Training Aviation Manned-Unmanned Teaming Skills at Home Station

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ABSTRACT

Manned-unmanned teaming (MUM-T) combines strengths of the scout-attack helicopter with those of the unmanned aircraft system (UAS). MUM-T requires that UAS operators become proficient in the same scout-reconnaissance (SR) skills as scout pilots. Research by the Army Research Institute (Stewart, Bink, Barker, Tremlett, & Price, 2011) indicated that UAS operators are seldom proficient at SR skills and that training opportunities at home station are limited. Thus, effective home station SR training is needed for UAS operators. SR skills are cognitive and procedural, perishable if not practiced. Training must incorporate advanced instructional strategies designed to optimize learning and retention. Learning research has suggested that faded, worked examples may be superior in terms of acquisition and retention to traditional, unguided methods for teaching novices complex problem solving skills. Fading reduces cognitive workload by providing worked items (scaffolding) that are gradually removed on subsequent trials, until the student completes an exercise unassisted. Fading is based on the sequence of problem solving steps (forwards/backwards), or the student's providing a correct answer (adaptive). A PC-based training tool was developed to determine which of two faded-worked instruction methods (backwards or adaptive) offers the more effective training approach for MUM-T skills, compared to self-directed training. Another important research question is whether fading techniques used to teach structured problem solving are also effective for scenario-driven exercises. Sixty-two UAS operators graduating training at Ft. Huachuca, AZ participated in an experimental test of these approaches, using two SR skills (SPOT report and Battle Damage Assessment). Participants indicated greater familiarity with SPOT than BDA. Results suggested that both backwards and adaptive fading produced skill acquisition superior to self-directed learning, though which fading method worked best seemed to depend upon familiarity of the task trained. Adaptive fading was more effective for SPOT, while backwards fading worked best for BDA.

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INTRODUCTION

Army Aviation faces many challenges in training operators of unmanned aircraft systems (UAS) to interoperate with manned scout-attack helicopters. This manned-unmanned teaming (MUM-T) requires the UAS aircrews to learn complex scout-reconnaissance skills that are cognitive and procedural, and therefore highly perishable. Stewart, Sticha, and Howse (2012), using a method similar to Mission Essential Competencies (Colegrove & Bennett, 2006) successfully identified and prioritized a final list of 20 training-critical skills for MUM-T. A training-critical skill is defined as (a) important to mission success, and (b) not performed or poorly performed by the majority of UAS operators who have graduated from Advanced Individual Training (AIT). Training these skills in the operational unit is made even more challenging when one realizes that training opportunities are very limited at home station, due to a host of reasons, such as restrictions on operation of pilotless aircraft in FAA airspace, and lack of suitable range space on the installation (Stewart, Bink, Barker, Tremlett, & Price, 2011). Stewart, et al., (2011) interviewed principal staff officers and UAS platoon leaders and trainers at three Brigade Combat Teams at United States Army installations. In addition to the limitations on training at home station, the investigators also learned that UAS aircrews acquired these critical tactical skills while deployed in theatre. This was primarily on-the-job training as opposed to formal, structured unit-level training. These subject matter experts also stated that the only real opportunity for unit-level training and practice in the United States for UAS aircrews was at the Combat Training Centers (CTC). However, a visit to one CTC by the research team (Stewart, Barker, & Bink, 2010), showed that RQ-7B Shadow crews were not evaluated on mission-relevant skills. Instead, they were assessed on such criteria as number of hours flown, and number of successful launches and recoveries. The missions were more characteristic of intelligence-gathering and surveillance, rather than scout-reconnaissance. Therefore, the opportunity to train and reinforce scout-reconnaissance skills at this CTC was not exploited. The present research effort addresses one potential approach to this set of challenges: the development of an accessible, affordable training tool that is PC-based and usable on common handheld platforms, such as smart phones and tablet PCs.

Guided vs. Unguided Instruction

Coupled with portability and usability, such a tool must be grounded in scientifically-based approaches to training. Evidence of the superiority of guided over unguided instruction is extensively supported in the research literature, including better transfer of learning to new contexts and situations (Kirschner, Sweller, & Clark, 2006). Conversely, Kirschner et al. also found that the effectiveness of purely unguided instruction was limited by prior knowledge and task familiarity. While there has been a historical debate over the efficacy of guided (direct) instruction compared to unguided (problem based) learning, faded worked example instruction has been proposed as a middle ground approach with the advantages of both and few of the drawbacks (Moreno, Reisslein, & Delgoda, 2006). In this approach to scaffolding, the provision of support at early stages of the learning process is gradually removed as the learner progresses through iterations of a task. For the present project, we concentrated on two fading approaches, which, through their use of worked examples and fading techniques, reduce the student's cognitive workload, thereby increasing the amount of working memory available for problem solving. After a learner initially views a complete step by step worked example of a problem or task, the scaffolding is removed at each step as the learner attempts subsequent iterations of the task until finally the learner completes the task with no support. The sequence in which scaffolding can be removed is defined by fading. Fading is based on the sequence of problem solving steps in which scaffolding is systematically removed (forwards or backwards fading), or on student performance (adaptive fading). Kirschner et al. present substantial empirical evidence that employing worked examples and fading techniques is superior to unguided instruction in which students are expected to discover the correct solution to a problem themselves. The authors add that there are pitfalls for the unguided and minimally guided techniques that were in vogue in the 1970s. Among these are numerous false starts due to misconceptions about the meaning of the content and high demands on cognitive and memory resources. This is attributed to the fact that minimally-guided instructional strategies tend to ignore the cognitive architecture that supports the learning process. The authors cite one qualitative classroom observation study by Aulls (2002), who found that when unguided instruction appeared to have succeeded, the teachers had actually provided their own scaffolding. It should be noted that guided instructional techniques have been shown to be successful for structured problems, which require several discrete steps to solve. This is typical for mathematics and engineering. It yet remains to be demonstrated how effective these guided approaches are for scenario-based training of the kind employed in the virtual and constructive simulation environments used for military team-level training. It is also not clear which guided instructional strategy works best for which kind of material, though Moreno et al. (2006) showed that forwards fading was better than backwards fading for relatively easy (and familiar) material that did not make great demands on working memory. Reisslein, Atkinson, Seeling, and Reisslein (2006) obtained a complex interaction between the learner's prior knowledge and efficacy of fading vs. other guided, worked-example approaches. In short, these investigators found that fading did not stand out as the superior approach, regardless of prior knowledge levels. Thus it would seem reasonable to expect interactive results when different guided instruction techniques are compared, across tasks varying on dimensions such as difficulty and familiarity.

Technical Objectives

The technical objectives of the present research effort are to (a) develop a prototype computer-based training tool for UAS operators to practice MUM-T skills at home station (training will be individual-based and adaptive to the trainee's skill progression), and (b) to evaluate experimentally the effectiveness of three approaches to delivering this adaptive training: (1) adaptive fading, (2) backwards fading, and (3) self-directed (non-scaffolded).

Hypotheses

We expected both fading approaches to be superior training methods compared to the self-directed method, with backwards fading as the most effective approach overall for training cognitive and procedural tasks for MUM-T. However, intervening variables may mediate this main effect. Due to complex interactions with task familiarly, it is somewhat difficult to specify in advance how backwards fading and adaptive fading techniques would compare in terms of accuracy and recall. Based on the limited findings from the research literature, it would seem reasonable to expect that backwards fading would yield better performance when compared with adaptive fading and self-directed approaches on a less familiar task, as opposed to a more familiar task. For the familiar task, which should impose a lesser cognitive load, adaptive fading should have the advantage over the other two approaches. One should note that often familiarity may be confounded with ease or difficulty of performing a task.

METHOD

Participants

Participants were 62 UAS operators, military occupational specialty (MOS) 15W. All had recently graduated from AIT and were currently training at Ft. Huachuca, AZ. TRADOC Capability Manager (TCM) UAS requested participation from units and helped to coordinate the participation schedule with the UAS Training Battalion (UASTB). Participation was based on unit and soldier availability. All soldiers were enlisted ranks between E-1(Private) and E-3 (Specialist), with no other MOS prior to their 15W designation.

Materials and Apparatus

MUM-T training tool. The MUM-T training consisted of three steps: a pretest, training phase, and posttest assessment. In each phase the program presents several scenarios in a narrative format that describe hypothetical scout/recon missions in which the UAS is supporting a manned aircraft or ground unit. The participant must assimilate the appropriate information provided in the narrative into the proper communication format for a report to an armed helicopter or ground unit. The response format was multiple choice and participants were prompted to select the correct information for each line of a report. The training tool contained two modules, each corresponding to a tactical task (or skill). One task provided training for making a SPOT or SALT-W report (size, activity, location, time, what to do next) while the other task provided training for making a battle damage assessment (BDA). SPOT training followed the familiar SALT-W format and BDA training followed an 8 line procedural format. On the basis of prior interviews with UAS trainers and operators, it was expected that students would be more familiar with SPOT reporting than BDA. All instructions and the MUM-T training tool itself were presented on a standard PC-based laptop computer. The posttest survey of attitudes toward the experiment and familiarity with the tasks performed was presented via a paper questionnaire.

Design

A 3 (instructional approach) X 2 (task) between-groups design was employed (i.e., independent assignment of participants to experimental conditions). Participants were randomly assigned to complete either the SPOT or BDA training task. In addition, again based on random assignment, the task employed either backwards or adaptive fading. The third, self-directed condition allowed the participant to engage in self paced study of worked examples. Skill acquisition was assessed immediately following training and by a test of retention administered 48 hours after training. The criterion for successful skill acquisition was established as two consecutive errorless SPOT or BDA reports. SPOT and BDA reports are concise narrative reports of essential information covering events or conditions that may have an immediate and significant effect on current planning and operations. SPOT reports provide information about potentially hostile activities, while BDA reports provide post-engagement intelligence on target disposition. Table 1 presents the reporting requirements for SPOT and BDA.

Table 1. SPOT (SALT-W) and BDA Reporting Requirements

SPOT Report in SALT-W Format
In this scenario, the UAS (call sign Condor 44), spots a group of 8 potential hostiles, which may be setting up an ambush on an infantry platoon. The platoon (Wizard 27) is conducting cordon and search of the same village that the 8 men are approaching. The UAS calls in a SPOT report. *Wizard 27, this is Condor 44 with a SPOT report:* **Size: Eight individuals carrying small arms.** **Activity: In a line parallel to the road among the trees.** **Location: 030 degrees at 1,200m down trail you are taking, on right as trail bends East.** **Time: 0545L (local). Estimate you are about 15min from their position.** **What: Continuing to observe activity; scanning area for any others.**
Battle Damage Assessment (BDA) report
In the same scenario, the UAS aircrew noticed that the 8 individuals were setting up a mortar position for an ambush on the infantry platoon (Wizard 27). An OH-58D helicopter (Spur 11) engaged the mortar team with 2 rockets then the rest of the enemy personnel with its .50 cal machine gun (about 300 rounds). Wizard 27 moved forward to establish defensive positions and engaged the enemy as well. The mortar received major damage. Both men manning the tube were destroyed. Spur 11 then engaged the remaining 6 personnel with 300 rounds .50cal. These enemy personnel were destroyed. There is no further movement around the area. Wizard 27 is asking for a final update so it can move forward to search the area for intelligence. *Wizard 27, this is Condor 44, with BDA:* **Line 1: Unit/Call sign: Spur 11.** **Line 2: Target: Enemy mortar position with 8 total individuals.** **Line 3: Location/Grid: XF 55456637.** **Line 4: Time of attack: 0556L.** **Line 5: Delivery System: OH-58D.** **Line 6: Weapons: 2 rockets; 300 rounds 50 cal.** **Line 7: Analysis: 1 mortar tube bent, 8 individuals destroyed.** **Line 8: Narrative: No further movement in area.**

Procedure

Orienting instructions. At the outset of the experiment, participants were presented with the following instructions: *In the training module you will be reading narrative scenarios that describe a tactical situation. You will be asked to select the appropriate information from these scenarios and use it to complete a (BDA report /SPOT* *report in SALT-W format). Before beginning the training, you will view a sample narrative and sample (BDA/SPOT) report and have a chance to complete a sample (BDA/SPOT) report on your own. Please ask the researcher any questions you have about (BDA/SPOT) reports or the training.*

Presentation of experimental materials. Participants first read a narrative and then as they clicked "next" the correct answers for the report were revealed. After viewing the initial worked example scenario, participants were presented with a second narrative and were asked to select the correct information for each line of the report without assistance (no-support trial). Following the pretraining test, participants entered in to the training portion of the task module where they continued to practice constructing SPOT or BDA reports from additional narrative scenarios in the same manner as the no-support trial. During the training trials, experimental participants were assigned to either of the two fading conditions or to the self-directed condition for each scenario. Which parts were completed and which parts participants were asked to complete varied from scenario to scenario based on fading condition. Scenarios presented to each participant were automatically and randomly drawn from a database of twenty tactical scenarios.

Backwards Fading

In the backwards fading condition participants were first presented with a partially completed worked example. All steps of the report were completed except for the final step. In the case of the SPOT report that would be "W" or "what." Participants provided the answer for this final step and the module progressed to a new narrative scenario. Again the report for this scenario was partially completed; however the final two steps were left unfinished for the participant to complete (for the SPOT report that would be T and W). As the participant filled in the missing portions of the report and received feedback, the task module progressed in this manner of presenting new narrative scenarios with fewer sections of the report completed, until the participant finally completed an entire report independently.

Adaptive Fading

The adaptive fading condition was identical to the backward fading condition with one exception. During the fading process if a trainee gave an incorrect response on a particular step of a report (e.g. incorrect Line 3 in a BDA report) instead of fading support for that step in the next narrative, that step would be demonstrated again. In addition, if a trainee made an error on a step that had already been demonstrated in a previous iteration, that step would also be demonstrated in the subsequent scenario. Thus, each time a trainee committed an error on a report, the section of the report in which the error was committed was presented, regardless of where the trainee was in the fading sequence.

Self-Directed

Participants were presented with the same narratives used in the faded worked example training conditions. However, instead of working their way through several scaffolded narratives, they were able to study the content of completed scenarios at their own pace. Participants were able to manipulate which parts of the completed report were revealed and which remained hidden by clicking buttons on the screen to reveal or hide each of the lines of the report. They were able to reveal or hide each line in any order and as many at a time as they wanted. When the participants finished studying a narrative they were able to proceed by clicking the NEXT button at the bottom right hand of the screen. A menu box provided the option of studying more narratives or moving on to the criterion/assessment phase.

Performance Assessment

When participants completed the training session or were finished studying examples, the program advanced to a criterion stage where their ability to complete SPOT or BDA reports without scaffolding support was assessed. Participants were required to complete two consecutive errorless SPOT or BDA reports. A mistake at any point, whether on the first or second report, required the participant to start over and attempt to complete two new reports correctly. After meeting the criterion, participants completed one final SPOT or BDA report without any scaffolding or support. After completing the training module, participants completed the training attitudes questionnaire.

Retention Test

The purpose of the 48 hour retention test was to assess how well the content taught was retained over time. Just as important, it is also a test of the degree to which what is learned generalizes to materials and settings that are different in some ways from those used in the acquisition phase. Participants returned after a 48 hour period to complete the retention trials. These were identical to the criterion trials from the training session, in which participants performed their assigned SR skills to a criterion of two consecutive error-free iterations, followed by a no-support trial. However, the scenarios presented to participants during the 48 hour retention phase were drawn from a new pool of 20 scenarios, thus the information presented was novel to all participants.

RESULTS

Forty-Eight Hour Retention Interval

The most critical performance indicator in this experiment, considering the scope of this research, is the participants' performance after the 48 hour retention interval, in which they were required to relearn the skills using new, unfamiliar scenarios. Testing retention after the 48 hour interval resulted in some significant changes in performance among SPOT and BDA trainees. Although there was no significant main effect due to the three training methods with regard to accuracy (% correct) a two-way analysis of variance (ANOVA) performed on criterion accuracy scores during the retention period revealed a significant (task x training method) interaction, $F(2, 56) = 4.8$, $p < .02$, such that in the adaptive and self-directed training conditions, trainees in the BDA condition performed worse on the retention task than those in the SPOT report condition. Conversely, in the backwards fading condition BDA trainees were more accurate in the retention task than SPOT trainees.

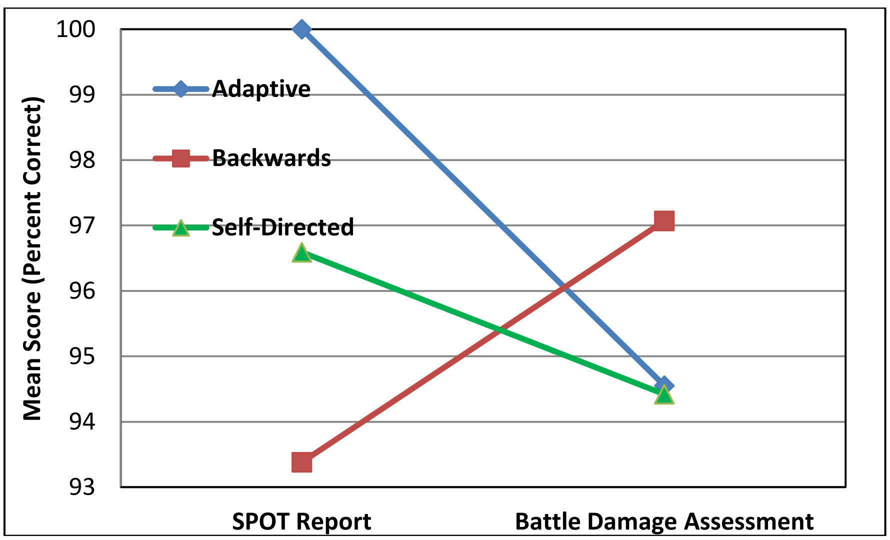

Figure 1. Mean scores on criterion trials as a function of training method and type of task.

Figure 1 illustrates the interactive effects of training method and task on performance accuracy on criterion trails during the 48 hour retention period. The dependent variable is the average percent of correct responses over the total number of trials to criterion, which varied with each participant. One caveat is the restricted range of scores, which may indicate a possible floor effect, as each participant was required to repeat the test trials until reaching criterion. A glance at this figure shows that adaptive fading was clearly the best approach for learning and retaining the steps required for completing a SPOT report. However, for the BDA task, backwards fading had the advantage.

Figure 2 presents the effects of the same independent variables on time in seconds to mastery. Participants in the backwards fading condition took the least time to reach criterion on the BDA task, but closely matched the other conditions on time to criterion on the SPOT task. Note that there were negligible differences between the three training methods in the SPOT condition. A two-way ANOVA showed a significant main effect of task module, $F(1, 56) = 4.50$, $p < .04$. There were no other significant main effects or interactions.

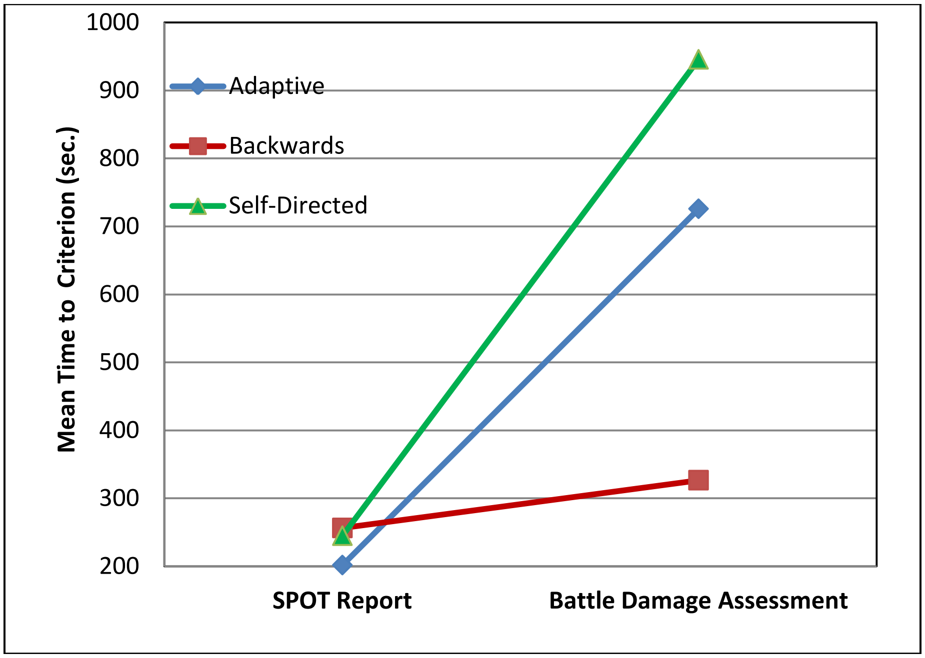

Figure 2. Mean time to criterion in seconds as a function of training method and type of task.

Figure 3 depicts the number of trials to criterion as a function of the+ assigned task. Participants in the backwards fading condition required the fewest trails to reach criterion for BDA, but not for SPOT, which differed little between conditions but slightly favored adaptive fading. Figures 2 and 3 show that on the retention test more time and effort was expended mastering BDA than SPOT, though this was difference was smallest for backwards fading.

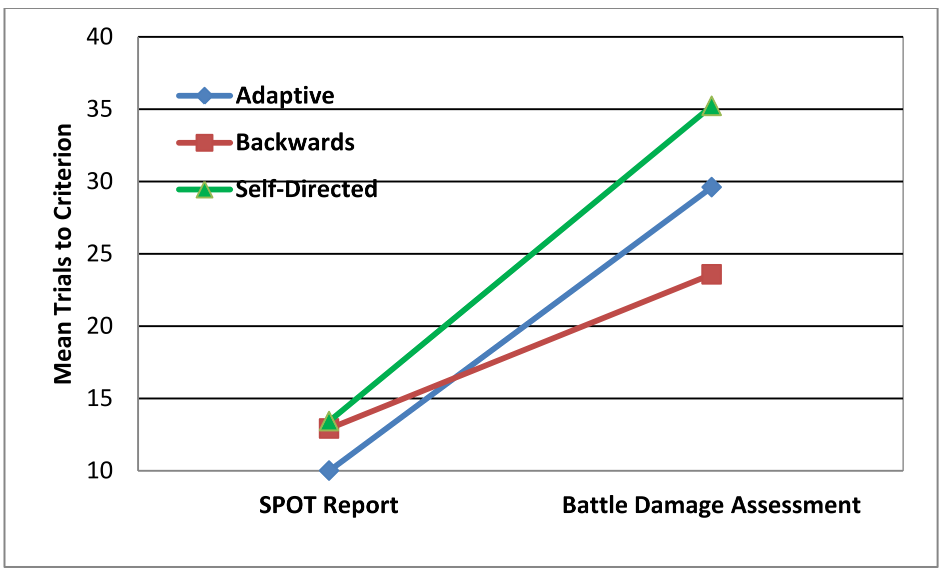

Figure 3. Mean number of trials to criterion as a function of training method and type of task.

In no instance was the self-directed (non-scaffolded) approach advantageous for learning and retaining either skill. On the contrary, this approach seemed the least efficient overall in terms of time, effort and performance. For number of trials to criterion, there was a significant main effect due to the task trained, $F(1, 56) = 31.13$, $p < .001$. No other effects were significant.

These three figures, based upon the estimated marginal means from the two-way ANOVA, further indicate an interaction between task type and training condition such that backwards fading seemed to have a somewhat more stable effect on performance across time and task. Adaptive fading on the other hand produced superior retention for SPOT training, though retention of BDA training suffered. These findings are consistent and in the expected direction with our hypothesis concerning the interactive effects of task familiarity and training method on learner performance. The greater difficulty and lesser familiarity of BDA vs. SPOT reporting is evident in the greater time and number of trials spent mastering this task. These findings are also consistent with research which has examined the mediating effects of task familiarity and difficulty (e.g., Moreno, Reisslein, & Delgoda, 2006).

DISCUSSION

Understanding Complex Interactions

No significant main effects were obtained across the three instructional approaches: adaptive fading, backwards fading, and self-directed study. Recall that we predicted interactions between task familiarity and the three instructional approaches, with backwards fading having the advantage for the less familiar tasks, and for the more familiar, adaptive fading. The interactive results obtained for scores on criterion trials were in the direction expected, when we consider that SPOT and BDA conditions were not equal in terms of apparent difficulty and prior knowledge. Participants' self-reports on the postexperimental questionnaire indicated that 35% in the BDA condition were "Very Familiar" with this task. By contrast, 85% in the SPOT condition were equally familiar with SPOT reporting. This was not surprising since SPOT reporting is an important part of the training syllabus. Moreno, et al. (2006), found that whether one fading approach worked better than the other depended in part on the learner's prior knowledge of the task. We found that participants in the adaptive fading and self-directed conditions experienced more difficulty with retention of BDA than SPOT reporting during the post training trials. The notable exception was those in the backwards fading condition, in which participants showed better retention on BDA. The time to reach criterion for BDA during retention trials was greater for adaptive fading and self-directed approaches than for backwards fading. These findings imply that backwards fading is the most stable and efficient approach. However, adaptive fading was the performance leader for SPOT, in terms of the percentage of correct responses. It seems then, that adaptive fading may facilitate retention of familiar tasks, though it could inhibit retention of less familiar tasks. Backwards fading, by contrast, appears to be the method of choice for the learning and retention of material that is relatively new (and hence more difficult) to the learner. Finally, the results obtained provided no grounds for recommending self-directed study as an instructional approach, regardless of the task trained.

Conclusions and Implications of Findings

From these findings we cannot simply recommend the "best" fading technique. In the present research effort, it was apparent that BDA required significantly more time and effort to master than did SPOT reporting. Participants overall appeared to have performed SPOT reports during training at Ft. Huachuca to a much greater extent than BDA. This research effort demonstrated that two fading techniques had their own unique advantages, depending on how well the learner knew the task. The important factor seems to be cognitive task load, which could suggest a practical recommendation for adaptive vs. backwards fading techniques. That is, for acquisition of new cognitive and procedural skills, backwards fading would be the technique of choice, whereas for the maintenance of skills already learned, adaptive fading would have the advantage. This is important for both manned and unmanned aviation, where many cognitive and procedural skills are highly perishable and must be kept current once acquired. In short, just as many if not more resources may be committed to maintaining proficiency on a particular skill as to acquiring it. The findings of the present research suggest that different instructional strategies may be required for each of these phases of the training process. One practical implication could be in the development of mobile training tools that incorporate both major fading approaches investigated in the present research, tailored to the cognitive demands of the task and to the student's prior experience. Before such technology can be implemented, there must be more research. This research effort was one instance of a field experiment with a relatively small sample, and two tasks representing MUM-T skills. Even a well-controlled, well-executed field experiment does not circumvent certain confounds. In the present case, the difficulty of the SPOT report and BDA tasks was confounded with the participant's prior knowledge and experience. The effects of both these task characteristics impact cognitive load. Therefore, replication in a laboratory setting, addressing a broader spectrum of tasks, where task characteristics can be manipulated independently, would assist in explaining the intriguing and complex interactions that were obtained in the present research.

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REFERENCES

Aulls, M. W. (2002). The contributions of co-occurring forms of classroom discourse and academic activities to curriculum events and instruction. *Journal of Educational Psychology, 94,* 520-538.

Colegrove, C. M., & Bennett, W. (2006). *Competency-based training: adapting to warfighter needs*. (*Technical Report.* AFRL-HE-AZ-TR-2006-14*).*

Moreno, R., Reisslein, M., & Delgoda, G.M. (2006). *Toward a fundamental understanding of worked example instruction: Impact of means-end practice, backward/forward fading, and adaptivity*. Paper presented at 36th ASEE/IEEE Frontiers in Education Conference, San Diego. October 28-31.

Kirschner, P.A., Sweller, J., & Clark, R.E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry- based teaching. *Educational Psychologist, 41,* 75-86.

Reisslein, J., Atkinson, R.K., Seeling, P., & Reisslein, M. (2006). Encountering the expertise reversal effect with a computer-based environment on electrical circuit analysis. *Learning and Instruction, 16,* 92-103.

Stewart, J. E., Barker, W. C., & Bink, M. L (2010). *Army RQ-7B unit training issues*. Paper presented at Meeting 64, Department of Defense Human Factors Engineering Technical Advisory Group Meeting, Tempe, AZ, May 3-6.

Stewart, J.E., Bink, M.L., Barker. W.C., Tremlett, M.L., & Price, D. (2011). *Training needs for RQ-7B unmanned aircraft system operators in the scout-reconnaissance role*. (*Research Report* 1940). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Stewart, J.E., Sticha. P.J., & Howse, W.R. (2012). *What are the most critical skills for manned-unmanned teaming?* (I/ITSEC Paper No. 12202). Paper presented at the Interservice/Industry Training, Simulation, and Education Conference, Orlando, December 3-6.