Soldier Information Requirements Technology Demonstrator (SIREQ−TD). This trial involved 3 sections conducting at least 8 tactical assault missions over the course of several days. Teams were required to manoeuvre on assigned routes through a heavily wooded area, to dispatch an enemy sniper encountered enroute, and to overtake two enemies occupying a defensive position at the final destination.

After each mission was completed, trust within the team was measured using the Trust in Teams Scale (Adams &Bruyn, 2003). During each mission, all communications were logged using a radio system. All communications were analyzed into discrete transmissions, and coded by type (transfer, request for information, acknowledgement), function (related to location, status), and referent (friendly or enemy) according to a classification system developed by Entin et al. (1993). In addition, the content of communications was also analysed for trust relevant events, in accordance with our existing model of trust in small teams (Adams &Webb, 2002).

Results showed that generic communication coding schemes were of limited usefulness for understanding trust−relevant communication, but did seem to indicate some relationship between team trust and anticipation ratios. Moreover, the relative lack of clearly trust−relevant communication suggests that it will be important to create experimental situations that more strongly pull for trust, such as varying risk levels. It will also be important to use less constrained criteria and a more qualitative approach to analyzing team communication. The first iteration of the team trust scale seemed to perform relatively well, and we received positive feedback about the scale from participants. More importantly, the team trust scale did seem to capture team trust as it evolved over time, and there were some predictable matches between events that occurred during tactical assault missions and measures of team and leader trust. Several conceptual and pragmatic challenges of conducting future trust field research are noted, including linking trust as a psychological state and as a choice behaviour, the need for experimental control, tailoring of the experimental context to data collection (e.g. performance data) and the time intensity of content analysis. Recommendations for future work are explored.

(U) Le présent document décrit les résultats d'une étude pilote visant à explorer la confiance et la communication au sein d'équipes. Un essai pratique auquel participaient 24 fantassins canadiens se trouvant à Fort Benning, en Géorgie, a été mené parallèlement au Projet de démonstration technologique des besoins des soldats en matière d'information (SIREQ−TD). Cet essai mettait en cause 3 sections qui ont effectué au moins 8 missions d'assaut tactique au cours de plusieurs jours. Les équipes devaient manœuvrer sur un parcours assigné dans une zone densément boisée, amener un tireur d'élite rencontré en chemin et évincer deux ennemis occupant une position défensive à la destination finale.

Après chaque mission, on mesurait la confiance au sein de l'équipe à l'aide du barème de confiance dans les équipes (Adams &Bruyn, 2003). Durant chaque mission, toutes les communications étaient consignées au moyen d'un système radio. Puis, toutes ces communications étaient analysées dans des transmissions discrètes et codées par type (transfert, demande d'information, accusé de réception), fonction (par rapport à l'endroit,

au statut) et référent (ami ou ennemi), selon un système de classification mis au point par Entin et al. (1993). En outre, nous analysions aussi le contenu des communications afin d'y déceler des activités liées à la confiance, conformément à notre modèle actuel de confiance au sein de petites équipes (Adams &Webb, 2002).
Les résultats ont révélé que des schémas de codage génériques des communications étaient peu utiles pour comprendre la communication applicable à la confiance, mais semblaient indiquer un certain lien entre la confiance de l'équipe et les rapports d'anticipation. De plus, l'absence relative de communication clairement applicable à la confiance suggère qu'il sera important de créer des situations expérimentales faisant plus directement appel à la confiance, comme des niveaux de risque variés. Il sera également important de recourir à des critères moins restrictifs et à une approche plus qualitative pour analyser la communication au sein de l'équipe. La première itération du barème de confiance au sein de l'équipe a semblé fonctionner relativement bien, et nous avons reçu des commentaires positifs des participants au sujet du barème. Fait encore plus important, le barème de confiance a semblé capter l'évolution de la confiance au fil du temps, et certains rapports prévisibles ont été constatés entre des événements qui se sont produits durant des missions d'assaut tactique et la mesure de la confiance de l'équipe et du chef. Plusieurs difficultés d'ordre conceptuel et pragmatique ont été notées pour la recherche future dans le domaine de la confiance, notamment l'établissement d'un lien entre la confiance en tant qu'état psychologique et comportement de choix, la nécessité d'un contrôle expérimental, l'adaptation du contexte expérimental à la collecte de données (p. ex., données sur le rendement) et l'intensité temporelle de l'analyse du contenu. Des recommandations de travaux futurs sont explorées.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

(U) trust; teams; team communication; Trust in Teams Scale