THE AFTER–ACTION REVIEW TRAINING APPROACH:

AN INTEGRATIVE FRAMEWORK AND EMPIRICAL INVESTIGATION

A Dissertation

by

ANTON JAMES VILLADO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2008

Major Subject: Psychology

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Approved by:

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ABSTRACT

The After–Action Review Training Approach:

An Integrative Framework and Empirical Investigation. (August 2008)

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Chair of Advisory Committee: Dr. Winfred Arthur, Jr.

The after–action review (AAR; also known as the after–event review or debriefing) is a training approach that is based on reviews of trainees' performance on recently completed tasks or performance events. Used by the military for decades, the use of AAR–based training has increased dramatically in recent years. Empirical research investigating AARs, however, is almost non–existent, and theoretical work on the effectiveness AAR–based training and the underlying processes have been limited. The present study presents a theoretical framework for the AAR by integrating the AAR into the existing training literature. In addition, this study presents an empirical evaluation of the effectiveness of AAR–based training, and an investigation of whether objective AAR–based training is more effective than subjective AAR–based training.

One–hundred twenty individuals were trained in 30 4–person teams on a cognitively complex performance task. Teams were trained using a non–AAR–, subjective AAR–, or objective AAR–based training approach. Declarative knowledge, team performance, and team–efficacy served as the measures of training effectiveness.

It was hypothesized that AAR–based training (subjective AAR– and objective AAR– based training combined) would be more effective than non–AAR–based training. Further, it was hypothesized that objective AAR–based training would be more effective than subjective AAR–based training.

The study results indicated that AAR–based training was more effective than the non–AAR–based training approach in terms of team performance and team–efficacy, but not team declarative knowledge. Objective AAR–based training was no more effective than subjective AAR–based training. Teams performed equally well on the training outcome measures regardless of whether they used an objective or subjective AAR– based training approach.

It is anticipated that the theoretical framework and empirical results of this study will serve as a catalyst for the integration of AAR–based training into existing training literatures and to inform the design and practice of AAR–based training systems to take full advantage of their efficacy as training interventions.

DEDICATION

This dissertation is dedicated to my fiancée, future wife, and my best friend,

Lisa M. Ray. Her undying support, encouragement, patience, and love have been pivotal

in completing this dissertation and my graduate studies. Lisa has played a principal role

in my personal and professional development. She is an extraordinary influence in my

life, and I am deeply grateful for all of the love and support she has freely given to me

throughout my graduate career. Lisa, this dissertation is for you.

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I would first like to acknowledge and express my gratitude to my mother, father, family, and friends who offered their undying support, encouragement, and enthusiasm throughout my graduate career. I know that I am truly blessed to be surrounded by such wonderful people.

Those students who took the time to serve as participants in this study also deserve my acknowledgement and thanks for their contribution to my dissertation. I appreciate the time they spent serving as participants, for without the participants, the empirical study would not have been possible.

Lisa M. Ray and A. McLeish Martin assisted in developing and evaluating early versions of the performance task and training materials. Their assistance and insight were instrumental in creating the training materials used in the laboratory.

I would also like to acknowledge the invaluable contributions of my committee members: Mindy E. Bergman, Michael K. Lindell, and Stephanie C. Payne. I am very appreciative of their helpful insights and suggestions. Their unique perspectives and experiences were helpful in developing the ideas presented in this dissertation. More importantly, their enthusiasm, patience, and collegiality made every step of my dissertation a most enjoyable experience.

I would like to extend a very special acknowledgement and thank you to my committee chair, graduate advisor, mentor, and friend, Winfred Arthur, Jr., for his support, guidance, and encouragement, not only regarding this dissertation, but also

throughout my graduate career at Texas A&M University. Winfred generously gave his time and resources to help bring this dissertation from idea to fruition. His selfless and gracious mentoring, patience, and trust have shaped my development as a scholar and future mentor. Winfred's extensive knowledge, experience, wisdom, and professionalism have helped to build the foundation of my future as an academic and he will continue to serve as a model throughout my career.

Most importantly, I would like to acknowledge and thank Christ Jesus, my Lord and Savior. Whether I recognized it or not, the Lord was with me every step of the way.

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CHAPTER I

INTRODUCTION

The after–action review (AAR), also known as the after–event review or debriefing, is a training approach that is based on a systematic review of trainees' performance during recently completed tasks or events. All branches of the military have used the AAR for decades, and the AAR is the Army's preferred method of review following collective training (i.e., training that involves two or more individuals participating in the training session; Meliza, Bessemer, & Hiller, 1994). More recently, the use of the AAR in both private and public organizations has increased dramatically (Zakay et al., 2004), with organizations such as Shell Oil, BP, Fidelity Investments, IBM, Nestlé, Harley–Davidson, and the Texas A&M University Corps of Cadets using the AAR training approach to facilitate learning in various environments.

Despite its, empirical research investigating the AAR is limited or of questionable methodological rigor. Perhaps of greater concern is the fact that theoretical work on the effectiveness of the AAR and its underlying processes is almost non–existent. What limited research exists is typically focused on either investigating the moderating effects of AAR features (e.g., Alexander, Kepner, & Tregoe, 1962; Ellis & Davidi, 2005; Zakay et al., 2004), or on how to integrate technology into the AAR process (e.g., Prince, Salas, Brannick, & Orananu, 2005).

This dissertation follows the style of *Journal of Applied Psychology*.

Neither stream of AAR research has sought to outline a comprehensive theoretical framework that addresses how the AAR may be an effective training approach, nor have they sought to empirically assess the effectiveness of such a training approach. The absence of theory and empirical investigation is evident in that the primary and perhaps the most critical questions concerning AAR–based training effectiveness remain unanswered. That is, is AAR–based training an effective training approach? What is the relative efficacy of the AAR in comparison with other training approaches? Is the AAR more effective at eliciting change in particular types of knowledge, skills, or attitudes than others? What are the critical design factors of the AAR? Is the AAR better suited for certain environments? What types of behaviors should be reviewed in the AAR and how should they be reviewed? How much structure is necessary? How often should an AAR be conducted? These and many other questions remain unanswered, and yet the AAR continues to be utilized throughout various organizations. Thus, it appears that organizations using AARs merely assume that they are effective and accept the AAR as a "hallowed institution" or "received doctrine," ignoring the possibility that they may not be effective in all situations or that certain factors may affect the efficacy of the AAR as a training approach.

Given the absence of theory and the limited empirical research addressing the efficacy of AAR–based training, the present study seeks to build a theoretically based rationale for the AAR by presenting a model of the AAR as a training approach, with a focus on identifying and relating relevant psychological theory and accompanying literature that underlies the process of the AAR. Although research investigating AAR

effectiveness is lacking, other relevant domains of psychology may shed light on the effectiveness of the AAR. Existing psychologically based theories of behavior and related literatures should serve as the building blocks for the various processes underlying the AAR, and subsequently provide researchers with an initial foundation upon which further investigations of the AAR may be based. Further, it is hoped that a review of applicable theory and relevant literatures will reorient researchers and practitioners with the intricacies of the underlying theories that are vital to designing and implementing effective AAR–based training programs. The framework presented here is intended to aid in identifying the features of the AAR that are critical to its efficacy in effecting change in the knowledge, skills, and attitudes of trainees. An AAR training approach was empirically tested to assess its efficacy as a training approach and to test the differential effectiveness of a subjective versus an objective AAR–based training approach. It is anticipated that the results of this study will serve as a catalyst for the integration of AAR–based training into future training research and literature and may be used to design AAR–based training systems to improve their efficacy as training tools.

CHAPTER II

THE AFTER–ACTION REVIEW

Defining the AAR

The AAR was originally developed by the military decades ago, and although several names exist (e.g., after–event review, debrief, group oral interview, and post mortem), it has remained relatively unchanged. At the broadest level, the AAR is an approach to training that turns a recent event into a learning opportunity by formally reviewing the task or event of interest. The United States Army (1993) defines the AAR as "a professional discussion of an event, focused on performance standards, that enables soldiers to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses" (p. 1). Ellis and Davidi (2005) define the AAR as, " . . . an organizational learning procedure that gives learners an opportunity to systematically analyze their behavior and to be able to evaluate the contributions of its various components to performance outcomes" (p. 857).

Goldstein and Ford (2002) describe training as the "acquisition of skills, rules, concepts, and attitudes that result in improved performance in another environment" (p. 1). The AAR facilitates knowledge and skill acquisition and attitude change through learning opportunities. Learning opportunities are created by systematically facilitating a systematic review of past trainee behavior. A critical element of the AAR is the systematic nature in which it facilitates the review of past trainee behavior. The systematic nature of the AAR ensures that the intended topics and material are reviewed.

The AAR is a collective training approach that facilitates training for two or more individuals. The collective nature of the AAR makes it a viable approach for training both groups and teams. Although the terms group and team are often used synonymously, the groups and teams literature often draws a critical distinction between the two. Furthermore, the distinction between groups and teams has important consequences for the development and implementation of group versus team training.

Groups are most often defined as two or more individuals who: (a) consider themselves as members of the group, (b) recognize one another as members of the group and are able to distinguish members from nonmembers, (c) share a common goal, and (d) experience collective outcomes (Arrow, McGrath, & Berdahl, 2001). A team, however, is a special case of a group where members are interdependent (e.g., Glickman et al., 1987; Morgan, Glickman, Woodward, Blaiwes, & Salas, 1986). As a function of their interdependency, individuals operating within a team have the added task of coordinating their efforts. Furthermore, as the level of interdependency between team members increases, so does the criticality of the skills related to coordination effort.

Along with the level or degree of interdependency of a team, a distinction is made between skills necessary to complete the task and skills necessary to coordinate an individual's efforts with those of other team members. The former are often labeled taskwork skills and refers to the skills necessary to understand and perform the requirements of the specific task or job, whereas the latter are labeled teamwork skills and refer to the skills necessary to facilitate the accomplishment of team's tasks (Arthur, Edwards, Bell, Villado, & Bennett, 2005; Glickman et al., 1987). Thus, both taskwork

and teamwork skills are critical to effective team performance, with the criticality of

teamwork covarying with the extent to which a team is interdependent. Furthermore,

like any team training approach, the AAR could have one of two foci. That is, the

training could focus on the performance of the team as a whole (i.e., team performance)

or the training could focus on the performance of individuals within the team (i.e.,

individual performance; Day et al., 2005).

During the AAR, trainees and a facilitator typically review (a) the intended

outcome of the action, (b) the actual outcome, (c) specific actions that assisted in

reaching the intended outcome, (d) specific actions that hindered reaching the intended

outcome, (e) intended future outcomes, and (f) means to increase the likelihood of

successfully attaining these future outcomes (see Figure 1). Thus, a complete AAR

seeks to provide answers to the following questions: What was the intended outcome?

What was the actual outcome? What behaviors contributed to meeting the intended

outcome? What behaviors detracted from meeting the intended outcome? What is the

intended outcome of future events? What actions will increase the likelihood of meeting

the intended future outcome?
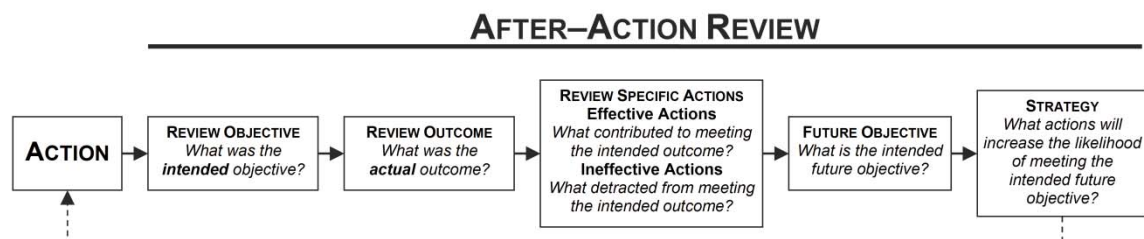
Figure 1. Primary phases of the after–action review.

Since its inception, the most substantial changes to the AAR have been the integration of various technological advances intended to facilitate the conduct of the review (e.g., video and other recording equipment to objectively document performance, and integration of recording and rating tools into simulation software). The present day AAR may differ greatly from the AAR of the past in terms of fidelity and objectivity because of technological advances in recording, playback, and evaluation systems. However, the purpose of the AAR remains unchanged: to systematically turn the performance of a recent task or event into a learning opportunity.

Distinctiveness of the AAR

The AAR is a unique training approach that is absent from the existing training literature. Consequently, it is noticeably absent from topical texts (e.g., Goldstein & Ford, 2002; Wexley & Latham, 2002) and quantitative and qualitative summaries of the training literature (e.g., Arthur, Bennett, Edens, & Bell, 2003; Salas & Cannon–Bowers, 2001; Tannenbaum & Yukl, 1992). Despite a continued reliance on AARs in both private and military settings, the AAR has rarely been studied in an empirical manner. Like any training approach, the AAR has many design features, some which set the AAR apart and distinguish it from other approaches to training. These similar, but distinct approaches (i.e., behavioral modeling training, reflective learning, and action learning) are reviewed below.

Behavioral modeling training. Behavioral modeling training draws on the concept of observational learning (Bandura, 1977, 1986) and incorporates modeled behavior into a training program. The behavior modeling training approach follows a

sequence of activities including (a) a description of the behaviors to be learned, (b) a model who demonstrates the behaviors to be learned, (c) an opportunity to practice the modeled behaviors, and (d) feedback focused on the performance of the practiced behavior (Taylor, Russ–Eft, & Chan, 2005). An essential element of behavior modeling training is the model. The model provides an additional layer of instruction above and beyond more traditional training approaches (e.g., lecture or discussion).

Although both the AAR and behavior modeling training use models, the models are the key difference between the two. In behavioral modeling training, the model is an expert, or at least skilled enough to effectively model the desired (or possibly undesired) behavior. As posited by social learning theory (Bandura, 1977), the choice of the model is a critical element and affects the likelihood that the modeled behavior will be learned by the trainees. Factors such as the similarity of the model to the observers and the attractiveness of the model affect the likelihood that the model will be effective and that the modeled behaviors will be learned (Bandura, 1986). Behavior modeling training uses a predetermined model. However, in an AAR, the trainees themselves serve as the behavioral models. Choosing a model that trainees will view as similar to themselves is negated by the fact that in the AAR, trainees serve as the models for themselves and others participating in the AAR. Models in the AAR are *always* similar to the trainees because they themselves *are* the models.

In behavioral model training, modeled behaviors are specified *a priori* and are typically scripted prior to the training. Unless the training program uses live models, behavioral modeling training is limited to the behaviors demonstrated on prefabricated

training materials. However, in the AAR, modeled behavior is not created prior to training, but is instead created during the training. Creating modeled behavior from recent past performance allows the AAR approach to training to be much more dynamic and flexible than behavioral modeling training with regard to the behaviors being trained. Although the dynamic nature of the AAR makes standardization of the specific modeled behavior essentially impossible, it does allow training to change and adapt to the most current environmental conditions. Content and/or processes that have been recently incorporated into operations or situations that had never previously been encountered may be turned into training opportunities immediately after they occur. That is, as soon as a new situation is experienced, the AAR is able to turn that experience into a learning opportunity. Thus, although behavior modeling training provides behavioral exemplars for specified behaviors, the AAR provides a dynamic training environment using behavioral exemplars that adjust to changing environmental and situational characteristics.

Reflective learning. Reflective learning is a learning or training technique in which a learner reflects upon prior experiences in order to maximize the learning gained from those experiences. Reflection may be done verbally, as in a discussion with others, or it may be done internally, with the learner merely thinking and reflecting on the experience. Mental rehearsal (i.e., cognitive rehearsal of a task, absent of actual task performance [Driskell, Cooper, & Moran, 1994]) is a technique similar to reflective learning. However, mental rehearsal can either occur prior to or following task performance. Although the AAR is an approach to training that uses reflective learning

techniques (creating learning opportunities from experiences), the AAR is always conducted in a collective environment. The AAR capitalizes not only on an individual trainee's experiences, but also on the experiences of other trainees and/or the facilitator.

A second critical difference between reflective learning and the AAR is the necessity that trainees participating in reflective learning possess the ability to review their own performance. Reflective learning relies on the ability of an individual to evaluate and assess behavior–outcome relationships on their own, whereas AARs benefit from the insight of others. During an AAR, participants and a facilitator work together to review, assess, and identify behavior–outcome relationships as a collective. Internal reflection, although certainly a form of reflective learning, is not an AAR.

Action learning. Action learning is another concept that is often associated with the AAR. In broad terms, action learning is a meeting of colleagues to discuss and question existing knowledge and relationships (Revans, 1982; Robinson, 2001). Action learning is best understood by examining its origins. Action learning was developed and used by physicists in the 1920s who met regularly to discuss their work and share the difficulties they were experiencing in their respective labs (Robinson, 2001). This meeting of peers afforded colleagues the opportunity to learn from one another's experiences based upon their well developed knowledge bases. Thus, Revans (1982) describes action learning as resulting from both the accumulation of programmed knowledge and the practice of questioning and testing that programmed knowledge. A key factor is the requisite level of knowledge that is most often gained independently.

Although the AAR does rely on both action and reflection, the AAR is an approach that brings together individuals who have shared the experience of the action under review. That is, action learning refers to the coming together of individuals to share and reflect on independent experiences, whereas the AAR refers to the coming together of individuals to share and reflect on a specific, recently shared experience.

A second noteworthy difference between action learning and the AAR is the requisite knowledge of the participants. The process of action learning relies on experts who have built a foundation of programmed knowledge and experiences of which to share. The AAR approach does not require trainees to be experts in the training domain, but rather the AAR only requires that trainees have shared a recent experience.

State of the AAR–based Training Literature

Although the breadth of the AAR–based training literature is deficient, there are a few notable exceptions (i.e., Alexander et al., 1962; Ellis & Davidi, 2005; Ellis, Mendel, & Nir, 2006). Despite being limited in number, these studies offer some initial support for the efficacy of the AAR–based training approach.

Alexander et al. (1962) evaluated the training performance of four air defense crews. Using a pretest–posttest experimental design, Alexander et al. found that experimental groups ($n = 2$) that had participated in an AAR after each training exercise improved their performance more than the control groups ($n = 2$) that received training only (no AAR). Interestingly, the control groups not only improved less overall than the experimental groups, but on some dimensions of performance, the control groups actually performed worse on the posttest than on the pretest.

In an effort to address their findings that the control groups' performance decreased on several dimensions from the pretest to the posttest, Alexander et al. (1962) introduced the notion that the effectiveness of the AAR may be affected by the visibility of results. They found that an AAR was more beneficial than no AAR when there was a lack of knowledge of results. However, for tasks in which the knowledge of results was clear, there was less of a difference between the AAR condition and the control. Thus, the effectiveness of their AAR was moderated by the extent to which the trainees were aware of the results of their actions, with the AAR being more effective for tasks where knowledge of results was lacking.

Ellis and Davidi (2005) have since presented empirical research investigating the AAR. In their quasi–experimental field study, Ellis and Davidi evaluated the effectiveness of the AAR by examining the content of the review. They found trainees who participated in an AAR that reviewed both failures and successes generated richer mental models and had substantially greater performance increases than trainees who participated in a failure–only–focused AAR. Ellis and Davidi concluded that although trainees, trainers, and organizations may focus on error reduction, reviewing successful and failed performance enhances the trainees' learning and task conceptualization.

The most recent empirical research was published by Ellis et al. (2006) and is an extension of the previous work by Ellis and Davidi (2005). In their study, Ellis et al. examined the effect of AAR type (failure–focused, success–focused, failure–success–focused, and no AAR) on learning and attributions in conditions of prior success versus prior failure. Using a laboratory–based market simulation task, Ellis et al. found that the

AAR improved learning, regardless of the team's success or failure on the task under review. Furthermore, the type of AAR also affected learning in that following successful performance, only AARs that included a review of failures (i.e., failure–focused and failure–success–focused) resulted in performance improvement, whereas all types of AARs improved performance following failed performance.

Although these studies offer some initial insight into the AAR, there are still many questions left unanswered. For example, Alexander et al. (1962) and Ellis et al. (2006) reported that trainees in AAR conditions demonstrated improvement over trainees in control conditions (i.e., no AARs). However, the small sample size of both studies raises critical questions about the stability of their results and subsequent conclusions. Furthermore, both studies utilized a pretest–posttest design, measuring performance once before and once after training. Pretest–posttest designs, although useful in assessing overall differences (i.e., main effects analyses), do not provide trend information. Thus, it is impossible to tell if the effect of the AAR increases, remains the same, or diminishes over time. Although Ellis and Davidi's (2005) research does offer similar insights into the effectiveness of the AAR as a training approach, the quasi–experimental nature, and administrative limitations (i.e., the authors were only provided with a subset of the trainees' mental models that precluded statistical significance testing) necessitate additional research.

The preceding AAR literature leaves many questions regarding the effectiveness of AAR–based training effectiveness unanswered. However, the AAR literature that does exist, in conjunction with relevant psychological theories may provide some insight

into the possible effectiveness of the AAR. Additionally, a theoretically–based rationale

for the AAR may serve to provide guidance into the features critical to designing an

effective AAR training program. The purpose of the following chapter is to develop an

initial theory based rationale for the AAR. This will be accomplished by examining

existing psychological theories and related literatures that are relevant to the specific

phases and functions of the AAR.

CHAPTER III

THEORETICAL FOUNDATIONS

In an effort to bridge the gap between training theory and practice, Canon–Bowers, Tannenbaum, Salas, and Converse (1991) presented a general framework of training, addressing what should be trained, how training should be designed, and why training is effective. As a result of their effort, Canon–Bowers et al. identified theory and research relevant to training in general. Whereas their framework was developed to encompass training in general, the theoretical framework presented in this paper is intended to address a single training approach, specifically an AAR–based approach. Thus, this paper provides a more focused review of theory and literature regarding the design and implementation of the AAR–based training approach.

Although some content might be more or less amenable to a specific training approach, any training approach may be used to train any knowledge, skill, or attitude of interest (Arthur et al., 2003) in the same way that any predictor method can be used to assess a wide array of predictor constructs, (Arthur & Villado, 2008). For example, Canon–Bowers et al. (1991) identified theory and literature relating to various forms of training content, including the nature of expertise, mental models and knowledge structures, teamwork skills, expert/novice differences, taxonomies of task requirements, meta–cognition, and information processing theory. An AAR–based approach is no different in that nothing inherently prevents such a training approach from being used to train any content of interest. Likewise, the effectiveness of any training approach may

be dependent on a number of factors, including individual differences, attitude/behavior relationships, and the training climate to name a few (Canon–Bowers et al., 1991). However, although AAR–based training may be similar to other training approaches in terms of what can be trained and why training is effective, such an approach is unique in its design and execution. Therefore, the present study seeks to build a theoretically based rationale for an AAR–based training approach by presenting a model of this approach with a focus on identifying and relating relevant psychological theory that underlies the process of the AAR.

The process of the AAR may be disaggregated into five primary phases (see Figure 2), and existing psychologically–based theories that address skill, knowledge, and attitude change might provide guidance in understanding how these five phases may work together to elicit such change. In the first two phases of the AAR, trainees review the intended and actual outcome of the action under review and the degree to which the two converge. This review serves to provide trainees with feedback upon which they may evaluate their preceding performance. During the third phase of the AAR, trainees review their behavior and the behavior of others. In reviewing behavior, trainees are provided with an opportunity to learn through observation and reflection. Finally, the trainees review the intended future outcome and requisite strategy to meet that outcome during the fourth and fifth phases, respectively. These final phases serve to provide the trainees with goals and strategies for future action. Borrowing from the feedback, observational learning, and goal setting literatures, a theoretical basis may be put forth to

aid in identifying features of the AAR that are critical to learning, and ways in which

these features may be manipulated to increase the effectiveness of AAR–based training.

AFTER–ACTION REVIEW

FEEDBACK COMPONENT

OBSERVATIONAL LEARNING COMPONENT

GOAL SETTING COMPONENTS

| ACTION | REVIEW OBJECTIVE *What was the intended objective?* | REVIEW OUTCOME *What was the actual outcome?* | REVIEW SPECIFIC ACTIONS **Effective Actions** *What contributed to meeting the intended outcome?* **Ineffective Actions** *What detracted from meeting the intended outcome?* | FUTURE OBJECTIVE *What is the intended future objective?* | STRATEGY *What actions will increase the likelihood of meeting the intended future objective?* |

Figure 2. Primary phases of the after–action review and relevant theoretical components.

Feedback

The first phase of the AAR provides trainees with a review of the *intended*

outcome (i.e., the previously set goal; see Figure 2), followed by the second phase of the

AAR, in which the *actual* outcome is reviewed. Of primary importance during these

two phases is the degree to which the actual outcome met the intended outcome.

Together, these two phases serve to provide feedback to the trainees about their

performance. Research investigating feedback has generally supported the notion that

feedback can enhance task performance by directing attention to aspects of the task on

which feedback is provided, allowing individuals to modify their behavior to reduce

errors and set goals (Ilgen, Fisher, & Taylor, 1979; Kluger & DeNisi, 1996).

Feedback is information about how an individual has performed or is performing a particular task. The origin of the information may be either intrinsic or extrinsic to the task. Intrinsic feedback is, by definition, part of the task. For example, while running a foot race alongside competitors, a runner is able to judge her place during the race by comparing her position to the position of her competitors. No information other than that provided by the race is necessary to judge her placement during and after the race. In contrast, extrinsic feedback is the result of a manipulation, existing only when some feedback intervention is in place. Recalling the footrace example, a runner's reaction time, intermediate distance/lap times, and total time remain unknown unless they were recorded by an external entity. As can be seen by these examples, any task may provide some level of intrinsic feedback and a feedback intervention provides another level of feedback extrinsic to the task.

The AAR may enhance performance, in part, by providing feedback to trainees as an external feedback intervention, supplementing any intrinsic feedback provided by the task. And although feedback may enhance performance in many situations, both the frequency and specificity of the feedback moderate the effect of feedback on performance.

Feedback frequency. Feedback frequency refers to how often feedback is provided during a specified interval of time. Feedback frequency has been shown to affect learning and performance both in terms of the acquisition and retention of knowledge and skills (Ilgen et al., 1979; Kluger & DeNisi, 1996). However, the effect of feedback on learning is somewhat different from that on performance. The

relationship between feedback frequency and performance is generally positive.

Feedback that is more frequent guides trainees toward the desired behavior, resulting in

reduced errors and increased performance. Conversely, the relationship between

feedback frequency and learning is generally negative. Although feedback that is more

frequent reduces errors and increases performance, trainees may experience fewer

opportunities for learning. Fewer opportunities for learning result from a lack of

experiencing errors and unfavorable situations that in turn reduce the breadth of trainee

experiences and opportunities to learn the generalities of the task.

A need for both performance and learning necessitate a balance between more

and less frequent feedback. Feedback may impede the overall effectiveness of training

when it is provided too frequently or too infrequently. Rather, a moderate frequency of

feedback is best. Research generally supports the notion that in most cases, a moderate

frequency of feedback produces positive effects in terms of skill acquisition in

comparison to more or less frequent feedback (Ilgen et al., 1979; Kluger & DeNisi,

1996). When feedback is provided too frequently, it may interfere with learning.

Feedback that is less frequent generally results in superior retention when compared to

feedback that is more frequent (Ammons, 1956; Ilgen et al., 1979). The rationale for this

effect is that frequent feedback reduces the need for trainees to develop a system of

monitoring their own performance during the acquisition phase. That is, trainees

provided with frequent feedback may develop a dependence on the feedback system

exclusively and fail to learn how to monitor their own performance. The issue is

highlighted by the finding that when feedback is lacking, individuals tend to monitor their own performance, making the performance of the task a learning opportunity.

Feedback specificity. Feedback specificity refers to the detail of information provided in the feedback. Similar to the effect of frequent feedback on learning and performance, specific feedback has generally been found to enhance performance but impede learning the generalities of a task when compared to less specific feedback (Goldstein, Emanuel, & Howell, 1968; Goodman & Wood, 2004; Ilgen et al., 1979; Wentling, 1973). Specific feedback aids performance by not only identifying which behaviors are appropriate and which are inappropriate for successful performance (Ilgen et al., 1979), but the detailed information provided by specific feedback also lessens the information processing associated with error detection and retrieval (Christina & Björk, 1991; Goodman & Wood, 2004; Schmidt, 1991). However, less specific feedback often results in increased retention (Goodman & Wood, 2004; Schmidt, 1991; Schmidt & Björk, 1992; Weinstein & Schmidt, 1990). The underlying rationale is the same as that for feedback frequency. When provided with specific feedback, individuals learn to rely on the feedback to reveal the essential behavioral–outcome relationships. Specific feedback inhibits learning the generalities that are critical to performing and monitoring one's performance during novel, complex, and/or dynamic situations (Goodman & Wood, 2004; Schmidt, 1991; Schmidt & Björk, 1992).

Providing feedback via the AAR would appear to have positive effects for the acquisition phase of learning, although negatively affecting retention performance. However, an important point to note lies in one of the benefits of training using the

AAR: it allows the identification of situations that may otherwise go unnoticed. Thus, the AAR would seem to provide the most utility when the task or event provides little or no intrinsic information regarding outcomes.

Observational Learning

The third phase of the AAR provides trainees with a detailed examination of their behaviors during the action under review (see Figure 2). The purpose of this phase is to identify those behaviors that contributed to, as well as those actions that detracted from, meeting the intended outcome. In this phase, trainees review their behavior and the behavior of other trainees in an effort to identify and clarify the behavior–outcome relationships of interest. This phase of the AAR facilitates observational learning by providing behavioral models to trainees.

In the context of the AAR, all of the participating trainees serve as behavioral models. This is beneficial in that the AAR may provide trainees with a wider range of behaviors for every performance episode than would be had by observing a single model. Thus, the AAR may offer trainees a wider range of behavior–outcome relationships from which to learn. However, benefits from observing a greater number of behavioral models rests on the assumptions that the behavioral models are demonstrating a wide range of behavioral–outcome relationships (i.e., fundamentally different behaviors), and that the trainees are able to cognitively process all of the behavior–outcome relationships being demonstrated. Although these assumptions may be met to varying degrees, as the number of behavioral models increases, the opportunity for trainees to witness a wide range of behaviors also increases. However, simply

providing behavioral models is not sufficient for observational learning. Observational learning requires that several processes must occur to facilitate learning (i.e., attention, retention, reproduction, and motivation [Bandura, 1986]). In an uncontrolled environment, the benefit of more models and a range of modeled behaviors may not result in any additional learning. The systematic nature of the AAR, however, maximizes the efficacy of observational learning by systematizing the conditions necessary for observational learning in the following ways.

Attention. Attention is the first critical process in what Bandura (1986) describes as the multi–process of observational learning. In observational learning, learners must attend to and accurately perceive the relevant aspects of the modeled behavior. However, several factors may work with or against the learner to affect attention. The modeled behavior itself may influence the attention paid by the learner. Saliency, complexity, prevalence, perceived functional value, and the attractiveness of the modeled behavior work to affect the learner's attention. In addition to factors associated with the modeled behavior, Bandura (1986) also recognizes characteristics of the learner that could influence the efficacy of observational learning. The learner's perceptual and cognitive capabilities, preconceptions of and prior experience with the modeled behavior, and observational habits all work to influence the effectiveness of observational learning.

The AAR may work to boost the attention of the observers and enhance their comprehension by actively directing the attention of the learners to the modeled behavior. Specifically, the AAR may also actively direct the attention of the trainees on

the most important behaviors and away from inconsequential behaviors. By selectively directing the attention of the learners, the saliency of the modeled behavior is enhanced via the AAR. In addition, the AAR may actively communicate the functional value of the modeled behavior instead of relying on the observers' independent perceptions. Thus, the AAR may enhance the perceived functional value and attractiveness of the modeled behavior.

Retention. The second necessary process in observational learning is retention (Bandura, 1986). Observers must be able to retain the modeled information. The retention of modeled behavior is affected by the coding and organization of the modeled behavior as well as the cognitive and enactive rehearsal. Characteristics of the observer, such as their cognitive skills and cognitive structures, also influence retention of the modeled behavior.

Again, the AAR enhances observational learning by actively aiding coding and organization of modeled behavior. AARs that follow structured training programs may proactively organize training content to enhance the coding and organization of information. AARs may do this by presenting frameworks within which to organize the modeled behavior. AARs maximize coding accuracy by providing an environment in which to rectify coding errors. During the AAR, incorrect coding may be detected through discussion and corrected immediately, rather than through future trial and error (or possibly never, if feedback is ambiguous or absent).

Production. After attending to and retaining the modeled behavior, the observer must be able to transform the encoded information into behavior (Bandura, 1986). The

production of modeled behavior is affected by the observer. These include the accuracy of the observer's representation of the modeled behavior, the ability of the observer to monitor his/her performance of the behavior, and the feedback received during and after the performance of the modeled behavior. Observer's characteristics, such as their physical skills and abilities, also work to affect their production of modeled behavior, further limiting the accuracy of production.

As with incorrect coding, inaccurate representations may be detected through discussion and corrected immediately, rather than through future trial and error. The AAR also provides feedback to learners so they may monitor their performance of the modeled behavior. Thus, the AAR actively works to enhance the production of behavior by limiting the factors that hinder behavior production.

Motivation. The final component of observational learning is the observer's motivation to perform the modeled behavior (Bandura, 1986). Various incentives (i.e., vicarious, external, and internal) influence the observer's motivation to perform the modeled behavior. Incentive preferences and internal standards affect the efficacy of the incentives for eliciting modeled behavior.

By providing clear goals and objectives that are challenging yet attainable, the AAR facilitates the observer's motivational level. Furthermore, the AAR may also work to further clarify the links between behaviors and various incentives, be they vicarious, external, or internal incentives. Behavioral models, by definition, demonstrate the behavior–outcome relationships. The outcomes function as the incentives for performing the behavior. During the review process, trainees observe the incentives

associated with a specific behavior and the level at which that behavior must be performed before receiving the incentive. Likewise, trainees also observe the disincentives associated with specific behaviors.

Goal Setting

The AAR concludes with the trainees participating in a discussion of how to increase the likelihood of future success (see Figure 2). Goals are typically set for future actions during this phase of the AAR. Goals have been found to influence performance, and the goal setting literature has identified several features of goals and the goal setting process that relate to performance. Thus, the goal setting literature can aid in identifying features of the AAR critical to its efficacy as a training approach.

Intentions to work toward goals are a major source of motivation (Locke, 1968; Locke & Latham, 1990, 2002). Generally, goals have the greatest positive effect on performance when they are both specific and challenging (Locke & Latham, 2002). As Locke and Latham (1990, 2002) describe, specific and challenging goals influence performance through four mechanisms: direction, energy, persistence, and the arousal, discovery, and/or the application of task–relevant knowledge. Goals that are specific, in contrast to "do your best" goals, provide individuals with a clear benchmark for which to strive (Locke & Latham, 1990; 2002). Specific goals serve to direct attention and effort towards goal–related activities and away from activities that are goal–irrelevant (Locke & Latham, 2002).

Challenging goals influence performance in several ways. First, challenging goals serve an energizing function in that they tend to elicit more effort than "do your

best" goals (Early, Wojnaroski, & Prest, 1987; Locke & Latham, 1990, 2002). Second, challenging goals tend to increase the persistence of effort toward a goal (LaPorte & Nath, 1976). Finally, challenging goals influence performance by arousing, aiding in the discovery of, and/or applying previously acquired task–relevant knowledge (Locke & Latham, 2002).

The effects of goals and goal setting are moderated by several factors. Locke and Latham (2002) identify goal commitment, feedback, and task complexity as features that may influence the effect of goal setting on performance.

Goal commitment. The extent to which individuals are committed to their goals influences the goal–performance relationship (Locke & Latham, 2002). Goals are most positively related to performance when commitment to the goals is high (Locke & Latham, 2002). Several factors affect the degree to which individuals are committed to goals. These factors may be categorized as being either (a) factors that make goal attainment important, or (b) factors that enhance the self–efficacy of the individuals (Locke & Latham, 2002).

Various strategies exist for increasing the importance of goals. Public commitment to a goal enhances goal commitment (Hollenbeck, Williams, & Klein, 1989) due to the accountability that results from such a public declaration. Goal commitment may also be enhanced by an authority figure with legitimate power assigning the goal to subordinates (Ronan, Latham, & Kinne, 1973). Allowing subordinates to set goals for themselves is another strategy for increasing goal commitment (Latham, Erez, & Locke, 1988).

Self–efficacy also influences goal commitment (Locke & Latham, 2002). When individuals feel that they are capable of attaining a goal, even if it is difficult, commitment is increased. Thus, self–efficacy is an important component of facilitating goal commitment. Self–efficacy may be enhanced using various strategies including providing individuals with adequate training, providing behavioral models with whom they, and providing persuasive communication that expresses confidence that the individual is capable of attaining the goal (Bandura, 1977).

Feedback. Feedback also affects the goal–performance relationship (Locke & Latham, 2002). Individuals rely on feedback to provide an assessment of their progress toward the goal. Feedback allows individuals to adjust their inputs to achieve the goal. The moderating effect of feedback is such that goals combined with feedback are more effective at enhancing performance than goals without feedback (Bandura & Cervone, 1983; Mento, Steel, & Karen, 1987; Neubert, 1998; Tubbs, 1986).

Task complexity. A final moderator of the goal–performance relationship is task complexity (Winters & Latham, 1996). In general, task complexity attenuates the goal–performance relationship (Kanfer & Ackerman, 1989, Locke & Latham, 2002). That is, as tasks become more complex, "do your best" goals may result in higher performance outcomes than specific, challenging goals. This result may be attributed to the interference caused by specific and challenging goals. When trainees are learning a new complex task, a specific difficult goal may divert attention away from the task. Rather than focus solely on learning the new task, trainees feel obligated to divide attention between the new task and goal attainment. Performance is thus reduced because

attention to learning the task is divided between the task and the goal. However, performance on complex tasks may be enhanced using goals with a learning focus. Winters and Latham (1996) found that specific and challenging learning goals led to greater performance than did a "do your best" goals. By matching the goal (i.e., learning how to perform the new task) to the desired outcome (i.e., knowing how to perform the new task), the positive effect of goals is restored, thus enhancing performance.

The AAR creates an environment in which goal setting may be practiced systematically. During the final phase of the AAR, trainees discuss what may be done to increase the likelihood of behaviors that contribute to achieving the intended outcome and decrease the likelihood of behaviors that detract from achieving the intended outcome. The intended outcome serves as a goal for future performance. As previously noted, the AAR provides a forum for the delivery of effective feedback and future AARs serve a goal setting function in that they provide the trainees with feedback. Therefore, through specific and challenging goals, followed by feedback regarding the attainment of those goals, the AAR may enhance performance through the mechanisms of goal setting.

Summary

The preceding review provides a theoretical basis for the effectiveness of an AAR–based training approach. Despite the absence of research investigating the combined effect of interventions based upon these theories, research investigating these theories supports the efficacy of organizational interventions using them.

Guzzo, Jette, and Katzell (1985) reported that the average effective size (d) for organizational interventions that included performance appraisal and feedback was 0.41. Noting the complexities of feedback interventions, Kluger and DeNisi (1996) reported an average feedback intervention versus no feedback intervention d of 0.38 ($SD_d = 0.45$), suggesting that feedback improved performance in some situations and impeded performance in others. However, effect size estimates are more encouraging for interventions that include frequent ($d = 0.32$, $SD_d = 0.31$) or specific (correct solution) feedback ($d = 0.43$, $SD_d = 0.38$). Feedback research suggests that when an intervention includes frequent and specific feedback, the effect on performance is positive.

Observational learning has shown positive effects for knowledge, skill, and attitude change within the context of training via behavioral modeling. Evaluating a behavioral modeling approach, Shebilske, Jordan, Goettl, and Paulus (1998) found that trainees who observed the behaviors to be learned, learned more during training than did trainees who only had hands–on practice. Furthermore, this effect was consistent for trainees working alone, in dyads, triads, or tetrads (Shebilske et al., 1998). Custers, Regehr, McCulloch, Pensiton, and Reznick (1999) provide further support for observational learning. In their research, Custers et al. examined the efficacy of a combination of reading and behavioral modeling training followed by hands–on practice as compared to reading and hands–on practice only. Surgical students in the reading and behavioral modeling training condition performed a surgical procedure at a higher quality and in less time than students who only read about the procedure. An early meta–analytic investigation of managerial training found behavioral modeling training to

be the most effective training technique (d = .92) for training managerial skills in comparison to sensitivity training (d = .80), lecture plus role play or practice (d = .60), or a combination of the techniques (d = .70; Burke & Day, 1986). A more recent meta–analysis provides further support for behavioral modeling training. Taylor et al.'s (2005) empirical review reported a sample–weighted mean d of behavioral modeling over other training methods to be 0.29. Their moderator analyses provide a more positive picture, estimating ds of 1.05, 1.18, 0.27, and 0.12 for declarative knowledge, procedural knowledge, job behavior, and workgroup productivity, respectively (Taylor et al., 2005).

Finally, empirical reviews have also shown goal setting to enhance performance in training environments. Several meta–analytic investigations have reported large positive ds for goal setting interventions that have provided both specific and difficult goals rather than do your best or no goals, including 0.42 (SD_d = .06; Mento et al., 1987), 0.50 (SD_d = 0.26; Tubbs, 1986), and 0.65 (Guzzo, Jette, & Katzell, 1985). When combined with feedback, the effect of goal setting is enhanced, producing meta–analytic ds ranging from 0.49 (SD_d = 0.08; Mento et al., 1987) to 0.56 (SD_d = 0.00; Tubbs, 1986).

Although these various organizational interventions have been shown to produce positive effects independent of (or partially combined with) one another, I was unable to locate any published empirical assessments of the combined effect of these interventions applied jointly in a systematic training approach, like an AAR–based training approach. However, each of these interventions requires proper implementation in order to effect change in the knowledge, skills, or attitudes of trainees. The preceding theories and literatures may thus be used to guide the design and implementation of an AAR–based

training approach. Using these theories and literatures, preliminary answers to critical design questions may be sought, providing a starting point for a program of empirical research. The following section attempts to address features of the AAR that are critical to its effectiveness as a training approach.

CHAPTER IV

CRITICAL FACTORS

Feedback, observational learning, and goal setting are three primary theories underlying the effectiveness of the AAR training approach. Each of these theories addresses specific phases of the AAR, providing a theoretical rationale for the each phase individually and the phases combined. These theories and related literatures may subsequently aid in identifying features and characteristics of the AAR that are critical to its efficacy as a training approach. Those features and characteristics critical to the efficacy of the AAR as a training approach may then be leveraged by researchers and practitioners alike to maximize its efficacy.

The aim of this chapter is to present a logical set of propositions derived from the conceptual framework presented in the preceding chapter. The propositions are intended to encompass the primary questions concerning the design and implementation of an effective AAR–based training approach. Although the ensuing propositions lend themselves to empirical assessment, they will all not be the focus of the present study. Rather, these propositions are intended to promote a framework of testable hypotheses, of which only a subset are empirically tested in the present paper.

Although many features and characteristics of training programs, as well as individual differences of trainees, influence various training outcomes (Arthur et al., 2003; Salas, & Cannon–Bowers, 2001; Tannenbaum & Yukl, 1992), including the acquisition, retention, and transfer of skills (Arthur, Bennett, Stanush, & McNelly,

1998), this review is limited to those outcomes that trainers and researchers can exert a meaningful influence, and those that can be controlled by practitioners. Consequently, various individual differences such as cognitive ability, personality, and pre–existing attitudes are not addressed here, nor are macro–environmental conditions (e.g., organizational culture, climate, and resource support). Although these are important considerations for training developers and researchers, these domains are beyond the scope of this present work.

Number of AAR Participants

The observational learning component of the AAR depends on observable behavior. An increase in exposure to modeled behavior leads to a refined cognitive representation of the task (Bandura, 1986). Increased exposure allows observers to organize and refine their representations and allows them to focus on areas of the modeled behavior that are difficult or problematic (Carroll & Bandura, 1990). Supporting empirical research suggests that increased exposure to modeled behavior increases learning and performance outcomes. Weeks and Choi (1992) found that varying the number of exposures to modeled behavior enhanced the performance of a motor task. They concluded that increasing the number of exposures to modeled behavior produced positive effects, up until five exposures.

Conversely, other researchers have concluded that anything more than a single exposure to the modeled behavior provides no additional benefit (Baldwin, 1992; Custers et al., 1999). Baldwin (1992), for example, found that multiple exposures to modeled behavior had almost no effect on various training outcomes. Providing a

second scenario modeling interpersonal skills failed to produce statistically significant effects on trainee reaction, learning, and retention, and only negligible effects on trainee behavior (Baldwin, 1992). Custers et al. (1999) found similar results when training medical students to perform a surgical task. In their study, Custers et al. found that after all students had read a description of the task, those who observed one model performed no worse than those who observed four models. However, students who watched either one or four models performed better than those students who only read the description of the task.

Custers et al. (1999) suggest that these contradictory findings may be due to several factors. Individual differences (e.g., intelligence) may play a role in the attention, encoding, and retention of modeled behavior. Individuals who are more intelligent are better able to attend, encode, and retain modeled behavior than less intelligent individuals. The task itself might also play a critical role in the efficacy of the increased exposure to modeled behavior. Tasks that are complex or contain subtle features may require repeated exposures before observers are able to form an accurate and complete representation of the task (Custers et al., 1999).

The number of participants plays a critical role in the observational learning aspect of the AAR. A greater number of participants ought to provide a greater number of behavioral models and thus should result in increased learning and performance. Thus, more participants would seem to enhance the effectiveness of the training compared to fewer participants. However, logistical constraints limit the number of trainees that are able to participate effectively in an AAR. To be effective, the AAR

training approach must give each trainee an opportunity and time to participate.
Furthermore, trainees themselves must be available to participate. The likelihood that
trainee schedules will converge decreases as the number of trainees increases.
Considering these constraints, the AAR should include as many participants as possible
considering the logistical constraints.

The relationship between AAR effectiveness and size of the team is likely
curvilinear. A team of moderate size should benefit trainees most by allowing a number
of individuals an opportunity to review and share their experiences. When the team size
is small, AAR participants are able to share more, but they have fewer models to
observe. Conversely, if teams are large, trainees have more models to observe, however
trainees may be unable to share within the limited time available and may feel less
motivated to share (i.e., social loafing). Social loafers would benefit least from the
AAR, as their fellow trainees would conduct the critical analysis.

> *Proposition 1*: The relationship between the number of trainees participating in
> an AAR–based training approach and knowledge and skill acquisition, and
> attitude change is curvilinear. The effectiveness of AAR–based training will
> increase as more trainees participate in the review. However, at a certain point,
> additional trainees will no longer increase, but rather, impede the effectiveness of
> the AAR.

Task Type

Tasks have been described along numerous dimensions, including solution multiplicity, intellectual requirements, difficulty, familiarity, intrinsic interest, and cooperation requirements (Wood, 1986). However, not all of the dimensions affect training and performance equally. Below are some of the task features that the psychological literature suggests may have the greatest effect on the effectiveness of an AAR–based training intervention.

Complex versus simple tasks. Task complexity is multidimensional in nature. In an attempt to provide a construct–oriented approach to task complexity, Wood (1986) identified the components of a task that aid in identifying its relative complexity: component complexity (i.e., number of information cues, required acts, and the products produced by the task), coordinative complexity (i.e., relationship between cues, acts, and products), and dynamic complexity (i.e., changing nature of the relationship between cues, acts, and products). In general, increases in component complexity, coordinative complexity, and dynamic complexity result in overall increases in task complexity.

Because the relationships between the cues, acts, and products are inherently more complex, it is often difficult to tell which behaviors led to the outcome, or worse, which errors led to poor performance for complex tasks (Schneider, 1985). To compound the issue, complex tasks typically have a large number of relationships between cues, acts, and products and those relationship themselves are often dynamic, making the tracking of performance even more complicated.

Given the complexity of the relationships between cues, acts, and products, a structured feedback system may enhance skill, knowledge, and attitude acquisition in training complex tasks. AARs used to train complex tasks may specifically identify critical behavior–outcome relationships to educate the trainee, aid in self–assessment, and monitor goal achievement. The AAR, however, may not provide as great an impact on simple tasks. Simple tasks do not inherently suffer from the hurdles encountered by complex tasks, such as the difficulty associated with identifying and processing feedback, increased number of behavior–outcome relationships, and the changing nature of those relationships. Thus, although the AAR approach to training may not impede the training of simple tasks, it should have the greatest effect on complex tasks.

Proposition 2: AAR–based training will have a greater effect on knowledge and skill acquisition and attitude change when used to train complex tasks rather than simple tasks.

Intrinsic versus extrinsic feedback. Tasks vary in the degree to which they provide feedback in respect to a goal. Some tasks provide a high degree of intrinsic feedback such that individuals are able to clearly judge the degree to which they are accomplishing their goals. Conversely, other tasks are characterized by providing little or no intrinsic feedback. The presence of feedback may affect performance in a number of ways. For example, without an obvious intrinsic feedback source, individuals will search for a source of feedback. Novices may find themselves monitoring incorrect

sources, or misinterpreting feedback sources, negatively affecting their training. A lack of intrinsic feedback may also have a negative effect on training by misdirecting the trainee's cognitive resources. Task strategy may also be affected by a lack of intrinsic feedback. Without knowledge of placement in a race (e.g., race against the clock), a runner may need to run as fast as possible to attempt to place first. However, with competitors running alongside, a runner may opt to run only as fast as necessary. Therefore, intrinsic feedback can affect the learning of trainees or the strategies used by the trainees to accomplish the intended goal.

When a task provides limited intrinsic feedback, extrinsic feedback becomes a more valuable source of information. Like any other extrinsic feedback source, the AAR offers greater benefit for tasks that provide limited intrinsic feedback or when that feedback is difficult to detect or interpret.

Proposition 3: An AAR–based training approach will have a greater effect on knowledge and skill acquisition and attitude change when used to train tasks that provide less intrinsic feedback than tasks that provide more intrinsic feedback.

Individual versus team tasks. Despite the criticality of teamwork for team performance, only a small number studies have specifically focused on training teamwork skills and the outcomes associated with such training (Ellis, Bell, Ployhart, Hollenbeck, & Ilgen, 2005; Salas, Dickinson, Converse, & Tannenbaum, 1992; Salas, Fowlkes, Stout, Milanovich, & Prince, 1999; Salas, Stagl, & Burke, 2004; Stout, Salas,

& Fowlkes, 1997). Prior to research concerned with teamwork training, most team training interventions may have assumed teamwork would be learned in the context of team taskwork training. However, merely training a team together does not always result in a team learning how to interact with one another (Salas et al., 2004). Rather, like any other skill to be trained, teamwork skills need to be a component of the training program, much like learning to use a piece of equipment, or learning a set of operating procedures (Salas et al., 2004). Because the AAR focuses on the process (i.e., reviewing actions that assisted in and hindered reaching the intended outcome) in addition to the outcome (i.e., either individual or team performance), the AAR training approach easily integrates teamwork skills into the training process.

Proposition 4: An AAR–based training approach will have a greater effect on knowledge and skill acquisition and attitude change when used to train domains with higher teamwork requirements (i.e., team tasks) than when used to train domains with less teamwork requirements (i.e., group or individual tasks).

Successful versus Failed Performance

At some point during their training, trainees are likely to make errors that result in some degree of failed performance. Although trainees may commit errors because they lack knowledge or experience, these are not the only causes of errors. Errors may also result from inappropriate goals and plans, interruptions during performance, and inaccurately processing feedback (Zapf, Brodeck, Frese, Peters, & Pümper, 1992). Both

novices and experts may experience errors while performing a task (Pümper, Zapf, Brodeck, & Frese, 1992).

Successful or failed behaviors or actions, or some combination of the two may be available for review during an AAR. The proportion of successful or failed behaviors or actions available for review is dependent on the performance of the trainees during the action under review. Trainees who perform flawlessly may not have any failed performance to review, whereas trainees who performed poorly may have *only* failed performance to review. Although the content available for review is certainly dependent on the trainees, or more appropriately, dependent on the performance of the trainees, an AAR does not have to review all available actions. Rather, an AAR may be designed and conducted to review only successful or failed actions. The choice to limit the review may be one of training design (e.g., error training) or necessity (e.g., time constraints). Regardless, it is likely that errors will result in failed performance during training and will thus be available to review during an AAR–based approach to training.

Early research suggested that including errors in training might impede the learning process (Bandura & Walters, 1963; Skinner, 1953). These early researchers concluded that errors focus trainees' attention on incorrect behavior and allow trainees to practice what should *not* be done. Thus, trainees should attempt to minimize errors during training.

More recently, research has specifically investigated the role of errors in training, producing findings that contradict many earlier beliefs. Whether training is specifically designed to elicit errors (e.g., Fowlkes, Dwyer, Oser, & Salas, 1998; Frese et al., 1991;

Ivancic & Hesketh, 2000), or simply reviews errors when they occur (Ivancic &

Hesketh, 2000), current thinking suggests that errors are a welcome addition to the

training process (Dorman & Frese, 1994; Gully, Payne, Koles, & Whitteman, 2002;

Heimbeck, Frese, Sonnentag, & Keith, 2003; Nordstrom, Wendland, & Williams, 1998;

Trimble, Nathan, & Decker, 1991). Research investigating the efficacy of error training

has found that in many situations, error training leads to positive outcomes (Dorman &

Frese, 1994; Frese et al., 1991; Ivancic, & Hesketh, 2000), including increases in

declarative knowledge, task performance, and self–efficacy (Gully et al., 2002). Errors

may aid training by providing feedback (Frese & Zapf, 1994), a requisite for learning.

Errors also allow trainees to develop comprehensive mental models of the content

domain (Ellis et al., 2006; Frese et al., 1991; Heimbeck et al., 2003). Furthermore,

errors in training provide trainees with opportunities to detect and monitor these events,

and to use them as a learning device (Keith & Frese, 2005). Research has found that

error training leads to higher performance for medium and high difficulty tasks than for

easy tasks (Dorman & Frese, 1994; Frese et al., 1991; Ivancic & Hesketh, 2000). Easy

tasks benefit least from error training because errors are less likely when learning easy

tasks, and thus provide fewer opportunities to experience errors from which to learn

(Frese, 1995).

However, Arthur et al. (2006) found that reviewing both failed and successful

performance might result in unintended outcomes. For example, Arthur et al. reported

that trainees who were required to view videos of failed and successful task performance

during a period of nonuse performed worse on measures of skill retention than trainees

who did not view the videos. However, trainees who viewed instances of both failed and successful task performance performed better on measures of skill transfer. Their findings suggest that passive reviewing instances of both failed and successful performance may impede retention but promote transfer.

One of the few empirical studies to employ an AAR–based training approach investigated the focus of what is reviewed during the AAR (Ellis & Davidi, 2005; Ellis et al., 2006). The findings of this research are congruent with error training in other domains in that reviewing instances of both failed and successful performance elicited greater knowledge, skill, and attitude change than reviewing successful performance alone (Ellis & Davidi, 2005; Ellis et al., 2006). Moreover, the behavior modeling training literature provides further support for the efficacy of errors in training (Baldwin, 1992; Taylor et al., 2005).

Proposition 5: An AAR–based training approach designed to review instances of both failed and successful performance will have a greater effect on knowledge and skill acquisition and attitude change than one designed to review either positive or negative performance alone.

Co–located versus Distributed Participants

The military's increasing interest in distributed mission operations combined with the growing trend of global organizations requires that individuals coordinate their efforts despite geographical or temporal distribution. These trends have prompted

researchers to examine the effectiveness and utility of teams and workgroups that operate in these environments. Research in this domain has primarily been concerned with the effects of geographical distribution on team performance, focusing specifically on the role of technology–mediated communication. As organizations increase their reliance on distributed teams, training, and thus the AAR, might have to be conducted in distributed environments. Research investigating the effects of geographical distribution on team training is sparse. Despite the lack of direct research, distributed teams research offers initial insight into conducting an AAR with geographically distributed participants.

Small groups researchers have been investigating the effectiveness of distributed teams for decades. A recent empirical review of this literature concluded that co–located teams are superior to distributed teams in terms of both performance and affective outcomes (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). Technology–mediated groups are rarely more effective than face–to–face groups. At best, technology–mediated groups perform as well as face–to–face groups, ". . . and even these results occur in very unusual and uncommon organizational conditions" (Baltes et al., 2002, p. 175). Based on the current literature, organizations would be well advised not to adopt a technology–mediated strategy if given the choice. However, in many situations, circumstances require that virtual teams be used. It is in these situations where the knowledge of how to improve the performance and affective outcomes of technology–mediated teams is most influential.

Of the various factors that have been found to influence performance and affective reactions in distributed teams, most research has concentrated on the effects of technology–mediated communication on team performance and affect. The appropriateness of the communication medium for the task and whether individuals in the team are able to employ the technology correctly are two phenomena of interest for virtual teams researchers. The communication medium must be appropriate for the specific task. Daft and Lengel's (1984) model focuses on the richness of the communication medium. Media richness refers to the amount of information (both verbal and non–verbal) that a communication medium is able to accommodate. Some media are considered lean (e.g., electronic mail) whereas other media are defined as rich (e.g., face–to–face). Although untested, recent theory has focused on task–communication medium fit (Zigurs & Buckland, 1998), suggesting that one must consider attributes of both the task and communication medium.

Based on DeSanctis and Poole's (1994) adaptive structurization theory, Maznevski and Chudoba (2000) suggest that effective technology–mediated teams are able to identify and use the most suitable communication medium for a particular task or activity. The suitability of the medium, of course, is dependent on the range of communication media available, and therefore, a broad range of communications media would increase the chances for a suitable medium to be available. In the absence of a suitable medium, team performance and affect may suffer, or teams could use a communication medium that is not provided or supported by the organization.

Research has also noted that both performance and affective discrepancies between co–located and distributed teams decreases over time (Hollingshead, McGrath, & O'Conner, 1993; van der Kleij, Paashuis, & Schraagen, 2005; Walther & Burgoon, 1992). Over time, individuals learn how to use the communication technology more effectively and learn how to work more efficiently with one another (van der Kleij et al., 2005).

Although using distributed teams may lessen the effect of logistical constraints (e.g., trainees no longer need to commute to a single location), coordination problems may increase (e.g., technological failures, network traffic, etc.) to such a level that the distributed training becomes ineffective. Fowlkes, Lane, Dwyer, Willis, and Oser (1995) reported that network reliability problems frequently necessitated changes in training simulations to maintain exercise continuity. When technology–related issues are absent, distributed training is at best as effective as co–located training. However, as technology–related issues increase, distributed training is expected to be less effective than co–located training.

> *Proposition 6*: An AAR–based training approach will be effective at facilitating knowledge and skill acquisition and attitude change whether trainees are co–located or distributed. However, as technology–related issues increase, a co–located AAR–based training approach will be more effective than one that is distributed.

Frequency of the AAR

The frequency of the AAR is yet another factor influencing success of the AAR. Frequency refers to how often an AAR is conducted. The frequency may be in relation to the action under review (e.g., after every two performance episodes), or it may be in relation to time (e.g., once a month).

Research generally supports the notion that in most cases a moderate frequency of feedback produces positive effects on skill acquisition in comparison to less frequent feedback (Ilgen et al., 1979; Kluger & DeNisi, 1996). Research has also documented instances where frequent feedback and infrequent feedback schedules result in no performance differences (Chhokar & Wallin, 1984). Furthermore, as noted by Ilgen et al. (1979), there are instances where feedback that occurs too frequently not only fails to improve performance but also is actually detrimental to performance. Taken together and assuming the task is relatively stable or repetitive, research would suggest that there exists an optimal frequency of feedback to facilitate skill, knowledge, and attitude change.

Proposition 7: The relationship between the frequency of an AAR–based training approach and knowledge and skill acquisition and attitude change is curvilinear. The effectiveness of AAR–based training will increase as AARs are conducted more frequently. However, at a certain point, AARs that are more frequent will no longer increase but rather impede the effectiveness of the AAR.

Action–review Spacing

Action–review spacing refers to the time that elapses between the performance of the action and the review. In operational settings, spacing may range from anywhere between a few minutes to several months or longer. At times, the spacing is under the control of the trainer, whereas in other instances, logistical constraints force the trainer to adopt a particular interval. Regardless of the reason for the spacing interval, the time that elapses between the action and the review is an important feature and may have implications for the efficacy of the AAR.

To maximize the effect of the feedback component, the AAR should be conducted as soon as possible to the action under review. The greater the delay between the action and the review, the less effect the information conveyed by the review will have on subsequent performance (Ammons, 1956). When trainees are provided with immediate feedback, they are able to use the information more effectively by repeating actions that led to good performance and avoiding actions that led to poor performance. Like the absence of feedback, which can be conceptualized as an infinite feedback delay, trainees may begin to search for feedback cues themselves, increasing their cognitive load, and possibly drawing their attention away from their task when the spacing between action and review is too long. Furthermore, trainees, especially novice trainees, may incorrectly interpret feedback from a novel task. An immediate review, therefore, would suggest a larger effect on knowledge and skill acquisition, and attitude change than a review conducted after a greater delay.

A second characteristic of spacing is its location with respect to subsequent performance (i.e., action–review–action spacing). In some situations, the timing of subsequent performance is unknown. An AAR to aid firefighters could be planned to occur immediately after a fire, but because the timing of a fire is unpredictable, it would be impossible to plan an AAR to occur immediately before the next fire. However, for tasks that are predictable (e.g., sales presentation), an AAR can be planned so that it occurs closer the upcoming action that the previous action.

Again, to maximize the effect of the feedback provided by the AAR, a review should immediately follow the action under review. An immediate review also has important implications for the observational learning component of the AAR. As the length of the delay after the action increases, there is a greater potential for subtle details of the task performance to be forgotten. Furthermore, retention of the behavior–outcome relationships is also likely to be impeded when the AAR is delayed. This is especially true when aspects of the modeled behavior are difficult or problematic.

Proposition 8: An AAR–based training approach will have a greater effect on knowledge and skill acquisition and attitude change when the review is conducted immediately after the task under review rather than when it is delayed.

Structure of the AAR

Borrowing from the employment testing and assessment literature, the structure of the AAR may have a significant effect on its effectiveness. Structure is described as

the reduction of procedural variability across applicants (Huffcutt, 1993). In their meta–analytic investigation of employment interview validity, Huffcutt and Arthur (1994) identified interview structure as a moderator of interview validity, such that validity generally increased as structure increased. However, as Huffcutt and Arthur noted, the relationship between structure and interview validity may not be linear. They observed a ceiling effect and suggested that after a certain point, structure may become a limiting factor because strict adherence to a prescribed protocol does not allow an interviewer to probe or follow–up interviewees' responses.

In a training context, the structure of the AAR may be described as having two different but related types of structure. Administrative structure refers to the AAR execution. An AAR with a high degree of administrative structure would follow a prescribed number and order of steps or phases (see Figure 1). A second form of structure is content structure. An AAR with a high degree of content structure would cover the same content areas during each session.

The relationship between structure and interview validity might shed light on the influence of structure on AAR effectiveness. Administrative structure should increase AAR effectiveness. Structure, as in the employment interview, ensures that a facilitator or team followed a predefined course of actions during the AAR. However, the relationship between AAR content structure and training effectiveness may be more complex. Although a high degree of content structure may be effective in situations where behavior–outcome relationships are known (e.g., driving a bus route), it may hinder AAR effectiveness when behavior–outcome relationships are less well known or

dynamic in nature (e.g., learning about a new market). When behavior–outcome relationships are known, structure prevents content contamination and deficiencies from occurring. However, when the behavior–outcome relationships are not known, structure may work to hinder the effectiveness of the AAR, increasing the likelihood of criterion contamination and deficiency.

Proposition 9a: An AAR–based training approach will have a greater effect on knowledge and skill acquisition and attitude change when it has a high degree of administrative structure as opposed to a low degree of administrative structure.

Proposition 9b: An AAR–based training approach that has a high degree of content structure will have a greater effect on knowledge and skill acquisition and attitude change than an AAR–based training approach with a low degree of content structure when the behavior–outcome relationships are known. However, an AAR–based training approach that has a low degree of content structure will have a greater effect on knowledge and skill acquisition and attitude change than an AAR–based training approach with a high degree of content structure when the behavior–outcome relationships are not known.

Objectivity of the AAR

The AAR relies heavily on the ability of the trainees and the facilitator to recall, identify, and evaluate behaviors or key events that occurred during the action under

review. The method of recall, identification, and subsequent evaluation used within the AAR may be described as falling along a continuum of objectivity. An AAR described as subjective might rely exclusively on the memory of trainees whereas an AAR described as objective might employ recordings (e.g., video, audio, and/or written communication) and/or memory aids (e.g., diaries or notes taken during the action) to facilitate the recall, identification, and evaluation of behaviors or key events that occurred during the action under review.

Assessment of the effectiveness of subjective versus objective AAR–based training in knowledge and skill acquisition or attitude change appears to be absent from the empirical literature. However, the performance appraisal and assessment center literatures have examined the effect of subjectivity on the comprehensiveness and accuracy of subjective evaluations and assessments (DeNisi, Robbins, & Cafferty, 1989; Sturman, Cheramie, & Cashen, 2005).

Performance appraisals made both with and without memory aids (e.g., diaries and notes) often demonstrate similar levels of rating accuracy in terms of assessing the overall performance of a target (Middendorf & Macan, 2002; Ryan et al., 1995; Sanchez & De La Torre, 1996; Woehr & Feldman, 1993). Similar results have been reported in the assessment center literature (e.g., Ryan et al., 1995). Assessors who make their ratings during the exercise are just as accurate at rating assesses as assessors who view videotaped recordings of the exercises (Ryan et al., 1995).

However, research has also consistently demonstrated that performance ratings made from memory have less recall accuracy (Middendorf & Macan, 2002; Ryan et al.,

1995; Sanchez & De La Torre, 1996; Woehr & Feldman, 1993). For example, DeNisi et al. (1989) found that raters who relied on their memory when evaluating a target recalled fewer incidents and made more recall errors than those who were allowed to supplement their recall with a diary–like aid. This finding is even more noteworthy given the relatively short time interval (i.e., several minutes) between the observation of performance and the rating session. Similar research has demonstrated that errors in recall are more pronounced as the time between performance and rating increases (DeNisi, 1989; Murphy & Blazer, 1986; Williams, DeNisi, Meglino, & Cafferty, 1986). Like DeNisi et al. (1989), Ryan et al. (1995) found that providing assessors with access to videotaped recordings of the exercises resulted in a greater quality of recorded observations.

Taken together, the literature would suggest that both objective and subjective ratings are accurate; but objective ratings have greater recall accuracy than subjective ratings (DeNisi et al., 1989; Ryan et al., 1995). These seemingly contradictory findings are the result of general evaluations made during the observation of the behavior being evaluated (Murphy & Balzer, 1986; Woehr & Feldman, 1993). When no evaluations are made prior to the appraisal, raters rely on memory to form their judgment (Murphy & Balzer, 1986; Woehr & Feldman, 1993). As time lapses between performance and rating, the rating is less influenced by the details of the performance and more influenced by the general impression initially formed about the performance (Murphy & Blazer, 1986). Moreover, when information is collected for decisions unrelated to the evaluation of performance, the potential for errors in recall during the evaluation process

are increased (Williams et al., 1986). Memory aids are not as critical for accurate appraisals as one might expect, as long as raters are able to form evaluations prior to the appraisal (Murphy & Blazer, 1986; Woehr & Feldman, 1993).

Although it may be feasible for experienced supervisors to generate memory aids during their workday to be used for subsequent performance evaluations, it is less likely that trainees would be able to do so during training. Because of the cognitive demands of learning new tasks and simultaneously attending to and evaluating their performance, trainees may be less able to note and record critical incidents and less able to form evaluations about their performance than incumbents due to. Given the difficulty of noting and evaluating their own performance, it is even less likely that trainees would be able to simultaneously note and evaluate the performance of other trainees during a task. In short, the cognitive demands of the action may prevent trainees from identifying, recording, and evaluating their behavior and the behavior of others.

Precise recall of behaviors or key events that occurred during the action under review is needed for effective performance feedback (Murphy, 1991). Errors in recall may lead trainees to omit behaviors or key events that affected performance. Errors may also lead trainees to include irrelevant behaviors or events in the review. Recall errors that result in review deficiencies or contamination may impede the effectiveness of the AAR. Because trainees are less able to generate memory aids of their behavior and the behavior of others, objective review methods other than self–generated diaries may enhance the training effectiveness of AAR–based training. The potential for recall accuracy is increased as the AAR relies more on objective review methods.

Proposition 10: An AAR–based training approach will have a greater effect on knowledge and skill acquisition and attitude change when it is characterized by a high degree rather than a low degree of objectivity.

Summary

As an approach to training, the AAR combines components of feedback, observational learning, and goal setting theories and literatures. These theories and literatures in combination provide initial guidance in developing and implementing an AAR–based training approach. Specifically, an AAR–based training approach may be best for training moderate size teams to perform complex tasks that provide little or no intrinsic feedback. An AAR–based training approach may be most effective for training teams performing tasks that require a high degree of teamwork skills. Both successful and failed performance should be reviewed during AAR–based training. An AAR–based training approach should be conducted with moderate frequency and should be executed as proximally as possible to the action or event under review. Finally, an AAR–based training approach will be most effective when it is structured and objective. Overall, an AAR–based training approach must be specific in terms of the feedback it provides, the behaviors or actions under review, and the goals set during the training.

CHAPTER V

EMPIRICAL INVESTIGATION

Despite the increasing use of AARs, empirical investigations of the AAR as a

training approach have thus far been limited or are of questionable methodological rigor.

Many fundamental questions concerning the AAR remain unanswered, and

unfortunately, practitioners have been left to design and implement AAR–based training

programs with little or no research–based guidance. Thus, it would seem that

organizations that have adopted AAR–based training have likely done so without any

knowledge of the efficacy and utility of the approach. This trend parallels that observed

with crew resource management training in that only recently have researchers attempted

to assess the utility of this training method (i.e., Roop et al., 2006) despite its prevalence

the aviation and medical industries and its growing use in the railroad and other high

reliability industries. Clearly, theory and supporting empirical research investigating the

AAR as an approach to training is necessary to understand more thoroughly the AAR,

aid in developing AAR–based training, and to document the efficacy and utility of this

training approach.

Theoretical Foundations of the AAR

As detailed in earlier chapters and illustrated in Figure 2, the AAR may be

broken into five primary phases. During the first phase, trainees review the intended

outcome of the preceding action or event. This is followed by a review of the actual

outcome. These phases provide feedback to the trainees by allowing them to compare

their actual outcome with the intended outcome. During the third phase, trainees then discuss and determine which actions contributed and which actions detracted from meeting the intended outcome. This phase provides trainees with behavioral models from which to learn and actively directs their attention to key behaviors facilitating a comprehensive review of modeled behaviors. After identifying and reviewing their effective and ineffective actions, trainees review and discuss their future objective. During the fifth and final phase of the AAR, trainees develop a strategy to meet their intended outcome.

Several existing psychological theories and literatures are particularly relevant to the specific phases of the AAR. The first two phases of the AAR serve to provide feedback to the trainees concerning their previous performance. Research investigating the effect of feedback generally supports the notion that feedback enhances task performance (Ilgen et al., 1979; Kluger & DeNisi, 1996). However, both the frequency and specificity of feedback are important considerations when developing a feedback intervention. Effective feedback interventions provide feedback that is frequent and specific enough to be useful but not too frequent or specific to prevent the receiver from learning the generalities of the task. Feedback during the initial stages of learning may need to be more frequent and specific than feedback during the later stages of learning (Goldstein et al., 1968; Goodman & Wood, 2004; Ilgen et al., 1979; Wentling, 1973).

The third stage of the AAR is characterized by observational learning. Bandura's (1977) Social Cognitive Theory provides guidance on the observational learning component of the AAR. Observational learning requires that several processes occur to

facilitate learning (i.e., attention, retention, reproduction, and motivation [Bandura, 1986]). The AAR systematizes observational learning by directing the attention of trainees to the key behaviors, and reviewing the extent to which those behaviors contributed to or detracted from meeting the intended outcome.

Finally, goal setting theory (Locke, 1968) suggests that intentions to work toward goals are a major source of motivation (Locke, 1968, Locke & Latham, 1990; 2002). Goals have the greatest positive effect on performance when they are both specific and challenging (Locke & Latham, 2002) and followed by feedback (Bandura & Cervone, 1983; Mento et al., 1987; Neubert, 1998; Tubbs, 1986). The fourth and fifth phases of the AAR serve to provide goals to the trainees. In combination with the first and second phases, which provide feedback regarding previously set goals, the AAR serves a goal setting function, providing trainees with goals and the necessary feedback regarding the attainment of those goals.

As a whole, an AAR–based approach to training incorporates feedback, observational learning, and goal setting to turn a recent experience or event into a learning opportunity. Although many questions regarding an AAR–based approach to training remain, questions regarding the effectiveness of such an approach are the most pressing and in need of empirical investigation.

Effectiveness of the AAR as a Training Approach

Feedback, observational learning, and goal setting provide the theoretical foundation upon which the AAR rests. Despite the absence of research investigating the combined effect of interventions based upon these theories, research investigating these

interventions supports their efficacy. Feedback interventions alone have demonstrated positive meta–analytically estimated results for frequent ($d = 0.32$, $SD_d = 0.31$) and specific ($d = 0.43$, $SD_d = 0.38$) feedback interventions (Kluger & DeNisi, 1996). Taylor et al.'s (2005) empirical review found training interventions that used an observational learning approach had a positive effect across multiple training outcomes, with ds of 1.05, 1.18, 0.27, and 0.12 for declarative knowledge, procedural knowledge, job behavior, and workgroup productivity, respectively. Just as promising are goal setting interventions that incorporate feedback. Interventions that combine goal setting and feedback have yielded meta–analytically estimated ds ranging from 0.49 ($SD_d = 0.08$; Mento et al., 1987) to 0.56 ($SD_d = 0.00$; Tubbs, 1986).

Although these various interventions (i.e., feedback, observational learning, and goal setting) have been shown to produce positive effects independent of (or partially combined with) one another, I was unable to locate any published empirical assessments of these interventions applied jointly in a systematic training approach. Despite this apparent omission in the literature, these individual theories and literatures each provide some general guidance for developing an AAR–based training approach. When considered jointly, these theories suggest that an AAR–based training approach may be best suited for training complex, team–based tasks that provide limited intrinsic feedback. Further, an AAR–based training approach should review both successful and failed performance, be conducted with moderate frequency, and executed as proximally as possible to the action or event under review. Overall, an AAR–based training approach should be structured and specific in terms of the feedback it provides, the

behaviors or actions under review, and the goals set during the training. Less clear is the degree of objectivity necessary to facilitate knowledge and skill acquisition, or attitude change.

Objectivity of the AAR

Considerable effort has been devoted to incorporating and assessing objective review systems in performance task environments. Most of the AAR literature has been concerned with the engineering of review systems and assessing the ease of using such systems during an AAR. The U.S. Army Research Institute for the Behavioral and Social Sciences, for example, has published book chapters and multiple technical reports espousing the need for and evaluation of performance task environments that enhance the objectivity of the AAR (e.g., Dyer, Wampler, & Blankenbeckler, 2005; Meliza, 1996, 1998; Meliza et al., 1994). However, it appears that practice has outpaced science in that no empirical investigation has examined the effectiveness of using objective review systems in the AAR, nor the effect that objective review systems have on various training outcomes. Identifying the requisite objectivity of an AAR–based training approach has important implications for the design of AAR training and the environments in which they are used.

The requisite objectivity of an AAR–based training approach is an important consideration for training developers. Developers have increasingly incorporated systems and tools to facilitate objective performance review into various performance tasks and simulators. Again, a majority of AAR research has focused on the need for and evaluation of objective review systems. However, the effect of objectivity on an

AAR–based training approach remains unknown, and less objective AARs are still conducted quite frequently. For example, the Air Force Research Laboratory conducts AARs following close formation flight training. During simulation–based exercises, pilot teamwork is rated by an observer, rather than from an objective recording device. Although it may be argued that some degree of objectivity may enhance training effectiveness, the question remains, how much objectivity is necessary? Should performance task and simulator developers continue to strive to create more objective review systems? Should trainers continue to call for more objectivity in their review systems? These questions highlight the need for empirical investigations focusing on the effect of objectivity on an AAR–based training approach.

Although some training domains may be able to integrate varying levels of objectivity into their AAR–based training, other domains may be less able to use objective review systems without the aid of cost prohibitive and intrusive systems and tools. For example, the Commandant of the Corps of Cadets at Texas A&M University conducts AARs after each commencement and commissioning ceremony. The focus of the AAR is on the preparation and the execution of the event. Although recording the commencement and commissioning ceremony may be feasible, using objective measures of performance related to the administrative preparation (e.g., correspondence with various vendors, officials, and participants, equipment reservations, etc.) would prove to be difficult, if not impossible, to do objectively. Incorporating objectivity into an AAR following simulator–based flight training is a viable option. However, incorporating objectivity into an AAR following a firefighting exercise may be difficult and possibly

quite dangerous. The degree to which objectivity enhances the effectiveness of AAR–based training would yield useful information regarding the utility of implementing such training in an environment where objectivity is difficult, dangerous, and/or impossible to achieve.

Present Study

The purpose of the present study is twofold. The first is to empirically investigate and document the effectiveness (or ineffectiveness) of an AAR–based approach in comparison to a non–AAR–based training approach. Second, this study empirically compares the effectiveness of an AAR–based training approach that uses a subjective review versus one that uses an objective review. The findings of this study provide much needed empirical evidence supporting or refuting the effectiveness of AAR–based training approaches. It is also anticipated that this research will also provide guidance to researchers and practitioners alike in developing an AAR–based approach in terms of the efficacy of objective versus subjective reviews.

Training effectiveness is the focus of the present study. As previously stated, Goldstein and Ford (2002) describe training as the, "acquisition of skills, rules, concepts and attitudes that result in improved performance in another environment" (p. 1). Therefore, several outcome variables will be assessed to obtain a comprehensive understanding of the training effectiveness of an AAR–based approach. Similar to previous training research (e.g., Arthur et al., 2006; Gully et al., 2002), training effectiveness was operationalized in terms of declarative knowledge, team performance, and team–efficacy.

Although the purpose of random assignment to the training conditions is expected to distribute equally potential sources of variance across the conditions, there is still a potential for systematic differences between conditions to affect the outcomes of interest. It is impractical to assess all potential sources of variance (hence the reliance on random assignment to equate conditions), however, cognitive ability has a nontrivial potential to effect the outcomes of interest. Cognitive ability has been shown to have a strong relationship with training performance (e.g., Ackerman, 1988; Day et al., 1995; Ree & Earles, 1991; Schmidt & Hunter, 1998; Warr & Bunce, 1995). Not only would cognitive ability provide information regarding the effectiveness of the random assignment to conditions, but it may also serve as a covariate in the event that the random assignment fails to equate the mean level of cognitive ability across training conditions. If the training conditions are equivalent in terms of cognitive ability, then cognitive ability will not be used as a covariate, and not included in any primary analyses. However, if the training conditions display significant differences in cognitive ability, then cognitive ability will be used as a covariate in all primary analyses.

Hypotheses

H1: Teams trained using an AAR–based approach (both objective and subjective combined) will have higher (a) team declarative knowledge, and (b) team performance scores, and (c) report higher team–efficacy than teams trained using a non–AAR–based training approach.

H2: Teams trained using an objective AAR–based approach will have higher (a) team declarative knowledge, and (b) team performance scores, and (c) report higher team–efficacy than teams trained using a subjective AAR–based training approach.

CHAPTER VI

METHOD

Participants

Participants were recruited from the human subjects pool of a large southwestern university's psychology department. The initial sample consisted of 132 individuals (39% female) who participated in 33 4–person teams. Participants reported a mean age of 19.08 years (*SD* = 1.01 years) and described themselves as having average video–game experience (*M* = 1.92, *SD* = 0.71; measured on a 3–point scale where 1 = novice, 2 = average, and 3 = expert). Participants were provided with course credit for their participation. Additionally, to motivate participants to remain focused and attempt to improve their performance during the study, participants in the first, second, and third highest performing teams in each of the three conditions were awarded $80, $40, and $20, respectively.

Data from 3 teams (12 participants) were removed from the sample. The data from one team assigned to the non–AAR–based training condition was removed because that team earned a baseline performance score that was uncharacteristically high for a baseline score and not consistent with their subsequent performance. Two additional teams were removed from the sample (one from the subjective and one from the objective AAR–based condition) because they consistently failed to follow the training directions. Consequently, the final sample consisted of 120 individuals (40% female) participating in 30 4–person teams. Participants in the final sample reported a mean age

of 19.08 years (*SD* = 1.03 years). Participants also described themselves as having

average video game experience (*M* = 1.93, *SD* = 0.71). The demographic composition

of the sample was consistent across conditions. Overall demographic information and

demographic information for each of the three conditions is presented in Table 1.

Table 1
Demographic Composition of the Sample by Training Condition

| | Training Condition | | | | | | | |
| | Non–AAR | | Subjective AAR | | Objective AAR | | Overall | |
	n	%	*n*	%	*n*	%	*n*	%
Sex								
Female	19	47.50	16	40.00	13	32.50	48	40.00
Male	21	52.50	24	60.00	27	67.50	72	60.00
Number of Males per Team[a]								
1	3	30.00	2	20.00	2	20.00	7	23.33
2	5	50.00	3	30.00	3	30.00	11	36.67
3	0	0.00	4	40.00	1	10.00	5	16.67
4	2	20.00	1	10.00	4	40.00	7	23.33
Race								
African–American	0	0.00	2	5.00	1	2.50	3	2.50
Asian	4	10.00	4	10.00	2	5.00	10	8.33
Caucasian	35	87.50	28	70.00	33	82.50	96	80.00
Hispanic	1	2.50	6	15.00	4	10.00	11	9.17
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age (in years)	19.00	0.88	19.18	1.20	19.08	1.00	19.08	1.03
Video Game Experience[b]	1.78	0.73	1.93	0.69	2.10	0.67	1.93	0.71

Note. *N* = 120. [a]*n* = number of teams; there were no all–female teams. [b]Video game experience was measured on a 3–point scale: 1 = novice, 2 = average, and 3 = expert.

The sample size necessary to test the hypotheses was determined *a priori* through a statistical power analysis conducted using *G*Power* (Faul, Erdfelder, Lang, & Buchner, 2007). The power analysis indicated that approximately 10 4–person teams, per condition would be needed to achieve a power level of .80, capable of detecting a moderate effect size ($f = .25$, $\eta^2 = .05$) at $p = .05$ using a 2 × 6, between–within analysis of variance (ANOVA). Hypothesis 1 was tested by comparing the effectiveness of non–AAR–based training to AAR–based training (subjective AAR– and objective AAR–based training combined). Hypothesis 2 was tested by comparing the effectiveness of subjective AAR–based training to objective AAR–based training. Therefore, the design of the study necessitated the use of three separate groups. Thus, 120 individuals participating in 30 4–person teams were expected to yield the necessary statistical power.

Design

This study utilized a 3 (training approach: non–AAR–based, versus subjective AAR–based, versus objective AAR–based) × 6 (session: Sessions 1–6) repeated measures design. Training condition served as the between–subjects independent variable, and session served as the repeated or within–subjects independent variable. Three separate dependent variables were measured at various sessions to assess knowledge, skill, and efficacy in teams. Table 2 provides an overview and summary of the experimental procedures.

Table 2

Schedule of Activities for Each Training Session by Training Condition

Session	Scheduled Actives		
0	Informed Consent Declarative Knowledge Cognitive Ability Video Game Experience Demographics Role Assignments Training Condition Assignments Individual Tutorials		
	Training Conditions		
	Non–AAR	**Subjective AAR**	**Objective AAR**
1	Briefing/Planning Team Mission A	Briefing/Planning Team Mission A AAR	Briefing/Planning Team Mission A AAR
2	Briefing/Planning Team Mission B Team–efficacy	Briefing/Planning Team Mission B AAR Team–efficacy	Briefing/Planning Team Mission B AAR Team–efficacy
3	Briefing/Planning Team Mission C Declarative Knowledge	Briefing/Planning Team Mission C AAR Declarative Knowledge	Briefing/Planning Team Mission C AAR Declarative Knowledge
4	Briefing/Planning Team Mission D Team–efficacy	Briefing/Planning Team Mission D AAR Team–efficacy	Briefing/Planning Team Mission D AAR Team–efficacy
5	Briefing/Planning Team Mission E	Briefing/Planning Team Mission E AAR	Briefing/Planning Team Mission E AAR
6	Briefing/Planning Team Mission A Team–efficacy Declarative Knowledge	Briefing/Planning Team Mission A Team–efficacy Declarative Knowledge	Briefing/Planning Team Mission A Team–efficacy Declarative Knowledge

Measures

      Performance task— Steel Beasts Pro PE. Steel Beasts Pro PE ver. 2.370 (eSim

Games, 2007) was used to assess team performance. *Steel Beasts Pro PE* is a

cognitively complex, PC–based tank simulation, allowing multiple players to be

networked together to cooperatively complete a mission on a simulated battlefield. The

simulator uses highly accurate replicas of U.S. M1A1 and Russian T–72 tanks to

simulate an armored warfare environment.

      Participants operated the PC–based simulator using a monitor, keyboard, mouse,

and joystick. The simulated environment consisted of a two–tank platoon of U.S. M1A1

tanks controlled by the participants. Four networked computers were used to operate the

two–tank platoon; each participant had his/her own computer. Each tank in the team

was operated by 2 participants, with 1 participant serving as the gunner and the other

serving as the commander/driver. Therefore, each team comprised two gunners and two

commander/drivers. All four participants in a team wore headsets and voice activated

microphones to facilitate communication both between and within each tank.

      Multiple first–person perspective views were available to each participant,

depending on their role. For example, gunners were able to view multiple gun sights and

a map view of the battle space. Commander/drivers were able to view the simulated

world from inside of the tank peering through vision blocks, sitting high up outside of

the tank, through the gunner's gun sight, and a map view of the battle space.

      The performance task was highly structurally interdependent, with elements of

both task and outcome interdependency. Task interdependency existed at the level of

the tank. Each tank was operated by two participants; one participant served in the role of gunner and the second served in the role of the commander/driver. The gunner was responsible for identifying enemy tanks, aiming the main gun, estimating the distance to targets, and firing at enemy tanks. The tank commander/driver was responsible for driving the tank, creating and following routes, identifying enemy tanks for the gunner, and strategically positioning the tank (e.g., using the terrain to protect the tank from enemy fire). Tanks could not be operated successfully without the combined effort of both participants. Outcome interdependency existed at the level of the team, where the two identical tanks were required to work together in order to complete the mission objectives. The mission difficulty level was such that a single tank was not able to complete the mission (i.e., 1 tank versus 10 enemy tanks) without the assistance of the other tank.

Steel Beasts Pro PE missions. A single mission template was created for this study. The mission template included a mission briefing and a map. The mission briefing described the mission objectives to participants. The map provided participants with an overview of the battle space and the general location of the enemy tanks. Four areas were marked on the map as possible locations of enemy tanks. Participants were informed in the briefing that the enemy tanks were clustered in pairs (i.e., two–tank platoons) and the general location of 8 out of the 10 enemy tanks was marked on the map.

The mission template presented teams with two objectives. The first objective required participants to locate, engage, and destroy 10 enemy tanks during the mission.

The second objective required participants to move their two–tank platoon from their starting location to a position marked on the map.

Five mission variations (Missions A–E) were created from the single mission template so that participants would not focus on learning the details of the mission (e.g., location of enemy tanks) but rather focus on learning how to perform the task (e.g., search for, identify, and destroy enemy tanks). All mission variations used the same mission briefing. Missions A–C presented participants with seemingly unique missions by varying the placement of the enemy tanks, the four areas marking possible locations of enemy tanks, and the destination to which participants were to travel. Missions D and E were similar to Missions B and C except that the areas marked as the possible location of enemy tanks in Missions D and E were larger than in previous missions (i.e., Mission A–C). The larger areas required a greater proficiency in navigating, searching, identifying, and destroying enemy tanks. Mission briefings and maps are presented in Appendix A.

Teams were allowed 15 minutes to complete each mission. A mission was terminated when either (a) the team had completed the mission objectives (i.e., destroyed all 10 enemy tanks and moved both of the tanks in their platoon to the specified location), (b) all of the participants' tanks were destroyed, or (c) when the 15 minute time limit had expired.

Performance scores were obtained at the team–level (i.e., two–tank platoon). Participants earned points for the length of time they remained alive (maximum of 900 seconds), hit percentage (number shots that hit an enemy tank divided by the total

number of shots fired, multiplied by 100), number of enemy tanks destroyed (maximum of 10), and whether the team (both tanks) reached their destination. Participants lost points for the number of friendly tanks destroyed by the enemy (maximum of 2), and the number of friendly tanks destroyed by fratricide (maximum of 1). All performance indicators were scaled to 100 and summed to obtain the 4–person team's performance score. Analyses of team performance are based upon these summed performance scores, which could range from -200 to 400. The method used to determine performance scores was explained to participants during the training. Performance scores were also available for participants to review at the conclusion of every team mission.

Declarative knowledge. Declarative knowledge was assessed using a 30–item, 3–alternative multiple–choice measure. This measure was developed using the measure used by Arthur, Edwards, Bell, and Bennett (2002) as a guide. Only the concepts on which both the gunner and commander/driver trained were assessed by the measure. The measure yielded a test–retest reliability estimate of .86 between the two administrations following training (i.e., second and third administration). Means, standard deviations, intercorrelations, correlations, and internal consistency estimates for all administrations are presented in Table 3. The declarative knowledge measure is presented in Appendix B.

Table 3
Individual– and Team–level Declarative Knowledge and Team–efficacy Score Means, Standard Deviations, Intercorrelations, Correlations, and Internal Consistency Estimates

Measure	M	SD	1	2	3	4	5	6	7
			Individual–level (N = 120)						
Declarative Knowledge									
1. Time 1 (Session 0[a])	10.98	2.85	—						
2. Time 2 (Session 3)	22.64	3.35	.31*	—					
3. Time 3 (Session 6)	22.70	3.65	.27*	.86*	—				
Team–efficacy									
4. Time 1 (Session 2)	3.30	0.82	-.11	.01	.00	(.93[b])			
5. Time 2 (Session 4)	3.51	0.80	-.12	.07	.10	.66*	(.95[b])		
6. Time 3 (Session 6)	3.58	0.88	-.11	-.01	.02	.49*	.69*	(.93[b])	
7. Cognitive Ability [a]	7.45	2.16	.06	.20*	.16	.09	.04	.01	(.67[c])
			Team–level (N = 30)						
Declarative Knowledge									
1. Time 1 (Session 0[a])	10.98	1.44	—						
2. Time 2 (Session 3)	22.64	2.07	-.01	—					
3. Time 3 (Session 6)	22.70	2.33	.12	.87*	—				
Team–efficacy									
4. Time 1 (Session 2)	3.30	0.47	-.03	.44*	.33	—			
5. Time 2 (Session 4)	3.51	0.47	.09	.35	.34	.56*	—		
6. Time 3 (Session 6)	3.58	0.58	.09	.22	.24	.52*	.74*	—	
7. Cognitive Ability [a]	7.45	1.22	-.04	.37*	.19	-.02	.00	-.15	—

Note. [a]Measured prior to training (baseline). [b]Internal consistency (alpha) reliability. [c]Spearman–Brown split–half (odd–even split) reliability. Scale score reliability estimates are presented in the diagonal in parentheses, where appropriate. * $p < .05$, two–tailed.

Team–efficacy. A version of the Arthur, Bell, and Edwards' (2007) team–efficacy measure was modified to reflect the performance task and used to assess team–efficacy. The measure consisted of six task specific items with a team referent.

Participants provided their ratings using a 5–point rating scale. Team–efficacy scores were calculated using the mean of the item responses. The mean internal consistency of the items across the three administrations was .93 (*SD* = .02). Specific internal consistency estimates and session intercorrelations are presented in Table 3. The team–efficacy measure is presented in Appendix C.

Cognitive ability. Cognitive ability was assessed using Arthur and Day's (1994) 12–item short form of the *Raven Advanced Progressive Matrices* (APM; Raven, Raven, & Court, 1998). The original *Raven APM* consists of 36 matrices arranged in order of increasing difficulty. If administered with a time limit, the test manual recommends 40 minutes. For the short form, Arthur and Day recommend a 15–minute time limit, so participants were allowed 15 minutes to complete the measure. The *Raven APM* was scored by summing the number of correct responses. An odd–even split of the items yielded a Spearman–Brown corrected reliability estimate of .67.

Demographics. Demographic information was collected from the participants in order to describe the study sample. Participants reported their age, sex, race, experience with video games, and whether they had previous experience with the performance task. The video game experience item asked participants to describe their general experience with video games using a 3–point scale (i.e., novice, average, expert). Prior experience with the performance task was collected with the intention of eliminating participants who had prior experience with the task. However, no participant reported any prior experience with the task and therefore, no one was removed from the study for this

reason. The study sample demographic information is presented in Table 1. The demographics measure is presented in Appendix D.

Training Manipulation

Participants trained to operate the simulator first as individuals and then as a team. During the individual training phase, participants were allowed 90 minutes to complete 10 training tutorials. To complete the tutorials, participants first read a brief instruction set that introduced the concepts to be learned and presented information necessary to operate the simulator. After reading the instruction set, participants then engaged in a period of hands–on practice that required applying the content of the tutorial. The training tutorials that each participant completed depended on their role in the team, either gunner or commander/driver. Approximately six of the training tutorials addressed a participant's role specific tasks while four tutorials addressed a participant's tank partner's tasks. Tutorial content and the tutorials completed by participants assigned to the specific roles (i.e., gunner or commander/driver) are presented in Table 4. Tutorials were completed in the order listed in Table 4, regardless of the participant's role.

During the team training phase, participants operated the simulator as a team to complete the six team–based missions. All participants completed the same team missions in the same order, regardless of training condition. The events that followed each team training mission depended on the training condition to which the team was assigned.

Table 4

Tutorial Content and Tutorial Assignments by Role

		Assignments	
Tutorial	Content	Gunner	Commander/ Driver
1	*Steel Beasts Pro PE* overview	×	×
2	Basic gun controls and basic lasing	×	×
3	Advanced lasing	×	
4	Automatic lead	×	×
5	Thermal imaging gun sight	×	×
6	Ammunition selection	×	
7	Manual range entry and auxiliary gun sight	×	
8	Basic driving controls	×	×
9	Advanced driving and setting routes		×
10	Basic tank commander controls	×	×
11	Designating targets and overriding the main gun		×
12	Primary sight extension and ammunition selection		×
13	Basic tank warfare tactics	×	×

Note. × = tutorial assigned to the specific role.

Non–AAR–based training condition. Once a team mission ended, participants assigned to the non–AAR–based training condition completed the paper–and–pencil assessments scheduled to follow that mission. After completing the measures, participants were given a 2–minute briefing/planning period and then began the next mission.

Subjective AAR–based training condition. After completing a team mission, participants in the subjective AAR–based training condition participated in a 10-minute AAR. Each AAR was guided by a facilitator. Participants were also provided with an AAR form which described the AAR process and steps (as depicted in Figure 1), and

served as an outline of the AAR (see Appendix E for a copy of the AAR form). The facilitator provided instructions during the first AAR to introduce participants to the AAR and to familiarize them with the AAR process. The facilitator interrupted the AAR only when a team deviated from the order or when the 10–minute time limit had expired. The AAR began with participants recalling the intended outcome and the actual outcome. Participants then compared the two outcomes to determine whether they had met the intended outcome. Participants recalled the events of the mission in order to identify key behaviors or events that contributed to, or detracted from achieving the mission objectives. The participants were then encouraged to set specific and difficult yet attainable goals for subsequent missions. The AAR concluded with participants identifying behaviors and actions that would increase the likelihood of meeting their self–set goals and subsequent mission objectives. Once they had completed the AAR, participants then completed the paper–and–pencil assessments scheduled to follow that mission.

Objective AAR–based training condition. Participants assigned to the objective AAR–based training condition participated in an AAR after each team mission in the same manner (and within the same 10–minute time period) as those participants in the subjective AAR–based training condition. However, participants in the objective AAR–based training condition objectively reviewed the progress of their recently completed mission during the AAR using the simulator's review tool, operated by the facilitator. The review tool allowed participants to replay, pause, and move forward or backward through the recorded mission. Participants could view the mission progress from

multiple perspectives and examine it from any point in the simulated environment (e.g., from either tanks' perspective, the enemy's perspective, or a top–down view of the mission). The tool also indexed key events (e.g. enemy hits or friendly hits) during the mission. Once teams had completed the AAR, they completed the paper–and–pencil assessments scheduled to follow that mission.

Procedure

The study took five hours and was divided into three phases. During the first phase of the study, participants were familiarized with the protocol, completed the informed consent form, the baseline (Time 1) Steel Beasts Knowledge measure, the Raven's APM, and a demographics measure. After completing the measures, participants were then randomly assigned to a specific role within the team, either gunner or commander/driver. The team was then randomly assigned to a training condition (i.e., non–AAR–based, subjective AAR–based, or objective AAR–based).

During the second phase of the study, participants began their individual training. Participants were given 90 minutes to complete the 10 tutorials in the order specified in Table 4. For the first tutorial, the researcher read the tutorial to the participants as they followed along in their tutorial handbooks. After completing the first tutorial, participants then completed the remaining tutorials at their own pace. Each tutorial began with participants reading the tutorial content from a tutorial handbook. Once participants understood the content and objectives of the tutorial, they then completed a tutorial–based mission that provided hands–on practice of the tutorial content. Subsequent tutorials continued following the same procedure. Participants who

completed their tutorials before the 90-minute time limit were allowed to repeat any of their assigned tutorials.

Upon completing the tutorials, participants then began the third and final phase of the study, the team training phase. To begin this phase of the study, the participants were shown how to use the headset and voice activated microphones. Participants were asked to demonstrate their ability to use the headsets and microphones, after which they began their first team mission.

Each team mission began with a planning period. Participants were allowed 2 minutes to review the mission briefing and map, formulate a strategy, and discuss the strategy with their teammates during the planning period. Teams were allowed to begin the mission prior to the 2-minute time limit if all team members agreed. Otherwise, the team mission began after 2 minutes had expired. Teams were allowed 15 minutes to complete each team mission. The simulator displayed the time remaining each mission. The timer flashed when a team had one minute or less of mission time remaining.

Once a team completed a team mission or the mission was terminated, teams continued the study as specified by their assigned training condition. Teams trained using a non–AAR–based approach completed the measures scheduled to follow that mission and then began the subsequent team mission. Teams trained using an AAR–based approach participated in an AAR for 10 minutes, completed the measures scheduled to follow that mission, and then began the subsequent team mission. The time limits for the team mission briefing (2 minutes), team mission (15 minutes), and AAR (10 minutes) were deemed to be sufficient for the respective tasks during pilot testing.

CHAPTER VII

RESULTS

Data Screening and Aggregation

Prior to the primary analyses of declarative knowledge, team performance, and team–efficacy, the data were screened and the assumptions of the specific statistical analyses were evaluated, as recommended by Tabachnick and Fidell (2007). There were no missing data, the sample size met that recommended by the *a priori* power analysis, and the data were adequately normally distributed. No cognitive ability scores were identified as outliers. However, nine individual–level scores were identified as univariate outliers across the declarative knowledge and team–efficacy measures. Upon examination, there was no reasonable justification for adjusting or removing these scores. Therefore, these outliers were retained in the data set.

Once the screening procedures were completed, the individual–level data (i.e., declarative knowledge and team–efficacy) was evaluated to justify aggregation to the level of the team. Agreement and reliability indices (i.e., $r_{wg(1)}$, $r_{wg(j)}$, r^*_{wg}, ICC_1, and ICC_2) were calculated to assess the appropriateness of aggregating individual–level data to that of the team–level (James, Demaree, &Wolf, 1984; Lindell, Brandt, & Whitney 1999). The reliability estimates and median agreement indices suggested that aggregation to the team–level was appropriate (see Table 5). Therefore, team–level scores for declarative knowledge and team–efficacy were created by averaging the individual–level scores within teams. Team performance scores were recorded at the

team–level and thus did not require aggregation. The intercorrelations and correlations

of team–level study variables are presented Appendix F.

Table 5
*Individual–level Declarative Knowledge and Team–efficacy Intraclass Correlation
Coefficients and Median Agreement Indices*

Measure	ICC_1	ICC_2	$r_{wg(1)}$	$r_{wg(j)}$	r^*_{wg}
Declarative Knowledge (30 items)					
Time 1 (Session 0)	.00	.04	.94	—	—
Time 2 (Session 3)	.10	.45	.89	—	—
Time 3 (Session 6)	.12	.51	.90	—	—
Team–efficacy (6 items)					
Time 1 (Session 2)	.06	.33	.73	.91	.64
Time 2 (Session 4)	.07	.38	.78	.92	.66
Time 3 (Session 6)	.14	.55	.82	.94	.74

Note. $N = 120$. $k = 30$. Median $r_{wg(1)}$ and $r_{wg(j)}$ were calculated using the formulas
presented by James et al. (1984). Median r^*_{wg} was calculated using the formulas
presented by Lindell et al. (1999).

Baseline Analyses

Team declarative knowledge, team performance, and team cognitive ability were

assessed prior to the introduction of the experimental manipulation (i.e., subjective or

objective AAR–based training). Team–efficacy was only assessed following the training

manipulation and thus there was no baseline assessment of team–efficacy. To document

effectiveness of random assignment of teams to the training conditions, analyses of

variance (ANOVA) were performed on team declarative knowledge and team

performance with training condition (non–AAR–based versus subjective AAR–based

versus objective AAR–based) serving as the between–subjects variable. There were no

statistical differences in teams' mean knowledge, $F(2, 27) = 0.22$, $p > .05$, $\eta^2 = .02$, or

performance, $F(2, 28) = 0.23$, $p > .05$, $\eta^2 = .02$, across the three training conditions.

There were also no statistical differences in the teams' mean cognitive ability across the

three training conditions, $F(2, 27) = 0.45$, $p > .05$, $\eta^2 = .03$. Therefore, the random

assignment of teams to training conditions was judged effective; teams in all conditions

demonstrated similar levels of declarative knowledge, performance, and cognitive ability

at baseline. Consequently, cognitive ability was not used as a covariate and is not

discussed further.

Hypotheses 1a–c

Three separate mixed ANOVAs were performed on team declarative knowledge,

team performance, and team–efficacy to test Hypotheses 1a–1c. Training condition (non

AAR– versus AAR–based [subjective and objective AAR–based training combined])

served as the between–subjects independent variable and session (Sessions 1–6 for team

performance, Sessions 0, 3, and 6 for declarative knowledge, and Sessions 2, 4, and 6 for

team–efficacy) served as the within–subjects independent variable.

Hypothesis 1a: Team declarative knowledge. Hypothesis 1a predicted that teams

trained using an AAR–based approach (i.e., subjective and objective AAR–based

training combined) would have higher team declarative knowledge scores than teams

trained using a non–AAR–based training approach. Using a 2 × 3 mixed ANOVA, the

between–subjects main effect was not statistically significant, indicating that teams in

the AAR–based training conditions did not differ from those teams in the non–AAR–

based training condition in their overall team declarative knowledge scores, $F(1, 28) =$

2.07, $p > .05$, $\eta^2 = .07$. Thus, Hypothesis 1a was not supported. The within–subjects

effect for session was statistically significant, indicating that team declarative knowledge

scores improved across sessions, $F(2, 56) = 506.10$, $p < .05$, $\eta^2 = .94$. However, the

training condition × session interaction was not statistically significant, $F(2, 56) = 2.32$,

$p > .05$, $\eta^2 = .00$. Thus, improvement in team declarative knowledge scores did not

depend on the training condition. Means, standard deviations, and standardized mean

differences for the team declarative knowledge scores by training condition and session

are presented in Table 6.

Table 6
Team Declarative Knowledge Score Means, Standard Deviations, and Standardized
Mean Differences by Training Condition (Non–AAR– versus AAR–based Training)

| | Training Condition | | | | |
| | Non–AAR | | AAR | | |
Time	M	SD	M	SD	d
1 (Session 0)	11.08	1.28	10.93	1.55	-0.11
2 (Session 3)	21.58	2.37	23.18	1.72	0.77*
3 (Session 6)	22.00	2.75	23.05	2.08	0.43
Overall	18.22	1.69	19.05	1.40	0.53

Note. $N = 30$. Non–AAR $n = 10$. AAR $n = 20$. *d* was computed so that positive values
indicate that the AAR–based training condition's mean score was greater than the non–
AAR–based training condition's mean score. * $p < .05$, one–tailed.

Hypothesis 1b: Team performance. Hypothesis 1b predicted that teams trained

using an AAR–based approach (i.e., subjective and objective AAR–based training

combined) would have higher team performance scores than teams trained using a non–

AAR–based training approach. Using a 2×6 mixed ANOVA, the between–subjects

main effect was statistically significant, indicating that teams in the AAR–based training

conditions obtained higher team performance scores than teams in the non–AAR–based

training condition, $F(1, 28) = 5.28$, $p < .05$, $\eta^2 = .16$. Therefore, Hypothesis 1b was

supported. Furthermore, the within–subjects effect for session was statistically

significant, indicating that team performance scores improved across sessions, $F(5, 140)$

$= 7.99$, $p < .05$, $\eta^2 = .21$. The training condition $\times$ session interaction was also

statistically significant, $F(5, 140) = 2.35$, $p < .05$, $\eta^2 = .08$. Thus, improvement in team

performance scores depended on the training condition. Although team performance

scores were similar during Sessions 1–3 ($d = 0.23$, -0.08, and -0.19, respectively), they

differed during Sessions 4 and 5 ($d = 1.18$ and 1.05, respectively), and were again

similar during Session 6 ($d = 0.16$). Means, standard deviations, and standardized mean

differences for the team performance scores by training condition and session are

presented in Table 7. Team performance score means by training condition and session

are illustrated in Figure 3.

Table 7

Team Performance Score Means, Standard Deviations, and Standardized Mean Differences by Training Condition (Non–AAR– versus AAR–based Training)

| | Training Condition | | | | |
| | Non–AAR | | AAR | | |
Session	*M*	*SD*	*M*	*SD*	*d*
1$_A$	-59.79	61.59	-45.95	60.44	0.23
2$_B$	-27.99	65.30	-32.86	62.59	-0.08
3$_C$	52.22	108.74	32.87	89.29	-0.19
4$_D$	-61.50	65.63	34.08	93.44	1.18*
5$_E$	-3.95	72.53	69.99	68.34	1.05*
6$_A$	38.69	101.27	52.50	71.48	0.16
Overall	-10.39	43.89	18.10	24.43	0.80*

Note. $N = 30$. Non–AAR $n = 10$. AAR $n = 20$. Subscript letters (A–E) represent the mission used during the specified session. *d* was computed so that positive values indicate that the AAR–based training condition's mean score was greater than the non–AAR–based training condition's mean score. * $p < .05$, one–tailed.
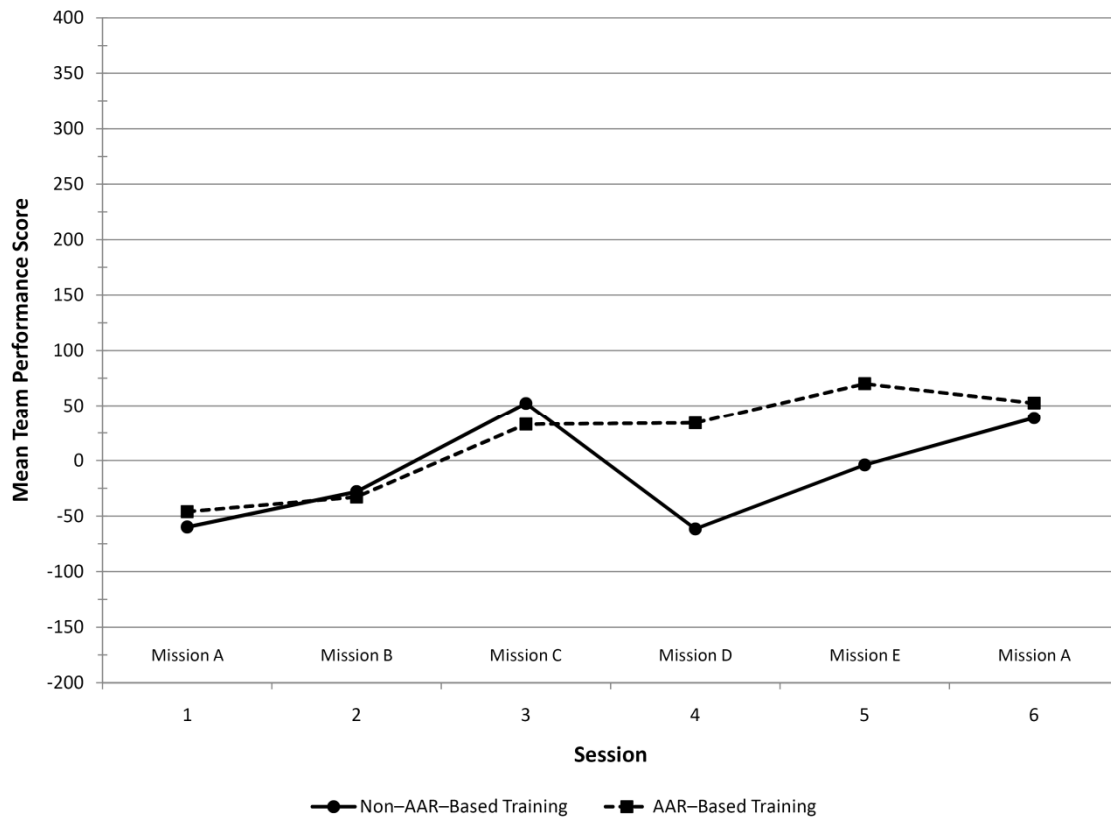
Figure 3. Mean team performance scores by training condition (non–AAR– versus AAR–based training). *N* = 30. Non–AAR *n* = 10. AAR *n* = 20.

Hypothesis 1c: Team–efficacy. Finally, Hypothesis 1c predicted that teams trained using an AAR–based approach (i.e., subjective and objective AAR–based training combined) would report higher levels of team–efficacy than teams trained using the non–AAR–based training approach. Using a 2 × 3 mixed ANOVA, the between–subjects main effect was statistically significant, indicating that teams in the AAR–based training conditions reported having higher team–efficacy than teams in the non–AAR–based training condition, $F(1, 28) = 9.11$, $p < .05$, $\eta^2 = .25$. Thus, Hypothesis 1c was also supported. Furthermore, the within–subjects effect for session was statistically

significant, indicating that team–efficacy increased across sessions, $F(2, 56) = 5.41$, $p <$ .05, $\eta^2 = .83$. However, the training condition × session interaction was not statistically significant, $F(2, 56) = 0.11$, $p > .05$, $\eta^2 = .02$. Thus, improvement in team–efficacy scores did not depend on the training condition. Means, standard deviations, and standardized mean differences for team–efficacy by training condition and session are presented in Table 8.

Table 8
Team–efficacy Score Means, Standard Deviations, and Standardized Mean Differences by Training Condition (Non–AAR– versus AAR–based Training)

	Training Condition				
	Non–AAR		AAR		
Time	M	SD	M	SD	d
1 (Session 2)	3.00	0.50	3.45	0.39	1.00*
2 (Session 4)	3.18	0.39	3.67	0.42	1.21*
3 (Session 6)	3.31	0.57	3.72	0.54	0.74*
Overall	3.17	0.36	3.62	0.40	1.18*

Note. $N = 30$. Non–AAR $n = 10$. AAR $n = 20$. *d* was computed so that positive values indicate that the AAR–based training condition's mean score was greater than the non–AAR–based training condition's mean score. * $p < .05$, one–tailed.

Hypotheses 2a–c

Three independent mixed ANOVAs were performed on team declarative knowledge, team performance, and team–efficacy to test Hypotheses 2a–c. Training condition (subjective versus objective AAR–based training) served as the between–subjects independent variable and session (Sessions 1–6 for team performance, Sessions

0, 3, and 6 for declarative knowledge, and Sessions 2, 4, and 6 for team–efficacy) served as the within–subjects independent variable.

   Hypothesis 2a: Team declarative knowledge. Hypothesis 2a predicted that teams trained using an objective AAR–based approach would earn higher team declarative knowledge scores than teams trained using a subjective AAR–based training approach. Using a 2 × 3 mixed ANOVA, the between–subjects main effect was not statistically significant, indicating that teams in the objective AAR–based training condition did not differ from those teams in the subjective AAR–based training condition in their overall team declarative knowledge scores, $F(1, 18) = 0.30$, $p > .05$, $\eta^2 = .02$. Therefore, Hypothesis 2a was not supported. The within–subjects effect for session was statistically significant, indicating that team declarative knowledge scores improved across sessions, $F(2, 36) = 527.00$, $p < .05$, $\eta^2 = .96$. However, the training condition × session interaction was not statistically significant, $F(2, 36) = 1.26$, $p > .05$, $\eta^2 = .00$. Thus, improvement in team declarative knowledge scores did not depend on the training condition. Means, standard deviations, and standardized mean differences for the team declarative knowledge scores by training condition and session are presented in Table 9.

Table 9

Team Declarative Knowledge Score Means, Standard Deviations, and Standardized Mean Differences by Training Condition (Subjective AAR– versus Objective AAR–based Training)

| | Training Condition | | | | |
| | Subjective AAR | | Objective AAR | | |
Time	*M*	*SD*	*M*	*SD*	*d*
1 (Session 0)	10.73	1.59	11.13	1.57	0.25
2 (Session 3)	23.65	2.12	22.70	1.13	-0.56
3 (Session 6)	23.30	2.71	22.80	1.27	-0.24
Overall	19.23	1.81	18.88	0.88	-0.25

Note. $N = 20$. Subjective AAR $n = 10$. Objective AAR $n = 10$. *d* was computed so that positive values indicate that the objective AAR–based training condition's mean score was greater than the non–AAR–based training condition's mean score. None of the *d*s were statistically significantly different at the $p = .05$ level, one–tailed.

Hypothesis 2b: Team performance. Hypothesis 2b predicted that teams trained using an objective AAR–based approach would have higher team performance scores than teams trained using a subjective AAR–based training approach. Using a 2×6 mixed ANOVA, the between–subjects main effect was not statistically significant, indicating that the team performance scores of teams in the objective AAR–based training condition did not differ from those of teams in the subjective AAR–based training condition, $F(1, 18) = 1.66$, $p > .05$, $\eta^2 = .08$. Thus, Hypothesis 2b was not supported. However, the within–subjects effect for session was statistically significant, indicating that team performance scores improved across sessions, $F(5, 90) = 7.14$, $p < .05$, $\eta^2 = .28$. Finally, the training condition $\times$ session interaction was not statistically significant, $F(5, 90) = 0.27$, $p > .05$, $\eta^2 = .01$. Thus, improvement in team performance

scores did not depend on the training condition. Means, standard deviations, and standardized mean differences for the team performance scores by training condition and session are presented in Table 10.

Table 10
Team Performance Score Means, Standard Deviations, and Standardized Mean Differences by Training Condition (Subjective AAR– versus Objective AAR–based Training)

| | Training Condition | | | | |
| | Subjective AAR | | Objective AAR | | |
Session	*M*	*SD*	*M*	*SD*	*d*
1$_A$	-54.45	31.69	-41.46	81.33	0.21
2$_B$	-45.02	52.63	-20.71	71.91	0.39
3$_C$	38.84	89.00	26.90	93.97	-0.13
4$_D$	35.45	94.80	32.71	97.16	-0.03
5$_E$	58.42	43.34	81.57	84.67	0.34
6$_A$	33.84	52.14	71.16	85.42	0.53
Overall	11.18	23.20	25.03	24.81	0.58

Note. *N* = 20. Subjective AAR *n* = 10. Objective AAR *n* = 10. Subscript letters (A–E) represent the mission used during the specified session. *d* was computed so that positive values indicate that the AAR–based training condition score was greater than the non–AAR–based training condition score. None of the *d*s were statistically significantly different at the *p* = .05 level, one–tailed.

Hypothesis 2c: Team–efficacy. Finally, Hypothesis 2c predicted that teams trained using an objective AAR–based approach would report higher levels of team–efficacy than teams trained using a subjective AAR–based training approach. Using a 2 × 3 mixed ANOVA, the between–subjects main effect was not statistically significant, indicating that the team–efficacy of teams in the objective AAR–based training

condition did not differ from that reported by teams in the subjective AAR–based training condition, $F(1, 18) = 0.65$, $p > .05$, $\eta^2 = .03$. However, the within–subjects effect for session was statistically significant, indicating that team–efficacy increased across sessions, $F(2, 36) = 5.47$, $p < .05$, $\eta^2 = .22$. Hypothesis 2c was also not supported. Finally, the training condition × session interaction was not statistically significant, $F(2, 36) = 1.44$, $p > .05$, $\eta^2 = .06$. Thus, improvement in team–efficacy scores did not depend on the training condition. Means, standard deviations, and standardized mean differences for the team–efficacy scores by training condition and session are presented in Table 11.

Table 11
Team–efficacy Means, Standard Deviations, and Standardized Mean Differences by Training Condition (Subjective AAR– versus Objective AAR–based Training)

| | Training Condition | | | | |
| | Subjective AAR | | Objective AAR | | |
Time	M	SD	M	SD	d
1 (Session 2)	3.00	0.50	3.45	0.39	-0.72
2 (Session 4)	3.18	0.39	3.67	0.42	-0.42
3 (Session 6)	3.31	0.57	3.72	0.54	0.04
Overall	3.69	0.39	3.54	0.42	-0.37

Note. $N = 20$. Subjective AAR $n = 10$. Objective AAR $n = 10$. *d* was computed so that positive values indicate that the AAR–based training condition score was greater than the non–AAR–based training condition score. None of the *d*s were statistically significantly different at the $p = .05$ level, one–tailed.

CHAPTER VIII

DISCUSSION

Overview

The present study sought to present a psychologically based rationale for AAR–based training, empirically assess AAR–based training in comparison to non–AAR–based training, and assess the comparative effectiveness of subjective versus objective AAR–based training. The results of the empirical study indicated that AAR–based training was more effective than non–AAR–based training in terms of team performance and team–efficacy but not team declarative knowledge. However, objective AAR–based training was no more effective than subjective AAR–based training in terms of team declarative knowledge, team performance, and team–efficacy.

Study Objectives

The present study advances the training literature through three primary objectives. The first objective was to present a theoretically based rationale for the AAR. This was accomplished by linking existing psychologically based theories of behavior and related literatures to the processes and components of the AAR–based training approach. In broad terms, AAR–based training is comprised of several steps that rely on a collection of psychological theories and concepts, including feedback, behavioral modeling, and goal setting. Each of these theories and concepts play a role in AAR–based training and may therefore each be used to inform the design and practice of AAR–based training to maximize its training effectiveness.

The second objective was to assess the effectiveness of AAR–based training in comparison to non–AAR–based training. The training outcomes of interest examined were (a) team declarative knowledge, (b) team performance, and (c) team–efficacy. The purpose of this was to provide researchers and training professionals with an empirically based assessment of AAR–based training effectiveness. Although studies have previously examined AAR–based training approaches (e.g., Alexander, Kepner, & Tregoe, 1962; Ellis & Davidi, 2005; Zakay et al., 2004), they have either not compared AAR–based training to non–AAR–based training or are of questionable methodological rigor (e.g., small sample size).

In response to training practitioners' continued efforts to incorporate objective review tools into training tools, the third objective of the present study was to assess the effectiveness of subjective AAR–based training in comparison to objective AAR–based training. Despite the espoused need for and evaluation of performance task environments that enhance the objectivity of the AAR (e.g., Dyer, Wampler, & Blankenbeckler, 2005; Meliza, 1996, 1998; Meliza et al., 1994), there appears to be no published empirical investigations examining the effectiveness of objective versus review systems in AAR–based training, nor the effect of objective versus subjective AAR–based training on various training outcomes. To fill this void, the findings presented in this study also provide researchers and training professionals with an empirical estimate of the effectiveness of objective versus subjective AAR–based training on the training outcomes of (a) team declarative knowledge, (b) team performance, and (c) team–efficacy.

Non–AAR– versus AAR–based Training

The first set of hypotheses (1a–c) predicted that teams trained using an AAR–based approach (i.e., objective and subjective AAR–based training combined) would obtain higher (a) team declarative knowledge, and (b) team performance scores, and (c) report higher team–efficacy than teams trained using a non–AAR–based training approach. AAR–based training was more effective than non–AAR –based training for some training outcomes but not for others. Whereas AAR–based training was no more effective than non–AAR–based training in terms of team declarative knowledge, AAR–based training was superior in terms of team performance and team–efficacy. Teams trained using an AAR–based training approach obtained higher performance scores and reported higher levels of team–efficacy than teams trained using a non–AAR–based approach. But the effectiveness of AAR–based training was not consistent across sessions in terms of performance. Team performance scores and were similar during Sessions 1–3, differed during Sessions 4 and 5, and were again similar during Session 6.

Although the finding that AAR–based training was more effective than non–AAR–based training for only two of the three training outcomes was unexpected, these mixed results are supported by the training literature. That is, the training literature has noted that a training manipulation may be differentially effective, depending on the training outcome of interest (Arthur et al., 1998; Schmidt & Björk, 1992). For example, Schmidt and Björk have shown that manipulations that enhance training effectiveness during acquisition might not be the most effective for distal training outcomes such as transfer, retention, or reacquisition. This point is echoed in Arthur et al.'s caution

against using one of these training outcomes (i.e., acquisition, transfer, and retention) as a surrogate for another. Therefore, as a training manipulation, AAR–based training may be effective for some training outcomes (e.g., acquisition of team performance and development of team–efficacy) but not others (e.g., acquisition of declarative knowledge). Moreover, these effects may not be consistent across other training phases of interest (e.g., retention or reacquisition), highlighting the need for additional AAR–based training research.

An unexpected and interesting difference between the non–AAR– and AAR–based training conditions is the point at which the two training conditions began to differ in terms of team performance. As illustrated in Figure 3, there was no difference in the mean performance of the two training conditions (non–AAR– and AAR–based training) during Sessions 1–3. The average standardized mean difference between the two conditions for Sessions 1–3 was -0.01 (SD = .21). However, the difference in team performance during Session 4 was the largest in magnitude (d = 1.18). The disparity in Session 3 and Session 4 performance may be attributed to the variation between Mission C and Mission D. Mission C and Mission D differed in the information provided to participants regarding the location of enemy tanks. Every mission provided teams with the general location of the enemy tanks. The enemy positions marked in Missions A–C were relatively small. The enemy positions marked in Missions D and E, however, were much larger than those marked in Missions A–C. During Missions D and E, teams had to modify the strategies they used on previous missions to accommodate the change. Although post–hoc in nature, Mission D may have elicited teams' capability to adapt. If

Mission D functioned as a measure of adaptability, then it is interesting to note that the performance of teams in the AAR–based training condition did not decrease, but rather remained stable when faced with the challenge presented by Mission D. This was in contrast to drop in performance for teams trained using the non–AAR–based approach. Interpreting Mission D as a measure of adaptability, these results suggest that AAR–based training may be an effective training approach when adaptability is a desired outcome. However, this finding is speculative and contingent on future research. This finding may provide a fruitful avenue of future research that focuses on the effectiveness of AAR–based training on adaptability and related concepts (e.g., transfer of training).

Subjective AAR– versus Objective AAR–based Training

The second set of hypotheses (2a–c) predicted that teams trained using an objective AAR–based approach would obtain higher (a) team declarative knowledge, and (b) team performance scores, and (c) report higher team–efficacy than teams trained using a subjective AAR–based training approach. The results indicated that subjective and objective AAR–based training approaches appear to be equally effective at enhancing team declarative knowledge, team performance, and team–efficacy. Teams trained using a subjective AAR–based training approach earned similar knowledge and performance scores and reported similar levels of team–efficacy in comparison to teams trained using an objective AAR–based approach.

The similarity in training effectiveness of subjective and objective AAR–based training is remarkable given the presence of errors during the subjective reviews and the inability of teams in the subjective review condition to correct those errors. For

example, teams trained using the subjective AAR–based approach often experienced a lack of situational awareness during a mission that would inevitably permeate the subsequent review. In the worst instances, incorrect information shared by one team member supported the incorrect information of another, causing a downward spiral of flawed information and misinterpretation based upon team member agreement.

Teams in the objective AAR–based training condition also experienced losses of situational awareness during their team missions. However, because the review was aided by the objective review tool, errors were more easily identified and corrected. Even when a team unanimously agreed on incorrect information (e.g., "our tank was destroyed by an enemy we couldn't see"), the objective review helped teams to correct their mistaken interpretations (e.g., "our tank was destroyed by friendly fire"). However, despite reviews that were more prone to errors and misinterpretations, the subjective AAR–based training was as effective as the objective AAR–based training. Moreover, the similarity was not only present in team–efficacy, whereby one might argue that teams also misinterpreted their efficacy in addition to information in their review, but also the similarity was also present in team declarative knowledge and team performance.

The unexpected finding that subjective and objective AAR–based training performed equally well suggests that the factual errors present during the subjective review were inconsequential. Despite the subjective review being prone to errors, the errors present during the reviews did not hinder teams from learning concepts and developing strategies that aided their performance. It appears as though teams may have

benefitted from the global concepts and meta–cognitive processes of the review. That is, despite making factual errors (e.g., the location of enemy positions), teams were able to discuss how strategies for improving their performance on the task (e.g., how to effectively search for and destroy the enemy). Despite the seemingly intuitive expectation that errors would attenuate the effectiveness of training using a subjective AAR–based training approach, it appears that in this study, learning the global nature of the task and learning how to think about approaching the task was unimpeded by errors in the review. The counter–intuitive nature of this finding warrants further investigation and serves as a cautionary note; training interventions should be submitted to empirical scrutiny despite their seemingly intuitive utility.

Effectiveness of AAR–based Training

The results presented in this study indicate that AAR–based training has a modest degree of training effectiveness. AAR–based training in this study yielded effectiveness estimates larger than those of interventions based on any one of the theories and concepts underlying the AAR alone (i.e., goal setting, observational learning, and feedback). AAR–based training was more effective than non–AAR–based training in terms of overall (i.e., average across sessions) team performance ($d = 0.80$) and team–efficacy ($d = 1.18$), but not team declarative knowledge ($d = 0.53$). These estimates of effectiveness were larger than those of feedback interventions alone (frequent feedback: $d = 0.32$, $SD_d = 0.31$, specific feedback: $d = 0.43$, $SD_d = 0.38$; Kluger & DeNisi, 1996). Furthermore, Taylor et al.'s (2005) empirical review of behavioral modeling training reported *d*s of 1.05, 0.27, and 0.12 for declarative

knowledge, job behavior, and workgroup productivity, respectively. Although the AAR–based training was not as effective as the behavioral modeling research would suggest for declarative knowledge, AAR–based training was more effective in terms of performance outcomes; AAR–based training was three to six times more effective in terms of performance than the behavioral modeling research would suggest. And finally, AAR–based training was more effective than interventions that combine goal setting and feedback. Such interventions have yielded meta–analytically estimated ds ranging from 0.49 (SD_d = 0.08; Mento et al., 1987) to 0.56 (SD_d = 0.00; Tubbs, 1986).

Implications

The results of this study suggest that AAR–based training may be a viable training approach, at least for the type of complex, team–based task used in this study. While the military has relied on the AAR for decades, and more recently, both private and public organizations have adopted AAR–based training, this study provides support, albeit preliminary in nature, for the continued use of AAR–based training.

The finding that subjective AAR– and objective AAR–based training were equally effective has two important implications. First, most of the of the existing AAR literature has been concerned with the engineering of review systems and assessing the ease of using such systems during an AAR. The results of this study suggest that incorporating objective review systems into training technology might not have high utility. Although objective reviews may not reduce the effectiveness of AAR–based training, this study demonstrates an instance in which objective reviews did not enhance

it either. Again, this finding warrants further investigation and also serves as a cautionary note; the utility of objective reviews is questionable.

A second implication is that AAR–based training may be effective in environments or for tasks where it would not be possible or feasible to incorporate objective review systems. For example, it may not be possible to record document all of the team members' actions needed to conduct an objective AAR. However, the lack of documentation might not hinder the effectiveness of AAR–based training in such an environment. Future research should work to substantiate this finding and identify any boundary conditions that might limit the effectiveness of a subjective AAR–based training approach. Investigating the effectiveness of AAR–based training in various environments and for various tasks is critical to building a comprehensive understanding of the AAR–based training approach.

Limitations and Directions for Future Research

There are some limitations with the present study that are worth noting and that may also yield fruitful lines of future research. First, one cannot overlook the similarity of the non–AAR–based training to massed practice and the AAR–based training to spaced practice. That is, teams trained in the non–AAR–based training condition experienced fewer breaks (i.e., only paused to complete the scheduled measures) between team missions than teams trained in either of the AAR–based training conditions (i.e., 10 minutes per AAR in addition to the scheduled measures). Therefore, one may question whether the difference between the non–AAR– and AAR–based training was a result of the intended manipulation (i.e., the 10–minute AAR) or

differences in practice schedules. This concern is reasonable, but it should be noted that although spaced practice has been shown to be more effective than massed practice when training simple motor tasks, research investigating the effectiveness of spaced practice on complex tasks is less conclusive (Goldstein & Ford, 2002). Nevertheless, researchers may want to examine the effectiveness of AAR–based training in comparison to a non–AAR–based training that follows a similar spaced schedule.

A second limitation concerns the content of the knowledge measure. Knowledge was assessed in this study using a 30–item measure, split into 15 gunner–related items and 15 commander/driver–related items. Therefore, the domain of knowledge assessed may have been deficient given the complexity of the task. Specifically, knowledge shared and learned during the AAR may have gone unmeasured, and thus, this measure of AAR–based training effectiveness (i.e., declarative knowledge) may have been too limited in scope. The results presented in this study regarding declarative knowledge may lead one to conclude that either both training conditions acquired a similar level of knowledge or AAR–based training did not facilitate knowledge acquisition. Neither conclusion is accurate. In fact, teams often shared information about the task during the AAR such as how to reduce confusion when communicating with each other (e.g., using call signs, or referring to each other by their role and tank number) and ways to improve their situation awareness (e.g., using north, south, east, and west or 1–12 o'clock rather than right, or left when communicating positions on the map). However, the declarative knowledge test did not assess these and possibly other content domains due to constraints on the test length and administration time. Future research should investigate

the effect of AAR–based training on knowledge acquisition using measure that completely assess a particular domain of knowledge and also with a specific focus on the type of knowledge (e.g., declarative, procedural).

A third limitation concerns the criteria used to define the end of training. That is, training was limited to a fixed amount of time (i.e., 90 minutes of individual training and 180 minutes of team training) rather than to a specified level of performance (e.g., three errorless trials, or asymptote). This is noteworthy in that different criteria represent different dimensions of acquisition (Arthur et al., 1998; Schmidt & Björk, 1992). The effectiveness of AAR–based training when acquisition is defined by a fixed amount of time may differ from its effectiveness when acquisition is defined by a specified level of performance. This is because the effectiveness of AAR–based training in the early stages of acquisition may differ from its effectiveness in later stages of acquisition. More directly to the point, acquisition should not be used as a surrogate for other training outcomes of interest (Arthur et al., 1998; Schmidt & Björk, 1992). Therefore, the findings presented here do not address, nor should these findings be assumed to generalize to, training effectiveness in terms of retention or reacquisition.

A fourth limitation of the study worth noting concerns the single–blind nature of the study in conjunction with the interaction between the experimenter and the participants. During the study, the experimenter served as the facilitator for each AAR. As the facilitator, the experimenter ensured that the participants completed the steps of the AAR in the prescribed order. When a team deviated from the order, the experimenter interrupted the AAR and reminded participants to complete the AAR in the

order prescribed. Although the interaction between the experimenter and participants was regimented and kept to a minimum, one cannot ignore the possible bias introduced by the experimenter serving as a facilitator. Therefore, it would be worthwhile to examine the effectiveness of AAR–based training with regard to how the AAR is led or facilitated (e.g., expert led, leaderless, or facilitated in a double–blind nature).

Finally, limitations regarding the ecological validity of laboratory results are also worth noting. By no means was this study meant to duplicate the team–based complex task training systems utilized in operational settings. Surgical and aviation training, for example, are characterized by training delivered over thousands of hours in contrast to the 5–hour training protocol of the present study. Although logistical and practical constraints prohibited this study from delivering operational complex task training (e.g., surgical or aviation training), many attempts were made to approximate complex task training. For example, the performance task used in this study was an ecologically valid analogue of the types of task (e.g., psychomotor, cognitive, information processing, and team coordination) that are trained in operational settings. This is highlighted by the fact that the performance task simulator is used by U. S. Department of Defense agencies and other military organizations around the world (e.g., Australian and New Zealand Armies). Furthermore, while the length of training did not approximate that of operational training, it does provide a glimpse of knowledge and performance acquisition and efficacy change during the initial phases of complex task training. Furthermore, the focus of the study was on the underlying psychological components and processes of AAR–based training. Thus, although several features of the study do

not match what is practiced in the field, the underlying psychological components and processes examined in this study generalize to operational practice. However, examining the acquisition, retention, and reacquisition phases in their totality in both laboratory and operational settings is necessary to obtain a more complete understanding of the effectiveness of the AAR–based training approach.

CHAPTER IX

SUMMARY AND CONCLUSIONS

The present paper advances the training literature by providing a much needed theoretical framework for the AAR by presenting a model of AARs as a training approach with a focus on integrating the AAR into the existing training literature. The theory outlined in this paper delineates the features of AARs that are critical to enhancing the acquisition of knowledge and skill, and modification of attitudes. In addition, this study provides a much needed empirical assessment of the efficacy of the AAR as a training approach. It is anticipated that the results of the study will serve as a catalyst for the integration of AARs into existing training literatures and subsequently be used to design AAR systems to improve their efficacy as training interventions.

The results of this study suggest that AAR–based training is an effective training approach. While the effect of AAR–based training on knowledge acquisition remains unclear, AAR–based training may be an effective training approach for training teams to perform a complex task and for developing or maintaining high levels of team–efficacy. Furthermore, AAR–based training may not be as dependant on an objective review as one might conclude given literature concerned with incorporating objective review systems into training tools. If AAR–based training is equally effective regardless of the objectivity of the review, AAR–based training may be an effective training approach when conducting an objective review is not feasible or not possible.

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APPENDIX A

MISSION A–E BRIEFINGS AND MAPS

MISSION 01
TIME TO COMPLETE : 15 minutes

BRIEFING
1st Platoon, G Company, 2nd Armored Cavalry Regiment

SITUTATION
Enemy forces have seized control of and are defending a vital supply road and small village in the RAY RIVER VALLEY. The enemy is thought to be using a village to the north as their headquarters.

The valley has been divided into 5 Regions (SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA). You are positioned in SIERRA. SIERRA is believed to be clear of enemy forces.

Your two-tank platoon, 1st Pltn, G Company has been tasked to engage and DESTROY ALL ENEMY TANKS in the valley and to occupy the small village to the north.

Your commanding officer (1/1 G) and a another tank in your platoon (2/1 G) departed to scout the valley, but came under heavy fire and were destroyed while approaching ALPHA. Their position is marked on your map (DESTROYED TANKS)

Area scouts have identified possible enemy positions (marked on your map as POS ENMY POSITION).

ENEMY
1) scouts report the presence of 10 tanks in the area (T-72 Ural tanks; operating in 2-tank platoons)

2) forested areas on either side of the valley are out of bounds (stay out of these areas)

3) improvised explosive devices (IEDs) MAY have been placed on the road; proceed with caution when traveling on the road

OWNSIDE
1) your platoon is the only friendly force in the area (you are on your own)

2) your platoon has enough ammo (12 SABOT and 4 HEAT) to complete the mission; resupply is NOT possible

MISSION
1) move your two operational tanks (3/1 G & 4/1 G) through the SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA regions

2) locate, engage, and destroy ALL 10 enemy tanks in the ALPHA, BRAVO, CHARLIE, and DELETA regions

3) reclaim and occupy the small village (marked OBJECTIVE) by moving your platoon to the GRAVEL LOT in front of the enemy headquarters (marked by
the BLACK CIRCLE in the OBJECTIVE area)

Note: the supply road leads to the small village

4) you have 15 minutes to complete the mission
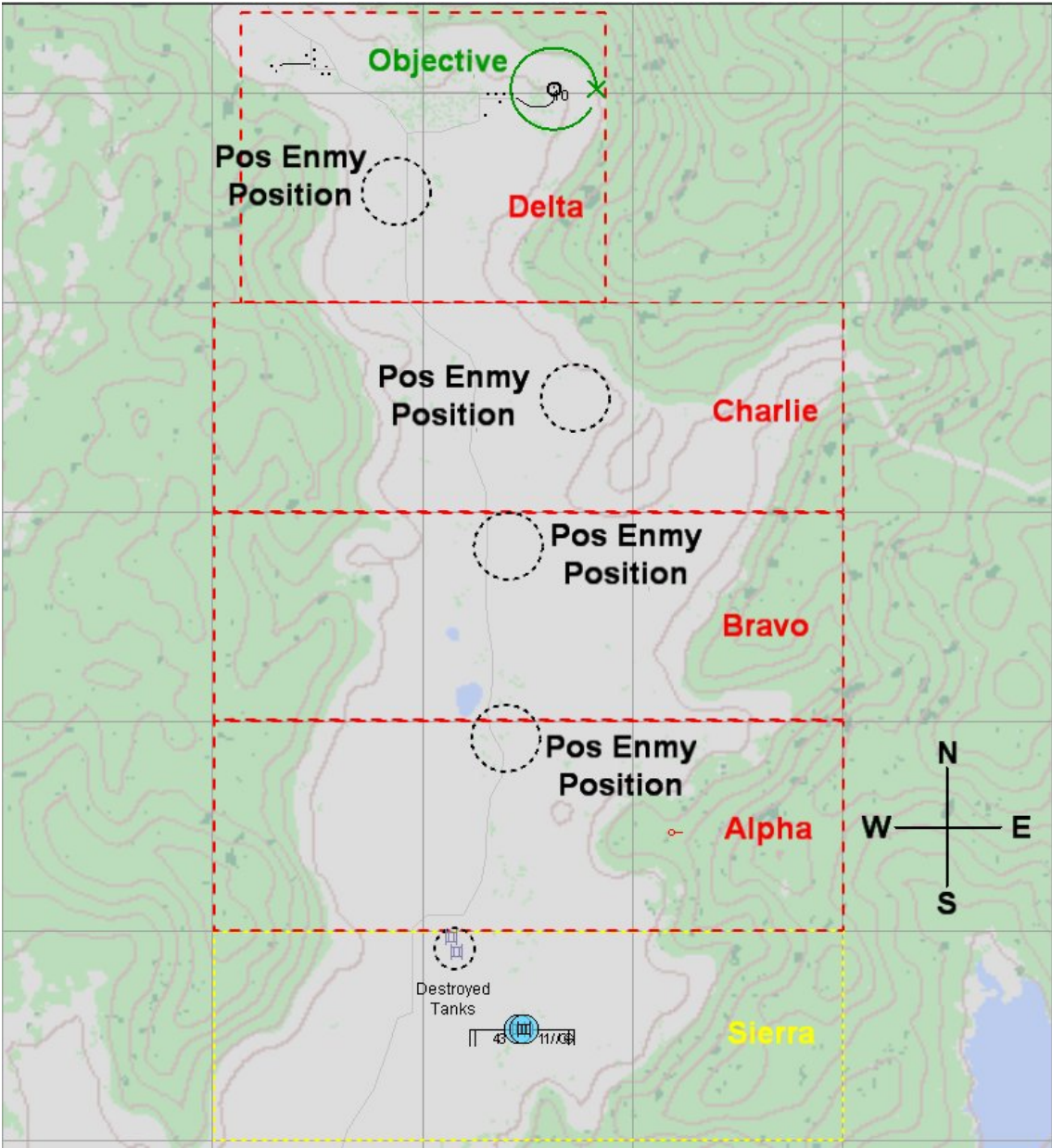
Figure A–1. Mission A briefing.

Figure A–2. Mission A map.

MISSION 02
TIME TO COMPLETE : 15 minutes

BRIEFING
1st Platoon, G Company, 2nd Armored Cavalry Regiment

SITUTATION
Enemy forces have seized control of and are defending a vital supply road and small village in the RAY RIVER VALLEY.
The enemy is thought to be using a village to the north as their headquarters.

The valley has been divided into 5 Regions (SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA). You are positioned in
SIERRA. SIERRA is believed to be clear of enemy forces.

Your two-tank platoon, 1st Pltn, G Company has been tasked to engage and DESTROY ALL ENEMY TANKS in the valley
and to occupy the small village to the north.

Your commanding officer (1/1 G) and a another tank in your platoon (2/1 G) departed to scout the valley, but came under
heavy fire and were destroyed while approaching ALPHA. Their position is marked on your map (DESTROYED TANKS)

Area scouts have identified possible enemy positions (marked on your map as POS ENMY POSITION).

ENEMY
1) scouts report the presence of 10 tanks in the area (T-72 Ural tanks; operating in 2-tank platoons)

2) forested areas on either side of the valley are out of bounds (stay out of these areas)

3) improvised explosive devices (IEDs) MAY have been placed on the road; proceed with caution when traveling on the
road

OWNSIDE
1) your platoon is the only friendly force in the area (you are on your own)

2) your platoon has enough ammo (12 SABOT and 4 HEAT) to complete the mission; resupply is NOT possible

MISSION
1) move your two operational tanks (3/1 G & 4/1 G) through the SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA
regions

2) locate, engage, and destroy ALL 10 enemy tanks in the ALPHA, BRAVO, CHARLIE, and DELETA regions

3) reclaim and occupy the small village (marked OBJECTIVE) by moving your platoon to the GRAVEL LOT in front of the
enemy headquarters (marked by
the BLACK CIRCLE in the OBJECTIVE area)

Note: the supply road leads to the small village

4) you have 15 minutes to complete the mission
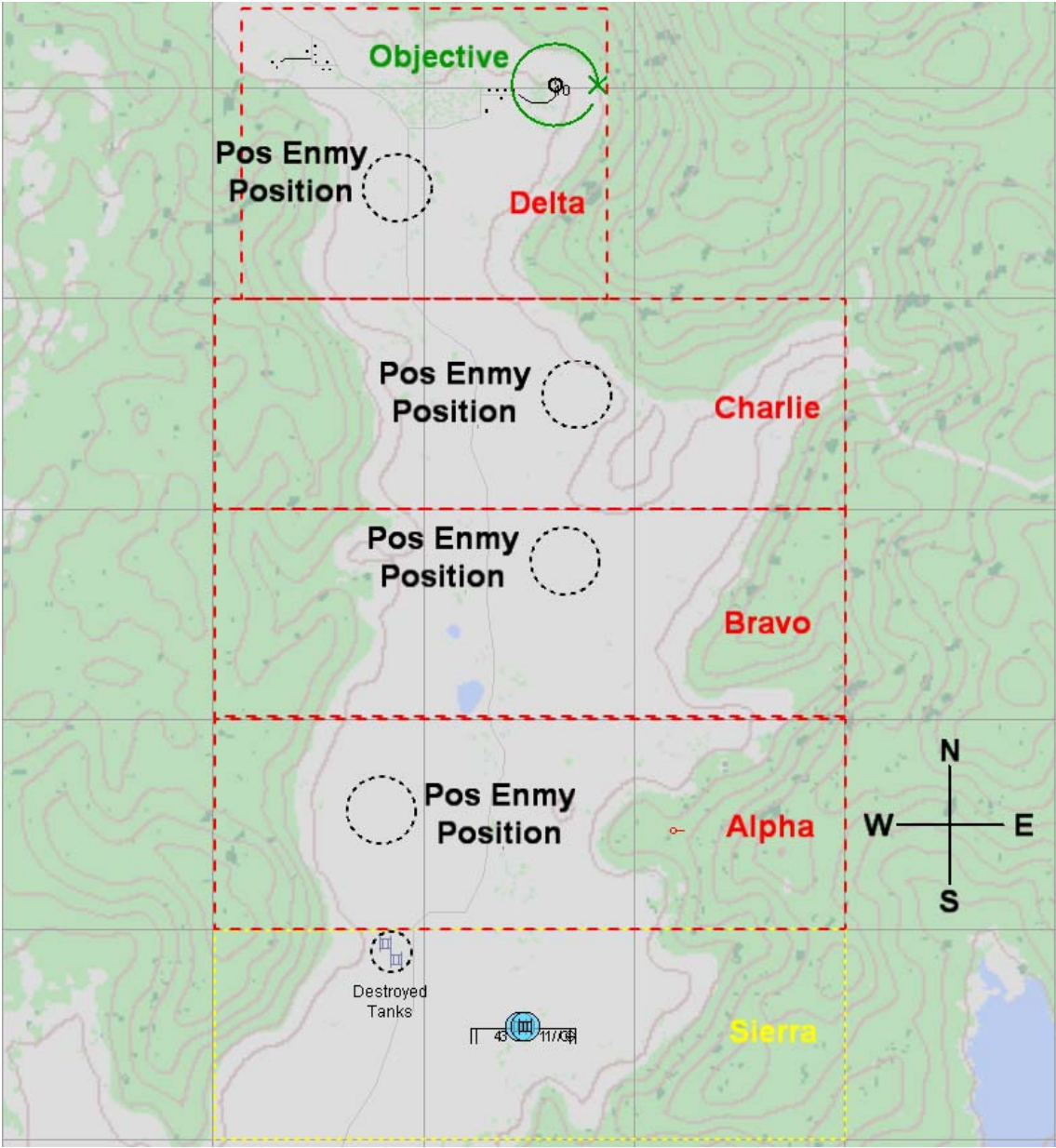
Figure A–3. Mission B briefing.

Figure A–4. Mission B map.

MISSION 03
TIME TO COMPLETE : 15 minutes

BRIEFING
1st Platoon, G Company, 2nd Armored Cavalry Regiment

SITUTATION
Enemy forces have seized control of and are defending a vital supply road and small village in the RAY RIVER VALLEY.
The enemy is thought to be using a village to the north as their headquarters.

The valley has been divided into 5 Regions (SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA). You are positioned in
SIERRA. SIERRA is believed to be clear of enemy forces.

Your two-tank platoon, 1st Pltn, G Company has been tasked to engage and DESTROY ALL ENEMY TANKS in the valley
and to occupy the small village to the north.

Your commanding officer (1/1 G) and a another tank in your platoon (2/1 G) departed to scout the valley, but came under
heavy fire and were destroyed while approaching ALPHA. Their position is marked on your map (DESTROYED TANKS)

Area scouts have identified possible enemy positions (marked on your map as POS ENMY POSITION).

ENEMY
1) scouts report the presence of 10 tanks in the area (T-72 Ural tanks; operating in 2-tank platoons)

2) forested areas on either side of the valley are out of bounds (stay out of these areas)

3) improvised explosive devices (IEDs) MAY have been placed on the road; proceed with caution when traveling on the
road

OWNSIDE
1) your platoon is the only friendly force in the area (you are on your own)

2) your platoon has enough ammo (12 SABOT and 4 HEAT) to complete the mission; resupply is NOT possible

MISSION
1) move your two operational tanks (3/1 G & 4/1 G) through the SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA
regions

2) locate, engage, and destroy ALL 10 enemy tanks in the ALPHA, BRAVO, CHARLIE, and DELETA regions

3) reclaim and occupy the small village (marked OBJECTIVE) by moving your platoon to the GRAVEL LOT in front of the
enemy headquarters (marked by
the BLACK CIRCLE in the OBJECTIVE area)

Note: the supply road leads to the small village

4) you have 15 minutes to complete the mission
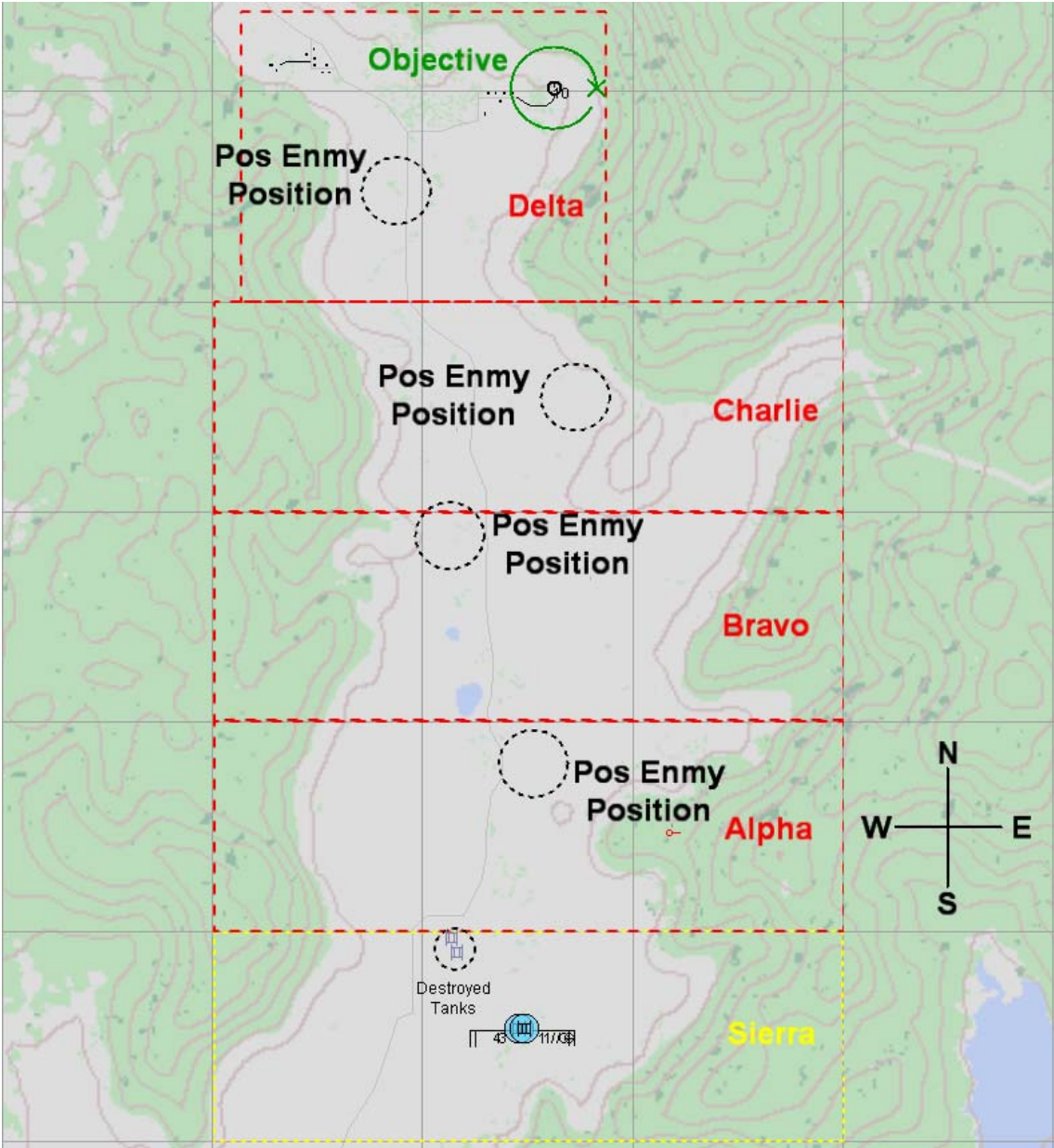
Figure A–5. Mission C briefing.

Figure A–6. Mission C map.

MISSION 04
TIME TO COMPLETE : 15 minutes

BRIEFING
1st Platoon, G Company, 2nd Armored Cavalry Regiment

SITUTATION
Enemy forces have seized control of and are defending a vital supply road and small village in the RAY RIVER VALLEY. The enemy is thought to be using a village to the north as their headquarters.

The valley has been divided into 5 Regions (SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA). You are positioned in SIERRA. SIERRA is believed to be clear of enemy forces.

Your two-tank platoon, 1st Pltn, G Company has been tasked to engage and DESTROY ALL ENEMY TANKS in the valley and to occupy the small village to the north.

Your commanding officer (1/1 G) and a another tank in your platoon (2/1 G) departed to scout the valley, but came under heavy fire and were destroyed while approaching ALPHA. Their position is marked on your map (DESTROYED TANKS)

Area scouts have identified possible enemy positions (marked on your map as POS ENMY POSITION).

ENEMY
1) scouts report the presence of 10 tanks in the area (T-72 Ural tanks; operating in 2-tank platoons)

2) forested areas on either side of the valley are out of bounds (stay out of these areas)

3) improvised explosive devices (IEDs) MAY have been placed on the road; proceed with caution when traveling on the road

OWNSIDE
1) your platoon is the only friendly force in the area (you are on your own)

2) your platoon has enough ammo (12 SABOT and 4 HEAT) to complete the mission; resupply is NOT possible

MISSION
1) move your two operational tanks (3/1 G & 4/1 G) through the SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA regions

2) locate, engage, and destroy ALL 10 enemy tanks in the ALPHA, BRAVO, CHARLIE, and DELETA regions

3) reclaim and occupy the small village (marked OBJECTIVE) by moving your platoon to the GRAVEL LOT in front of the enemy headquarters (marked by
the BLACK CIRCLE in the OBJECTIVE area)

Note: the supply road leads to the small village

4) you have 15 minutes to complete the mission
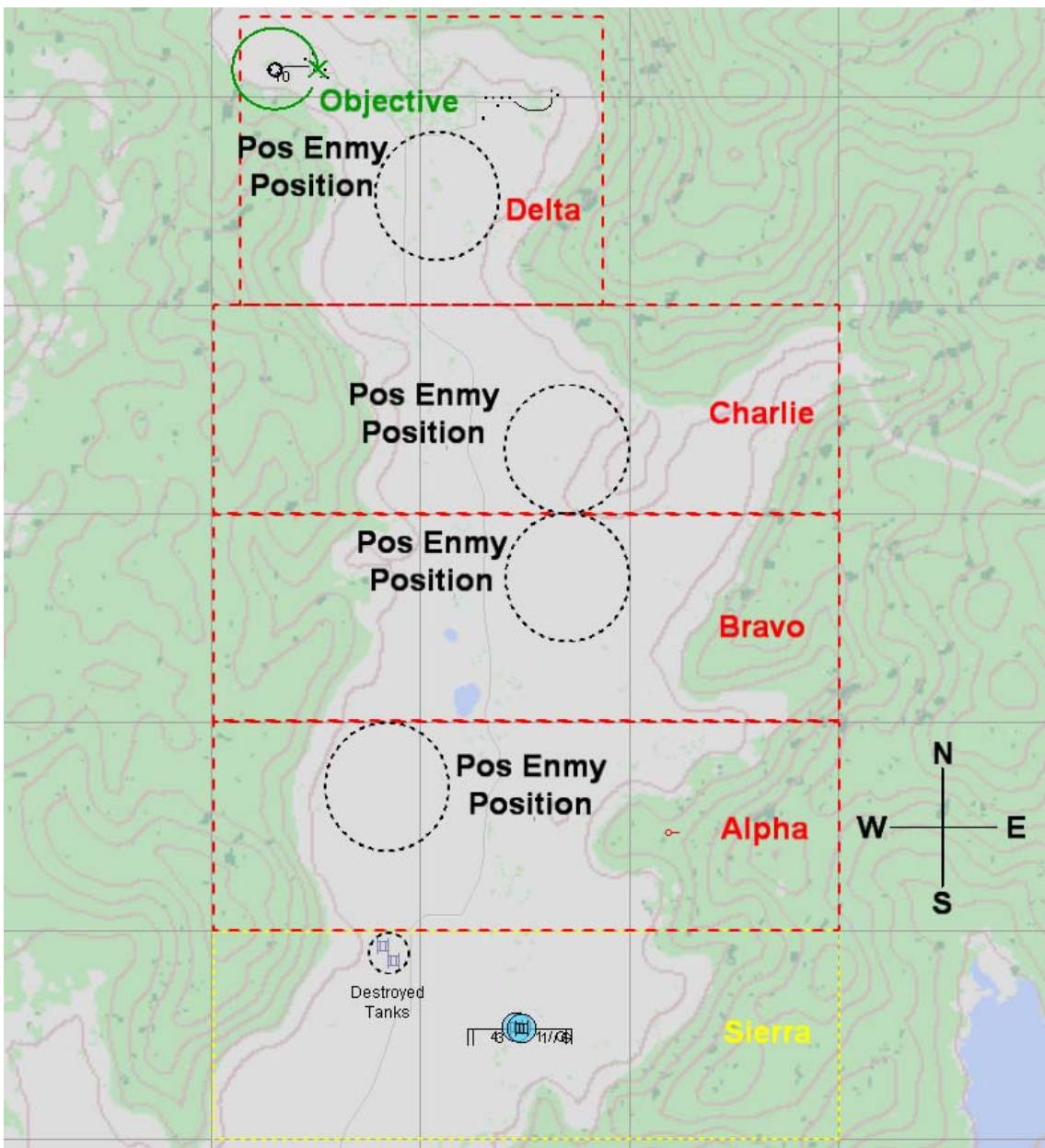
Figure A–7. Mission D briefing.

Figure A–8. Mission D map.

MISSION 05
TIME TO COMPLETE : 15 minutes

BRIEFING
1st Platoon, G Company, 2nd Armored Cavalry Regiment

SITUTATION
Enemy forces have seized control of and are defending a vital supply road and small village in the RAY RIVER VALLEY. The enemy is thought to be using a village to the north as their headquarters.

The valley has been divided into 5 Regions (SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA). You are positioned in SIERRA. SIERRA is believed to be clear of enemy forces.

Your two-tank platoon, 1st Pltn, G Company has been tasked to engage and DESTROY ALL ENEMY TANKS in the valley and to occupy the small village to the north.

Your commanding officer (1/1 G) and a another tank in your platoon (2/1 G) departed to scout the valley, but came under heavy fire and were destroyed while approaching ALPHA. Their position is marked on your map (DESTROYED TANKS)

Area scouts have identified possible enemy positions (marked on your map as POS ENMY POSITION).

ENEMY
1) scouts report the presence of 10 tanks in the area (T-72 Ural tanks; operating in 2-tank platoons)

2) forested areas on either side of the valley are out of bounds (stay out of these areas)

3) improvised explosive devices (IEDs) MAY have been placed on the road; proceed with caution when traveling on the road

OWNSIDE
1) your platoon is the only friendly force in the area (you are on your own)

2) your platoon has enough ammo (12 SABOT and 4 HEAT) to complete the mission; resupply is NOT possible

MISSION
1) move your two operational tanks (3/1 G & 4/1 G) through the SIERRA, ALPHA, BRAVO, CHARLIE, and DELTA regions

2) locate, engage, and destroy ALL 10 enemy tanks in the ALPHA, BRAVO, CHARLIE, and DELETA regions

3) reclaim and occupy the small village (marked OBJECTIVE) by moving your platoon to the GRAVEL LOT in front of the enemy headquarters (marked by
the BLACK CIRCLE in the OBJECTIVE area)

Note: the supply road leads to the small village

4) you have 15 minutes to complete the mission
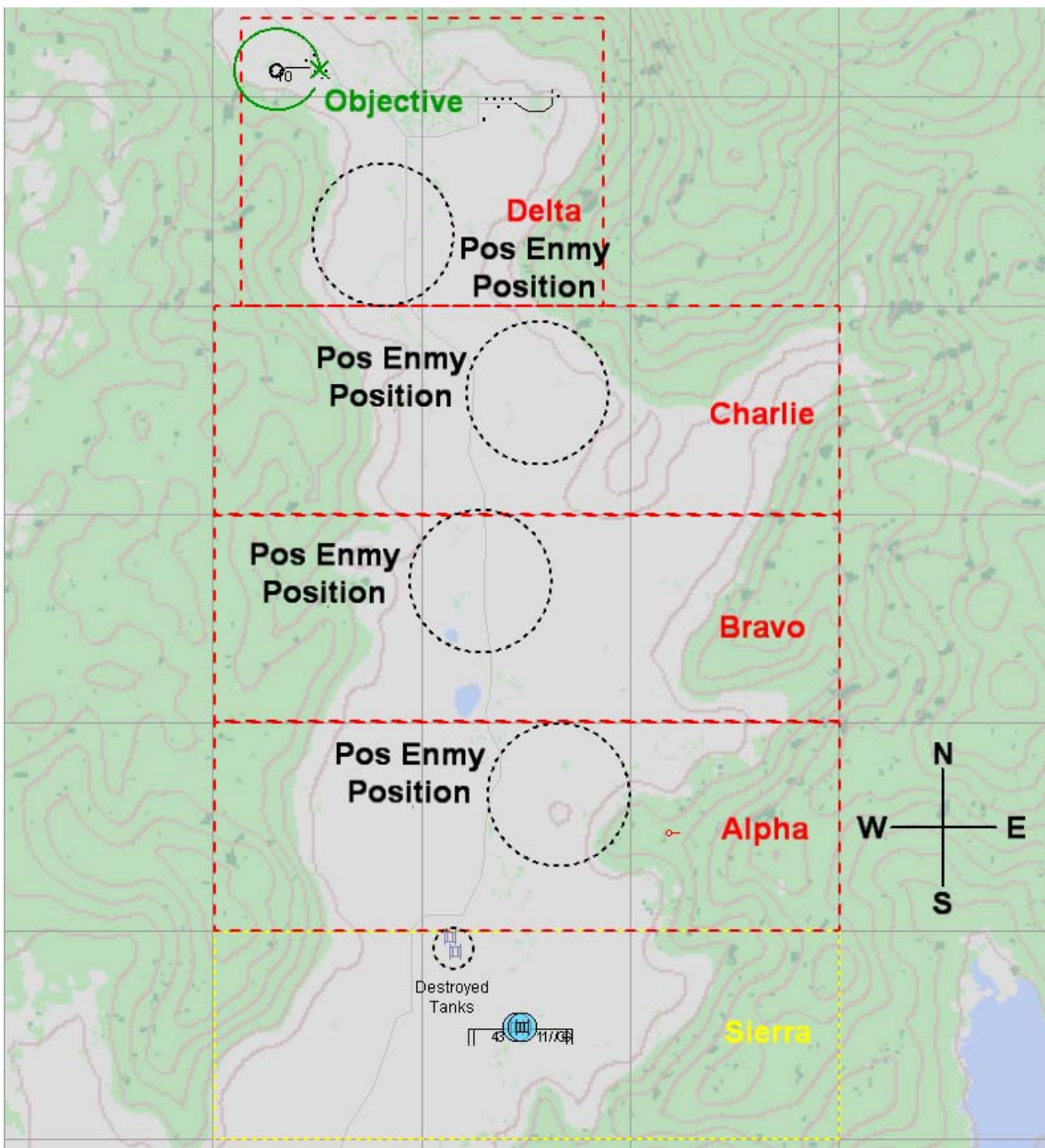
Figure A–9. Mission E briefing.

Figure A–10. Mission E map.

APPENDIX B

DECLARATIVE KNOWLEDGE MEASURE

STEEL BEASTS DECLARATIVE KNOWLEDGE TEST

Research ID: _____

For each question, please select the alternative that you think is the **BEST** answer. Mark you answer by filling in the bubble next to your selection. Please treat this test as you would a classroom exam. You are allowed to look at your keyboard and joystick, but you are not allowed to use any other materials nor discuss the answers with others—this is a "closed book" test.

Please complete all items on this test. There is no penalty for guessing so it is in your best interest to guess if you do not know the answer to a question.

1. The JOYSTICK hat button is used by the tank commander to:

   ○A. designate targets for the gunner.
   ○B. fire the .50 caliber coaxial gun.
   *○C. set the view relative to the turret.

2. Which of the following JOYSTICK buttons should be pressed by the gunner to toggle between 3× and 10× magnification?

   ○A. 2
   *○B. 4
   ○C. 6

3. When the map DISPLAY is set to LOS, the white area on the map indicates points at which:

   ○A. a majority of your tank is fully exposed.
   *○B. only the turret of your tank is exposed.
   ○C. your tank is fully exposed to thermal imaging.

4. Which of the following tanks is the enemy using?

   ○A. Leopard 1A4
   ○B. M1A1 Abrams
   *○C. T–72 Ural

5. The tank commander must press the _____ KEYBOARD key to request that the loader begin loading HEAT ammunition.

   *○A. DELETE
   ○B. HOME
   ○C. INSERT

6. Which of the following functions is disrupted when the stabilization is damaged?

   *○A. Aiming the main gun
   ○B. Driving the tank
   ○C. Firing the main gun

7. Routes may be created by the tank commander on the:

   ○A. eye view screen.
   *○B. map screen.
   ○C. route toolbar.

8. Which of the following KEYBOARD keys orders the tank into battle position (hull down position) when pressed by the tank commander?

   ○A. B
   *○B. E
   ○C. H

9. The tank commander must press the _____ KEYBOARD key to move up out of the tank, and the _____ to move down into the tank.

   ○A. ↑; ↓
   *○B. Q; Z
   ○C. U; D

10. When the loader says "HEAT up," this indicates that the loader:

   ○A. is continuing to load HEAT ammunition.
   *○B. has just loaded a different type of ammunition and that it is a HEAT round.
   ○C. will begin loading HEAT ammunition after the round in the gun has been fired.

11. The tank commander may override the gunner to slew the main gun to face a target by pressing JOYSTICK button:

   ○A. 2.
   *○B. 3.
   ○C. 4.

12. When driving the tank, pressing the "C" KEYBOARD key will cause the tank to:

   ○A. coast by shifting into neutral.
   *○B. continue on the original route.
   ○C. switch to the coaxial gun.

13. When a green "F" appears next to the numbers at the bottom of the gunner's primary sight and the reticle disappears, the:

   *○A. laser range finder is burned out.
   ○B. main gun stabilization is down.
   ○C. the target is too far away to engage.

14. According to the tutorials, a crew member who is first to spot an enemy tank should say:

    ○A. "fire!"
    ○B. "identified!"
    *○C. "tank!"

15. The white dot in the tank orientation diagram at the bottom right of the screen represents the direction:

    *○A. that you are looking.
    ○B. that your tank is pointing.
    ○C. of the nearest enemy.

16. The tank commander may button or unbutton the tank by pressing the _____ KEYBOARD key.

    *○A. B
    ○B. U
    ○C. Y

17. The M1A1's .50 caliber machine is an unstabilized gun which is **MOST** effective when fired:

    ○A. at slow speed.
    ○B. in NORMAL mode.
    *○C. while stationary.

18. The strongest armor on a tank is located _____ the tank?

    *○A. in the front of
    ○B. on the side of
    ○C. underneath

19. While in NORMAL mode with a fully operational tank, to determine the distance to the target, the gunner should _____ the target before firing.

    ○A. contact
    ○B. track
    *○C. lase

20. When shooting at moving targets, the **<u>LEAST</u>** amount of time a gunner should steadily track a target before lasing is _____ seconds.

   ○A. 0.5
   ○B. 1.0
   *○C. 1.5

21. Which of the following is displayed near the bottom of the gunner's primary sight in green numbers?

   ○A. Direction of the tank commander's view
   ○B. Range (in meters) to target
   ○C. Type of ammunition loaded

22. Which of the following KEYBOARD keys must the gunner press when switching to sabot ammunition so that the ballistic computer calculates the proper super elevation.

   ○A. DELETE
   ○B. HOME
   *○C. INSERT

23. The weakest armor on a tank is located on the:

   ○A. front of the tank.
   ○B. front of the turret.
   *○C. back of the tank.

24. Main gun automatic lead is continuously added once:

   *○A. a range value has been entered.
   ○B. the gunner begins to track the target.
   ○C. the previous lead has been dumped.

25. After firing on a moving target in NORMAL mode, it is recommended that the gunner:

   *○A. dump the lead in the ballistic computer.
   ○B. manually enter the range of the next target.
   ○C. recalibrate the laser rangefinder.

26. The tank commander may chose to view the outside world with his/her head out of the hatch to:

    *○A. improve situational awareness.
    ○B.   properly aim the main gun.
    ○C.   reduce the risk of injury.

27. Which of the following JOYSTICK buttons should be pressed by the gunner to lase a target?

    *○A. 2
    ○B.   3
    ○C.   4

28. The furthest distance that an M1A1 main gun will reliably hit a target using armor piercing (AP; sabot) rounds is _____ meters.

    ○A.   1,500
    ○B.   2,000
    *○C. 3,000

29. Which KEYBOARD key increases tank speed to the next higher speed?

    ○A.   S
    *○B. W
    ○C.   X

30. When moving at high speed, in which of the following situations would the main gun stabilization on the M1A1 **NOT** work well?

    ○A.   In a reverse direction
    *○B. Over rough terrain
    ○C.   Over steep terrain

APPENDIX C

TEAM–EFFICACY MEASURE

TEAM–EFFICACY

Research ID: _____

Please read each of the statements listed below and mark the response that best indicates the extent to which you agree with each statement

①	②	③	④	⑤
Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**

Rate each of the following statements to indicate the extent to which they are descriptive of **YOUR** opinions of your **PLATOON**.

1.	I feel confident in **my platoon's** ability to perform well on Steel Beasts.	① ② ③ ④ ⑤
2.	I think **my platoon** can meet the challenges of Steel Beasts.	① ② ③ ④ ⑤
3.	I know **my platoon** can achieve good scores on Steel Beasts.	① ② ③ ④ ⑤
4.	I know **my platoon** can master Steel Beasts.	① ② ③ ④ ⑤
5.	I do **NOT** think Steel Beasts is something that **my platoon** will become good at.	① ② ③ ④ ⑤
6.	I am confident that **my platoon** has what it takes to perform well on Steel Beasts.	① ② ③ ④ ⑤

APPENDIX D

DEMOGRAPHICS MEASURE

DEMOGRAPHICS

Please read each of the statements listed below and respond in a manner that best describes you.

Research ID:_____

Age: _____   Race: _____

Sex: ☐ Male ☐ Female   Major: _____

Occupation: _____

Please answer each of the following questions as honestly and truthfully as possible.

1. Generally, what is your playing ability regarding video/computer games? (check one)

   ☐ Novice   ☐ Average   ☐ Expert

2. What is your playing ability on *Steel Beasts™*? (check one)

   ☐ Never Played   ☐ Average   ☐ Expert

APPENDIX E

AFTER–ACTION REVIEW FORM

AFTER–ACTION REVIEW DESCRIPTION

An after–action review (AAR) is a systematic review of trainees' performance after a recently completed task or event. An AAR allows trainees to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses. During the AAR, your team attempt to answer the specific questions presented in the figure below.
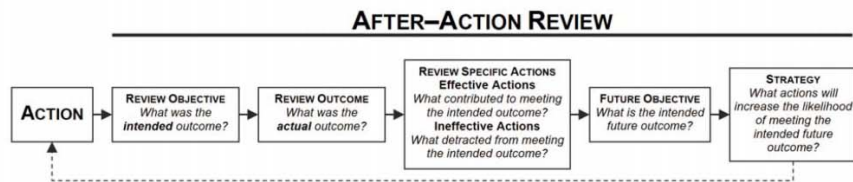
The AAR is a professional discussion. Therefore, it important that you follow the guidelines listed below while conducting the AAR so that each AAR remains professional and productive. Specifically, you and your platoon should strive to:

1. **Avoid assigning blame**

2. **Focus on actions or behaviors, NOT the person**

3. **Avoid generalizations**

4. **Avoid dwelling on issues unrelated to the discussion or the mission**

5. **Participate; everyone should participate when able**

You will be allowed 10 minutes to complete each AAR, so you must work quickly while being thorough. Your proctor will guide you through the AAR, however, it is the job of you and your platoon members to provide answers to the questions posed.

AFTER–ACTION REVIEW FORM

REVIEW OBJECTIVE
What was the *intended* outcome?

REVIEW OUTCOME
What was the *actual* outcome?

REVIEW SPECIFIC ACTIONS
EFFECTIVE ACTIONS
What specific actions contributed to meeting the intended outcome?

INEFFECTIVE ACTIONS
What specific actions detracted from meeting the intended outcome?

FUTURE OBJECTIVE
What is the intended future outcome?

STRATEGY
What actions will increase the likelihood of meeting the intended future outcome?

M1

APPENDIX F

TEAM–LEVEL INTERCORRELATIONS AND CORRELATIONS

Table J–1

Team Declarative Knowledge, Team Performance, and Team–efficacy Intercorrelations and Correlations

Measure	1	2	3	4	5	6	7	8	9	10	11	12
Team Declarative Knowledge												
1. Session 0	—											
2. Session 3	-.01	—										
3. Session 6	.12	.87*	—									
Team Performance												
4. Session 1	-.05	.09	.11	—								
5. Session 2	-.12	-.21	-.20	.09	—							
6. Session 3	.41*	-.17	.01	.16	.08	—						
7. Session 4	.05	.36	.25	-.10	.07	-.38*	—					
8. Session 5	-.14	.36	.34	.15	.00	.07	.03	—				
9. Session 6	.03	-.14	-.11	.35	-.03	.28	-.37*	.28	—			
Team–efficacy												
10. Session 2	-.03	.44*	.33	-.12	.21	.02	.15	.31	.17	—		
11. Session 4	.09	.35	.34	.04	-.02	.04	.49*	.13	.11	.56*	—	
12. Session 6	.09	.22	.24	.24	.13	.26	.11	.33	.52*	.52*	.74*	—

Note. $N = 30$. *$p < .05$, two–tailed.

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Selected Publications:

Arthur, W. Jr., & Villado, A. J. (2008). The importance of distinguishing between
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     research and practice. *Journal of Applied Psychology, 93,* 435–442.

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