

Critical Thinking In Tactical Command: A Training Study

Karel van den Bosch; Anne Helsdingen

TNO Human Factors

Soesterberg, the Netherlands

Vandenbosch@tm.tno.nl; Helsdingen@tm.tno.nl

Abstract. Recent studies have shown that experts in military tactical command treat decision making as a problem-solving process. They use familiar elements to construct an initial interpretation of the situation. The plausibility of this interpretation is verified by explicitly challenging the critical assumptions. Novices, on the other hand, lack these critical thinking skills. They tend to interpret situations more superficially, and often assess the nature of a situation on isolated cues, without taking the larger pattern into account. The way in which experts handle new and unfamiliar situations is used to develop scenario-based training in critical thinking skills. Empirical studies have shown encouraging results, but the effects of training have been compared to controls that did not receive training at all. The present study investigates the effects of training in critical thinking on tactical command. Trainees were instructed how to critically evaluate available information and how to develop comprehensive situation models. They then received guided training in scenario-based exercises. After completion of training, test scenarios were administered. A control group participated in the training- and test scenarios, but never received instruction or guidance. Results show positive effects of critical thinking training on process measures (i.e. argumentation) and outcome measures (i.e. contingency planning) of tactical command.

1 INTRODUCTION

All modern armies recognise the prime importance of effective command and control [9], [11]. In the past decade, a new approach in the study of situation assessment and decision making in real-world problems emerged: "Natural Decision Making" (NDM) (e.g. [6], [10]). Rather than developing analytic procedures designed to eliminate domain knowledge from the decision making process, NDM-researchers argued that procedures should be tuned to the way experts behave in natural tasks. Expert decision makers have large collections of schemas, enabling them to recognise a large number of situations as familiar. Another capacity of experts concerns their problem solving skills that are required if an immediate match between the actual problem situation and available schemas in memory can not be established. When faced with a complex and unfamiliar tactical problem, experts collect and critically evaluate the available evidence, seek for consistency, and test assumptions underlying an assessment. They try to integrate the results of the processes in a comprehensive, plausible, and consistent story explaining the actual problem situation. Novices, on the other hand, are more inclined to focus on isolated cues and tend to take them at face-value. Furthermore, they are often not explicitly aware of the assumptions they maintain, hence are less critical about them, and are more likely to "jump to conclusions".

NDM theories recommend modelling training after the approach taken by experts [7], [4]. The way in

which experts handle new and unfamiliar situations is used to develop scenario-based training in critical thinking skills [2], [5]. The focus of training is to critically evaluate the available information in the scenario and to develop comprehensive stories explaining the situation. Effects of critical thinking training have been studied in a series of field experiments (e.g. [3], [8]), with encouraging results. However, results were compared to control groups that did not receive training exercises but participated in activities that are not very relevant to tactical command, like filling out psychological test forms, or discussing work related issues. This allows for the possibility that not critical thinking, but mere participation in scenario-based exercises, accounts for the effects.

1.1 The present study

The present study investigates the question whether scenario-based training in critical thinking leads to better improvement in tactical command than mere participation in the exercises.

Participants were taught not to produce stories solely on isolated events, but to include them in a pattern including elements as: the history leading to the current situation, the presumed goals and capacities of the enemy, the opportunities of the enemy, etc. They were instructed how to identify (in)consistency, and to detect missing or unreliable information. Finally, a procedure handling time constraints was also part of the program. The components of the training program are visualised in Figure 1:

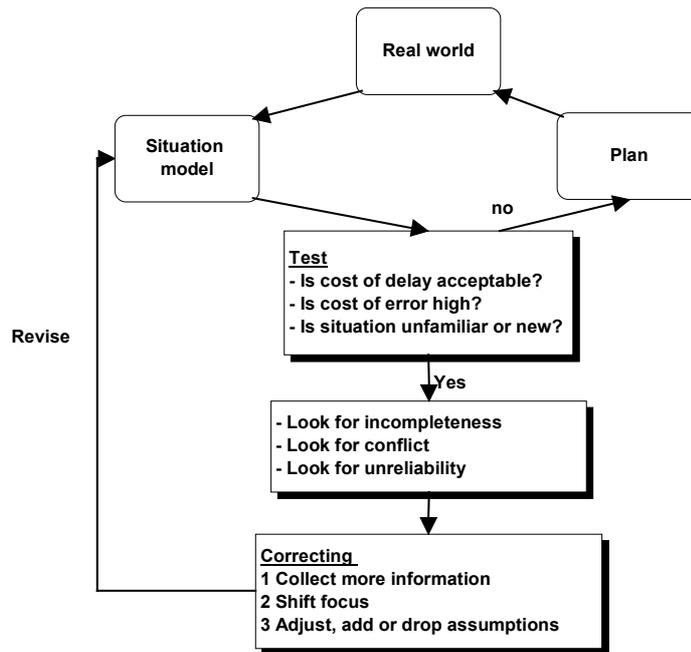


Figure 1: Process for critical thinking training [4]

2 METHOD

2.1 Domain

The study is conducted in the domain of “air defence” of the Royal Netherlands Air Force, in particular the Tactical Command Station (TCS) of a ground-to-air defence battalion. The mission of the battalion is to defend military assets, troops, civil infrastructure and communities against air borne and missile attacks. The command team of the TCS is responsible for mission planning, positioning of the different weapon systems, co-ordinating system movements and transfer, assignment of priorities, and for logistics, combat support, security and communication.

Trainees played the role of battle captain, which is the decision-preparing officer. They are told that in the training scenarios, they have the authority and responsibility for making tactical assessments and decisions.

2.2 Subjects

All 16 participants occupied commanding functions in operational ground-to-air defence units of the Royal Netherlands Air Force. They were ranked captain or major. Their age varied from 26-40 years, with a mean of 32. The supervising project officers split participants in two groups of 8 persons in such a way that the amount of tactical experience was approximately the same.

2.3 Task

In an office room, trainees played air-defence scenarios under supervision of the scenario leader (see Figure 2).



Figure 2: experimental setting

The trainee played the role of battle captain, the scenario leader played all other functions (lower and higher control), and introduced the -prespecified- events in the scenario (e.g. battle damage reports, information about enemy movements, identified radar tracks). Prior to each training scenario, the trainee was provided with a short description of the political, military, and civil situation, the battalion’s mission and its preconditions. The task of the trainee was to assess the situations and to make tactical plans and decisions.

2.4 Scenarios

Scenarios were constructed in such a fashion that they allowed for alternative interpretations of events. Ambiguous, incomplete and inconsistent information was intentionally introduced. Scenarios thus provided ample opportunity for critical thinking, in particular:

- producing explanations for observed events
- recognising critical assumptions of situation assessment

- critiquing and adjusting assumptions and explanations
- mentally simulating outcomes of possible decision

2.5 Design

A training-posttest design was used (see Table 1).

Table 1: Research design

Group *	Instruction	Training	Test
<i>Critical Thinking</i> -group (N=8)	Instruction and demos in critical thinking	Scenarios 1-6, with support in critical thinking process- and outcome feedback	Scenarios 7-8; without support; no feedback
Control-group (N=8)	No specific instruction	Scenarios 1-6, no support outcome feedback only	Scenarios 7-8; without support; no feedback

* Groups matched on tactical education and experience

2.6 Procedure

Instruction, training, and test required approximately 8 hours per trainee. All parts were administered on a single day.

Briefing and instruction: Trainees of the critical thinking group received a critical thinking tutorial, followed by a demonstration in which two scenario leaders (one of them played the role of trainee) showed how critical thinking should be used in the scenarios. Trainees of the control group were instructed to run the scenarios in the same way as they normally run CPX-exercises.

Training general: Two sets of three scenarios were used. Two scenario leaders were available. Order of scenario sets, and assignment of sets to scenario leaders was balanced. While performing the scenarios, trainees were asked to think aloud to give the scenario leader access to the assumptions and reasoning underlying the assessments and decisions. At pre-specified moments, the scenario leader interrupted the scenario and asked the trainee for a situation report ("sitrep"). After each scenario, the scenario leaders filled out an evaluation form. Amplifying comments were audiotaped.

Training: Critical Thinking: Trainees had critical-thinking supporting schemes (e.g. Figure 1) available during training. During and after each

scenario, the scenario leader provided support and feedback on the critical thinking process (e.g. by asking "which alternative explanations are possible?", or "how can you verify that assumption?").

Training: Control Group: After each scenario, trainees received outcome feedback only (e.g. "that was a good decision", or "you should have issued that request earlier").

Test: Two test scenarios and two scenario leaders were available. Order of scenario and assignment of scenario to scenario leader was balanced. All trainees were asked to think aloud. No support or feedback was given.

2.7 Performance measures

Two main types of performance measures can be distinguished: outcome and process measures [1]. Outcome measures assess the quantity and quality of the end result (what is actually achieved?); process measures describe the strategies, steps or procedures used to accomplish a task. *Information processing* and *argumentation* were selected as process measures; *result* and *contingency plans* as outcome measures. Scenario leaders used a form to evaluate trainee performance on these variables (see Table 2). Scores were given on a 10-point scale.

Table 2: Sample of performance evaluation form

Performance	Specific	Amplifying Notes
Information processing	Selection of information	Relevant information
	Detecting conflict of information	
	Detecting missing information	
Result	Timeliness	Brief and to the point
	Conciseness	No ambiguity
	Completeness	In conformance with expert
	Unambiguous	Consistent with assumptions
	Quality	

3 RESULTS

3.1 Training

Scores on *information processing*, *argumentation*, *result* and *contingency plans* were entered into a multivariate analysis of variance with *scenario* (6) as repeated measure, and *training* (2) as between-subjects factor. A main effect of training was found ($F(4,11)=4.5$, $p<.05$). The *critical thinking* group performed better than the control group (5.9 vs. 4.6). The main effect of *scenario* ($F(20,280)=1.8$,

$p<.05$) showed that trainees improved over time. No interaction between *training* *en scenario* ($F<1$) was found, indicating that the improvement was equal for both groups.

Process measures: univariate analyses showed that trainees improved their performance on *information processing* and *argumentation* ($F(5,14)=5.7$ and 2.9 respectively, both $p<.05$). The interaction between *scenario* and *training* was not significant for these variables (both F 's <1), revealing that the magnitude of improvement over training was identical for both groups. Figure 3 shows results.

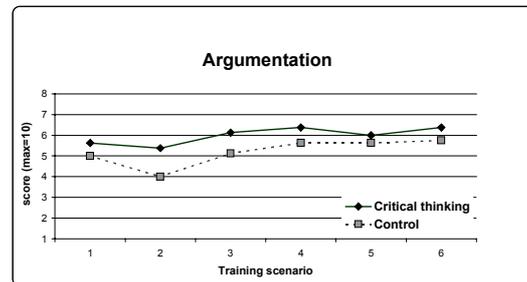
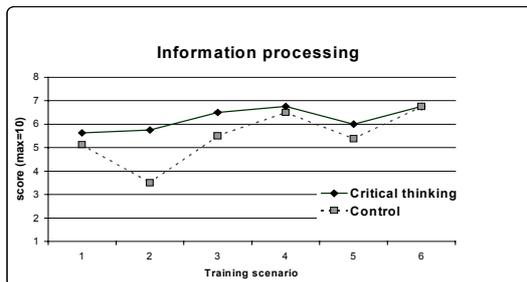


Figure 3: Process measures during training

Outcome measures: univariate analyses showed that trainees improved their performance on *result* ($F(5,70)=2.1$, $p<.05$), but not on *contingency plans*

($F(5,70)=1.9$, $p=.1$). No interaction between *scenario* and *training* was found (both F 's <1). Figure 4 shows the results.

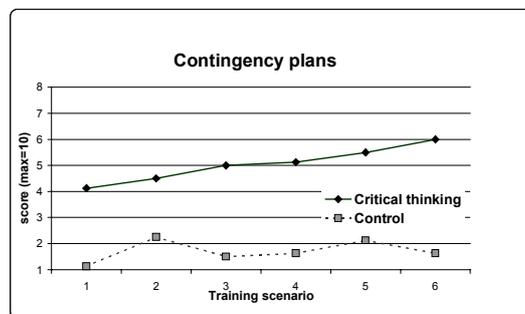
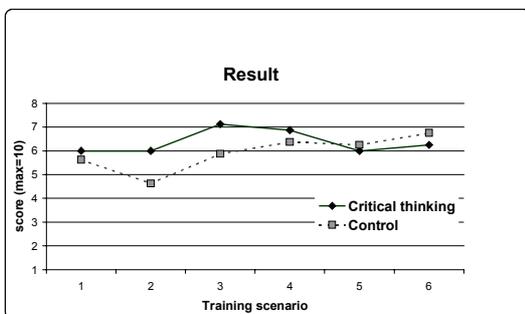


Figure 4: Outcome measures during training

3.2 Test

Scores on *information processing*, *argumentation*, *result* and *contingency plans* were entered into a

multivariate analysis of variance with *scenario* (2) as repeated measure, and *training* (2) as between-subjects factor. Figure 5 shows the data.

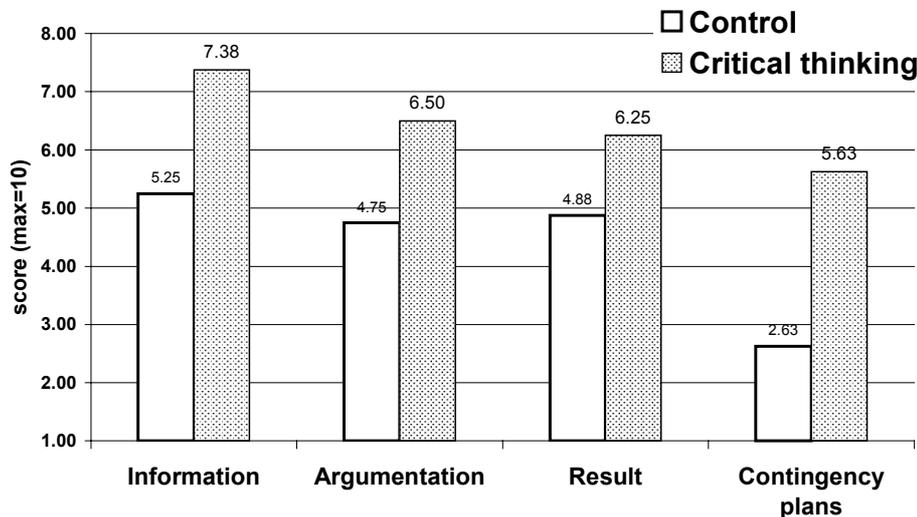


Figure 5: Results on test scenarios

Multivariate testing showed no effect of training ($F(4,11)=2.3$, $p=.12$). Univariate testing showed significant differences between groups for *information processing*, *argumentation*, and *contingency plans* ($F(1,14)=7.2$, 6.7 , and 6.3 , respectively, all $p's < .05$). The variable *result* revealed no between-groups difference ($F(1,14)=1.8$, $p=.2$).

4 DISCUSSION

Tactical command is characterised by dynamic and uncertain situations, multiple events often occurring simultaneously, time pressure, high stakes, multiple and interdependent goals, co-operating systems, and massive amounts of information. The goal of the present study was to investigate whether training in critical thinking improves the process and outcome of tactical command. Trainees of the *critical thinking* group performed better than the control group already at the first stage of training, and continued to do so throughout the training program. This indicates that the instruction to follow the critical thinking approach is in itself sufficient to improve the quality of tactical command.

The critical thinking approach stimulates trainees to produce a founded situation assessment, and helps

them to anticipate to alternative courses of events by developing contingency plans. This turns out to be an important feature, because trainees from the control group hardly made any contingency plans at all. Trainees from the critical thinking group made contingency plans more frequently, but even they achieved poorly in the opinion of experts.

In general, scenario leaders rated trainee performance quite low. They explained that the paper-based form of scenario-based training used in the present study disclosed gaps in tactical education of the participating officers. These gaps had remained concealed in the large-scale exercises constituting normal training. This indicates that individualised scenario-based training is a valuable contribution to tactical education programs.

Compared to officers' accumulated amount of training and experience in tactical command, the amount of exercise provided in the present study is obviously very small. The finding that significant results can be obtained even with such a small-scale training study demonstrates the value of the training concept for tactical education.

Conclusion: The concept of *critical thinking* investigated in the present study enables officers to assess complex situations, facilitates their plan development and helps them to prepare for

alternative courses of events. More research is needed to examine the concept of training in more natural task environments (i.e. training of teams) and to study the transfer of training to operational environments.

11. Trees, H. L. van. (1989). "C3 systems research: a decade of progress". In: S. Johnson; & A. Levis (Eds.), *Science of command and control: part II. Coping with complexity* (pp. 24-44). Washington, DC: AFCEA International Press.

REFERENCES

1. Bosch, K. van den, & Riemersma, J.B.J. (submitted). "Reflections on scenario-based training in tactical command". In: Elliott, L. (Ed.), *Scaled Worlds: Current issues in human-based performance research*.
2. Cannon-Bowers, J.A. & Bell, H.H. (1997). "Training decision makers for complex environments: implications of the naturalistic decision making perspective". In: C. E. Zsombok, & G. Klein (Eds.), *Naturalistic decision making* (pp. 99-110). Mahwah, NJ: LEA.
3. Cohen, M.S. & Freeman, J.T. (1997). "Improving critical thinking". In: R. Flin; E. Salas; M. Strub, & L. Martin (Eds.), *Decision making under stress: emerging themes and applications* (pp. 161-169). Brookfield, Vermont: Ashgate.
4. Cohen, M.S.; Freeman, J.T.; & Thompson, B.B. (1998). "Critical thinking skills in tactical decision making: a model and a training strategy". In: J.A. Cannon-Bowers & E. Salas. *Making decision under stress: implications for individual and team training* (pp. 155-190). Washington, DC: APA.
5. Helsdingen, A.S. & Bosch, K. van den. (1999). "Concepten voor training in tactische commandovoering [Concepts for training in tactical command and control]". (*Report No. TM-99-A043*). Soesterberg, the Netherlands: TNO Human Factors.
6. Klein, G. (1997). "The current status of the naturalistic decision making framework". In: R. Flin; E. Salas; M. Strub; & L. Martin (Eds.), *Decision making under stress: emerging themes and applications* (pp. 11-28). Brookfield, Vermont: Ashgate.
7. Klein, G. (1998). *The source of power: how people make decisions*. Cambridge, MA: MIT Press.
8. Klein, G.; McCloskey, M.; Pliske, R.; & Schmitt, J. (1997). "Decision skills training". In: *Proceedings of the Human Factors Society 41th Annual Meeting*, (pp. 182-185). Held at: Albuquerque, AL. Santa Monica, CA: The Human Factors Society.
9. Levis, H., & Athans, M. (1989). "The quest for a C3 theory: dreams and reality". In: S. Johnson; & A. Levis (Eds.), *Science of command and control: part II. Coping with complexity* (pp. 4-9). Washington, DC: AFCEA International Press.
10. Lipshitz, R. (1997). "On-line coping with uncertainty: beyoynd the reduce, quantify and plug heuristics". In: R. Flin; E. Salas; M. Strub; & L. Martin (Eds.), *Decision making under stress: emerging themes and applications* (pp. 149-160). Brookfield, Vermont: Ashgate.