



Exploration of Team Communication Behaviors from a Live Training Event

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Abstract. Investigating communication data during team training activities can provide insight into the rich processes underlying team collaboration and coordination. In this paper we explore team communication behaviors collected during a live training capstone involving six squads from the U.S. Army, three of which were experimentally assigned to receive instruction for improving team behaviors. Communication among squads was recorded, transcribed, and labeled for speech acts and team development dimensions. A series of analyses were used to investigate communication pattern differences over time between teams of higher and lower performance. Findings and implications are discussed.

Keywords: Live training · Team communication · Team performance

1 Introduction

Recent advances in the science of teams have provided critical insights into the attitudes, cognition, and behaviors that contribute to effective team performance and how to measure them [1]. Research shows high performing teams share and pass relevant information to the right team members at the right time, seek information from relevant sources, communicate clearly and concisely, and adapt to changing demands and circumstances. Of the many methods team science researchers have utilized to investigate team effectiveness, the analysis of team communication provides one of the most promising approaches for identifying factors that contribute to effective team performance. Team communication is an observable behavior that changes over time, based on task demands, changing priorities, and team goals. Decades of research have shown that communication is critical to effective teamwork [2–4]. It serves as a medium for sharing information about team structure, team roles, team coordination [5], cognition [6], and situational factors [7] that affect performance. Investigating team communication behaviors during team training activities can thus provide insight into the rich processes underlying team collaboration and coordination.

1.1 Team Communication Analysis Techniques

Team science researchers have utilized several methods for the analysis of team communication data. One of the most common is to analyze transcripts of team communication and hand-code team communication based on a pre-established coding scheme. The frequencies at which the coded categories emerge from the data, or their patterns, are then correlated with team performance measures. For example, Bowers and colleagues [2] coded utterances collected from flight crews during a simulated flight mission into eight categories that were statements about uncertainty, actions, acknowledgements, responses, planning, facts, and non-task related communications. They analyzed the frequency and sequences of these categories to examine differences in high and low performing flight crews. Results showed the higher performing flight crews had fewer non-task related communications and were more likely to follow communications from air traffic control with planning statements compared to lower performing crews. Fisher et al. [8] used a similar approach to examine communication differences in high and low performing teams who performed a computer simulated search and rescue mission. Utterances were coded into task and response-related categories with analyses showing that successful teams shared information more often.

Another approach team science researchers have used to examine team communication and the underlying team processes is by computing ratios of team communication behaviors. For example, Entin et al. [9], proposed an anticipation ratio index that represents how often information statements or actions are pushed versus how often they are requested from team members. Ratios larger than one indicate that a team pushed or sent information more frequently than they requested information; that is, they anticipated each other's information needs. Ratios less than one suggests that information needed to be requested more often than it was provided. This measure of team anticipation and coordination has been associated with improved team performance in a number of studies [10, 11]. Additional techniques for analyzing team communication have included examining patterns of team communication sequences [12] and examining communication patterns based on task flow [13].

1.2 Goals of Current Effort

Team science researchers have increasingly called for the investigation of team communication behaviors in real world settings to better understand and advance the theory of team development and provide insights for team development training. The goal of this research was to address this need by exploring team communication behaviors collected during a military live training exercise. Spoken utterances were captured among squad members during a live-training capstone involving six U.S. Army squads as part of the Squad Overmatch project [14]. Three of the six squads received team development training to improve teamwork behaviors, team situation awareness, and stress management prior to the training exercise. Spoken utterances were recorded, transcribed, and labeled for speech acts and team development dimensions. Our analyses focused on addressing which speech acts and team dimensions were related to team performance ratings and whether high performing teams demonstrated different communication behaviors compared with low performing teams.

2 Methodology

2.1 Dataset

The dataset used for this study consisted of transcribed audio logs of six U.S. Army squads, ranging from 8 to 10 members with one squad leader and two team leaders subordinate to the squad leader in every squad, who completed a 45-min live training that included a scripted set of training objects and training events designed to elicit team development behaviors. In the scenario, the squad was tasked with entering a village they experienced in prior missions, making contact with key local leaders, and gaining intelligence on local gang movements and activity. During the course of the mission, the squad encounters village characters in need of assistance, an improvised explosive device event, a firefight with local gang leadership, and simulated gunshot wounds to attend to.

Speech Labels. A total of 6,181 utterances were coded using a framework of 27 speech act labels and 18 team dimension labels, where speech act labels represented the basic purpose of a given utterance, such as requesting information or stating an action being taken, and team dimension labels reflected how different forms of information were being transferred up and down the chain of command (CoC). While every utterance was assigned a speech act label, not every utterance constituted a team dimension label ($n = 2743$). The five most frequently occurring speech acts and team dimension labels are presented in Table 1.

Table 1. Top speech act and team dimension label frequencies.

Label	CTL 1	CTL 2	CTL 3	EXP 1	EXP 2	EXP 3	Total
Speech act labels							
Inform	125	139	111	188	235	237	1035
Command	141	143	73	224	186	216	983
Request information	68	123	70	123	113	137	634
Acknowledgement	90	98	59	108	110	133	598
Provide information	62	99	59	83	75	130	508
Team dimension labels							
Provide info up CoC	103	94	59	105	127	149	637
Command team leader	61	60	16	153	71	71	432
Command squad leader	58	52	47	45	85	123	410
Provide info down CoC	24	46	47	61	45	104	327
Request info down CoC	47	64	30	45	71	66	323

Team Performance Ratings. Team performance ratings collected via subject matter experts (SMEs) who followed and observed squad performance in real time during the

course of M3 were used as an index of team performance for this study [14]. SMEs completed Targeted Acceptable Responses to Generated Events or Tasks (TARGETs) checklists that broke down the mission into individual events, each with several target behaviors such as providing situation updates up the CoC or providing cover to a squad member completing a task for SMEs to watch for. Ratings for each of 27 behaviors were dichotomous numerical completion ratings (0/1), with a final score for the squad assessed via the total percentage of behaviors completed.

2.2 Data Analysis

A series of correlations and t-tests were conducted to examine the relationship between frequencies of speech act labels and team dimension labels and team performance ratings, as well as to explore the effects of the team development training to which half of the squads were experimentally assigned. Next, a median split of performance ratings was conducted such that squads were designated as either “high performance” or “low performance.” Given the limited sample size, the two squads of most average performance were excluded from further analyses so as to generate more variance between performance groups. This resulted in two control condition squads representing the low performance group and two experimental condition squads representing the high-performance group. T-tests were conducted to examine the relationship between frequencies of speech act labels and team dimension labels and a dichotomous team performance rating.

In addition to examining frequencies of team communication behaviors we also calculated two anticipation ratios based on speech act label data to explore how squads shared information. The “information ratio” involved the passage of all general information compared with how often requests for information were made. The “action ratio” involved information being passed relating to how often squad members verbalized what they were doing compared with how often they were asked to do something.

Finally, we examined how squads performed when met with increased situational stressors such as gunfighting and simulated wounds requiring treatment. We coded all events within the mission as either occurring before or after hostile contact occurred. Label values were normalized as a percentage of the total utterances for either before or after hostile contact. MANOVAs and paired t-tests were then used to examine differences between and within performance groups across contact event types.

3 Results

Prior to examining differences in communication behaviors between high and low performing squads’ correlations between the experimental condition of team development training, speech act labels, and team performance were examined, where experimental condition was represented by a 0 or 1, with a 1 representing squads who were experimentally assigned to receive team development training. The correlation between condition and team performance was found to approach but not reach significance ($r = .749, p = .087$). Condition was significantly positively correlated with the total number of commands given ($r = .867, p = .025$), number of statements providing information ($r =$

.936, $p = .006$), number of hail statements gaining the attention of another individual prior to continuing speech ($r = .892$, $p = .017$), and total number of utterances ($r = .869$, $p = .025$), indicating a greater number of these statements by squads who received the team development training.

Speech Act Labels. Next, we aimed to examine differences in counts of speech act labels between high and low performance squads using a median split of team performance score, omitting the two average performing squads. T-tests were conducted on counts of speech act labels and anticipation ratios for squads classified as either high or low performance. Results indicated that high performing squads made inform statements ($t = -14.708$, $p = .005$) at significantly higher rates than low performing squads, while command statements approached significance ($t = -3.925$, $p = .059$). There were no differences between high and low performing groups in the number of information requests ($t = -.664$, $p = .575$), information statements provided in response to a question ($t = -.664$, $p = .575$) or acknowledgement statements ($t = -2.259$, $p = .152$). In relation to anticipation ratios, there was no difference in the ratio of information shared versus requested between performance groups ($t = -1.078$, $p = .394$), but there was a significant difference in the ratio of action statements made versus actions requested ($t = 6.503$, $p = .023$) signifying that members of low performance squads stated the actions they were taking more often than actions were requested at a comparatively greater rate than those in the high performing squads.

Team Dimension Labels. Similar to the examination of speech act labels, t-tests were conducted on counts of team dimension labels for the high and low performing squads. Results indicated that team leaders in high performing squads gave commands significantly more often than team leaders in low performing squads ($t = -21.0$, $p = .002$). No significant differences were found between low and high performing groups for the number of commands provided by a squad leader ($t = -2.547$, $p = .126$), providing information down the chain of command ($t = -1.255$, $p = .336$), or requesting information from down the chain of command ($t = -1.467$, $p = .280$).

Team Communication Behaviors Based on Event Type. Next, a series of multivariate analyses of variance (MANOVAs) were conducted to examine differences in team communication between performance groups for either non-contact or contact categories. Then, to further explore and contextualize changes over time within squads, paired t-tests were conducted on the difference in proportion between speech act and team dimension labels before and after contact took place. Results indicated that, prior to contact, there was a significant difference in the proportion of information statements given by low performing squads ($M = .122$) and high performing squads ($M = .172$) ($F = 35.501$, $p = .027$). Whereas after contact, the relationship between the number of information statements given by low performance squads ($M = .129$) and high performing squads ($M = .185$) approached but did not reach significance ($F = 13.893$, $p = .065$). These findings suggest that compared to low performing teams, members of high performing squads provided more information to each other prior to combat events, but not necessarily after the combat began.

Similarly, we found that, compared with low performing squads ($M = .083$), high performing squads ($M = .140$) had a significantly higher rate of requests for information

issued down the chain of command prior to contact ($F = 19.891, p = .047$). But, after contact, no differences were found between the low ($M = .257$) and high ($M = .161$) performing squads ($F = 5.08, p = .153$). Expanding on these results, paired t-tests revealed seemingly large mean differences between low performance squads' information requests by superiors before contact ($M = .083$) and after contact began ($M = .257$), but this only approached significance ($t = -10.046, p = .063$). Furthermore, we found that squad leaders issued a similar number of command statements across groups and events, but team leaders in the low performing groups ($M = .209$) issued more commands than team leaders in the higher performing groups ($M = .144$) after contact ($F = 40.319, p = .024$) (See Table 2).

Table 2. Differences in team communication proportions across events

Labels	Pre-contact			Post-contact		
	Low	High		Low	High	
	M(SD)	M (SD)	$F(p)$	M(SD)	M(SD)	$F(p)$
Speech act labels						
Inform	.122 (.002)	.172 (.012)	*35.501 (.027)	.129 (.019)	.185 (.009)	13.893 (.065)
Command	.206 (.055)	.229 (.042)	.224 (.682)	.241 (.037)	.287 (.072)	.668 (.500)
Request info	.095 (.056)	.112 (.026)	.148 (.737)	.144 (.005)	0.103 (.04)	1.983 (.294)
Provide info	.018 (.014)	.05 (.010)	7.198 (.115)	.062 (.013)	.044 (.159)	1.563 (.338)
Team dimension labels						
Request info down CoC	.083 (.016)	.140 (.008)	*19.891 (.047)	.257 (.008)	.161 (.059)	5.080 (.153)
Provide info down CoC	.130 (.083)	.183 (.067)	.473 (.563)	.111 (.017)	.141 (.064)	.398 (.593)
Command team leader	.190 (.045)	.182 (.038)	.038 (.864)	.209 (.005)	.144 (.014)	*40.319 (.024)
Provide info up CoC	.197 (.085)	.157 (.005)	.444 (.574)	.144 (.017)	.102 (.015)	7.381 (.113)

4 Discussion

Squads trained on team development demonstrated greater information sharing and exchange and more closed-loop communication. While the relationship between condition assignment and overall performance score only approached statistical significance, it is worth noting that when squads of the most average performance were omitted, the lower performing squads did not receive the training, while higher performing squads did. Higher performing squads made more “hail” statements to gain someone’s attention prior to speaking and shared more information with each other, although the action anticipation ratio based on speech act labels suggests that members of lower performing

squads provided information about their own actions at greater rates than higher performance squads when compared to how often actions were requested. Team dimension labels suggest that higher performing squads had team leaders who gave more commands and subordinates who provided information up the chain of the command at greater rates. We then looked at how the communication patterns of teams at different performance levels changed when met with situational stressors such as active combat sequences. We found that high performing squads had leadership requesting information of their subordinates at a consistent rate *before and after* receiving enemy contact, whereas lower performing squads proportionally tripled their requests *after* taking contact.

While this set of preliminary analyses provides some insight into team communication behaviors, future analyses should include stochastic analysis over time to explore team communication patterns and their relationship to team performance. In addition, future research should explore using multi-task learning techniques to determine which sets of labels or features are best combined to understand and predict team performance. A second limitation of this study is the very small sample size. Relatedly, several utterance categorizations such as requesting information from a superior or correcting what someone else said remained largely absent from the squad transcripts, leaving marginal differences in mean scores to have large effects on correlations. Because team knowledge develops over time, a more granular and event-based approach could have future research highlight critical differences in communication behaviors around these key events.

5 Conclusion

In this paper we report on an exploration of team communication behaviors collected during a live military training exercise using a frequency-based approach. Results provided insights into team communication differences between high and low performing teams. In a training context, communication data can provide especially valuable information about what differentiates communication patterns of high and low performing teams and even how patterns of communication within a team shift over time. When used alongside performance data, team communication data has the potential to greatly improve the understanding and assessment of teams in action.

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