NAVAL AIR WARFARE CENTER
TRAINING SYSTEMS DIVISION
ORLANDO, FLORIDA

TECHNICAL REPORT 97-004

THE EFFECTS OF HIGHLIGHTING IN A MULTIMEDIA TRAINING INTERVENTION TO ENHANCE TEAM PERFORMANCE

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CENTER OF EXCELLENCE FOR SIMULATION AND TRAINING TECHNOLOGY

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Lori Rhodenizer
Clint A. Bowers
Department of Psychology
University of Central Florida
Orlando, Florida 32816-1390

Maureen Bergondy
Michael Martin
Naval Air Warfare Center Training Systems Division
Orlando, Florida 32826-3224

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NAVAL AIR WARFARE CENTER TRAINING SYSTEMS DIVISION
SCIENCE AND TECHNOLOGY DIVISION
Orlando, Florida 32826-3224

W. A. RIZZO, Head
Science & Technology
Division

DR. JINE S. TSENG, Director
Research & Engineering
Department

W. HARRIS, Director
Science & Technology
Office

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EXECUTIVE SUMMARY

PROBLEM

The advent of multimedia and advancement of technology provide new and untested tools for improving training and training systems. Specifically, technologies now allow for easy application of visual augmentation to computer displays that may enhance performance and learning. However, not enough is known about the implementation of display augmentation techniques which lead to enhanced team performance.

OBJECTIVE

The objective of the current experiment was to determine if the use of display augmentation, specifically highlighting important display characteristics, during a training intervention could improve performance on a team task. It was hypothesized that participants in the highlighted condition would perform better than those in the other two conditions.

APPROACH

A total of 32 individuals were randomly assigned to sixteen 2-person teams. Teams were trained to perform AIRTANDEM, a radar simulation task, prior to watching a multimedia training intervention which trained teams on the selection of targets for engagement. The multimedia training intervention included video vignettes of experts performing the radar task, still frames of the radar screen, and a transcript of the experts' communication. After the final testing trials, participants completed a questionnaire that was designed to assess the degree to which the highlighting manipulation was successful.

RESULTS

Highlighting the transcript reduced the average amount of time targets were in the protected area significantly when compared to the non-highlighted transcript condition and the control condition. Teams which received highlighting were significantly better at selecting targets before they entered protected areas and were faster at acting on targets which had entered protected areas. On average, participants rated the training intervention as moderately helpful.

CONCLUSIONS

The present experiment demonstrated that highlighting textual information during a training intervention can positively impact performance. These results indicate that the positive benefits in performance were due to the display augmentation rather than the presence of textual information on the display or to the experts' communication. These results suggest that highlighting strategies within text may help trainees acquire strategies more quickly, focus attention on critical aspects of the task, and provide a framework for learning.

RECOMMENDATIONS

Additional research is needed to investigate alternative forms of display augmentation to enhance the selection of material for schema encoding. Additional research is needed to determine the long-term effects of highlighting display elements.

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INTRODUCTION

PROBLEM

The advent of multimedia and advancement of technology provide new and untested tools for improving training and training systems. Specifically, technologies now allow for easy application of visual augmentation to computer displays that may enhance learning and performance. However, not enough is known about the implementation of display augmentation techniques that lead to enhanced team performance. Trainers and instructional developers need to take advantage of current technology and employ it within the proper settings in order to optimize its utility and provide the most benefit for trainees. It has become common practice to use these technologies haphazardly. In order to achieve optimal learning from display augmentation techniques, learning theory must guide the implementation of display augmentation.

OBJECTIVE

The current investigation proceeds from a critical review of cognitive theory to drive the use of display augmentation in training. This experiment was designed and executed in order to determine the effectiveness of using a display augmentation technique, specifically highlighting, empirically during a multimedia training intervention on team performance.

BACKGROUND

Schemas and Display Augmentation

Schema theory provides a powerful organizing framework for enhancing the efficacy of visual technology use in the provision of training. According to schema theory, the application of different visual technologies may vary depending on the skill that is being trained. A schema refers to the "general knowledge a person possesses about a particular domain" and "allows for the encoding, storage, and retrieval of information related to that domain" (Alba & Hasher, 1983, p. 203).

Schemas are useful ways to organize and reason about large complex knowledge bases. In order for a schema to guide processing it must be active in memory. Once active, it guides subsequent information processing via four encoding processes: selection, abstraction, interpretation, and integration (Alba & Hasher, 1983). Information from the environment is selected for further processing depending on its relevance to the activated schema. Following the selection process, meaning is derived from the relevant stimuli during an abstraction process, which produces a representation of only the crucial aspects of the stimulus. Meaning is then interpreted in the context of pre-existing knowledge (i.e., the active schema). This contextually dependent interpretive process allows the derivation of inferences about the current environment. Finally, the integration process refers more directly to learning processes and how memory traces are modified through experience. Integration occurs when a new schema is formed or an existing one is modified. This information is stored and now available for subsequent use.

Visual technologies when used appropriately can have a powerful impact on these encoding processes. It has been suggested that less experienced people have greater difficulty than more experienced people in selecting task-relevant cues that lead to the activation of appropriate schemata (Bransford & Nitsch, 1978, as cited by Alba and Hasher, 1983) while experts store information with cues that can later expedite retrieval (Ericsson & Staszewski, 1989). Schema theory indicates the need for displays that distinguish important cues from irrelevant ones within a complex, stimulus array during training. This directly suggests an application of visual technologies to alleviate the novice's performance deficit. For example, visual technologies that highlight important information may increase cue saliency, which in turn assists in the selection of appropriate schemata to guide subsequent information processing.

As a first step, training interventions should target the activation of task-appropriate schemata. Research indicates this can be accomplished, for example, by using training interventions such as advanced organizers or advice which frame an upcoming experience by relating new information to prior knowledge, thus activating relevant schemata (Kraiger, Salas, & Cannon-Bowers, 1995; Phye, 1989; Phye & Sanders, 1994). After task-relevant schemata are active in memory, novices can be assisted by technologies that distinguish between important and irrelevant environmental cues. For example, visual technologies that highlight important information may increase cue saliency, which in turn assists in the selection of appropriate information for subsequent processing.

It can be argued that influencing the selection encoding process would have the most effect on learning because if information is not selected for encoding, then it will be unavailable for further processing. Consequently, an understanding of display augmentation that positively impacts the selection process is warranted. There is support that display augmentation can benefit the acquisition of flight skills (Lintern & Koonce, 1992; Lintern, Roscoe, Koonce, & Segal, 1990; Lintern, Roscoe, & Sivier, 1990; Taylor, Lintern, Koonce, Kaiser, & Morrison, 1991) and influence the internal representation (schema) developed during a second order tracking task (Eberts, 1983; 1988; Eberts & Schneider, 1985) and visual search tasks (Fisher & Tan, 1989; Fisher, Coury, Tengs, & Duffy, 1989) in individuals.

Team Schemas and Display Augmentation

Given the trend toward the use of work teams to accomplish organizational goals (Salas, Dickinson, Converse, & Tannenbaum, 1992), it is becoming increasingly important to understand the defining characteristics of teams in order to optimize team training. Despite the increasing use of teams and a resurgence of team training research, there remains a lack of behavioral guidelines to guide team training design (Swezey & Salas, 1992). With the established need to understand teams, researchers have begun to address issues of team cognition (Hinsz, Tindale, & Vollrath, 1997). Concepts, such as team schemas (Rentsch & Hall, 1994) and shared mental models (Cannon-Bowers, Salas, & Converse, 1993) have been introduced as guiding forces in team training research.

As an extension of the schema concept discussed previously, Rentsch and Hall (1994) define team schema as the "common understandings among team members that occur when there is substantial overlap or complementarity in the content and organization of their team-related knowledge" (p. 232). The assumption that team members with similar schemas share the same teamwork knowledge with the same organization perform better as a team is inherent in this definition (Rentsch & Hall, 1994). To date, there is limited empirical support demonstrating a relationship between team member schemas and team effectiveness.

Rentsch and Hall (1994) have identified a teamwork schema that appears relevant to teams. Rentsch, Heffner, and Duffy (1994) refer to teamwork schema as knowledge about elements of teamwork, such as interdependence, cooperation, and communication. Each individual's abstraction of the team schema could vary depending upon the level of experience the individual has working in teams or the type of team to which the individual belongs. In fact, Rentsch, Heffner, and Duffy (1994) found that high experience team members represented their teamwork schema using more abstract defining dimensions than low experienced team members. According to Rentsch (1993), similar teamwork schema predicted three aspects of team effectiveness: client satisfaction, member growth, and team viability.

Rentsch and Hall (1994) hypothesized that agreement in team member schemas would enhance team performance because the similar schemas would decrease the amount of time members spent in deliberation over team issues and performance standards. Recently, Jenkins and Rentsch (1995) also identified accuracy as an important component of team member schemas. These authors speculate that accurate schemas will enable members to anticipate and understand the actions of team members.

According to the Team Evolution and Maturation Model, teams develop two kinds of skills: teamwork and taskwork skills (Morgan, Glickman, Woodard, Blaiwes, & Salas, 1986). Rentsch and her colleagues have confined their research to teamwork knowledge. Taskwork knowledge, however, is equally important in designing team training that will optimize team performance. Taskwork knowledge includes those task-related skills that team members must understand and acquire for task performance. There is growing evidence that team members must have a shared understanding of task as well as team demands in order to coordinate their efforts, facilitate communication, and consequently, perform effectively.

The concept of a team schema is congruent to that of an individual schema. Therefore, it is appropriate to infer that the four schema encoding processes that were described previously would be in operation for team schemas. In order to develop team schemas, whether they are teamwork or taskwork related, information must be selected for inclusion, abstracted and interpreted for meaning, and integrated into existing schemata. These encoding processes should also be subject to factors that may either facilitate or hinder schema development and learning.

As described above, it has been suggested that display augmentation should aid in the selection of information for inclusion in one's schemata. In the case of teams, display augmentation should facilitate the selection of information that should be shared by the team members and incorporated into the team's schema for the task at hand. The display augmentation should make the task demands that should be shared by the team members more salient; thus contributing to enhanced communication and coordination between team members.

The Current Experiment

Training as it is performed in many settings is often observational and text-based. Given the trend toward computer based delivery of training programs (Bassi, Benson, & Cheney, 1996), there will be an increased use of computer presented text-based training programs. It is likely that many training programs will be multimedia presentations. Since many multimedia development programs easily allow for display augmentation, it is essential to determine if beneficial effects can be found in text-based training settings. One display augmentation approach beginning to receive attention from scientists in this area is highlighting display elements. Highlighting refers to the practice of contrasting a display element (i.e., text) with the display background (Cory, 1990). It has been suggested that highlighting "aids in cue differentiation by calling attention to important words and phrases" without adding additional visual complexity to computer displays (Cory, 1990, p. 25). As argued above, highlighting should facilitate the selection of information for inclusion into a trainee's as well as the team's taskwork schema leading to more rapid and accurate incorporation into performance (i.e., learning). However, there is limited empirical data to support the notion that highlighting enhances performance in individuals or teams (Fisher & Tan, 1989; Fisher, Coury, Tengs, & Duffy, 1989; Hessler, 1972). Fisher and Tan (1989) have determined empirically that highlighting attracts attention initially to highlighted elements on a display. These authors used a visual search task in which participants needed only to identify a target digit from among a series of five digits. The current experiment, however, seeks to determine whether highlighting the target cues (within textual information) to which trainees should attend influences their performance. Consequently, this experiment is investigating the beneficial effects of highlighting on team performance.

ORGANIZATION OF THE REPORT

This technical report documents a research project investigating the use of highlighting display elements during training to enhance learning and performance. First, the methodology of the empirical research project, including a description of the participants and materials, is described. Then, the statistical analysis of the data is reported. The results are followed by the conclusions and recommendations that could be deduced from the data. A participant demographics form, the training materials, and an assessment questionnaire which were developed as part of this research project are included in appendices A, B, C, and D.

METHOD

PARTICIPANTS

Participants were recruited from an introductory psychology course at the University of Central Florida and were offered course extra credit for their participation. A total of 32 individuals (22 females and 10 males) were randomly assigned to two-person teams. There were a total of 16 teams who completed the experiment. Participants described themselves as either juniors or seniors in college and ranged in age from 20 to 48 years of age. The mean age was 25 years old. GPA ranged from 2.0 to 3.99, with a mean of 3.0. Twenty-one of the participants were majoring in psychology; the remaining eleven participants were majoring in subjects other than psychology. Participants ranged in computer experience from having used computers a few times to using computers everyday. Participants also ranged in their experience with video games, some reported never playing video games while others reported playing video games several times a week.

MATERIALS

Simulation Description

Two networked IBM compatible computers were used in conjunction with AIRTANDEM, a program adapted from TANDEM (Weaver, Morgan, & Hall, 1993). AIRTANDEM is a low-fidelity simulated radar task that mimics the operations of the E-2C. In this simulation, targets appear as 'blips' on a radar screen. Either team member may select targets by pressing the right button on a computer mouse. Once a target is selected, the team members must determine the type of craft (air, sea, or land), its threat level (civilian, military, or unknown) and its intent (peaceful, hostile, or fleet member). These determinations are made by gathering information available in pull-down menus located in the upper right hand corner of the computer screen.

Forms and Questionnaires

Additional materials used in this investigation include: 1) a demographics form that is used to obtain personal information about each participant; 2) video-based training on the operation of AIRTANDEM; 3) a multimedia training intervention was developed using video vignettes and Microsoft Power Point; and 4) a questionnaire that was designed to assess the degree to which the highlighting manipulation was successful. The demographics form, training materials, and the questionnaire are included in Appendices A, B, C, and D respectively.

Video Vignettes

Two experts were videotaped as they interacted with the AIRTANDEM simulation task. Selected clips, which described the process the team of experts was using to select targets for identification and prosecution, were digitized and imported into a Microsoft Power Point presentation in order to produce the video vignettes. The video showed two experts sitting at computer facing one another. Their communication was also recorded and digitized along with the video. Participants could see and hear the experts as they performed the task. The vignettes also included still screens from the AIRTANDEM radar scope which were attained using the full screen capture feature available on Paint Shop Pro. The target that the experts were selecting was highlighted. To complement the video vignettes, the transcript of the experts' communication was added into the presentation and appropriate text was highlighted in a high contrast color for the experimental condition.

PROCEDURE

Sixteen two-person teams were trained to perform AIRTANDEM, a multi-player radar simulation task (Weaver et al., 1993). After completing four practice trials, teams were randomly assigned to one of three training conditions (highlighted transcript, non-highlighted transcript, or no transcript control). Teams in all conditions were shown a multimedia training intervention that was designed to aid teams in the selection of targets for engagement, specifically teams were instructed to attend to the location and characteristics of targets. The multimedia presentation contained video vignettes of experts performing the task and video snapshots of the radar simulation screen. The snapshots of the radar simulation provided a visual representation of the target the experts were selecting as well as the other targets in the immediate vicinity. The target that was being discussed was highlighted for participants in each condition. In addition to the screen snapshots and the vignettes, which included video as well as audio of their communication, two groups viewed a transcript of the experts' communication that was displayed while the vignette played. The transcript allowed participants to read along as they watched and heard the experts perform the task. For one group, the important phrases were highlighted in the transcript (highlighted transcript). Participants were simply told to watch the presentation. The experimenter did not point out or mention the highlighted text. Similarly, participants were not told that the important cues to which they should attend were highlighted in the transcript. The second group viewed the transcript that was not highlighted (non-highlighted transcript). The third group did not view a transcript of the experts' communication; they only heard the experts' conversation and viewed the screen snapshots and video vignettes (control). In the highlighted transcript condition, critical information about the characteristics of the targets that should be selected for engagement was highlighted. The authors determined the "critical" information that was highlighted in each vignette based on their judgment as to the importance of the meaning conveyed by the phrase. Phrases that described the target's characteristics and/or an action that should be taken were highlighted. For example, the experts selected targets that were described as "heading straight toward us". The training intervention lasted approximately twenty minutes. At the beginning of the presentation, the experimenter explained each piece of the information that was displayed on the screen. Then, the experimenter controlled the presentation of each of the video vignettes by starting the video clip. The experimenter interacted with the trainees during the presentation of each slide by answering questions and providing additional explanations when necessary. After the presentation, the experimenter answered trainee's questions. After the intervention, teams performed two additional trials. Participants then filled out a questionnaire concerning the effectiveness of the training intervention.

RESULTS

MANIPULATION CHECK

A manipulation check verified that all teams in the highlighted transcript condition detected the highlighting. These participants rated the highlighting as moderately helpful in making strategies obvious to them ($x = 2.8$ out of 5). The dependent measures for performance were (a) the total amount of time targets spent in the protected area around the ship and (b) the average time that each target spent in the protected area before a final action was taken to shoot the target or clear it through the air space. These measures were used because they indicate that targets were close to the participant's own ship.

PERFORMANCE DATA

A multivariate analysis of covariance (MANCOVA) was performed, using the total amount of time targets spent in the protected area and the average time that each target spent in it during the post-training trial (i.e., trial 5) as the dependent variables. Both classes of performance data during the pre-training trial (i.e., trial 4) were entered as covariates to account for individual differences in ability between the teams. Using Wilks' criterion, the regression for the combined covariates was significant, $F(4, 20) = 13.72$, $p < .001$. Univariate regressions for both classes of performance data also showed significant relationships between performance in the pretraining trial and in the post-training trial, $F(2, 11) = 47.12$, $p < .001$ [the total amount of time targets spent in the protected area], and $F(2, 11) = 55.98$, $p < .001$ [average time each target spent in the protected area].

After adjusting for the covariates, the combined adjusted means for both performance variables during the post-training trial showed the patterns indicated in Figure 1. The patterns of means were in the expected direction, with teams in the control condition allowing targets to spend somewhat longer amounts of time in the protected areas than those in the non-highlighted transcript condition, and those teams in the highlighted transcript condition allowing the targets to spend significantly less time in the protected area than teams in the other two conditions. Using Wilks' criterion, the combined dependent variables were, in fact, significantly affected by the training condition, $F(4, 20) = 2.70$, $p < .05$ (one-tailed). Univariate F-tests also indicated that for both performance measures individually, training condition had a significant effect, $F(2, 11) = 4.65$, $p < .02$ (one-tailed) [i.e., total amount of time targets spent in the protected area] and $F(2, 11) = 2.92$, $p < .05$ (one-tailed) [i.e., the average time each target spent in protected area].

Insert Figures 1 & 2 about here

Fisher LSD post-hoc tests indicated that, with respect to the total amount of time targets spent in the protected area, highlighting of the transcript led to significantly lower total amounts of time than were found in either the non-highlighted transcript, $t(13) = 2.78$, $p < .01$ (one-tailed), or the control groups, $t(13) = 2.65$, $p < .05$ (one-tailed). The difference between the non-highlighted transcript and the control groups, however, was not significant, $t(13) = 0.23$, ns.

With respect to the average time each target spent in the protected area, the same pattern of results was found: Highlighting the transcript reduced the average amount of time targets were in the protected area significantly when compared to the non-highlighted transcript condition, $t(13) = 2.05$, $p < .05$ (one-tailed), and the control condition, $t(13) = 2.20$, $p < .05$ (one-tailed). The difference between the non-highlighted transcript and the control conditions, however, was not significant, $t(13) = 0.48$, ns.

QUESTIONNAIRE DATA

Analysis of the assessment questionnaire revealed that, on average, the participants considered the highlighting moderately helpful for making the targeted behaviors more obvious to them (mean = 2.9). They judged the training intervention to be moderately helpful in teaching them which targets to select for prosecution (mean = 2.7). On average, participants also rated the overall training intervention as moderately helpful (mean = 2.7). Similarly, participants stated that they would moderately recommend using this technique for team training (mean = 2.7). Despite the measured increases in performance, participants perceived the training intervention to be only moderately helpful in enhancing their performance.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The present experiment employed highlighting as a technique for aiding teams in the selection of targets for engagement in a radar simulation task. One previous experiment failed to find significant performance improvements when using a highlighted textual display (Cory, 1990). The present experiment, however, showed that highlighting textual information during a training intervention can positively impact performance. Teams that received highlighting were significantly better at selecting targets before they entered protected areas and were faster at acting on targets that had entered protected areas. Additionally, these results indicate that the positive benefits in performance were due to the display augmentation rather than the presence of textual information on the display or to the experts' communication. These results suggest that highlighting strategies within text may help trainees acquire strategies more quickly, focus attention on critical aspects of the task, and provide a framework for learning.

The positive benefits that were found from highlighting display elements adds credence to the hypothesis that shared taskwork knowledge can benefit team performance. As evidenced by the faster average and total times to react to targets in the protected area, it can be inferred from these results that teams which received the augmented displays coordinated better than teams in the non-highlighted and control conditions. This also implies that the highlighted information was selected for inclusion into a team schema for taskwork knowledge. Before making any conclusive statements about the use of display augmentation to aid in the selection of material for inclusion into team taskwork schemas, a more rigorous examination of the team member's knowledge structures is needed.

Despite the beneficial performance effects that were found, team members perceived the training intervention to be only moderately helpful in helping them to acquire this task. These results raise more questions concerning the use of display augmentation in multimedia training materials. Trainee reactions to the training are important in training design, even though they may not be an indicant of what or how much the trainee is learning. In examining reasons why trainees found the training intervention only moderately helpful, the design of each POWER POINT slide was considered. For instance, the issue of the amount of information that the trainees received during the multimedia presentation may have overwhelmed them. The multimedia presentation as developed in this experiment included video vignettes, AIRTANDEM screen shots, and text (except for the control group). Perhaps, the highlighting was viewed as only moderately helpful because all of the additional material that was included served as distractions, although not detrimentally so, from the display augmentation.

In conclusion, these results suggest that highlighting a visual display can be beneficial as a training tool. Highlighting, as employed in this experiment, provided an inexpensive methodology for enhancing training and performance upon which trainers may be able capitalize. However, additional research is warranted to determine the circumstances or contexts under which highlighting should be implemented; the cognitive processes that are impacted by the display augmentation; and the long-term benefits that may result.

RECOMMENDATIONS

This investigation into the use of display augmentation to enhance learning and performance has yielded several significant findings that can lead to recommendations for the use of highlighting in a multimedia training intervention and also for additional research. First of all, highlighting can be used to make phrases stand out from other textual information. Highlighting textual information in this manner can aid in the selection of material that is encoded in a trainee's schemata. Since on average participants judged the training intervention as moderately helpful, it may be important to note that despite the demonstrated benefits of the intervention trainee's may have gained more from an alternative intervention format.

Additional research is needed to investigate alternative forms of display augmentation to enhance the selection of material for schema encoding. Display augmentation and more specifically, highlighting, are often used in computer based training programs, but limited empirical research exists which sheds light on the most optimal techniques that can be used for differing tasks. The long-term effects of this type of training intervention must also be investigated. Due to the experimental design employed, long-term effects were not investigated. The beneficial effects obtained in the current experiment may be subject to rapid decay.

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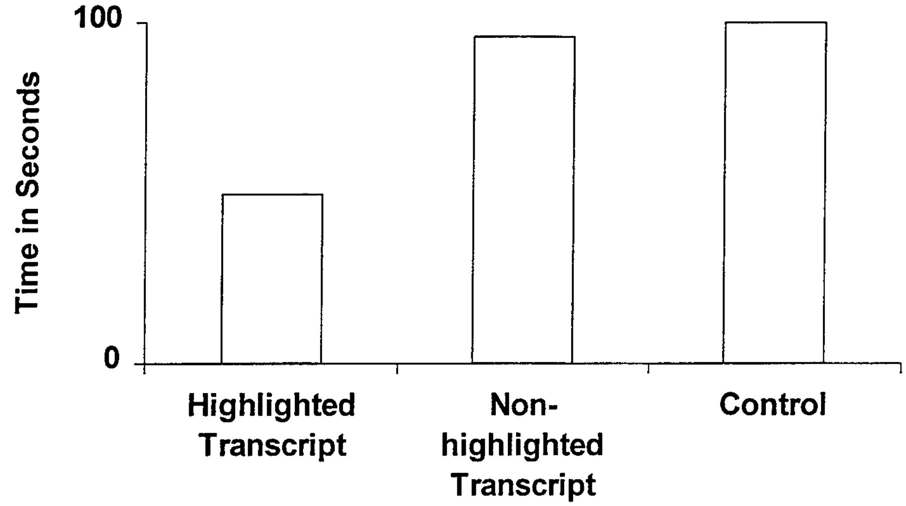


Figure 1. Adjusted means for average time spent in protected area.

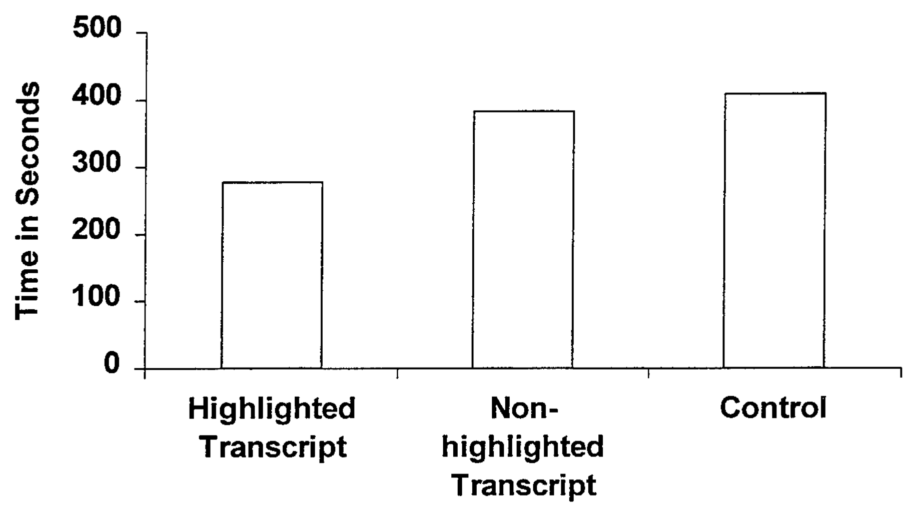


Figure 2. Adjusted means for total time spent in protected area.

APPENDIX A

DEMOGRAPHICS FORM

Identification Number: ________________________

Demographic Data Form for AirTandem

1. Social Security Number: __________________

2. Gender: Male Female

3. Age: ______________

4. Major: ______________

5. Class Standing:
   A. Freshman
   B. Sophomore
   C. Junior
   D. Senior
   E. Other

6. GPA: ______________

7. How often do you play video games?
   A. Never
   B. Have played a couple of times
   C. Several times a year
   D. Several times a month
   E. Several times a week
   F. Everyday

8. How often have you worked with personal computers?
   A. Never
   B. Have played a couple of times
   C. Several times a year
   D. Several times a month
   E. Several times a week
   F. Everyday

9. Rate your experience with personal computers:
   A. Little or none
   B. Know a little; have played some computer games; know some word processing and some other software
   C. Know quite a bit; have played computer games, know Internet access, know word processing well, used other software packages
   D. Expert; have played computer games; know Internet access, word processing, other software and some programming

10. How well do you know the people who are your team members in this experiment?
    A. Not at all
    B. Casual acquaintance
    C. Friend
    D. Very close friend

11. Have you ever served in the military or had experience with a simulated radar task?
    A. No
    B. Yes
    If yes, please explain: ____
    ____

APPENDIX B

TRAINING MATERIALS

AIRTANDEM INSTRUCTIONS

During the next few hours, you will be playing a radar simulation game. First, you will be given instructions on the task, and then you will be asked to play the game. Then, you will watch a short multimedia presentation that should help you to improve your performance. This research should give us insight into how we can use multimedia to enhance team training. So, I ask that you please give your full attention and try to do your best in this experiment.

First, you will be trained on the task of operating the program. You will have an opportunity to practice with the task before any record is kept of your performance. Then you will be asked to play the game for several trials. Once you have learned how to play the simulation, you will watch a multimedia presentation. After the presentation, you will play two more times and complete a short questionnaire. Please feel free to ask questions anytime throughout training, because it is very important that you understand how to perform this task.

Scenario Script

During the simulation, you will be monitoring a radar screen onboard the Eagle Eye, an airborne early warning airplane. Your aircraft is currently positioned in the Misty Gulf, where tensions are high. The US Navy is about to deploy a strike package and there have been reports of enemy contacts in the area. Your craft is on alert and has orders to prosecute hostile targets. Your aircraft is manned by two radar operators, referred to as Alpha and Bravo.

Alpha and Bravo have the same radar scope in the middle of their screens. Your aircraft is in the center of the radar scope in the middle of the computer screen. **(POINT TO THE SHIP)**. Surrounding your ship will be a series of fuzzy "blips" called targets. **(POINT TO THE TARGETS)**. Your team's task is to assess information pertaining to the fuzzy images or targets on your radar scope. More specifically, three decisions must be made about each target. The first decision requires you to determine what type of craft you have hooked. The second decision requires you to determine the force of this contact. The third decision requires you to identify the craft's intent. This information will allow you to identify these targets and make decisions about whether to clear them or shoot them to gain points for your team. Your objective for this experiment is to maximize your team score.

There is no need for you to actually memorize all of the information and rules you are about to receive. You may refer to Posters A, B, and C **(POINT TO POSTERS)** while playing the game. Poster A indicates the type of craft, which will be air, land, or sea. Poster B indicates civilian, unknown, or military craft. Poster C indicates intent to your own ship with the possible intent being friend, fleet, or foe. Upon reference to the computer screen you will notice the drop down menus A, B, and C, which correspond respectively with posters A, B, and C.

An example of how to use the posters is as follows: To determine Initial Climb or Dive Rate poster A is utilized (**POINT TO POSTER A**). This is used to determine whether a contact is climbing or diving. Positive numbers mean climbing, indicating Air or Land and 0 means level, indicating Sea. You will need to go through similar steps to make accurate decisions for each of the posters.

Now, let's look at the menus. Menu OP is for set-up purposes. (**POINT TO MENU OP**).

Menus A, B, and C (**POINT TO MENUS**) are your information fields. This is the information that is being picked up by your sensors. You will need to access these fields to carry out your task. You will use the menus to get the information you will need to determine the type of craft.

Menu Description

Next, I am going to walk you through an example.

To begin, we first need to start the system. To do that, you will use the right mouse button to click on the OP Menu. As you can see, this reveals four choices: Start Exercise, Shutdown System, Zoom In, and Zoom Out. Please do not click on Shutdown/End System. If you mistakenly select this option, an information box will appear asking if you want to quit the simulation. At that point, type "n" for no and the box will disappear. Zoom In and Zoom Out will be discussed later. Go ahead and click on Start System. Please be careful when using the Zoom In and Zoom Out options so as to avoid accidentally selecting the shutdown system option. You can click on OP again to close the menu.

Now let's continue. To select a target, use the mouse to position the pointer directly over the fuzzy image, then click on it using the left mouse button. You will know if you hooked the target because it will change from white to green. The number of the target which you have hooked appears in the lower right hand corner of your radar screen. You have hooked target # 2. If you change your mind and wish to hook a different target simply position the mouse pointer over that target and click on it using the left mouse button. Now, please hook the target # 1 and we will work on this one as a team.

Now click on Menu A. We will take a look at the five pieces of information that you will need to determine the type of craft (air, land, sea) for each target. They are current speed, initial altitude/depth, initial climb/dive, communication time, and signal strength. Click on Current Speed using the right mouse button and continue to press the mouse button. The current speed of this craft will appear in the menu box. As you can see, the current speed for this craft is 11 knots. According to poster A, this craft is a sea craft. Each information field is queried using the same procedure, that is by clicking on the menu bar with the right mouse button.

The Initial Altitude/depth for this craft is 5524 ft which indicates that is an air craft. Its initial climb/dive rate is 939 ft, also indicating an air craft. The Communication Time is 116 sec indicating sea, while the Signal Strength is medium designating an air craft. Since we have three pieces of information which suggest that the craft is an air craft and only two suggesting it is a sea craft, we will decide that this target is an air craft. After querying all this information and making your decision, you must select the "change symbol type" option from the menu and label the target as either a air, land, or surface. In this case, we will label it an air craft.

Now click on Menu B in order to determine the force of this target. We will take a look at the five pieces of information that you will need to determine whether the targeted craft is civilian or military. These are Initial Bearing, Initial Range, Intelligence, Direction of Origin, and Maneuvering Pattern. The same procedure is applied when determining if a craft is civilian or military. That is Click on Initial Bearing using the right mouse button. A menu box will appear indicating that the craft's initial bearing is 117. According to Poster B, this indicates a civilian craft. The Initial Range is 2.5 nautical miles which indicates a civilian. Intelligence is platform which designates military. The Direction of Origin is Red Sea, which indicates that it is military. The Maneuvering Pattern is Code Delta, which also indicates military. Since three pieces of information suggest a military craft and two indicate a civilian craft, we will decide that the aircraft is military. Then choose the "change military status" option and label the target as civilian or military. In this case, we will label it military.

Finally, we will determine the crafts' intent. Now click on Menu C. We will look at five pieces of information that you will need to determine the intent to your own craft. These include countermeasures, electronic warfare, threat level, response, and missile lock. Countermeasures for this target are IRST, according to poster C, this indicates a the target is part of the Fleet. Electronic warfare is big bulge radar which also indicates Fleet. Threat level, however, is 1 which suggests a friend. Response is given, designating friend. Finally, missile lock is unengaged meaning Fleet. Since three pieces of information indicate Fleet, we will decide that this military air craft is part of the Fleet. Now, you must choose the "change intent" option and label the target as Fleet.

The final action that must be taken to prosecute this target is the final engagement. The rules for determining the final engagement action are: A friend does not pose a threat so, they are cleared. A foe means harm to your ship and you should choose "shoot" it. If you decide that the craft is Fleet, it is part of the Navy's strike package- do not shoot it down, choose "clear" from the menu.

Now let's select Final Engagement from Menu C and clear this craft. When you click on clear continue to hold down the right mouse button to determine if you correctly engaged the target. Are there any questions?

Now, let's return to the issue of zooming in and zooming out. Click on the OP menu, and you will use zoom in to view a smaller range of the total radar screen. You should notice that range of your radar screen changes from 32 nautical miles to 16 nautical miles. You will use zoom out to view a larger range of the total radar screen. You may want to zoom out to get a better view of possible incoming targets. Now, zoom out to 64 nautical miles. Do you see the other target?

At this time, I would just like to take a few moments to provide you with a little more information about the decision process. You are likely to get conflicting information on most targets. As we did in our example. To make an accurate decision, you will need at least three pieces of information indicating the same type of craft. For example, if you found that two information pieces indicated Sub, and three indicated Air, for a particular target, then you could confidently judge the target as an aircraft. Keep in mind that each of the five types of information are of equal importance for you to make an accurate decision. In other words, you should not weigh one type of information more heavily than another.

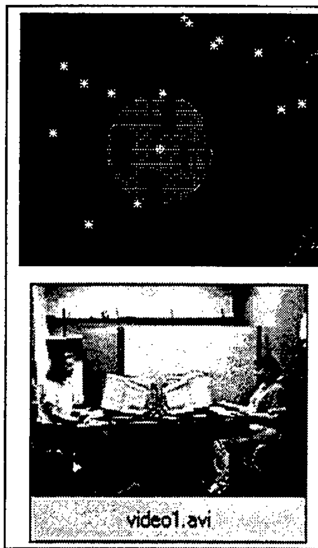
This simulation has two additional features you should know about: the clock and the score box. As you can see, there is a clock on the upper left hand corner of the computer screen. **(POINT TO CLOCK)**. You will be given twenty minutes for each trial. On the upper right hand corner, you will see a box containing your score **(POINT TO SCORE BOX)**. The box labeled T score is the teams score. If the team is correct in all three decisions, then clearing or shooting the target will earn the team 100 points. If any one of these decisions is incorrect, the team will lose 100 points. The two of you as a team will accumulate one score throughout task performance.

We have taken you through each step in identifying and engaging targets. If you have any questions, do not hesitate to ask them at this point because it is very important that you understand how to perform this task.

APPENDIX C

TRAINING INTERVENTION MATERIALS

Slide 1

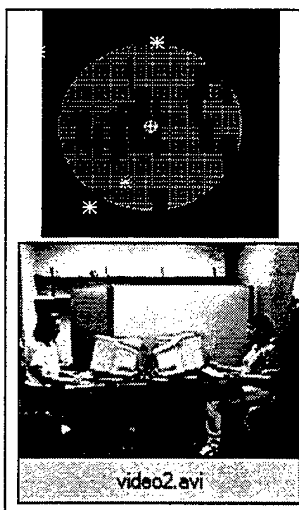


Player 1: Let's take a moment to **look at all the targets and determine which ones could be threats** to us.

Player 2: I think that is the best strategy. Let's take a moment to **look at all the targets, determine if any are flying in formation, or if any are heading straight toward us.**

Player 1: Let's also zoom out and see how many other targets could be potential threats…and there seem to be a lot. So, let's zoom in and concentrate on those closest to us.

Slide 2



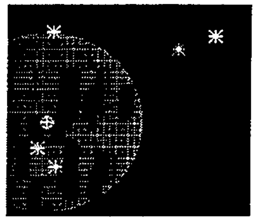
Player 2: Have you **identified any problems**?

Player 1: There is a target **heading straight toward us** and he's coming at a quick speed.

Player 2: I see him.

Player 1: I hooked him. He's target 28. Let's query his information.

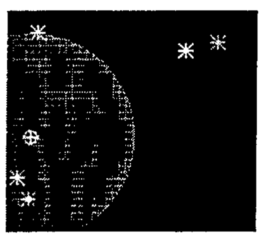
Slide 3



Player 2: I have **identified a problem**? There seem to be **two craft in formation** and **heading toward us.**

Player 1: I see him. Let's hook the guy closest to us. It is track 15.

Slide 4

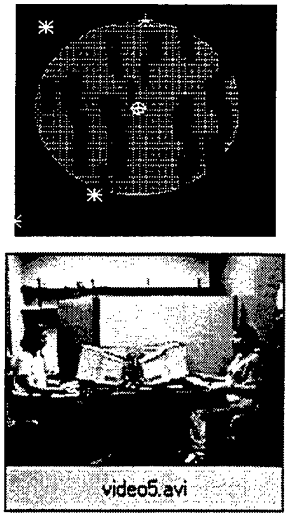


Player 1: He was one of our guys, but let's **check the guy behind him** to make sure he's also not a threat.

Player 2: Ok. I have hooked him. He's number 7.

Player 2: Let's query that information.

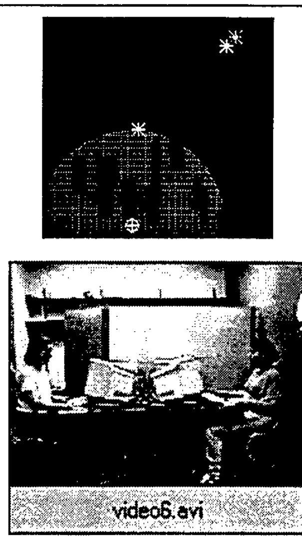
Slide 5



Player 2: Have you **noticed that there is a craft just hovering** over the perimeter of the Circle of Fear?

Player 1: Yes, I think that we should query him to find out if he's a threat. I've hooked him and he's track number 33.

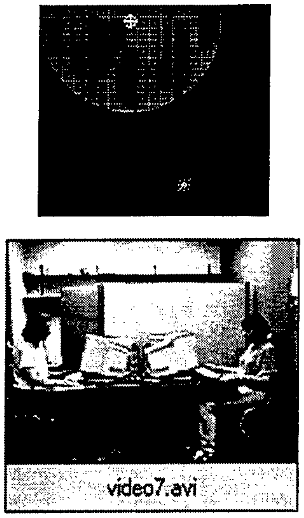
Slide 6



Player 2: I think I have identified another problem. There seem to be two craft very close to each other.

Player 1: Yes, they do **look suspicious**. Let's click on one and query that information. I hooked track 16.

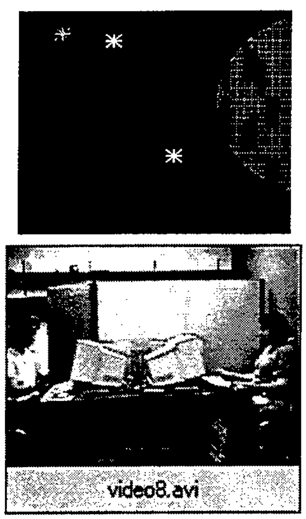
Slide 7



Player 1: I just identified another problem. There was a target that **popped up** close to the perimeter.

Player 2: I saw him. Let me go ahead and hook him. He's track 34.

Slide 8

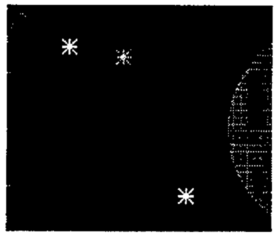


Player 2: Have you identified any other problems?

Player 1: I think I see two **craft in formation** toward the outside, around 290 degrees.

Player 2: I see him. I hooked him. He's number 29.

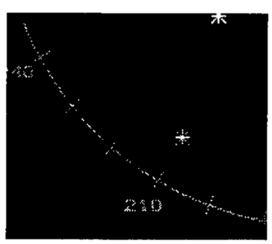
Slide 9



Player 1: I think we should also **check the target that was behind him.** He may also be a threat.

Player 2: I hooked him. He is number 32.

Slide 10

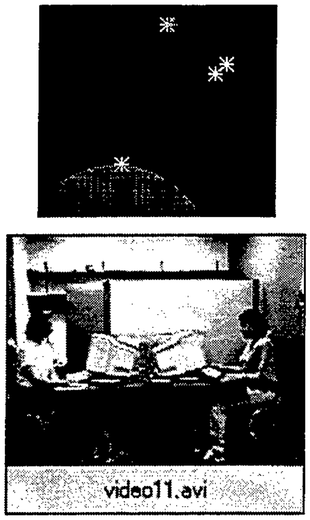


Player 2: Have you noticed if **any new targets** have popped up?

Player 1: **One just popped up** at around 210 degrees.

Player 2: I see him. I have hooked him. He is number 6.

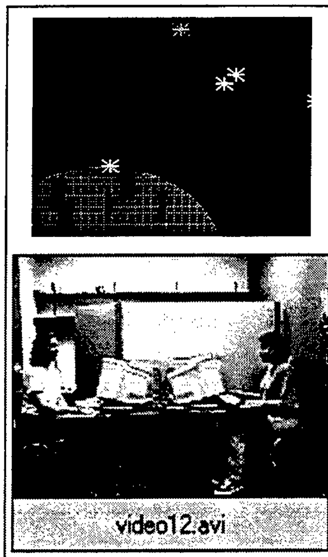
Slide 11



Player 1: Do you see the target at about 10 degrees? Is that **one target or two**?

Player 2: I am not sure. I see them. Let me go ahead and try and hook one. I have hooked number 25.

Slide 12



Player 1: **That was two targets.** So we need to **click on the next one** and see if he is also a threat.

Player 2: Ok. I have hooked him. He is number 17.

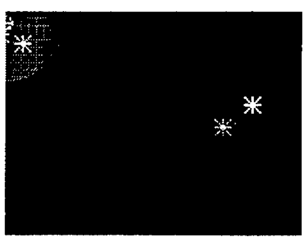
Slide 13

Player 1: There is a target coming in **quickly toward us, that looks like a potential threat**. I think we should query that information.

Player 2: I see him at the bottom of the screen. I have hooked him. He is number 1.

Player 1: Ok, I have him hooked.

Slide 14



Player 1: This situation is **evolving** nicely. I think we should maybe **zoom out and see what else is coming toward** us or is active.

Player 2: Ok, I am zooming out now.

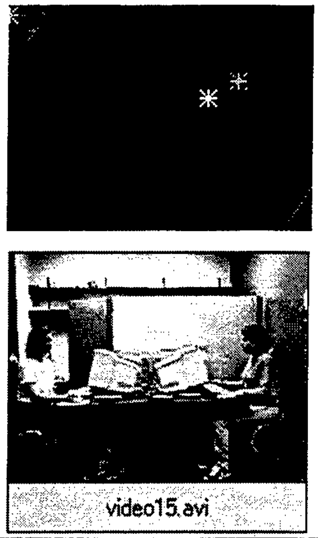
Player 1: Actually, I see two targets which **look somewhat suspicious**. They are at approximately 100 degrees. They are both traveling together.

Player 2: Do you think they pose a threat to us?

Player 1: I think we should **check it out**.

Player 2: Ok, I have hooked number 24.

Slide 15



Player 1: Let's go ahead and **check the craft that was with him,** just to be on the safe side.

Player 2: I hooked him also. He's number 27.

APPENDIX D

TRAINING INTERVENTION QUESTIONNAIRE

Identification No. ____________________

The following questionnaire is designed to inform us about the effectiveness of our multimedia training intervention. Please circle the number which corresponds to your perception of the relative helpfulness of the multimedia presentation. Please refer to the following scale for the assignment of numerical ratings.

1	2	3	4	5
Not at all	Slightly	Moderately	Very	Extremely

1. How helpful was the training intervention in teaching you which targets to select for prosecution? 1 2 3 4 5

2. How helpful was watching another team playing this simulation? 1 2 3 4 5

3. Do you feel that watching another team perform the simulation helped you to coordinate better with your teammate? 1 2 3 4 5

4. After watching the presentation, would you agree that you adopted the strategy used by the team you watched? 1 2 3 4 5

5. Did your presentation contain text that was colored or highlighted? Yes No

6. What color was the highlighted text?
   A. Blue
   B. Green
   C. Yellow
   D. Red
   E. Purple

7. Please circle those phrases that were highlighted?
   A. noticed that there is a craft just hovering
   B. two craft in formation
   C. I have hooked the target
   D. That's the best strategy
   E. Look at all the targets and determine which could be threats
   F. Check the guy behind him
   G. Find out if he is a threat
   H. popped up
   I. identified a problem
   J. look suspicious
   K. Let's zoom out
   L. Let's query him
   M. He's track 34

8. Did your presentation contain colored or highlighted targets? Yes No

9. What color were the highlighted targets?
   A. Blue
   B. Green
   C. Yellow
   D. Red
   E. Purple

10. Do you typically highlight passages in your textbooks? Yes No

11. How helpful do you feel the highlighting was in making behaviors more obvious to you? 1 2 3 4 5

12. Overall, how helpful do you think the training intervention was? 1 2 3 4 5

13. How strongly would you recommend using this technique for team training? 1 2 3 4 5

DISTRIBUTION LIST

Chief of Naval Education and Training
NAWCTSD Liaison Office
ATTN: Mr. John J. Crane, Code L02
250 Dallas Street
NAS, Pensacola, FL 32508-5220

Commanding Officer
Naval Education and Training Professional Development and Technology Center
ATTN: Dr. Nancy Perry, Code N-7
6490 Saufley Field Rd.
NAS, Pensacola, FL 32509-5237

Commanding Officer
Naval Air Warfare Center Training Systems Division
Code 497
Orlando, FL 32826-3224

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Washington, DC 20350-2000

Department of the Navy
Bureau of Naval Personnel
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DoD Technology Analysis Office
ATTN: Dr. Bart Kuhn
5109 Leesburg Pike, Suite 317
Falls Church, VA 22041-3208

Office of the Chief of Naval Research
ATTN: Dr. Harold Hawkins, Code 342
800 North Quincy Street
Arlington, VA 22217-5000

Office of the Chief of Naval Research
ATTN: Dr. Terry Allard, Code 342
800 North Quincy Street
Arlington, VA 22217-5000

Office of the Chief of Naval Research
ATTN: Dr. Susan Chipman, Code 342
800 North Quincy Street
Arlington, VA 22217-5000

Office of the Chief of Naval Research
ATTN: CDR Tim Steele, Code 342
800 North Quincy Street
Arlington, VA 22217-5000

Chief, U.S. Army Research Institute Orlando Field Unit
ATTN: Dr. Stephen Goldberg
12350 Research Parkway
Orlando, FL 32826-3276

Defense Technical Information Center
FDAC
ATTN: J. E. Cundiff
Cameron Station
Alexandria, VA 22304-6145

Dee Andrews, Ph.D.
Division Technical Advisor
Air Force Research Laboratory
Operations Training Division
Aircrew Training Research Division
6001 S. Power Rd., Bldg 558
Mesa, AZ 85206-0904

Clint Bowers, Ph.D.
University of Central Florida
4000 Central Florida Blvd.
Orlando, FL 32816

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University of Central Florida
Team Performance Laboratory
Department of Psychology
Orlando, Florida 32816-1390

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Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5000

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13. ABSTRACT *(Maximum 200 words)*
The advent of multimedia provides new and untested tools for improving team training. Specifically, technologies now allow for easy application of visual augmentation to computer displays that may enhance performance and learning. However, not enough is known about the implementation of display augmentation techniques which lead to enhanced team performance. An approach receiving attention is highlighting display elements. The objective of the current study was to determine if the use of display augmentation, specifically highlighting important display characteristics, during a training intervention could improve performance on a team task. It was hypothesized that participants in the highlighted condition would perform better than those in the other two conditions. Sixteen 2-person teams were trained to perform AIRTANDEM, a radar simulation task, prior to watching a multimedia training intervention which trained teams on the selection of targets for engagement. The multimedia training intervention included video vignettes of experts performing the radar task, still frames of the radar screen, and a transcript of the experts' communication (in experimental conditions.). After the final testing trials, participants completed a questionnaire that was designed to assess the degree to which the highlighting manipulation was successful. Highlighting the transcript reduced the average amount of time targets were in the protected area significantly when compared to the non-highlighted transcript condition and the control condition. Teams which received highlighting were significantly better at selecting targets before they entered protected areas and were faster at acting on target which had entered protected areas. On average, participants rated the training intervention as moderately helpful. The present study demonstrated that highlighting textual information during a training intervention can positively impact performance. These results indicate that the positive benefits were due to the display augmentation rather than presence of textual information on the display or to the experts' communication. These results suggest that highlighting strategies within text may help trainees acquire strategies more quickly, focus attention on critical aspects of the task, and provide a framework for learning.

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