Effectiveness of Process Level Feedback at Training Tactical Decision Making

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ABSTRACT

Decision making is a critical skill throughout all echelons of the military. From command and control to the front line, Warfighters must be trained to quickly and effectively make decisions. Key to the development of effective decision makers is the utilization of targeted learning strategies, designed to improve an individual's decision making process. One such strategy is process level feedback, which provides information regarding how effectively an individual is utilizing task strategies or performing task sub steps necessary to achieve task goals. Process level feedback can be employed to improve decision making skills by identifying and correcting breakdowns in the decision making process. A process level feedback method to target decision making skills was developed for use in simulation-based training. This feedback method incorporates outcome feedback with process level feedback aimed at decomposing decision making performance into sub-processes using the OODA loop as the theoretical model (Observe, Orient, Decide, Act; Boyd, 1987). Feedback is provided on errors/error patterns across these sub-processes. This feedback strategy was evaluated in a series of experiments conducted both in the laboratory and in the field with Marines. In the laboratory study, participants who were recruited from the community performed tactical decision making tasks in a simulation testbed and either received the process level feedback or a control condition of outcome feedback. A similar study was conducted with experienced Marine Corps squad leaders. Marines at the School of Infantry East received training utilizing either a simulation-based training approach which incorporated this process level feedback method or simulation training with methods traditionally used in the Marine Corps. This paper will describe the process level feedback method, present results of both experimental studies, and discuss implications and lessons learned for implementing this method in a military training setting.

ABOUT THE AUTHORS

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INTRODUCTION

Decision making is a critical skill throughout all echelons of the military. From command and control to the front line, Warfighters must be trained to quickly and effectively make decisions under stressful conditions. Key to the development of effective decision makers is training which effectively targets decision making skills. The US Marine Corps (USMC) has recognized this and made it a priority as evidenced by 1) one of their key Training and Education (T&E) Science and Technology Objectives (STOs) being focused specifically on Warrior Decision making (STO 1) and the development of products and technologies to assist Marines at all levels better prepare to make effective decisions in complex environments (United States Marine Corps, 2012), and 2) the USMC 36th Commandant's Planning Guidance (2015) placing a priority on the fielding of capabilities that support the development of resilient leaders and sound tactical and ethical decision making. Key to the development of effective decision makers is the utilization of targeted learning strategies, designed to improve an individual's decision making process and bolster its resilience to stress on the battlefield. Carroll et al. (2013) provide a brief review of a number of training strategies which can be used to target the decision making process. Of particular note are after action review techniques such as error-based or causal-based feedback that provide the opportunity to target decision-making at the process level. This type of feedback is known as process level feedback and provides information regarding how effectively an individual is utilizing task strategies or performing task sub steps necessary to achieve task goals. Process level feedback can be employed to improve decision making skills by identifying and correcting breakdowns in the decision making process.

Process Level Feedback

Feedback is recognized in the research and training realm as a significant factor in the learning process (Buff & Campbell, 2002; Salas, Dickinson, Converse & Tannenbaum, 1992). The aim of feedback is to reduce the gap between the task goal and current performance levels; however, the type of feedback utilized can impact the effectiveness in achieving this goal. Feedback can be at the outcome level (i.e., information regarding how you are doing with respect to task goals) or at the process level (i.e., information regarding how effectively you are utilizing task strategies or performing task sub steps necessary to achieve task goals), or both. The most effective feedback will have both of these elements built in to help the learner understand where they are going (goals), how they are doing with respect to these goals (outcome) and how performance needs to change to help meet these goals (process; Hattie & Timperley, 2007). Earley et al., (1990) found the greatest impact on performance when outcome and process level feedback were combined. It is hypothesized this is because they influence unique aspects of the learning process, with outcome feedback influencing motivation and effort (i.e., to decrease the gap between goals and current performance) and process feedback influencing the task strategies used to perform (i.e., due to a better understanding of how they should be performing; Earley et al., 1990). In a meta-analysis of over 600 effect sizes Kluger and DeNisi (1996) found that feedback interventions which incorporate cues that direct attention to task processes promote learning and achievement compared to those that draw attention to the self (such as praise). This is consistent with results from a study conducted by Davis and colleagues (2005) which found that the greater specificity that feedback had (i.e., the more information regarding task performance), the greater impact it had on performance.

Process level feedback often incorporates information regarding learner errors. Errors are valuable learning opportunities (Mory, 2004) that provide insight into underlying learner deficient processes which can be corrected through targeted feedback (Salas, Rosen, Burke, Nicholson, & Howse, 2007). Feedback techniques such as error-based, process level feedback have been shown to be effective in improving performance compared to outcome feedback (Carroll, 2010). Error-based process feedback can be further enhanced by incorporating error management instructions which present feedback as a positive tool and encourage the learner to take advantage of the feedback instead of feeling disappointed in errors. Heimbeck et al. (2003) found that incorporation of error management instructions with error-based feedback led to significant improvements in performance over error-based feedback alone. This is proposed to be due to the instructions reducing negative emotions surrounding feedback and promoting a good mental model of how training should work (Heimbeck et al., 2003). In a meta-analysis of 24 studies (Keith and Frese, 2008), error management training was found to have a significantly greater impact than other methods including error avoidant training and exploratory training.

Targeting the Decision Making Process with Process Level Feedback

This type of process level feedback is particularly promising for promoting the development of complex skills, such as decision making, which entail multiple sub-processes during which an array of different errors could occur. For instance, a poor decision could result from an individual: 1) not collecting the relevant information necessary to make the decision, 2) misinterpreting the meaning of this information, 3) selecting a poor decision response, or 4) incorrectly executing the decision response selected. Feedback, which can help a learner identify where in the decision making process the error occurred, can help to focus their attention on deficient sub steps in the decision making process. Boyd's OODA (Observe, Orient, Decide, Act; 1987) loop provides an effective framework for identifying where in the decision making process errors occur. Although it has been criticized for being out of date with respect to modern theories of human cognition (Bryant, 2006), it has been used successfully as the basis for training tactical decision making (Von Lubitz, 2008) and provides a simple, easy to interpret framework for breaking the decision making process down into targetable sub-processes.

A process level, feedback-based, decision making learning strategy was developed to target errors in the decision making process and effectively improve decision making skills. The learning strategy: 1) incorporates feedback both at the outcome and process level, 2) provides process feedback regarding errors in task performance and task strategies for improving performance, and 3) incorporates error management instructions designed to encourage learners to fully leverage feedback to improve performance. To facilitate effective feedback interpretation, prior to task performance, the concept of process level feedback is first introduced, along with the concept of the OODA loop, the impact of stress on each stage, and performance strategies for improving the OODA loop. Error management instructions are then introduced, encouraging the learner to utilize error feedback as an opportunity to learn. During task performance, an event based checklist is utilized to assess learner decision making at the process level. As an individual performs and encounters decision events, he is prompted to report what he sees, what it means, and his possible courses of action. The event-based checklist allows an observer to check off responses and quickly and easily determine: 1) percentage of critical cues observed (Observe Score), 2) percentage of situational factors recognized (Orient Score), 3) effectiveness of the course of action selected (Decide Score) and 4) effectiveness of the course of action execution (Act Score).

After scenario completion, the performer is first given outcome feedback which includes their mission effectiveness score and the reason for this score (e.g., only 1/3 mission objectives met, time to complete mission unacceptably long, too many civilian/friendly casualties taken). Next, the performer is given process level feedback. For each event (or a subset of events in which poor performance is displayed), the event outcome is reported along with the effectiveness of each stage of the OODA loop. For instance, the individual is prompted regarding: 1) any critical cues he failed to observe (e.g., "You seemed to observe X and Y in the environment, did you see Z?"), 2) any situational factors not recognized ("You seemed to recognize X and Y, did you realize Z?"), 3) sub optimal courses of action selected ("You chose X course of action, did you consider Y course of action which would have been a better choice because Z?"), and 4) ineffective execution of courses of action ("You incorrectly did X, you should have done Y"). Performers are then given recommended tasks strategies for improving these processes (e.g., "Please be sure to thoroughly scan the environment and report all cues that may impact your mission."). Finally, error pattern feedback is given on the OODA stage that the performers had poorest performance during the scenario as a whole (i.e., If Observe stage: "You seem to have problems detecting all critical cues; be sure to scan the environment thoroughly for all relevant cues.; If Orient Stage: "You have problems effectively assessing the situation; be sure and consider mission objectives, Rules of Engagement, and what you have seen in previous scenarios when trying to understand the situation unfolding.").

A series of two studies were conducted to evaluate the training effectiveness of this learning strategy. A laboratory study was conducted with participants recruited from the community to evaluate the training efficacy of the feedback strategy in a laboratory setting. A field study was conducted with experienced Marines at the USMC School of Infantry East (SOI-E) to evaluate the effectiveness of the learning strategy when integrated into a military schoolhouse. The sections below detail the study methods and results, and present a discussion of findings and implications for future use in military training settings.

LABORATORY STUDY

The objective of the laboratory study was to measure the effectiveness of the process level feedback-based, decision making learning strategy on decision making performance under stress in a simulated environment. To achieve this, performance was monitored while participants conducted a series of complex military decision making tasks in the Virtual BattleSpace2 (VBS2) simulation environment after receiving a laboratory stressor. It was hypothesized that process level feedback would result in an increase in decision making performance from pretest to posttest.

Methods

Participants

A total of 42 male individuals between the ages of 18 and 30 (M = 21.8, SD = 2.5) in the central Florida area participated in the study. One participant had formal military training (Air Force, SrA, Reserve), and there was a wide variability in participant computer gaming experience: 9 participants had none or low experience, 14 had moderately low experience, 10 had moderately high experience, and 9 had high experience. Participants received monetary compensation for their time at the rate of $25/hour and an additional $25 bonus upon the completion of the study.

Experimental Design and Measures

The overall design of the study was a 2 x 2 mixed between-within subjects design. The between-subjects factor was learning strategy (Decision Making vs. Control), and the within-subjects factor was trial (pretest and posttest). Participants in both conditions completed the same series of steps throughout the study: Introduction, VBS2 familiarization training, pretest (social evaluative stress induction technique and VBS2 Scenario), education phase, acquisition phase, application 1 and 2 (each with a different VBS2 Scenario+ feedback), and posttest (social evaluative stress induction technique and VBS2 Scenario). Both the stress induction techniques and the first and last VBS2 scenarios were counterbalanced to account for potential order effects. Table 1 summarizes the high level experimental design and procedure.

Table 1: High Level Experimental Procedure

Condition	Intro	VBS2	Pretest	Education	Acquisition	Application 1	Application 2	Posttest
Control	Informed Consent, Surveys	Training + Practice Scenario	Stressor + Scenario	Triage presentation	Practice triage steps	Scenario + outcome feedback	Scenario + outcome feedback	Stressor + Scenario (High Stress)
Decision Making Learning Strategy				Decision Making Process presentation	Practice error-based DM feedback	Scenario 2 + outcome & process feedback	Scenario + outcome & process feedback	

The primary measure was decision making performance, which was a composite score of OODA loop performance. Specifically, each VBS2 scenario was designed to include five discrete decision events. For each event, Observe, Orient, Decide and Act Scores were determined as described above, with possible scores of 100%, 50%, and 0%. These metrics were restricted to three levels to allow the observer to very quickly and easily categorize performance and give feedback immediately after the scenarios without lengthy manual calculations. These scores were averaged for each event resulting in an event decision making performance score. Decision making performance scores for the five events of each scenario were then averaged to result in a scenario level decision making performance score.

Materials and Apparatus

Participants performed the experimental task at a computer work station consisting of a laptop, keyboard, mouse, and printouts of rules of engagement and scenario maps, which were displayed on the wall facing the participants. A total of four VBS2 scenarios were created for this experiment. VBS2 is a simulation tool used by the U.S. Marine Corps that simulates realistic enemy engagements and munitions. The scenario names were Clandestine Demolition (CD), Sleight of Hand (SOH), Helo Down (HD), and Assassination (ASSN), and participants were given a different overall mission in each. CD required participants to plant remote detonation explosives on two radar targets deep in enemy territory. In SOH, the participants had to create a diversion by blowing up a vehicle in order to swap a cellphone being held as evidence at a police station. HD required the participants to extract from a helicopter crash site. In ASSN, the participants had to use sniper skills to assassinate a high-ranking military official. Decisions events included identifying targets, when to engage enemies, which routes to take, when to perform key mission objectives such as blowing up targets, and when to exercise tactical patience. All scenarios were designed to induce similar levels of stress (for method see Carroll et al., 2014) and be equivalent in difficulty by ensuring that all scenarios had the same number and type of decisions including: ethical dilemmas, time pressure, the need to remain covert in open areas, and the need for tactical patience. Additionally, all scenarios met the same overall guidelines including: similar potential of being shot at, similar potential of shooting/killing civilians, similar number of enemies that can be engaged, and similar objectives and number of waypoints. Further, initial pilot testing with the scenarios revealed similar average mission performance scores and standard deviations for CD and HD and thus these scenarios were chosen as the pre and post test scenarios.

Procedure

All participants were run individually and had a set start time of 8:00 AM. Upon arrival at the laboratory, participants read and signed the informed consent form and then filled out the demographics form. Participants then viewed a presentation of how to interact with the VBS2 simulation and were guided through a series of practice scenarios within the system. Upon completion of the scenario, any questions about performance were answered by the experimenter. After all questions were answered and participants were comfortable with performing the basic training tasks, a pretest was administered. The pretest consisted of one of two types of social evaluative stress induction techniques followed by a complex decision making scenario in VBS2. Some participants underwent the Trier Social Stress Task (TSST) which has been shown to induce high levels of stress across a range of participants through anticipatory, public speaking and mental arithmetic tasks (see Dickerson, & Kemeny, 2004 for procedure details). Other participants underwent the Socially-Evaluated Cold Pressor Test (SECPT) that involves the participant immersing their full hand past their wrist in a bowl of ice water and has shown similar stress effect sizes as the TSST (Schwabe, Haddad & Schachinger, 2008). The stress induction techniques as well as the pretest scenario were counterbalanced to account for different effect sizes and order effects. Next, participants received training per their condition (decision making learning strategy vs. control learning strategy. Both groups received training in three phases, described below, including 1) a 10-minute education phase, 2) a 15-minute acquisition phase and 3) a 60-minute application phase. Next, all participants performed a posttest consisting of a second social evaluative stress induction technique (which ever one was not received during pretest) followed by the last VBS2 scenario. Following the posttest, participants were fully debriefed. The participants were given monetary compensation and were thanked for their time. The study lasted approximately five hours.

In the decision making learning strategy condition, the education phase consisted of a PowerPoint© presentation which taught the concept of process level feedback, the concept of the OODA loop, the impact of stress on each stage, performance strategies for improving the OODA loop and error management instructions. During the acquisition phase, participants were given the opportunity to practice interpreting and delivering process level feedback by analyzing previous situations that have occurred in VBS2 scenarios for analysis. Next, in the application phase, participants performed two VBS2 scenarios while the experimenter utilized an event-based checklist to assess performance and deliver outcome and process level feedback as described above.

In the control condition, the education phase consisted of a PowerPoint© presentation which taught the Simple Triage and Rapid Treatment (START) Combat Triage decision making strategy, the triage decision making process for determining the priority of an injured patient's treatment based on the severity of their health condition, including information about how to sort patients into one of four categories (i.e., green/minor, yellow/delayed, red/immediate and black/deceased) and examples of successful categorization. During the acquisition phase, participants were given the opportunity to practice making decisions using the START strategy by categorizing 15 patient situations. Next, in the application phase, participants performed two VBS2 scenarios while the experimenter utilized an event-based checklist to assess performance and delivered solely outcome feedback as described above. Outcome feedback included a mission effectiveness score, performance outcomes that contributed to this score, whether the performance outcomes were good or bad, and goals for each performance outcome. Performance outcomes included whether they met the scenario's mission objectives, how many times they were shot, how many civilians were killed, and the amount of time it took for them to complete the mission.

Results

Preliminary correlational analyses revealed that decision making performance in the pretest scenario was significantly correlated with computer gaming experience (r = .39, p =.01), and as a result, computer gaming experience was used as a covariate in the analysis to account for this variance. Additionally, despite efforts to equalize difficulty and stress levels across pre and posttest scenarios, these analyses also revealed that changes in decision making performance from pretest to posttest were significantly correlated with pretest scenario (r = .47, p =.01). The scenarios were counterbalanced to counteract such effects, however, the pretest scenario was also used as a covariate in the analyses.

A mixed between-within subjects analysis of variance (ANOVA) was conducted to assess the effectiveness of learning strategy type (Decision Making, Control) on participants' decision making performance across two trials (pretest and posttest). Participants' computer gaming experience and pretest scenario were used as covariates in this analysis. The main effect comparing the two learning strategy types was not significant (F (1, 38) = .15, p = .70, η^2 = .004). There was also no main effect for trial (F (1, 38) = 1.28, p = .26, η^2 = .03), indicating no significant change in performance across the two trial periods when looking across groups. There was, however, a significant interaction between learning strategy type and trial, (F (1, 38) = 4.94, p = .032, η^2_p = .12), with the process level-based decision making learning strategy group showing significantly greater improvements in decision making performance from pretest to posttest than the control group. Figure 1 below shows the results.

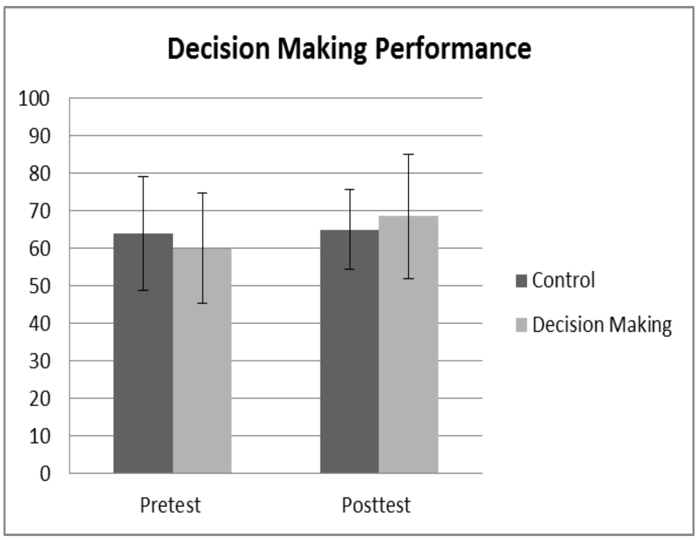

Figure 1: Decision Making Performance between Conditions across two Trials.

The interaction effect suggests that the process level-based decision making feedback led to significantly higher decision making performance improvements than did the outcome feedback received by the control group. Although these gains appear modest, a 14% increase in decision making performance after only two scenarios (approximately one and a half hours of training) are very promising results for such a complex decision making task.

FIELD STUDY

One of the objectives of the field study was to determine the effectiveness of the process level feedback strategy within a military school house training regime, compared to traditional military training methods currently utilized. The study also explored the effectiveness of simulation based-training stress induction techniques; see Carroll et al. (2014) for discussion of these aspects of the study and results, as they are not the focus of this paper. It was hypothesized that Warfighters receiving process level feedback would perform better than a control group that received feedback as traditionally delivered in a military schoolhouse setting. It was also hypothesized that the experimental group would perform better in a transfer environment (live exercise).

Methods

Participants

Participants in the study included 30 Marine Corps Sergeants (E-5) with squad leader experience participating in the six- week Marine Corps Infantry Small Unit Leader Course (ISULC) at the School of Infantry East (SOI-E). They were all male and ranged in age from 23 to 35 years (average = 27). Participants' average time in military service was 7.5 years, with an average of 3.5 years of squad leader experience and an average of 1 deployment as a squad leader.

Experimental Design and Measures

The experiment was a between-subjects repeated-measures design. After receiving classroom instruction within the course curriculum, the participant pool was randomly assigned to two conditions. The experimental group received a simulation-based training approach which incorporated process level feedback and the control group received simulation-based training as it is currently implemented within the ISULC training course. Within each of the groups, a subset of participants acted as squad leaders (1 per scenario), receiving feedback directly on their performance, while the other participants acted as the supporting squad, following orders from the squad leader. In the experimental group, there were five participants of focus who acted as squad leaders, while there were eight participants of focus in the control group. The experimental group had 10 team members who did not have the opportunity to act as squad leaders during the study. The control group had seven participant who were not the focus of the study, but did have the opportunity to lead a squad at some point during the study. The difference between the focus and non-focus squad leaders in the control group was the application of physiological sensors (see Carroll et al., 2014 for details). Group differences are summarized in Table 1 below.

Table 1. Group Descriptions

Condition	Focus of Study	Not Focus of Study
Experimental	*Experimental Group Squad Leaders* (5) • Acted as Squad leader during training • Received process level feedback • Wore physiological sensors	*Experimental Group Teammates* (10) • Did NOT act as Squad leader during training (therefore, no feedback received) • Did not wear physiological sensors
Control	*Control Group Squad Leaders* (8) • Acted as Squad leader during training • Received traditional feedback • Wore physiological sensors	*Control Group Teammates* (7) • Acted as Squad leader during training • Received traditional feedback • Did not wear physiological sensors

The primary measures in the study included pre and posttest decision making competency and decision making expertise levels displayed during transfer. Decision making competency was assessed using a Situational Judgment Test (SJT) administered to all trainees before and after training. SJTs assess problem solving and decision making abilities and consist of a series of domain-relevant decision dilemmas, each accompanied by a set of possible courses of action (COAs). In this application, trainees rated each COA based on its perceived effectiveness. Trainee ratings were compared to ratings provided by Subject Matter Experts (SMEs) both pre- and post-training, enabling assessment and quantification of changes in the decision making process. Decision making transfer performance was assessed by the instructors utilizing a Behaviorally Anchored Rating Scale (BARS) to select the description of performance that best fit the Marine's performance during the live transfer exercises. These behaviors were mapped to expertise level ranging from novice (1) to expert (5), allowing assessment of the level of expertise displayed by each squad member on key performance areas, including Tactical Thinking and Adaptability.

Procedure

The study was run at Camp Geiger, North Carolina, during the ISULC. Pre, training and posttest data was collected over a three-day period, followed by four days of field exercises performed two weeks after the initial 3 day training and testing period. On the first day, participants were given a brief introduction to the study, and then they completed informed consent forms and questionnaires. On the second day, the participants performed the SJT pretest and were then randomly split into experimental and control groups. The groups split into two separate computer laboratories and over a day and a half received approximately eight hours of VBS2-based simulation training per their condition.

Prior to scenario performance, participants in the experimental group received 45 minutes of VBS2 familiarization, or "buttonology" training. Control group participants did not receive this training because they did not directly interact with VBS2 during their scenarios. Rather, they were presented a Gods eye view and reported COAs chosen to higher command. A simulation analyst would then interact with VBS2 to enact the COA within the simulation. During the training, both groups completed a series of scenario missions in which each squad encountered a sequence of decision events to which they had to react (e.g., movement in danger area, priority of targets, weapons employment). After each scenario, squad leaders in the experimental group were given process level feedback utilizing the OODA checklist described above. Instructors provided outcome feedback with respect to overall mission performance and decision event outcome, as well as process level feedback on the OODA loop for each decision event, including: 1) cues detected/not (Observe), the situational factors recognized/not (Orient), the effectiveness of COAs chosen/not (Decide) and the effectiveness of COA execution (Act). Instructors also provided feedback on general tactics and procedures utilized. Instructors in the control group provided outcome feedback for each decision event, including feedback on the effectiveness of the responses to the event and planned COAs as well as feedback on general tactics and procedures utilized. For full study procedure details, see Carroll et al. (2014).

At the end of the third day, participants completed the SJT posttest. Two weeks after the posttest, all squad members performed in a series of two field exercises in which seven participants from the experimental group had the opportunity to act as squad leaders in a training exercise. Instructors utilized the BARS assessment discussed above to assess transfer performance on key performance areas.

Results

Decision Making Competency

Change in decision making competency was calculated by computing the difference between the SJT pretest score (difference from expert score in standardized z scores) and the SJT posttest score. A between subjects ANOVA was performed on SJT decision making competency change score with a between groups independent variable of group (Experimental Group Squad Leaders, Experimental Group Teammates, Control Group Squad Leaders and Control Group Teammates). Results indicated a significant effect of group (F (3, 26) = 3.15, p = .04, η^2 = .27), with the Experimental Group Squad Leaders having the greatest improvements from pre to post test. Pairwise comparisons revealed that the significant group differences were between: 1) the Experimental Group Squad Leaders and both the Experimental Group Teammates (p <.05) and the Control Group Teammates (p<.05) and 2) the Control Group Squad Leaders and Control Group Teammates (p=.05). Results are illustrated in Figure 2 below.

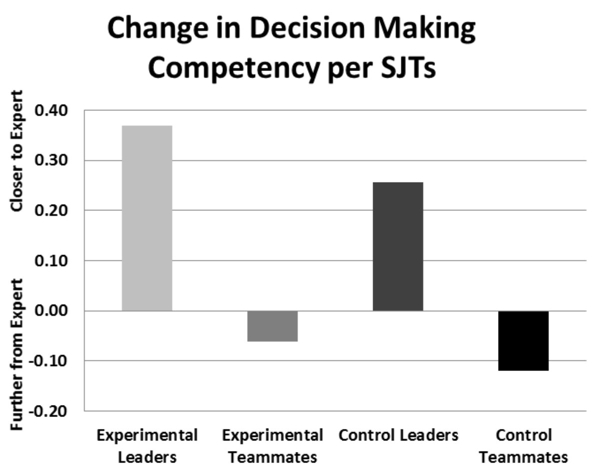

Figure 2. Change in Decision Making Competency as indicated by SJT Scores.

Decision Making Expertise

Due to the inherent uncontrollability in field studies, the only participants chosen to be squad leaders in the live transfer exercise were from the experimental group. Therefore, an analysis between the experimental and control groups was not possible. Instead, the analysis compared the differences between Experimental Group Squad Leaders and the Experimental Group Teammates. Eight participants had the opportunity to lead in the live transfer exercise (Experimental Group Squad Leaders = 3, Experimental Group Teammates = 4), so it was not anticipated that statistical analyses would lead to statistically significant finding. Albeit, a multivariate ANOVA was performed on the decision making expertise scores of those who led in the live transfer exercise with an independent variable of group (Experimental Group Squad Leaders vs. Experimental Group Teammates). As expected, results revealed no statistically significant differences between the groups, however, there was a moderate effect size, indicating that with a larger participant pool, statistical significant might have been achieved ($F(2,4) = .87$, $p = .49$, $\eta^2 = .30$). Although the results do not have statistical significance, they have operational significance. Experimental Group Squad Leaders, who were the focus of the training and received the process level feedback performed an entire expertise level above Experimental Group Teammates, indicating there were significant operational differences in how they performed during the live transfer exercise. Specifically, Experimental Group Squad Leaders displayed tactical thinking and adaptability behaviors associated with a Competent squad leader, whereas Experimental Group Teammates displayed tactical thinking and adaptability behaviors associated with an Advanced Beginner squad leader. Results are illustrated in Figure 3 below.

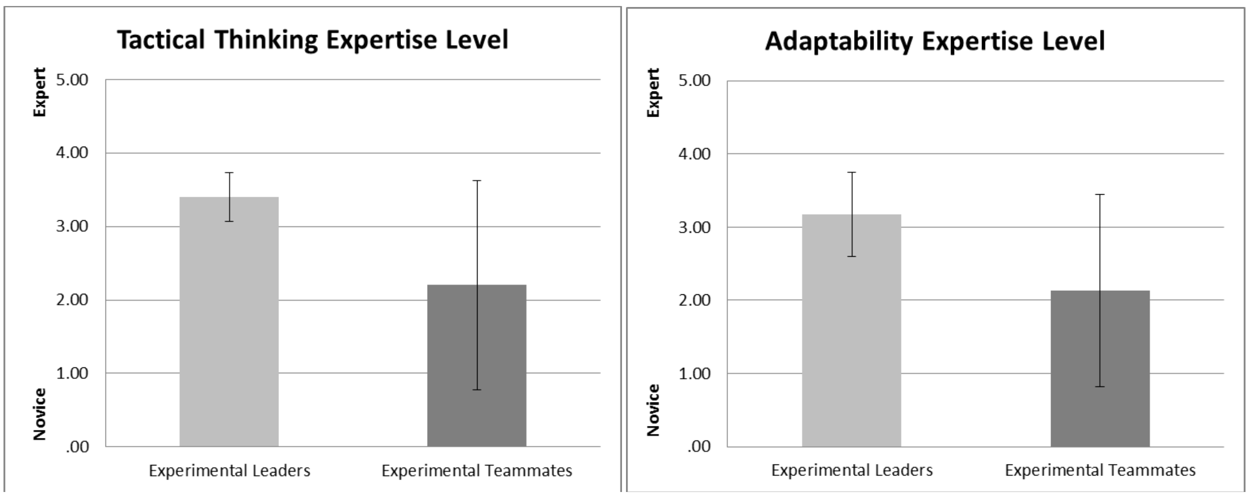

Figure 3. Tactical Thinking and Adaptability Expertise Levels during Transfer Exercise

DISCUSSION

The results of the laboratory study support the hypothesis that the learning strategy which combined both process level and outcome feedback led to significantly greater increases in decision making performance than the outcome feedback alone received by the control group. This is in line with findings from the literature (Earley et al., 1990; Carroll et al., 2010) and provides support for utilizing such a strategy to target decision making performance in training. The process level feedback allows for the pinpointing of where in the decision making process the breakdown occurred so the performer can focus their attention on task strategies used in deficient sub steps, allowing a more effective and efficient learning experience.

Even when utilized in a field setting, specifically in simulation based training in an actual Marine Corp training course, results show similar promise for the process level feedback effectiveness in improving decision making competency of squad leaders with a team who received it during training. These squad leaders showed the greatest increases in decision making competency, although not statistically significantly greater than their control group counterparts. The lack of significant differences between Experimental and Control Group Squad Leaders may be due to the amount of training received. Given the time constraints of the course, each Experimental Group Squad Leader had the opportunity to lead for one scenario, consisting of five discrete decision events for which they received process level feedback. This is half the decisions/feedback opportunities provided to participants in the laboratory study and a very limited amount of training for such a complex task as military small unit decision making. With greater amounts of training, we may have seen a more significant difference between the Experimental and Control Group Squad Leaders.

Though not significantly greater than their control group counterparts, the Experimental Group Squad Leaders' decision making competency improvements were significantly greater than the Experimental Group Teammates and Control Group Teammates. The lack of improvement in the Experimental Group Teammates is not surprising as these participants did not practice making decisions or receive feedback on these decisions. They served more as training aids in the development of the squad leader decision making skills than actual trainees themselves. However, the significant difference between the Control Group Squad Leaders and Teammates was not anticipated. These groups received the same training, with the exception of how they were monitored; the Squad Leaders wore physiological sensors (see Carroll et. al., 2014 for sensor details) and the Teammates did not. The study was designed this way to ensure we were able to capture any testing effects related to wearing the sensors; however, the large boost in learning that occurred as a result of the extra monitoring was a surprise. This is likely due to an increase in trainee motivation and engagement in training, either as a result of increased interest due to curiosity regarding the sensors or concern that their lack of interest in the training would be detected by the sensors and result in negative judgment by instructors. Researchers did observe a keen interest displayed by the Control Group Squad Leaders in their physiological activity, supporting the former prediction. Regardless, these findings have interesting implications for training across the military. Military courses often suffer from lack of trainee engagement, the most optimal psychological state for promoting learning (Engeser, 2012). If increased levels of monitoring can lead to significant improvements in engagement and, as a result, learning, this may be a strategy for increasing training effectiveness. Physiological sensors may not be necessary to induce engagement; there may be monitoring techniques that require no additional technology or expertise and may show similar effects. Further research is needed to investigate this hypothesis.

Also supporting the effectiveness of the process feedback-based learning strategy is the increase in expertise level displayed by the Experimental Group Squad Leaders over their Teammates. Unfortunately, due to lack of control over how instructors performed the live transfer exercises, there were not control group participants selected to act as squad leaders during the exercises. Instead, expertise level of the Experimental Group Squad Leaders in the transfer environment was compared to Experimental Group Teammates. This group served as more of a “no training” control group as they did not have the opportunity to make decisions or receive feedback in the simulation portion of the study. This comparison revealed that the Experimental Group Squad Leaders were performing at an entire expertise level above the Experimental Group Teammates. The Experimental Group Squad Leaders were displaying tactical thinking and adaptability decision making behaviors at levels associated with a Competent decision maker, whereas the Experimental Group Teammates displayed behaviors in these two areas at levels associated with an Advanced Beginner. These results suggest the process level feedback not only impacted performance and competency levels during and just after training, but that these changes persisted in a live transfer environment several days after the training occurred.

These results must be viewed with caution as there were several limitations of the studies. One limitation of both studies was the amount of training time. Given the limited amount of time participants were available, both training times were severely limited. Decision making is a complex skill which depends heavily on building up one’s experience base, something not possible in one to two training scenarios. A second limitation with the field study was the severe lack of control in the study design and execution. Given the great opportunity to collect data with actual Marines in an actual USMC training course, we had to be sensitive to course objectives and requirements, interfering as little as possible in instructors working to deliver effective training to all trainees. As a result, there were several differences between the Experimental and Control Group training, in addition to whether the feedback was process level or outcome feedback. Finally, the field study in particular had a small number of participants, limiting the power of the study.

CONCLUSION

Taken together, these results show promising support for the effectiveness of the above described process level feedback strategy at improving decision making skills, both for the general population operating as individuals, as well as with actual Warfighters leading a squad in a military schoolhouse setting, demonstrating the robustness of the feedback strategy. Future research is needed to validate these results with a larger participant pool, receiving greater amounts of training, in a more controlled setting. Future research should also investigate the effectiveness of increased monitoring (i.e., both physiological monitoring as well as instructor/observer-based monitoring) at increasing engagement and motivation in learners during training.

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