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Establishing an Intellectual and Theoretical Foundation for the After Action Review Process – A Literature Review

James P. Bliss
Old Dominion University

Steven A. Minnis, Jeffery Wilkinson, and Thomas Mastaglio
MYMIC LLC

John S. Barnett
U.S. Army Research Institute

Technology-Based Training Research Unit
Stephen L. Goldberg, Chief

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Director

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The purpose of this report is to provide a literature review of the cognitive and learning science research that is relevant to defining an effective after action review (AAR) process. The goal of this review is to assemble research sources that apply to the design and conduct of after action reviews. Therefore, this report provides a synopsis of research that exists, identifies notable researchers who have addressed the problem, presents results of both military and non-military investigations or implementations of the AAR technique, highlights existing theories that may contribute to the advancement of AARs, and isolates specific areas that demand further work. The findings are a distillation of what is known about the AAR process. As such, they would be of interest to researchers who wish to acquire or update their knowledge of the area. The findings would also be of interest to those who train AAR facilitators as a comprehensive foundation of AAR research.

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U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926

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ESTABLISHING AN INTELLECTUAL AND THEORETICAL FOUNDATION FOR THE AFTER ACTION REVIEW PROCESS – A LITERATURE REVIEW

EXECUTIVE SUMMARY

Research Requirement

The purpose of this report is to provide a literature review of the cognitive and learning science research that is relevant to defining an effective after action review (AAR) process. The goal of this research review is to assemble research sources that apply to the design and conduct of AARs. Therefore, this report provides a synopsis of research that exists, identifies notable researchers who have addressed the problem, presents results of both military and non-military investigations or implementations of the AAR technique, highlights existing theories that may contribute to the advancement of AARs, and isolates specific areas that demand further work.

Procedure

AARs are meant to serve a pedagogical purpose: to enhance learning from experience. As such, their structure and function is reminiscent of a number of theoretical domains. Such domains may include:

- Mainstream Psychology (particularly with regard to the optimization of feedback, training methodology, and the behavior of small groups and teams)
- Education (especially curriculum development and the behavior of facilitators)
- Instructional Technology (as concerns the development and incorporation of methods by which performance data may be gathered and replayed to participants)
- Industrial Psychology (for the design of performance appraisal systems, the study of leadership, and the role of organizational influences)
- Knowledge Management (an interdisciplinary endeavor that reflects organization of curricular issues and their sequential presentation and mastery)
- Military Planning
- Leadership.

Previous attempts to understand the AAR process have typically restricted themselves to a subset of these areas, or have taken a decidedly theoretical position. However, consideration of theory is necessary so as to avoid reinventing the wheel and to ensure that the AAR represents a flexible and powerful method for optimizing operational learning.

Because of the diversity of theoretical contributors to AARs, it has been difficult to formulate one master list of best practices. Rather, what is needed is a theoretical model that reflects the myriad of discipline influences, and that is flexible enough to apply to diverse operational circumstances. To date, few theoretical models have been proposed. Those that have been proposed suffer from lack of validation. Thus the irony: even though AARs are meant to be the pinnacle of a "learning organization," there have been few documented attempts to specify the principles of learning or knowledge management to the conduct of AAR sessions.

Findings

The report by Newlin and Bliss (2007) included an expansive description of a number of research-driven recommendations for the optimal conduct of AARs. Further conclusions are drawn from the research that is presented here. The following bullet points summarize the significant theoretical information that emerged from this work.

- AAR designers and facilitators should arrange and implement AAR sessions to ensure the prompt encoding, robust storage, and ready retrieval of task relevant information by trainees. An example of such a process may involve exploiting human tendencies for spreading activation by pointing out relationships among mission items, goals and procedures.

- To enable deep and lasting processing of mission information, AAR facilitators should arrange for presentation of "ground truth" from a variety of perspectives.

- Facilitators should use hierarchical review of mission events to cater to the development of cognitive scripts, mental models, and cognitive maps.

- To prevent false memory formation, facilitators should encourage checks and balances among team members, along with presentations of recorded mission action.

- Facilitators should take care to address the need for shared situation awareness among team members.

- Team members should be encouraged to express the benefits gained by review of team performance.

- Demands for divided attention should be balanced with the growth of expertise by presenting material in a graduated (adaptive) and distributed fashion.

- Facilitators should be flexible in team assignments and feedback, focusing on dyads or smaller team units to illustrate important points.

- Facilitators and team members should be sensitive to communication requirements and breakdowns. Social dynamics such as attributions, conflict, and cooperation are central to a team's ultimate success.

- Feedback sessions should allow for self-feedback and task feedback possibilities.

- Facilitators should be aware of the potential for negative reactions to feedback, and plan accordingly.

- Facilitators should ensure that all team members accept the feedback given during the AAR session. If dissent exists, work to resolve the conflict.

With the complexity of the AAR process and the advancements being made in simulation and training and automated task delegation, we believe that additional research is warranted in several areas. In some of these areas, research has been conducted by a limited number of scientists, trainers, and institutions. In others, little work has been attempted:

Distributed AAR. Modern simulation technology has offered the capability to train tasks to teams that are geographically distributed. Yet, AARs are a piece of the training puzzle that has yet to be well refined for application to geographically dispersed teams.

Shared Mental Models. As we investigated the relevant literature with regard to cognition, team training and situation awareness, we realized that these three areas were of extreme importance to the success of AARs, and that they intersected though one major construct: shared mental model.

Shared Situation Awareness. It is clear that a desired product of the AAR session is a common appreciation for the battle situation and the influences on it. Of particular importance are the various levels of situation awareness and how they may change given tactics and strategies employed by the trainees. Investigating shared situation awareness may entail examinations of technology-driven environmental displays (of terrain, forces, or supplies) and may require integrated consideration of past performance and events as they relate to current performance.

Leadership. Within this report, we have made several recommendations that concern the leadership behaviors demonstrated by AAR facilitators. The AAR process bears a similarity to a number of leadership situations such as sports teams or business-related “tiger teams”, where problems are relatively well-defined and members have acknowledged areas of expertise. Future researchers may do well to explore the practice of effective leaders so that facilitator actions may be prescribed and perhaps ultimately automated.

Effectiveness of AAR. Though the AAR has been an Army tradition for more than 30 years, investigations of its effectiveness have been few and anecdotal. Such investigations must go beyond collecting subjective opinions and general statements of approval voiced by command elements. Rather, researchers must complete a program of transfer of training studies to show that variations in AAR design and conduct will cause differences in individual and collective task performance.

Utilization and Dissemination of Findings

These findings are a distillation of what is known about the AAR process. As such, they would be of interest to researchers who wish to acquire or update their knowledge of the area. The findings would also be of interest to those who train AAR facilitators as a comprehensive foundation of AAR research.

ESTABLISHING AN INTELLECTUAL AND THEORETICAL FOUNDATION FOR THE AFTER ACTION REVIEW PROCESS – A LITERATURE REVIEW

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ESTABLISHING AN INTELLECTUAL AND THEORETICAL FOUNDATION FOR THE AFTER ACTION REVIEW PROCESS – A LITERATURE REVIEW

Overview

Modern warfare is increasingly complex. Historically, battles could be predictably counted on to occur on a large battlefield with readily identifiable opponents, weapons, tactics and strategies. However, in recent years, the scope of warfare has changed. Today's Soldiers must prepare to fight using unconventional techniques against unpredictable and adaptable enemies. Furthermore, the time available to train is often constricted, so that Soldiers must adopt techniques quickly, and must learn to work together as a team (Kerrick, 2005).

Teamwork, especially, is a crucial element of battle planning and execution. Military peacekeeping and peace enforcement campaigns in theatres such as Bosnia, Haiti, Iraq, and Afghanistan have required Soldiers from all branches of the U.S. military to come together and cooperate. Such a joint philosophy is to many an unfamiliar concept, particularly because Soldiers are generally trained at centers that reflect their branch of service (Army, Navy, Air Force, Marines). It is imperative that military training centers adopt training methods that enhance trainees' willingness and ability to adopt complex skills quickly and that foster their capacity for teamwork on the battlefield (Lowrey, 1999).

Increasingly, the military has turned to simulation as a way to represent skill sets that are complex, dangerous, or costly to train. Historically, it has been common to teach teamwork and battle skill execution using physical mockups and devoted environments for practice (such as the National Training Center). In recent years, the concept of battle task simulation has evolved so that trainees interact not just with physical simulators (as in the case of specific weapons or transportation systems) but with local area and distributed virtual environments (especially for dismounted infantry). Regardless of the form of simulation employed, however, a central challenge has been the capture of action during a training exercise so that trainees may review it and be taught to improve performance.

Researchers have for many years acknowledged provision of feedback as essential for efficient learning (Mory, 1992). Yet, the methods available for administering feedback vary widely, as does the consistency with which human trainers and automated training systems accomplish feedback administration. Unfortunately, failures to consistently and faithfully administer meaningful training feedback have led to poor knowledge retention, poor knowledge transfer, and a tendency among some to discount the importance of the feedback process. Some of these failures are undeniably caused by difficulties capturing meaningful data. However, more often, poor feedback stems from the intuitive design of feedback sessions and variability in feedback administration. Consequently, trainees who could benefit from proper feedback administration may adopt a cavalier or skeptical opinion of the importance of training feedback. The complexity of modern military missions and the necessity for seamless interaction of Soldier team members requires that feedback be designed consistently and effectively, and that it be

delivered to ensure maximal retention and task transfer (Baird, Holland, & Deacon, 1999).

After Action Review Definition

Within and outside of military circles, the provision of training feedback has been termed "after action review (AAR)." Even though the notion of review of training success has arguably been considered since Alexander the Great standardized military training, the modern definition of this term originates with the U.S. Army's conceptualization of the AAR technique in the 1970s. Following the Viet Nam war, the Army reflected upon its status; morale among troops was low, and battle missions had not progressed as intended (Darling, Parry, & Moore, 2005). Development of the AAR concept was intended to enable quality improvement consistent with the restructuring of the Army during the 1980s and 1990s. Subsequently, the AAR technique has been incorporated into training practice and is now a formal element of all training (Department of the Army, 1993). Most recently the Army published FM 6-01.1, titled Knowledge Management Section, which stresses the importance of the conduct of the AAR as an integral part of operations. Appendix B of FM 6-01.1 is devoted to a detailed discussion of the process for preparing and conducting AAR for use as a learning technique during operations (Department of the Army, 2008).

The AAR is a reflective session that is designed to allow trainees to review prior training performance. The philosophy of AARs is pedagogical. The sessions are not intended to be critical evaluations of performance so much as collaborative meetings held to enhance learning. Ideally, AARs should be conducted to focus on what was planned to happen during training, what actually did happen during training, why events unfolded as they did, and what might be modified during subsequent training or performance sessions. It is important to emphasize that AARs are generally conducted at the team level. Though individual AARs are possible, they are typically introspective and personal. Optimally, AAR sessions should be held as soon after training as is practical.

In practice, AARs vary in terms of their formality. Formal sessions may be supplemented by individual debriefings, collective "hot washes," and periodic reviews of success toward objectives. An important element of AARs is the role of the facilitator. This person (ideally a training expert who is also familiar with the goals of the training session) leads the trainees through the session, guiding discussion and ensuring that the pedagogical and collaborative spirit of the AAR is not forsaken and that participants accrue the knowledge that is intended.

The above discussion highlights the intended practice and implementation of AARs. However, there is considerable variability with regard to how AARs are conducted in the field. Much of this variability reflects the complexity of the training situation. Many training sessions (particularly at formal, full-fledged facilities such as the National Training Center) may stretch for two weeks or more, as Soldiers engage in simulated combat against thinking, flexible, creative opponents. Over that period, there are likely to be many iterations of AAR, from less formal "hot washes" to more formal collaborative sessions.

An important element that contributes to the variability of the AAR implementation is the AAR facilitators (Keene, 1994). Each one may have a different philosophy about how best to approach the team, and may have a different interaction style. Similarly, different facilitators may be more or less effective at stimulating discussion, leading participants, structuring the lessons, reflecting on planned goals, and synthesizing the lessons learned from the AAR. Trainees, themselves, also constitute a source of variability. Some groups function as a cohesive unit with a clear leader. Other groups may be relatively unfamiliar with each other, may have a less effective leader, or may suffer from internal strife or conflict. Ultimately, the AAR process resembles a sort of dance, where the trainees and facilitator must share responsibility for teasing out lessons learned from the training exercise. The music they dance to may represent the tempo of battle, the coordination with other allied teams, the awareness of overall goals, and the progress made toward the overall objectives.

Each of these issues has rendered the AAR a highly important but inconsistent and potentially unpredictable tool. The following quote from Peter Senge (2001) illustrates the first basic problem:

> *The Army's After Action Review (AAR) is arguably one of the most successful organizational learning methods yet devised. Yet, most every corporate effort to graft this truly innovative practice into their culture has failed because, again and again, people reduce the living practice of AAR's to a sterile technique.*

This suggests that the AAR technique is more than simply a process that is transferable across organizations and contexts. Rather it should be tailorable for the needs of particular groups who adopt it.

A second problem with current AAR practices is that they are frequently defined by practical constraints, rather than findings from behavioral researchers. AARs have been referred to as a self-contained substantiation of a broader knowledge management program. As such, they are designed with the overriding purpose of increasing knowledge gained. However, to realize the benefits that are possible from AARs, it is necessary to learn from researchers who have devoted their efforts to optimizing learning. Such researchers have published volumes devoted to curriculum design, practice, feedback and other theoretical concerns. Yet, too often the implementation of AARs caters to time constraints, leadership constraints, labor constraints, and monetary constraints. As a result, the value of the technique is distilled or eliminated altogether. As an illustration of these problems, DeGrosky (2005) highlighted several problems faced by Wildland Fire Agencies as they worked to incorporate the AAR process. Among the specific problems DeGrosky noted were following AAR technique without context, irregular use of AARs, practicing informal or unstructured AARs, engaging in unsystematic preparation for AARs, and not properly training AAR facilitators.

A third problem with the conduct of AARs reflects the theoretical grounding of the technique. AARs are meant to serve a pedagogical purpose: to enhance learning from experience. As such, their structure and function is likely reminiscent of a number of theoretical domains. Such domains may include mainstream psychology (particularly with regard to the optimization of feedback, training methodology, and the behavior of small groups and teams), education (especially curriculum development and the behavior

of facilitators), instructional technology (as concerns the development and incorporation of methods by which performance data may be gathered and replayed to participants), industrial psychology (for the design of performance appraisal systems, the study of leadership, and the role of organizational influences), knowledge management (an interdisciplinary endeavor that reflects organization of curricular issues and their sequential presentation and mastery) and military planning and leadership. Previous attempts to understand the AAR process have typically restricted themselves to a subset of these areas, or have taken a decidedly a theoretical position. However, consideration of theory is necessary so as to avoid reinventing the wheel and to ensure that the AAR represents a flexible and powerful method for optimizing operational learning.

Because of the diversity of theoretical contributors to AARs, it has been difficult to formulate one master list of best practices. Rather, what is needed is a theoretical model that reflects the myriad of discipline influences, and that is flexible enough to apply to diverse operational circumstances. To date, few theoretical models have been proposed. Those that have been proposed suffer from lack of validation. Thus the irony: Even though AARs are meant to be the pinnacle of a "learning organization," there have been few documented attempts to specify the principles of learning or knowledge management to the conduct of AAR sessions.

The goal of this research review is to assemble research sources that apply to the design and conduct of AARs. Our research team is concerned mostly with academic research that pertains to the topics mentioned earlier. Therefore, the following sections will provide a synopsis of research that exists. We also plan to review that research in an attempt to identify notable researchers who have addressed the problem, present results of both military and non-military investigations or implementations of the AAR technique, highlight existing theories that may contribute to the advancement of AARs, and isolate specific areas that demand further work.

Research Approach Followed

The approach that the research team followed demonstrates several priorities. First, it was necessary for the researchers to understand the AAR process as it was initially envisioned by the U.S. Army, as it has evolved since its inception, as it is currently practiced, and as it must change to fit foreseeable demands. Second, it is important for the literature review to comprehensively focus on a relevant variety of academic disciplines. Therefore, we emphasized available academic research from conventional article and report databases. We also stipulated a number of search terms that corresponded to the functions, qualities and challenges of the AAR process.

Because our research team had developed a theoretical model of AAR (see Mastaglio, Jones, Bliss, & Newlin, 2007), we considered that model as a basic starting point for our investigation. The Integrated Theory of After Action Review (ITAAR) model (see Figure 1) stipulated several theoretical areas that are presumed central to AAR development and implementation. The current literature review in this report was intended to supplement the research that led to the development of ITAAR. Toward that end, part of the current report will summarize past research (leading to ITAAR) and will

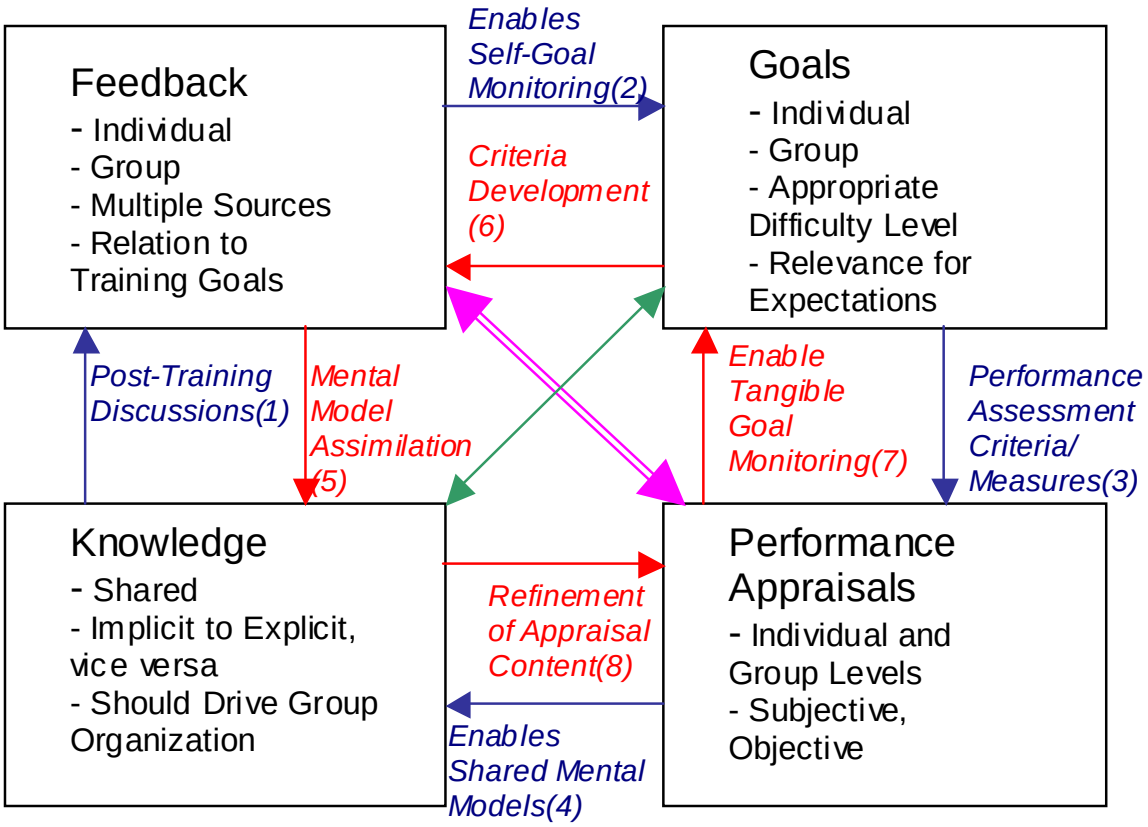
present additional evidence in these areas. Furthermore, we will discuss literature that reflects application of AARs in military and industrial environments.

Reliance on Prior Research

As we assembled relevant research articles, we paid particular attention to individuals and research centers that have been notably influential or active in the study of AAR. To do so, we searched research databases to determine those articles and authors that were commonly cited by others. Our hope was that reviewing these sources would allow us to determine whether the most prolific authors in the field had attempted to explore theoretical foundations of the AAR process.

Our investigative process focused mostly on established research databases, including PsychINFO, ERIC, Google Scholar, the Defense Technical Information Center, and Applied Science and Technology. After we initially focused on research specifically targeting AAR, we then explored four key areas (inspired by ITAAR): learning theory, team dynamics, feedback, and relevant cognitive processes (examples within the latter category include reward, reinforcement, and memory). We employed a number of search terms to ensure that our investigation was powerful enough to uncover existing research. Examples of these search terms include "feedback," "after action review," "performance review," "learning from experience," "knowledge management," and "action learning."

Our search led us to over 150 sources that we considered central to the design and implementation of AAR. They are listed in the bibliography section at the end of this report. After identifying these sources, we then obtained them and created an online database to organize those considered most directly influential. We posted summaries of the obtained articles using a publicly available spreadsheet tool sponsored by Google (http://spreadsheets.google.com/pub?key=pNt_AV5mAcxT41ABZHDSpSQ). Within that spreadsheet, we provided a summary of each article as well as key identifiers to assist us in the classification of each source. Concurrently, we constructed a synopsis of research in each domain area in the form of bullet points to drive our subsequent discussion (http://docs.google.com/Doc?id=dgw9kpjw_22d3dmsg4w). Ultimately, we categorized and organized our sources according to several criteria: the application area (military, academic, industrial), theoretical domain (learning theory, team dynamics, feedback, or cognitive processes), and application field (specific application area).



- Knowledge of task facilitates goal setting; goals structure the knowledge dispersement process.(9)
- Feedback is formalized within performance appraisals; performance appraisals are the mechanism for feedback.(10)

1 Wiener (1948)
2 Saavedra, Earley & Van Dyne (1993); Matsui, Kakuyama & Onglatco (1987)
3 Mager (1984)
4 Cannon-Bowers & Salas (2001)
5 Smith (2001)
6 Schmidt & Kleinbeck (1990)
7 Jones (1997)
8 Dyer (1986)
9 Dyer (1986); Saavedra et al. (1993)
10 Patrick (1992)

Figure 1. Integrated theory of after action review (Newlin & Bliss, 2007).

Detailed Results Organized by Source, Domain, and Field

In our examination of the pertinent literature available, we determined that there were several researchers and research centers that appeared to be particularly active with regard to investigations of AAR. Some of these centers and individuals have focused on the history of AARs, some have concentrated on the structure and implementation of AARs, some have developed or modified the underlying theories that support AAR design, and some have focused on the variability of AARs given particular goals. To be relevant for our review, each source was required to have focused on ultimate optimization of AARs. Our research team valued this above other criteria because of the noted failures of the AAR process to achieve goals of information transfer and learning from experience (DeGrosky, 2005).

The agencies or organizations that have concerned themselves with AARs span government as well as industry. Each of the armed forces has adopted their own version of AAR, with the U.S. Army leading the way. Perhaps the most prolific military organizations to study AAR have been the U.S. Army Research Institute and the Center for Army Lessons Learned (CALL). These groups have produced many reports and guides that describe methods for conducting AARs and recommendations for their effective implementation and facilitation. The Army's Functional Area (FA) 57, Simulation Operations, proponency office published an extensive DVD-based AAR Toolkit (2003) that provides multi-media instruction, recommendations and example templates for trainers to use in the preparation and facilitation of AARs (FA-57 Proponency, 2003). This toolkit was not widely distributed beyond FA 57 personnel so it had relatively little impact on the large population of Army trainers.

As we searched for relevant research bearing on the success of the AAR procedure, our research team concerned itself first with the identification of critical or influential articles discussing AARs. Perhaps the most widely cited resource is Morrison and Meliza's (1999) foundations report. That report discusses the history, structure and function of AARs. It also discusses the theoretical grounding for AAR and the need for research in particular areas. Darling, Parry and Moore's (2005) article in the Harvard Business Review examines the practice of AAR, discussing the implications and potential benefits of extrapolating the AAR technique to the business world. There have also been academic works such as Justin Gubler's (1997) doctoral dissertation at the University of Central Florida. That effort addressed the AAR's role within unit simulation training. Also, we consider Salter and Klein's (2007) research report to be highly relevant and timely for our effort. Finally, we believe that the recent work by the Wildland Fire Safety Association (see DeGrosky, 2005) reveals important truths about the applicability of the AAR procedure to non-military domains.

Our search for information relevant to the design and implementation of AARs led us to consider several supporting theoretical areas within the psychological, educational, and social research fields. From our review of the AAR research that has been conducted in the past, we considered the most relevant academic literature areas to be performance appraisal design, development of instructional technology, human learning, task training, teamed or group performance, leadership, design and implementation of feedback (knowledge of results or performance), and knowledge

management. In subsequent sections of this report, we will present summarized findings from our prior work in many of these areas. This report adds to that previous literature review by presenting additional relevant literature in the areas of human cognition, team dynamics, and feedback.

In each of the areas mentioned above, there appeared to be seminal articles that drove our investigation forward. Those sources are listed below within Table 1. It is important to emphasize that this is not an exhaustive list, as each area has within it a plethora of sources available.

Summary of Findings

As mentioned above, our findings in this report are meant to supplement research conducted earlier in support of the development of the Integrated Theory of After Action Review (ITAAR, Mastaglio et al., 2007).

In their report, Newlin and Bliss (2007) stipulated several recommendations for the AAR process, driven by research in each of the relevant research fields (see Figure 1). We include those recommendations in toto as Appendix A of this report, and consider them as a starting point for the current literature review. The research that was completed by Newlin and Bliss (2007) led to a number of conclusions and recommendations pertinent to the improvement of the AAR process. These are listed below. First are presented recommendations concerning the facilitator's role, followed by recommendations relevant to the trainees and the AAR process in general.

- Based on several integrated theories about a leader's role in providing feedback, facilitators should be experienced leaders who cater to learners by providing knowledge of results.

- Facilitators should implement an instructional plan that includes challenging, yet attainable goals. These goals should be specified before training occurs.

- Facilitators who feel capable in their communication skills and knowledge evoke better performance from trainees. This efficacy should be evident within the AAR process. Facilitator training should focus on building leadership efficacy, communication skills and interpersonal confidence.

- Facilitators in training should assist with the development and implementation of AARs before leading an AAR process alone. Such a practice would build their knowledge of the process and their confidence.

- Facilitators who possess implicit knowledge must be encouraged to verbalize this knowledge to learners through behavioral role modeling and documentation.

Table 1. *Seminal Research Articles in Supporting Research Areas*

Research Area	Citation(s)
Performance Appraisal	Brett & Atwater (2001); Borman (1997)
Instructional Technology	Baird, Holland, & Deacon (1999); Briggs (1977)
Human Learning	Garvin (2000); Bilodeau (1966); Atkinson & Shiffrin (1968)
Task Training	Holding (1965); Patrick (1992); Goldstein & Ford (1992)
Team Performance	Minionis, Zaccaro, & Perez (1995); McIntyre & Salas (1995)
Leadership	Hoyt, Halverson, Murphy & Watson (2003)
Feedback Design and Implementation	Nadler (1979); Downs, Johnson, & Fallesen (1987); Ammons (1956)
Knowledge Management	Nonaka & Takeuchi (1995); Joshi, K.D., Sarker, S., & Sarker, S. (2007)

Recommendations were also presented by Newlin and Bliss (2007) that are relevant for the training audience:

- Trainees who go through joint AARs must be encouraged to work collaboratively with other team members to achieve performance goals and learn from the AAR process.

- Team members can acquire skills and build mental representations by acting out behavioral responses and understanding the theoretical benefit of doing so.

- Past research suggests that groups perform more efficiently and appropriately when team members share mental models. Therefore, AAR sessions should be designed to yield a common understanding of the trained material.

- AARs should promote shared mental models by encouraging team members to actively participate in discussions.

- When new team members enter an AAR group, experienced trainees should share mental model information quickly to assist the new member to form an accurate mental representation.

- AAR sessions should focus on both individual and group feedback.

- AARs should focus on unconventional or novel measures of group effectiveness, including measures of cohesion and cooperation.

Generalized Research Findings by Domain – Human Cognition

The first area that we consider to be central to AAR effectiveness is human (trainee) cognition. It is important to emphasize here that almost all functions and elements of human cognition bear some relevance to the design and implementation of

AARs. For that reason, an unabridged discussion of human cognition as it relates to AAR is a daunting task. We have constrained our treatment to those elements that we believe are most directly concerned with the facilitation of trainee learning and performance.

Cognitive learning. The AAR process deals heavily with cognitive learning, because such learning will be continuous when Soldiers solve problems on the battlefield and away from it. During battle, there is an abundant amount of information; to successfully perform their role, Soldiers must learn quickly what to expect from the battle situation and how to manage available resources to make effective decisions. During the AAR, facilitating cognitive learning is crucial, as the participants will be expected to take the information and incorporate it into their current existing knowledge framework. If accomplished effectively, trainees will be able to form a meaningful network of information that transfers to operational situations when needed.

Research that pertains to cognitive learning theory concerns mainly the transfer of information between short term and long term memory storage areas. Long term storage is a collection of past information learned, semantic meanings, episodic memories, and the linkages among items in long term storage. Short term storage is an intermediate "buffer" that contains information of events that have just recently happened, and transferring these items from short term to long term storage is the main aspect of the cognitive learning process (Atkinson & Shiffrin, 1968).

For many years, training researchers have encouraged the development of training procedures to facilitate the transfer of information from short term to long term storage. Specific foci of these procedures have included utilizing methods and techniques to speed up the learning process, ensure long term access, and provide many meaningful cues leading to the information stored (Patrick, 1992). The learning process consists of encoding and retrieval of learned information. Encoding, in particular, concerns the process of placing the information in LTS, while retrieval deals with the process of accessing this stored information (Hunt & Ellis, 2004).

Learned knowledge is maintained in long term storage as a "semantic network" or schema. These terms basically suggest a cluster of related items that become activated when one single entity in the network is activated (Crestani, 1997). For example, if the schema contains information of a classroom, once "desk" is cued, "teacher" or "lecture" will be available for retrieval faster than it would be without cueing the schema. Any given item's connections can be strengthened with frequent and consistent pairings, as well as meaningful, self-generated cues. Deep processing and self-generation of cues lead to a stronger bond between items in memory (Hunt & Ellis, 2004). The links between items in memory are not immune to decay, as the links leading to information can weaken if not used on a somewhat regular basis. Forgetting stored information can occur when there is little frequency or recency of the retrieval process, interfering associations, or little association with other information. Longer spans of time between recall of the items will lead to a weakening of the associations, allow for the related cues to be associated with other items (Wickens, Lee, Liu, & Becker, 2004).

Implications. There are implications of such "spreading activation" for training. Specifically, the theory suggests that for training to be successful, attempts should be

made to encourage deep, meaningful processing, which ensures multiple cues and stronger associations between items in memory. This starkly contrasts with simple rote memorization, as the information stored will be difficult to access without the meaningful associations or links leading to the stored knowledge. Attempts should be made to ensure that the information links are consistently paired with the events or stored knowledge and accessed often, as disuse will lead to information decay, or forgetting. In the context of an AAR, review of missions completed should be approached from multiple viewpoints (for example, command, OPFOR, teamed blue force, communications, and support) to enable complete processing of the material for later recall and application (see Paivio, 1971).

Memory. Knowledge stored in long term storage may be categorized four ways: schemas, scripts, mental models, and cognitive maps (Doyle & Ford, 1998). A schema is a collection of semantically related items in memory, such as "classroom", while a script is an extension of this concept, adding in a time sensitivity or process to this information network. Scripts are episodic in nature, such as "steps involved in conducting an AAR" (Schank & Abelson 1977). Mental models represent learners' understandings of systems or equipment, how they are used, when they are used, and why. Cognitive maps are generally a map layout or spatial information. Because of the complexity of AARs in practice, it is likely that trainees will often be called on to form schemas (for example "ways to identify OPFOR members"), scripts ("potential ways that identified OPFOR members may disguise themselves when conducting espionage"), mental models ("how can I use robotic tools to search for insurgents?") and cognitive maps ("where have we already searched for insurgents in this community?").

Episodic information is used to catalogue a series of events. It is important to understand the many aspects of episodic information, as research has demonstrated a tendency for learners to remember information falsely under stressful or overloaded conditions (Wright & Davies, 2007). Episodic memory can be distorted or modified by the retriever in three different stages. Encoding incorrectly can lead to a biased episodic memory, because there is a limit on attention capacity at any given time. It can be expected that items demanding more attention (a dangerous item, such as a weapon) will detract from the person's ability to encode the rest of the scene correctly. Secondly, a storage bias can occur to alter the integrity of episodic memory. Cognitive researchers have demonstrated the ubiquity of storage bias as the mind attempts to "fill in the blanks" of memory via top down processing (Hyman, 1999). Missing information is often filled in with items that are expected to potentially be there, often the items activated in the schema of the event. For example, during an AAR, a trainee might be inclined to remember there being more OPFOR present on the battlefield than were actually there. A related problem involves retrieval biases that can occur when information is not retrieved (because of a lack of conceptual links), or retrieved incorrectly.

Implications. As suggested above, false remembrance can impact learning that transpires in a training situation, as information remembered incorrectly can directly influence the acceptance (or rejection) of perceived feedback. Feedback that misaligns with a person's perception of their own performance will be rejected by that person, so it is crucial that if episodic memory of a battle situation reflects false memory reconstruction, AARs take action to present (where possible) ground truth in a

convincing manner. The use of automated tools for AAR [such as the Dismounted Infantry Virtual After Action Review System (DIVAARS; Clark, Lampton, Martin, & Bliss, 2004)] may provide an excellent way to capture training action for subsequent replay. Furthermore, facilitators should be trained to recognize the potential for false memories, and taught strategies by which they may be prevented or corrected. Generally, the AAR facilitator should ensure that the best possible representation of the battle should be recreated, and that each person accepts this representation as what actually happened.

Situation awareness. Another cognitive phenomenon that may influence the success of an AAR session is situation awareness. Defined formally by Mica Endsley (1995), situation awareness refers to a person's general understanding of the real time changes in their surrounding environment. This includes perceiving their environment, understanding how the elements work together, and predicting how these elements will interact in the near future (termed "levels 1, 2, and 3" of situation awareness (Durso & Gronlund, 1999). Situational awareness also includes the ability to "filter out" information that is irrelevant to the task at hand (Endsley, 1995). An AAR facilitator should be committed to addressing learners' shortcomings or proficiencies in situational awareness, and encourage knowledge transfer to ensure that each participant will understand which information is crucial to battle success and which information is irrelevant. A variety of tools have been proposed to enable the measurement of situation awareness, including questionnaires, task probes, and secondary tasks. Yet, in most AAR situations, little if any systematic attempt is ever made to determine the situation awareness that trainees demonstrate. Recent work regarding the concept of "teamed situation awareness" (Endsley & Robinson, 1996) may be particularly relevant here, as a primary goal of AARs should be the facilitation of shared awareness by team members.

Implications. Situation awareness often has a direct impact on problem solving and decision making strategies. AAR feedback should assist trainees to improve their skills for these things. Problem solving involves taking cognitive steps to arrive at a desired "goal state" or solution. Troubleshooting adds a step to this process, as cognitive steps to diagnose a particular problem, followed by the problem solving step (Wickens et al., 2004). Working memory, or one's ability to encode information in LTS while doing cognitively demanding processes simultaneously, imposes limits to a person's ability to troubleshoot and problem solve. AAR facilitators should work to identify and engender this ability in those that seem proficient at it, as well as ensuring that the "problem solver" is able to walk the other AAR participants through his or her steps to arrive at the goal state.

Attention. Though much of our discussion has been targeted toward the AAR facilitator, it is important to recognize that individual trainees bear a considerable responsibility for cognitive learning. Personal effort is crucial to ensure learning and retention, because combat situations frequently present difficult or complex concepts that can be judged by trainees as too much effort to be worth their while. People in general often pursue strategies that utilize low-effort actions rather than more complex (but more efficient) high-effort strategies. Economic or "rational" theories of decision making (Sternberg & Smith, 1988) often stress the potential for individuals to engage in a sort of "cost-benefit analysis" to determine whether a course of action is worth the effort. In certain combat situations, individual trainees may judge information or knowledge to be

gained as trivial compared to the effort required to gain it (Fennema & Kleinmuntz, 1995). An example relevant to the AAR process would be a trainee in one particular role being uninterested or "tuning out" during the discussion of another team member's actions. The AAR benefits can be weakened by this behavior if trainees do not understand the knowledge that accrues from shared mental models. AAR facilitators, then, should work to enable the sharing of crucial knowledge, so that audience members see its value and are not tempted to consider the cost as excessive relative to the benefit. One possible method for achieving this is to reword lessons in terms of shared benefit; another might be to have team members verbalize the benefit that each of them has gained.

As a cognitive resource, attention is essential for learning to take place. Scientists have for many years considered the abilities of learners to divide their attention between multiple demanding sources. As with memory and decision making, cognitive resources are important to understanding why some individuals might have difficulty timesharing attention during an exercise. Four major factors contribute to the success (or failure) in dividing one's attention: resource demand, structure, similarity, and resource allocation. Resource demand deals with how much cognitive effort is required by a task. As the demand of one or more shared tasks increase, performance on all tasks will decrease. Structure refers to which resource the task depletes, such as visual processing, auditory processing or spatial processing (Wickens, 2002). Similarity among tasks is often discussed with regard to structure, but deals more with the cognitive resources each task demands. Finally, resource allocation deals with attention, and how much is available for each respective task.

Implications. The role of an AAR should be to identify these situations that require divided attention, so that trainees may recognize them and disperse the responsibility of the task to other individuals with lower task demands accordingly. Multiple tasks that require too much attention or resources will not be performed well by individual trainees (Wickens, 2002). AAR facilitators should be keen to identify persons who are vulnerable to such strains, and encourage other group members to assume task responsibilities when needed. Ultimately the overall task will benefit from enhanced performance and flexibility for additional cognitive challenges as they arise.

Expertise. With repeated exposure to training, Soldiers are expected to develop "expertise" in their particular roles. The study of expertise development has a long and important history (Ericsson, 1996). As trainees progress in expertise, they typically go through a number of stages of cognitive skill development. Initially, knowledge about a task is represented as "declarative knowledge", or knowledge that is represented loosely as a set of definitions that lacks practical application. After repeated practice, declarative knowledge gives way to "procedural knowledge", which refers to hands-on knowledge of the task. Procedural knowledge represents the development of explicit rules to govern under specific occurrences. For example, a trainee may learn a procedure for building assault that represents a string of behaviors (approach building under cover, enter building from rear, search perimeter, and so forth). Automaticity develops after many iterations of performing the activity; at an automatic level, individuals have more efficient ways of chunking information. Little attention is required to perform the task, and it is carried out quickly and efficiently (Hunt & Ellis, 2004). At the automatic level,

information garnered during an exercise is likely to be stored and retrieved more quickly and efficiently than at prior levels.

Implications. The development of expertise is something the AAR should heavily focus on and facilitate. Although practice is crucial to developing expertise, any steps that can be taken to shorten the amount of time needed to gain expertise should be emphasized. A variety of training methods have been proposed in the literature (see Patrick, 1992): adaptive training, scaffolding, part-task training, and distributed training are all viable options and should be weighed to determine their appropriateness for various training situations. Expertise development is crucial, as it will quicken the process of Soldiers developing skills and efficiency they need to be successful when performing their tasks.

The AAR facilitator should work to ensure that individuals who are "quicker" at acquiring expertise verbalize the processes and methods they use so that members who have not achieved expert status can benefit from that knowledge. Each AAR session should have information to strengthen the mental models of the battlefield system, so that information is recalled more readily in a time of need.

Facilitators must be mindful that one of the challenges to using "self report" by unit experts to impart successful processes and methods to teammates is the great potential that the resulting information often contains significant errors and omissions. These errors are not often recognized by participants who solved important problems in emergency situations and wish to give accurate reports on their solutions because the knowledge they are describing is largely automated and unconscious. As AAR can be used as a process to document new methods to overcome unique challenges this phenomenon can be problematic if incomplete or inaccurate lessons learned are passed from experts to novice participants. There is some evidence to support the belief that one needs to use methods such as Cognitive Task Analyses (CTA) in conjunction with AAR to actually obtain a high degree of accuracy when documenting expert solutions to complex problems. (Clark, 2007)

Generalized Research Findings by Domain – Team Dynamics

A team is defined as a small number of people who hold specialized or individual roles or functions, and act dynamically towards a shared goal for which each member views themselves as mutually accountable. One of the defining aspects of a team is interdependence (McIntyre & Salas, 1995). Teams are viewed as a "work unit" by both members and non-members alike. The goals held by the team reinforce the notion of interdependence among the group members. Each member of the group carries out a different role, and the output or outcome created by the group is a combination of all the member's efforts.

An interesting component of military teams is that the roles of the team members are often prescribed by rank, experience, and convention. However, in the event that a person who is designated as the leader becomes incapacitated, it may be necessary for other team members to adopt aspects of that role. An important element of an AAR may be to rehearse contingencies in such events. Doing so may allow the team members to

gain a broader appreciation of each others' roles and may ultimately result in better training.

Communication. Successful team performance depends on the right mix of members who understand their own roles as well as other members' roles (Belbin, 1981). The team leader should have a style that matches the tone and nature of the mission, and the other team individuals should have the correct complementary task and teamwork skills to be successful. Communication among team members is also crucial to success, so much so that the size of the team is limited by the ability of the members to quickly and accurately communicate with each other. If members of the unit face issues communicating among themselves, the group should be broken down for training purposes to facilitate the dissemination of information.

Implications. As communication has been proven to be an essential part of teamwork success, one of the AAR's main foci should be facilitating effective, effortless, and efficient communication among its participants. Special attention and care should be given to communication errors or breakdowns, and steps to avoid similar situations should be explored, because communication is central to team performance. An example of the fragility of team communication in AAR situations is shown by Gratch and Mao (2003), who investigate team communication factors such as attribution and blaming within team interaction.

Goals. Team effectiveness is determined by several key factors of team interaction. Within all group members, a common, meaningful purpose needs to exist. The product or output of the team should be well defined, so that each member knows exactly what the objectives of the team are. Setting specific performance goals, rather than general ones, for both the team overall and each member will lead to greater team effectiveness. Each member of the team should be committed to working as a team, maintaining mutual dependent needs on the other members' abilities. Team effectiveness hinges upon the leader following the project guidelines, and appropriately delegating responsibilities to the correct team member. The execution of these responsibilities needs to be well coordinated with the other's responsibilities, and each team member needs to feel a shared accountability towards the overall performance of the group.

Implications. Goal driven interaction between team members should be encouraged and engendered within the AAR. For many years, behavioral scientists have acknowledged the importance of goal setting in the performance appraisal process (DeShon, Kozlowski, Schmidt, Milner, & Wiechmann, 2004). Any verbalizations made by trainees during the AAR session, particularly those referring to a specific team goal, are signs of team growth and should be encouraged. Group accountability and interdependence should also be emphasized, and feedback directed at the group should be directed at strengthening these concepts for the group (Hackman, 1987).

Team dynamics. Adherence to these teamwork tenants leads to optimal performance; however, there are some team dynamics known to cause poor performance. Disagreements over authority or perceived power can cause a disconnect within the groups' shared goals. Members who maintain incongruent norms or values can lead poor performance, as well as low team morale, undefined team roles or structure, a lack of mutual goals, poor communication, and finally, lack of feedback or criticism. Also,

rewarding individual performance can cause a decrease in commitment to team goals, which decreases team effectiveness. Facilitators of the AAR should pay special attention to these team shortcomings, and offer up corrective feedback to the group to ensure these characteristics are lessened or abandoned (Nadler, 1979).

Team training. Team training is crucial to the eventual performance of the team. Properly structured advanced training sessions can ensure that the members of the team can work together and communicate more effectively before real-time performance of the task. Building "task work" skills (tasks performed by each individual in the team task) trained without the other team members will undermine the development of "teamwork skills". Teamwork skills include cooperation, coordination, communication, adaptability, ability to give criticism, acceptance of criticism, and maintaining high team morale. Groups that practice their individual tasks concurrently with the other members will facilitate an increase in teamwork skills, while those that practice them individually will not perform as well in a team setting. Team building activities that focus on goal setting, problem solving, and interpersonal relationships do not do as well as those that focus on roles and responsibility development of each team member (McIntyre & Salas, 1995).

Implications. In training teams, cross training is considered a highly effective practice. In cross training, team members are trained to do other members' jobs. This can lead to higher team cohesiveness and more efficient communication, as members are expected to have an intimate understanding of what the other members need to know and when.

Military combat teams have been characterized as "action/negotiation teams", which require high role differentiation (and the team life spans are often long), and high synchronization with outside units. The teams are guided by externally imposed pacing and cycles of work that are often short and take place under dynamic conditions. Training and technology are essential for determining team effectiveness.

Dynamic and complex environments can lead to high stress work tasks that can cause cognitive overload. Team communication and performance decreases as a result. Training must combat this effect by facilitating the development of shared mental models, effective communication, stress adaptation, maintenance of situation awareness, and coordination. Shared mental models combat the effects of stress by allowing for anticipatory communication (or a lowering of the need for communication), such as a person offering crucial information before the information is requested. Good teams take advantage of the time between these high-stress scenarios, at which point they take the opportunity to share information and build their shared mental model for the subsequent encounters. Effective teams often distribute work load beyond what is expected in times of high demand, blurring the lines between team members in stressful situations.

Generalized Research Findings by Domain – Feedback

Feedback is the process of providing an individual or group information about their performance. The feedback research literature generally supports the idea that providing an individual with information about performance increases motivation and improves subsequent performances (London, 2003). Feedback consists of a source, a message, and a recipient, all of which play special roles in the feedback process.

Delivering feedback. The major difference between a critique and an AAR is how feedback is acquired by the trainee. In a critique, an evaluator provides feedback to the trainee in the form of statements about good and poor performance. In an AAR, the facilitator provides feedback to the trainee in such a way that the trainee identifies their own good and poor performance. The advantage of the trainee forming their own feedback is that there is often greater acceptance of self-determined feedback than that which is presented from others. Self-feedback and task-feedback are generally regarded as more reliable by the recipient, and as such should not be ignored (Ilgen, Fisher &Taylor 1979).

The source of feedback can be broken down into three categories; individuals who have observed the task performance, the task environment itself (objects in the environment displaying an effect when you act upon them), and finally the recipients themselves. Feedback in the AAR mainly consists of outside individuals who have observed task performance and present this information to trainees to help them to understand their performance. Ideally, trainees use this information, along with task feedback, to form self-feedback. The closer the source of the feedback is to the recipient, the more likely they will accept and respond to it (Greller & Herold, 1975).

Individuals providing feedback can differ in their power and credibility (which are independent of each other), each having their own effects on the reception and acceptance of the feedback. Credible sources will have their feedback more readily accepted and acted upon, while non-credible (at least perceived) sources will have their feedback disregarded or ignored. Non-credible sources' feedback is perceived as faulty, and is thought to not actually refer to the receiver's performance. The less the recipient feels the feedback deals with their actual performance, the less they'll use the information to alter their behavior. Sources with more power are perceived as being important, and will have their feedback attended despite the feelings of the receiver.

Implications. The feedback given in the AAR should incorporate these concepts. Feedback given should be delivered so that the recipient(s) feel it actually reflects their performance, which can present a problem when dealing with multiple people. Great care should be given to ensuring each AAR participant agrees with the assessment of their performance, otherwise they will simply disregard the information. The facilitator should be highly concerned with his or her credibility, and take steps to ensure that this credibility stays as intact as it possibly can be.

The message of the feedback contains some form of information about the receiver's past information (Annet, 1969), which should provide some sense of accuracy, correctness, and adequacy of the response (Bourne, 1966). The receiver should be able to convert the feedback message into meaningful units, as ambiguous information will have little effect on behavior (Annet, 1969). The information value of the message depends on the amount of knowledge of the recipient's performance the feedback provides above and beyond what they already know about their performance. The cybernetic approach to feedback suggests it is most effective when it causes an increase in knowledge through a reduction of uncertainty. This is done by eliminating half of the alternative explanations for behavior (Shannon & Weaver, 1949).

AAR practices should be sure to provide feedback information in a manner that is easily broken down into meaningful units for the receivers of the feedback. The more specific the information given, the more likely the receiver will be able to incorporate the feedback and use it in later performances. The information provided should contain information that subsidizes the AAR participant's existing knowledge of team or individual performance. Dispensed information should also reduce the participants' uncertainty of the outcomes of particular events. They should be clear on who's actions led to what event, as reducing the ambiguity of the situation will provide the ability to alter behavior.

There are four levels of recipient's processing of feedback: perception of the feedback, acceptance of the feedback, desire to respond to the feedback, and the intended response (Ilgen, Fisher &Taylor, 1979). Each of these stages represents a distinct moment in the AAR feedback process, with each stage providing its own obstacles to the desired outcome. Each stage also can be affected by the previously discussed aspects of feedback, the source, the message, and the recipient.

Perception of feedback. The perception of the feedback refers to a person's receiving and interpreting the feedback, and deals with how accurately this process occurs. Feedback, to have an effect on behavior, must be believed and understood by the receiver. The source of the feedback interacts with the perception of the feedback, as self and task feedback are remembered more accurately than supervisor feedback.

The message can alter the perception of feedback in three ways; the timing, the sign, and the frequency. Timing deals with the speed in which the information is delivered after the task is complete. The quicker the information gets to the recipients, the more likely they are to attribute their actual performance with the feedback they receive (Ammons, 1956). The longer the amount of time, the chances of linking the two lessens. The next aspect of the message is its sign. Feedback with a positive sign is feedback that confirms or supports correct task performance. Positive feedback is received more readily and accurately than negative feedback (Halperin et al., 1976). Negative feedback is feedback that informs the receiver that the task was performed incorrectly or not well enough. Retention of negative feedback has been shown to be faulty over time, as the receiver faces a challenge accepting these negative attributions about themselves. Lastly, the message can differ in its frequency, with more frequent feedback leading to a bigger effect on performance.

Finally, the recipients themselves can determine the perception of the feedback. The individual holds several expectations about their performance, and when the feedback does not meet these expectations, the feedback's credibility is called into question. Persons with external loci of control are more likely to be motivated by external source feedback, while persons with internal loci of control are more motivated by self-discovery feedback (task-supplied) (Baron, Cowan, & Ganz, 1974). Also, high self-esteem individuals are more likely to rely on themselves for feedback, and raise their competency more when positive feedback is received.

Acceptance of feedback. The acceptance of feedback, particularly external feedback, involves the recipients belief that the feedback actually refers to their performance. After the feedback has actually been perceived, the feedback must then be

accepted by the participant. If there is any disconnect between the facilitators view of the exercise and the trainee's view of the exercise, the effect of feedback will be reduced.

The source of the feedback plays a large role in acceptance of the feedback, with self-feedback and more credible sources of external feedback having their feedback accepted. Five characteristics of the external source have been identified to play a role in feedback acceptance by Giffin (1967); Expertise, reliability, intention toward the listener, dynamism, and personal attraction. Expertise refers to the source's knowledge of the task at hand, with more perceived knowledge leading to more acceptance (Tuckman & Oliver, 1968). Reliability refers to the source's tendency to be consistent in their methods, delivery, judgments contained in their feedback, and how often the receiver accepts their feedback (Giffin, 1967). Intention towards the receiver is how the AAR participant feels about the source's motives for giving feedback. If the participant feels that the facilitator is "on their side", they will be more likely to accept the feedback (Hogan, Fisher, & Morrison, 1974). Dynamism is how energetic or bold the source is, with more energy leading to a higher acceptance of feedback. Personal attraction is how the receiver feels about the source (whether the source is friendly, hostile, or disinterested).

Implications. The most important aspect of the message as it pertains to the acceptance of external feedback is the sign, positive or negative. Once again, people are more likely to accept positive feedback and reject negative feedback. It has also been found that message consistency across time affects acceptance, as consistently positive (or negative) feedback is given, the opposite type of feedback will be harder to accept when offered. To increase the acceptance of the feedback, it should always be accompanied by some form of example or critical incident exemplifying the feedback.

The recipient's personal characteristics can also alter the acceptance of external feedback, as people with an internal locus of control will be more likely to accept the feedback and act upon it versus people with external loci of control (Feather, 1968). Age can impact the acceptance of feedback, as older and more experienced individuals are less likely to accept feedback than younger, less experienced individuals (Meyer & Walker 1961).

Desire to respond. After the acceptance stage, participants often feel the desire to respond. The desire to respond to the feedback concerns the individual having the choice to act upon received feedback, either making the behavioral changes or not. The recipient plays a large role in this aspect. Expectancy theory suggests that individuals with high self-efficacy will increase the chances of action on received feedback (Campbell & Pritchard, 1976). Motivation of the individual can also impact the desire to respond, as feedback allows the recipient to judge his or her performance. If the performance is judged to be proficient, then feelings of competence will increase, which is a strong motivator (White, 1959). Personal level of control can dictate one's desire to respond, with individuals who attribute behavior changes to their own will showing a greater likelihood of responding. Alternatively, those who feel controlled by the source of the feedback will decrease in desire to respond (Deci, 1975). For example, leaders who structure behavior will promote satisfaction only if the group lacks structure; however if the structuring is redundant, it will be received as controlling and cause dissatisfaction (House, 1971).

Implications. , Feedback should be designed to bolster the recipients' feelings of competency, while reducing the feeling of external control to be most effective. The feedback should generally be positive, and provide information above and beyond the information already retained by the recipient.

Intended response. The last stage of the feedback process is the intended response step. The desire to respond to feedback does not always mean an actual response, as there are internal and external factors that may interrupt the response after the decision has been made to make it. The intended response ties in heavily with goal setting and checking, as feedback is essential to the goal process. Specific goals lead to a more substantial increase in performance compared to general goals which suffer from limited functionality (Steers & Porter, 1974). Difficult goals also increase performance in comparison to easy ones. The more personal control over goals set, the more performance will increase. To support specific goals, specific feedback should be provided, and done so in meaningful chunks of information that the recipient will be able to act upon.

Implications. What this four-step process suggests for the AAR is that the facilitator attempt to ensure that each person in the AAR agrees with the feedback that is given so that it will not be disregarded. Feedback should also be delivered in a timely fashion; the general feedback messages should be frequent and consistent. Feedback generated by the AAR participants about themselves will be accepted more readily, so the facilitator should try to have the participants generate their own personal feedback when addressing issues. Facilitators should try, when possible, to avoid delivering excessive negative feedback, as it is generally not as effective as positive. Positive feedback will boost the participants' feelings of competency, which will increase motivation to perform. AAR facilitators should work hard to maintain themselves as credible, energetic, reliable, and representing the participants' best interests. The AAR designer and AAR facilitator should also help the participants develop challenging, specific goals for future performance, and subsequently offer specific feedback to provide a means of monitoring progress towards these goals.

Recommendations

From the research findings that were discussed by Newlin and Bliss (2007) as part of their ITAAR report, and from the research findings discussed in this report, several conclusions are worthy of discussion. In the following paragraphs, we discuss the AAR as a subject of research. The initial section will discuss major centers of AAR research. Subsequent sections will include lessons learned across research domains and fields, areas that have yet to be investigated, and potential avenues for further work regarding AAR.

Our literature review revealed that there are a number of research centers (military and non-military) that have actively studied the effectiveness of AARs. In some cases, the driving force behind such work is the improvement of the process for theoretical purposes. This could be referred to as "basic research" with regard to the AAR. Given the wide variety of psychological and social constructs impacting the delivery of training feedback (some of which have been reported in this document), it is not surprising that

certain research centers have focused on acquisition and dissemination of knowledge as their primary goal.

Other centers have focused on improvement of the AAR process from a logistic standpoint. More specifically, these centers are concerned mostly with how AARs might be designed to benefit the trainees and facilitators who must use them. Questions pertinent to this line of inquiry often concern the optimal duration, foci, environment, and material to be addressed within the AAR. Often, aspects of leadership (with regard to the AAR facilitator) may arise here as well, along with the more basic investigations of the AAR process.

A third category of research center revolves around the examination of AARs for the purpose of generalization. As an increasing number and variety of organizations adopt the AAR for their particular purposes, questions about duration, focus, and interaction style must be addressed. Unfortunately, many organizations have not considered such questions in sufficient detail. As a result, the application of prior AAR methodology to specialized training scenarios has been inefficient at best and at times counterproductive.

As a result of the diaspora of the AAR concept that occurred in the 1990s, allied military institutions began to adopt the AAR for their own use. Prolific examples of research activity may be found within literature published by (at a minimum) the Air Force, Navy, Marines, and Coast Guard. The U.S. Army Center for Army Lessons Learned (CALL) has as its mission the improvement of performance; for that reason, they are among the most invested agencies in the AAR process.

Outside of the military, there have been a number of organizations in the commercial sector that have studied the AAR process. Many of these organizations view the AAR as a panacea for the low-performing organization. In fact, the Harvard Business School has included methodology and philosophy of AARs as essential reading for the study of high-performing organizations (Garvin, 2000). Many of the organizations are consulting centers, catering to the military, academic, and business world in their quest for high performing teams. A large variety of academic institutions have also been active in the study of AARs. In most cases, such institutions have been those with ties to the academic fields of human factors, industrial psychology, industrial engineering, instructional design, or training. Frequently, such schools will also be co-located with military centers or units.

In recent years, there have been a number of agencies that have begun to look strongly at the AAR process. The military remains invested in the process, due to unconventional conflicts being pursued in Afghanistan, Iraq, and Bosnia. In addition, the reaction of aid relief centers to natural disasters such as Hurricanes Katrina, Rita, and Ike have caused a renewed interest in the AAR procedure to understand the fallibilities of the emergency response system. In fact, Pulliam (2006) noted that President Bush had ordered an investigative AAR process to be completed in the wake of Hurricane Katrina. In addition, as noted earlier in this report, the Wildland Fire Safety Association has developed its own AAR process, based in large part on the U.S. Army's approach. As businesses and agencies continue to grapple with global economic challenges, it is foreseeable that the AAR procedure will be adopted by even more agencies. Such

attention may result in the growth and maturation of the AAR. Research has already been completed to facilitate the automation of the AAR process (Chen, Jensen, Bascara, & Harmon, 2007).

Lessons Learned Across Research Domains or Fields

The report by Newlin and Bliss (2007) included a number of research-driven recommendations for the optimal conduct of AARs. The majority of those recommendations have been reproduced as Appendix A of this report. Further conclusions may be drawn from the research that has been presented here. The following bullet points are meant to summarize the theoretical information presented earlier.

- AAR designers and facilitators should arrange and implement AAR sessions to ensure the prompt encoding, robust storage, and ready retrieval of task relevant information by trainees. An example of such a process may involve exploiting human tendencies for spreading activation by pointing out relationships among mission items, goals and procedures.

- To enable deep and lasting processing of mission information, AAR facilitators should arrange for presentation of "ground truth" from a variety of perspectives.

- Facilitators should use hierarchical review of mission events to cater to the development of cognitive scripts, mental models, and cognitive maps.

- To prevent false memory formation, facilitators should encourage checks and balances among team members, along with presentations of recorded mission action.

- Facilitators should take care to address the need for shared situation awareness among team members.

- Team members should be encouraged to express the benefits gained by review of team performance.

- Demands for divided attention should be balanced with the growth of expertise by presenting material in a graduated (adaptive) and distributed fashion.

- Facilitators should be flexible in team assignments and feedback, focusing on dyads or smaller team units to illustrate important points.

- Facilitators should be prepared to rehearse contingency leadership plans in situations where attrition occurs.

- Facilitators and team members should be sensitive to communication requirements and breakdowns. Social dynamics such as attributions, conflict, and cooperation are central to a team's ultimate success.

- Teams and facilitators must be aware of mission tempo, to take advantage of "down times" for reorganization and planning.

- Feedback sessions should allow for self-feedback and task feedback possibilities.

- Facilitators should be aware of the potential for negative reactions to feedback, and plan accordingly.

- Where possible, feedback items should be accompanied by critical incidents.

- Facilitators should ensure that all team members accept the feedback given during the AAR session. If dissent exists, work to resolve the conflict.

Need for Additional Research

The burgeoning interest in AAR design and implementation has led to advancement in many areas. Yet, given the complexity of the AAR process and the advancements being made in simulation and training and automated task delegation, we believe that additional research is warranted in several areas. In some of these areas, research has been conducted by a limited number of scientists, trainers, and institutions. In others, little work has been attempted.

Distributed AAR – As the nature of warfare changes to accommodate a variety of battle scenarios, Soldiers often find themselves fighting an unconventional foe that relies on unorthodox methods to achieve its goals. Additionally, military forces are often required to win the hearts and minds of citizens and governments by engaging in peacekeeping, peace enforcement, and humanitarian missions. Such a diversity of duties frequently requires that teams of Soldiers be formed from several centers. The result reflects a joint philosophy of warfare, and requires novel training methods to ensure that Soldiers can learn quickly and perform their duties effectively. Modern simulation technology has offered the capability to train tasks to teams that are geographically distributed. Yet AARs are a piece of the training puzzle that has yet to be refined for application to geographically dispersed teams. Some systems are in place to attempt this (Lampton, Bliss, Kring, Martin, Saffold, & Garrity, 2008); however, the emphasis has been largely on technological capability. If successfully used, distributed AAR systems may allow performance to be enhanced. However, a considerable number of social and knowledge management issues must be considered before seamless implementation is achieved.

Shared mental models – As we investigated the relevant literature with regard to cognition, team training and situation awareness, we realized that these three areas were of extreme importance to the success of AARs, and that they intersected through one major construct: shared mental models. In many cases, AAR facilitators must lead team members to understand the battle scenario from a common point of view. They must also encourage individual team members to appreciate their teammates' points of view. For both of these goals to be achieved, it is necessary to understand how team members can develop a shared mental model of the battle, the terrain, the opposing force, and the guidelines that shape the encounter. Shared mental models have been a popular topic for

researchers to explore for many years (Banks & Millward, 2007; Cannon-Bowers, Salas, & Converse, 1993; Minionis, Zaccaro, & Perez, 1995). However, such investigations have not always targeted the AAR process. Such a process is unique because of its complexity and its focus on instructor-led instruction. We believe it is imperative to study variables specific to the AAR experience to understand how they might influence the acquisition of shared mental models. Such variables may include (to name a few) inter-team competition, conflicting goals, attrition of team members, and spontaneous collaboration with outside leaders or teams.

Another area that is related to shared mental models is the notion of shared situation awareness. Though not emphasized strongly in this report, it is clear that a desired product of the AAR session is a common appreciation for the battle situation and the influences on it. Of particular importance are the various levels of situation awareness and how they may change given tactics and strategies employed by the trainees. Military teams, like many other teams, are encouraged to anticipate conflicts and obstacles to success. To do so, it is imperative that members maintain shared level 3 situation awareness. However, communication is essential for the formation of such a commodity. Frequently, members of a fire team may experience different aspects of a conflict. Similar to the blind men describing the elephant, they may each hold a piece of the puzzle, so that only by sharing their information might they all enjoy an accurate prognostication of future events. Investigating shared situation awareness may entail examinations of technology-driven environmental displays (of terrain, forces, or supplies) and may require consideration of past performance and events.

A further area that has enjoyed considerable research is leadership. Within this report, we have made several recommendations that concern the leadership behaviors demonstrated by AAR facilitators. Though researchers have studied leadership behaviors for many years (dating back, perhaps to the Ohio State studies of leadership; see Fleishman, 1953), the AAR environment introduces aspects of contingency-based leadership that may be most relevant for modern theories. Yet, certain modern theories of leadership such as transformational leadership and leader-member exchange theory may not apply to the AAR situation, due to the scripted nature of training missions and trainee roles and behaviors. Interestingly enough, the AAR process bears a similarity to a number of other leadership situations such as sports teams or business-related “tiger teams”, where problems are relatively well-defined and members have acknowledged areas of expertise. Future researchers may do well to explore the practice of effective leaders so that facilitator actions may be prescribed and perhaps ultimately automated.

A final area that warrants study seems obvious enough to raise eyebrows. Yet, though the AAR has been an Army tradition for more than 30 years, investigations of its effectiveness have been few and anecdotal. As is reflected within our review of the literature, the theoretical substrates of the AAR have been investigated to a similar conclusion: a structured feedback session that includes collective review of performance and guided improvement steps should be successful for performance refinement. However, what are missing are rigorous, empirical demonstrations of this conclusion. It is necessary, now more than ever before, that experimenters demonstrate that well-designed and meticulously implemented AARs can lead to improvements in training. Such investigations must go beyond collecting subjective opinions and general statements

of approval voiced by command elements. Rather, researchers must complete a program of transfer of training studies to show that variations in AAR design and conduct will cause differences in individual and collective task performance. Naturally, studies such as these have been extremely difficult to complete because of the variability associated with human facilitators, human trainees, complex missions, and logistic constraints. However, with the growth of virtual battlespaces and tools for reviewing and documenting training performances, the ability now exists to accomplish this goal. An associated but loftier goal would be the documentation of relative benefit linked to changes in facilitator technique and AAR content. Showing such a linkage would allow commercial, governmental and academic enterprises to adopt the AAR method and reap its benefits more reliably.

In conclusion, much work has been completed to support the design and implementation of AARs for military and non-military purposes. However, those who have employed AARs have not been content to wait for analysts to complete their work. Instead, event trainers and investigators have proceeded with AAR implementation, using the technique to justify policy shifts, design decisions, and implementation of strategies for training. It is now time to integrate the underlying theories into a general theory of AAR. Doing so may allow researchers to better study the technique, and will hopefully encourage AAR designers to consider the implications of their decisions. Our research team faces a clear path forward: we plan to validate the ITAAR model, noting where it converges and diverges with real-world AAR practice and established theory. We will then be poised to make clear recommendations for its improvement and use.

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Appendix A: Recommendations (from Newlin & Bliss, 2007)

Recommendations for the Facilitator's Role in AAR

Topic	Source	Recommendation
Facilitator's Role	Dyer, 1986	Facilitators should not interrupt during training exercises. Evaluation aids help the instructor monitor actions that are indicative of good trainee coordination and communication. Diagnostic tools assess trainee knowledge prior to training assessment and Using a standardized assessment of team performance periodically during the training exercise.
	Atwater, Rousch, & Fischthal, 1995	A 360 degree evaluation helps the facilitator maintain objectivity and improve instructional methods.
	Borman, 1997	A 360 degree evaluation provides the facilitator with information about their abilities as well as group training performance.
Effective Leadership	Borich, 1989	The facilitator should clearly communicate with trainees. The facilitator should be capable of adjusting their communication style to fit the trainees' level of knowledge. Facilitators should be task oriented. Effective facilitators should incorporate all trainees in training.
	Schmidt & Kleinbeck, 1990	Facilitators should formally state their expectations in an instructional plan so the trainees understand their learning goals.
	Mager, 1984	Learning goals should describe the appropriate action, clearly identify the environment and accessible tools, and the acceptable parameters for performance. Facilitators should provide feedback that compares training performance to goal criteria.
	Rosenthal & Jacobson, 1968; Eden & Shani, 1982; Hoyt, Halverson, Murphy & Watson, 2003	Facilitators should be aware that their expectations improved performance.
	Gobet, 1998	Facilitators should possess expert knowledge because they must quickly identify critical events during training.

The facilitator's role in feedback	Spencer & Spencer, 1993; Raynor & Rubin, 1971	The facilitator should not be the only feedback source. Trainees are more engaged in learning, post training discussions, and generating feedback when the facilitator addresses their needs. An AAR facilitator should communicate to group members that their opinions are essential to the AAR process.
	Watkins, 1990	The AAR facilitator should utilize trainees when generating feedback and guiding discussions. Facilitators should perceive training as an opportunity to learn from trainees.
	Marquardt, 1999	In action learning, the facilitator should teach trainees to evaluate their individual and group performances and generate effective feedback. The facilitator should be aware of how trainees' assumptions influence their ability to identify problems and develop solutions.
	Dyer, 1986	A facilitator should effectively communicate information to learners and appear open to input from trainees.
	Smith, 2001	Those with implicit knowledge should concretely describe his or her implicit knowledge when information is changed from implicit to explicit form. This is done by experiencing one's state of mind while performing a task and then explaining their thought processes. When converting explicit knowledge to implicit knowledge, the knowledge should be specifically framed to fit the trainee's frame of reference.
	Bandura, 1977; Hoyt et al., 2003	A facilitator should have confidence in their abilities because this affects how they lead and how a group of trainees perform.
	Bandura, 1977; Goldstein and Sorcher, 1974	Facilitators should model behaviors that generally promote better performance.
	Gist, 1989	Facilitators should encourage trainees to use analytical thinking to brainstorm problems. The facilitator should encourage trainees to entertain all ideas during brainstorming, despite their acceptability. Trainees should express their self-generated solutions with other group members through writing or verbalizing. Facilitators should encourage trainees to counteract a negative thought about their ideas with a positive one.

Recommendations for Groups of Trainees in AAR

Topic	Source	Recommendation
Effective teams	Gladstein, 1984	Arrange trainees to optimize positive group member interactions.
	Sundstrom, DeMeuse & Futrell, 1990	Provide trainees with a clear mission statement. This should refer to their purpose within the larger organization.
	Borman, 1997	A 360 degree evaluation provides the instructor with information about their abilities as well as group training performance.
Factors that affect group performance	Matsui, Kakuyama & Onglatco, 1987	Collective group feedback improves group training performance. Individual and group feedback also prevents social loafing and improves both individual and group performance.
	Matsui et al., 1987; Saavedra, Earley & Van Dyne, 1993; Locke & Latham, 2002	Goals should relate to the training task and the feedback should describe how training performance meets training goals. Group goals plus individual goals are conducive to group performance when the feedback reflects the goals. Setting group goals causes trainees to collectively generate solutions and strategize about how they can improve performance. Specific and challenging goals often generate better performance.
	Kiggundu, 1981	Trainees should organize their group to maximize team members' abilities.
	Lim & Klein, 2006	Shared mental models must contain accurate information about the procedures, technology and environment. All group members should share similar information.

Topic	Source	Recommendation
	Cannon-Bowers & Salas, 2001	Group members should share similar performance expectations because there are certain protocols and procedures associated with the task. Team members should have the same task performance knowledge. Team members should know their teammates' weaknesses and proficiencies and how these are distributed among the group. Team members are generally more effective when they have similar perceptions of the same events. This includes sharing similar attitudes and beliefs of a variety of tasks.
	Saavedra, Earley & Van Dyne, 1993	Group members who share information, collectively discuss problems and develop solutions will be more cohesive.
Learning	Fitts, 1962; Gobet, 1998, Logan, 1988; Gonzalez, Lerch & Lebiere, 2003; Patrick, 1992	Trainees should verbalize newly acquired knowledge. Trainees should fixate on newly acquired knowledge until all errors are eliminated. Increased practice leads to increased automaticity and generalization. Once skills become automatic, trainees should focus on increasing speed and efficiency despite multiple tasks, task complexity or time pressure.
	Hendrickson & Schroeder, 1941	Trainees should be given theoretical information about the training task. Theoretical explanations during training must be applicable and relate to a task. In AAR, theoretical explanations should explain why training tasks are important in the overall scheme of the learning task.
	Marquardt, 1999	Trainees should collectively create solutions to problems while learning task skills. Each team member should actively contribute to the group's learning by problem solving and discussing group performance. Team members should collectively interpret performance data, thereby creating consensus and group cohesion.

Recommendations for Performance Appraisal

Topic	Source	Recommendation
Purpose of the Performance Appraisal	Patrick, 1992	The performance appraisal should identify which training elements benefit training performance, so adjustments can be made to the training process. By manipulating training variables, training elements are isolated and assessed.
Objective and Qualitative Measures used in Performance Appraisal	Kahn, 1977 & Jones, 1997	Objective measures can evaluate performance and compare performance to team goals.
	Kinlaw, 1991; Coulter, 1979; Scott, 1977	To evaluate group functioning, surveys should include questions about team members' feelings of cooperation, group cohesion, and flexibility. These questions should assess group members' open mindedness in discussions and responsiveness to criticism.
	Borman and Motowidlo, 1993; Levy & Steelman, 1997; Cohen, 1994	Less traditional measures provide a more complete assessment of AAR effectiveness when coupled with objective measures. AAR performance appraisals should evaluate team members' interactions and cooperation with others, their willingness to participate in discussions, and the facilitators' eagerness to teach.
	Cohen, 1994	Appraisals should include other elements that affect group effectiveness: task inherent characteristics, team member organization, self management and group member encouragement.
	Nieva, Fleishman and Rieck (1978)	Appraise team design and how information is dispersed among team members. This includes how trainees share resources and knowledge. Assess how group members assigned and completed tasks. Groups should assign tasks based on their knowledge of group member's abilities. Evaluate how group members collectively identify performance errors and problems.
	Hackman, 1987	Evaluate the effect of team member interactions on other group members. These interactions should encourage and fulfill individual group members.

Appraisal Systems	Levy and Steelman, 1997; Matsui et al., 1987	Appraisal methods should combine elements of individual and group assessment. Using multiple raters, additional peer and self evaluations eliminates the problems associated with a biased evaluator.