Technical Report 1287

Feedback in Videogame-based Adaptive Training

Iris D. Rivera
Florida Institute of Technology
Consortium Research Fellows Program

May 2011

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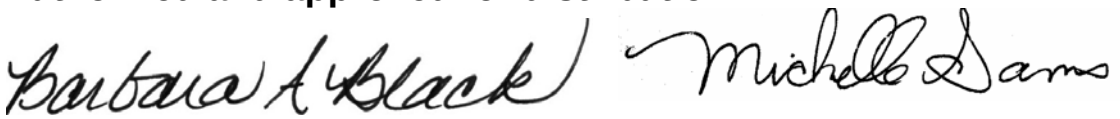

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14. ABSTRACT *(Maximum 200 words)*:

The field of training has been changing rapidly due to advances in technology such as videogame-based adaptive training. Videogame-based adaptive training has provided flexibility and adaptability for training in cost-effective ways. While this method of training may have many benefits for the trainee, current research has not kept up to pace with its implementation. This research closes this gap by testing four competing feedback and training theories. The ACT-R theory and the feedback intervention theory provide different recommendations for the frequency (frequent or infrequent) that feedback should be provided during training. Self-efficacy theory and control theory provide different recommendations for the appropriate feedback sign (positive or negative) that should be provided during training. Research was conducted in which the frequency of feedback and feedback sign were manipulated in a videogame-based adaptive training environment. MANOVA results indicate that frequent negative feedback and infrequent positive feedback were beneficial to trainee performance. The role of feedback orientation was also examined as a moderator of the relationship between feedback and performance, but was not supported. The findings serve as a framework for practitioners in determining the necessary type of feedback needed when designing videogame-based adaptive training.

15. SUBJECT TERMS

Interpersonal skills, Army training, videogame-based training, adaptive training, scenario-based training, VECTOR

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Feedback in Videogame-based Adaptive Training

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EXECUTIVE SUMMARY

Research Requirement:

Military, industry, and education continue to investigate the use of an increasingly popular instructional tool known as videogame-based adaptive training (Orvis, Horn, & Belanich, 2008). Videogame-based adaptive training has provided flexibility and adaptability for training in cost-effective ways. While this method of training may have many benefits for the trainee, current research has not kept up to pace with its implementation.

One area of research that has not received much attention is the effect of feedback in videogame-based adaptive training. Research suggests that training alone is not sufficient to enhance performance but that feedback is a necessary component (Komaki, Heinzmann, & Lawson, 1980) and is critical for evaluating new skills (McKendree, 1990). Additionally, feedback has been shown to motivate and direct employees' attention and thus increase learning and performance (Kluger & DeNisi, 1996). As critical as feedback appears to be, few studies have evaluated the real impact of different types of feedback on training performance. Most computer based training systems provide some sort of immediate feedback but feedback content is rarely explicitly discussed (McKendree, 1990). Another issue is that the literature is mixed on which type of feedback is most effective for learning.

To address this gap, competing theories in feedback frequency and sign were evaluated to determine the most effective training design features. The feedback intervention theory (Kluger & DeNisi, 1996) supports the notion that for a complex skill it is optimal to provide trainees with infrequent feedback. Contrary to this theory, Anderson's (1983) ACT-R theory suggests that frequent feedback is ideal for learning. Bandura's (1986) self-efficacy theory claims that people will try harder or raise their goals after success (i.e., positive feedback). However, control theory (Carver & Scheier, 1981) claims that failure (i.e., negative feedback) motivates performance more than success does. Furthermore, an individual's level of feedback orientation, which is an individual's overall acceptance of feedback, will be examined as a potential moderator. This research is the first to examine feedback orientation in a training context.

Procedure:

The training program used was Virtual Environment Cultural Training for Operational Readiness (VECTOR), developed for the U.S. Army Research Institute for the Behavioral and Social Sciences by Chi Systems, Inc. VECTOR is designed to provide videogame-based adaptive training in interpersonal skills through the application of highly experiential and scenario-based training. Participants were asked to complete two missions in VECTOR.

The design of the experiment was based on the voice-over feedback that was provided to the trainee. The design was a 2 x 2 mixed-design with the dependent variable as a performance change score. Participants were randomly assigned to one of four conditions: (1) frequent positive feedback, (2) infrequent positive feedback, (3) frequent negative feedback, or (4) infrequent negative feedback. All

feedback provided was based on the trainee's actual performance. In addition to playing the videogame, participants were asked to fill out several paper-and-pencil measures. These measures were: a multiple-choice pre- and post-test on interpersonal skills, Feedback Orientation Scale, manipulation check scale, presence scale, attention scale and self-efficacy scale.

Findings:

The results reinforce Anderson's ACT-R model. That is, in videogame-based training scenarios, frequent feedback leads to higher post test scores than infrequent feedback. It appears that infrequent feedback did not provide enough cues for the participant to detect and reject erroneous hypotheses and this in turn caused the participant to compile incorrect information which decreased performance (Anderson, 1983, 1996, 2000). Furthermore, the results indicate no support for the main effect of feedback sign on performance, and thus neither theory regarding the role of feedback sign on training performance was supported.

The interaction between feedback frequency and feedback sign was also examined. The interaction was significant and further post-hoc analyses indicated that frequent feedback was most beneficial when the feedback was negative rather than positive. Also, positive feedback leads to better performance when it was infrequent rather than frequent.

Lastly, it was predicted that feedback orientation would moderate the relationship between feedback intervention and performance. This prediction was not supported. In a training environment, feedback orientation may be less influential because trainees are expecting to receive feedback on their performance.

Utilization and Dissemination of Findings:

Instructional designers can use this information to determine what form of feedback is most beneficial to training a complex task. Instructional designers need to keep in mind that during a complex task the trainee requires frequent feedback about their performance. Preferably, the feedback provided will be constructive rather than just positive praise. Positive praise only informs whether the goal was accomplished. However, constructive feedback provides information on how to improve performance. Lastly, feedback should adapt to the trainee's learning and performance. The use of technology such as computer-based training, videogames and web-enabled training is still an emerging field where there is a lack of theoretical background to help develop training. This effort takes a step toward resolving this problem to allow practitioners a framework upon which to base their training design.

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Feedback in Videogame-based Adaptive Training

The field of training has been quickly evolving due to the implementation of new and advanced technology. Military, industry, and education continue to investigate the use of an increasingly popular instructional tool known as videogame-based adaptive training (Orvis, Horn, & Belanich, 2008). Videogame-based adaptive training involves a videogame platform where automatic adjustments are made to problems or tasks based on a trainee's performance. The use of videogames has become a popular medium for training in the military because they are effective tools for learning and understanding complex subject matter (Ricci, Salas, & Cannon-Bowers, 1996). This approach is also immersive and engaging in ways that traditional workbooks or manuals are not and has the capability to provide realistic feedback and multi-sensory information (Garris, Ahlers & Driskell, 2002; Tarr, Morris, & Singer, 2002). Research has also shown that skills learned in game-based training environments transfer to real-life situations (Gopher, Weil, & Bareket, 1994; Knerr, Simutis, & Johnson, 1979). Additionally, videogame-based training offers a training medium that is quickly deployable, has low costs and can be easily administered without the expertise of a trainer. The rapid growth and implementation of videogame-based training reinforces the need for a theoretical framework that guides the design of these tools. For this reason, this research will examine an important design element in training: feedback. More specifically, this research tests conflicting feedback theories regarding feedback sign and feedback frequency. The goal was to determine which type of feedback (positive, negative, frequent, or infrequent) is most effective for improving interpersonal skills in a videogame-based adaptive training environment.

According to the U.S. Army Concept for the Human Dimension in Full Spectrum Operations 2015-2024 (TRADOC Pamphlet 525-3-7, 2008), there is a need to expand the skills of Soldiers beyond specialty skills and common warrior skills to include interpersonal skills. More specifically, there is a shift from training for operations in sharply defined institutional chains of command to decentralized, collaborative operations requiring the use of negotiation skills. Army leaders need experience negotiating in the context of ambiguous authority, political turmoil and cultural differences. The future of interpersonal skills training requires the leader to have access to experiential learning opportunities such as scenario-based vignettes with coaches that allow them to practice adaptable decision making skills. Research must address these needs in order to provide Soldiers with the most effective training tools for the future.

Currently, most of the research in computer-based training has been focused on motor or "hard skills" due to the feasibility in defining, measuring, and testing a well-defined task or domain (Schmidt & Wulf, 1997; Swinnen, Schmidt, Nicholson & Shapiro, 1990; Todorov & Shadmehr, 1997). However, computer-based training has the potential to also train "soft skills" such as interpersonal skills. Interpersonal skills refer to a person's ability to present oneself in a manner that promotes positive relationships through social communications and interactions. This includes the ability to manage people, negotiate, and give and receive constructive criticisms. Some organizations have begun to apply computer-based adaptive training to interpersonal skills (Bailey, 1990; Drew & Davidson, 1993; Ross, Pollman, Perry, Welty & Jones, 2001; Torney-Purta, 1998). However, to date, the effectiveness of this training has not been established.

Another area of research that requires further investigation is the role of feedback in videogame-based adaptive training. Research suggests that training alone is not sufficient to enhance performance but that feedback is a necessary component (Komaki, Heinzmann, & Lawson, 1980) and is critical for evaluating new skills (McKendree, 1990). Additionally, feedback has been shown to motivate and direct employees' attention and thus increase learning and performance (Kluger & DeNisi, 1996). As critical as feedback appears to be, few studies have evaluated the real impact of different types of feedback on training performance. Most computer-based training systems provide some sort of immediate feedback but feedback content is rarely explicitly discussed (McKendree, 1990). Another issue is that the literature is mixed on which type of feedback is most effective for learning. There has been some limited research on topics such as face-to-face feedback versus electronic feedback (Earley, 1988; Kluger & Adler, 1993; Kluger & DeNisi, 1996). Beyond this there has been little empirical work examining the optimal use of feedback in videogame-based adaptive training.

To address this gap in the literature, the current research compared trainee performance on a videogame-based adaptive training program for interpersonal skills after receiving different types of feedback. The training program used for this research was the Virtual Environment Composable Training for Operational Readiness (VECTOR) developed by Chi Systems, Inc., for the U.S. Army Research Institute (ARI), partly through an Army Small Business Innovation Research contract and partly with ARI funding. VECTOR is designed to provide game-based adaptive training in interpersonal skills through the application of highly experiential, scenario-based training in a virtual environment. This type of platform is in line with what is recommended by the U.S. Army Concept for the Human Dimension in Full Spectrum (TRADOC Pamphlet 525-3-7, 2008), which states the need to expose Soldiers to risk in realistic simulation-supported training in order to improve decision making skills without fear of injury. Additionally, competing theories in feedback frequency (feedback intervention theory and ACT-R theory) and feedback sign (self-efficacy theory and control theory) were evaluated to determine the most effective training design features. Furthermore, an individual's level of feedback orientation, which is an individual's overall acceptance of feedback, was examined as a potential moderator between the feedback intervention and performance. It was hypothesized that if trainees in the frequent feedback condition performed better (i.e., improved posttest scores and improved scores from Mission 1 to Mission 2 in the videogame) in comparison to trainees in the infrequent feedback condition then the ACT-R theory would be supported. If trainees in the positive feedback condition performed better than trainees in the negative feedback condition then the self-efficacy theory would be supported.

The feedback intervention theory (Kluger & DeNisi, 1996) supports the notion that for an interpersonal or complex skill it is optimal to provide trainees with infrequent feedback. Contrary to this theory, Anderson's (1983) ACT-R theory suggests that feedback should take place immediately after every action, in other words, frequent feedback is viewed as ideal for learning. By empirically examining these two competing theories of feedback, this effort will help instructional designers incorporate the appropriate amount of feedback in their videogame-based adaptive training programs. This research will also test two competing theories regarding

feedback sign. Bandura's (1986) self-efficacy theory claims that people will try harder or raise their goals after success. This is supported by research that shows positive feedback is best for improving performance on a task (Becker & Klimoski, 1989; Ilgen, Fisher & Taylor, 1979; Kluger & DeNisi, 2005; Shrauger & Rosenberg, 1970; Van-Dijk & Kluger, 2004). On the other hand, the control theory perspective (Carver & Scheier, 1981) claims that failure motivates performance and persistence more than success does. Consistent with this approach, research demonstrates that negative feedback is beneficial for improving performance (Atawater, 1995; Johnson & Ferstl, 1999; Reilly, Smither, & Vasilopoulos, 1996; Smither et al., 1995; Walker & Smither, 1999). The current investigation will examine which type of feedback sign is most beneficial for learning an interpersonal skill in a videogame-based adaptive training environment.

Lastly, a key challenge in the feedback literature is the need for a better understanding of an individual's response to performance feedback (Fedor, 1991) in a videogame-based adaptive training environment. Little research has examined how responses to feedback may differ across individuals (Renn & Prien, 1995). This is especially the case concerning a person's feedback orientation, which is an individual's overall acceptance of and value placed on feedback. This is an important characteristic to examine because researchers suggest that a positive feedback orientation may lead to performance improvements (London & Smither, 2002; Smither, London, & Reilly, 2005). Prior to designing a training program, knowing a trainee's feedback orientation may help in determining what form of feedback would lead to superior performance. This effort is the first to examine feedback orientation in a training context and its impact on feedback acceptance and performance.

The goal of this research is to address the following issues: Which is most useful for learning interpersonal skills in a videogame-based adaptive training environment, frequent or infrequent feedback, positive or negative feedback? Which theory best explains this relationship? Does feedback orientation moderate the relationship between feedback intervention and performance?

The next section will review the current training and feedback literature. The following section will consist of an explanation of the methods used and results. Finally, the discussion section will review the theoretical and practical implications of this investigation.

Training Interpersonal Skills

Current Trends in Interpersonal Skills Training

The importance of training Soldiers on interpersonal skills is emphasized in the U.S. Army Concept for the Human Dimension in Full Spectrum Operations by TRADOC (2008). Soldiers' interpersonal skills will largely determine their success as followers, team members, and representatives of the U.S. Army when deployed. Once deployed, Soldiers must shape the perceptions and win the acceptance of the local populace, which is possible through the display of effective interpersonal skills. Thus, there is a need for the Army to train a broader range of skills beyond warrior skills. For this reason, it is necessary to develop interpersonal skills through the use of technology or other

means that will compress time ("TRADOC Pamphlet 525-3-7", 2008). To better understand the role of videogame-based training in training interpersonal skills, this section will review the current trends for interpersonal skills training.

Training interpersonal skills is not common in the military, but industry and education have begun to use different media to implement this form of training. The most common forms of training used in interpersonal skills training include lecture-based classroom courses, leadership seminars, coaching, scenistic methods, and role-playing. Maki and Maki (2002) found lecture courses were the most commonly used training medium by organizations. Lecture courses have been used to teach factual and procedural knowledge as well as interpersonal skills. Formal classroom training is often supplemented with post-training feedback and self-coaching (Tews & Tracey, 2008).

An example of a classroom-based interpersonal skills training is seen in research conducted by Tews and Tracey (2008). The foundation of their research was based on a program conducted in an organization's centralized corporate training center. The training program was focused on developing supervision skills by aiming to develop five general skill sets. The general skills were clearly communicating performance expectations, observing employee performance, rewarding employees with frequent praise and recognition, addressing performance issues, and creating enthusiasm for hard work. The interpersonal skills training format lasted 8 hours and included lectures, discussions, videos, and role-playing activities. No formal evaluation of the effectiveness of this program has been done. However, the problem with lecture courses is that although they may be appropriate for achieving cognitive objectives, they are hardly sufficient for psychomotor or interpersonal skills. Lectures are too passive a medium for most adults (Pedler, 1978). Additionally, lectures do not address trainee individual differences such as interests, abilities, background and personalities. Lectures prevent individualized feedback and reinforcement from trainers (Wexley & Latham, 1991). Furthermore, some researchers argue that formal classroom training produces individuals who are only able to perform crude and forced imitations of target behaviors (Tews & Tracey, 2008).

Another popular trend in training interpersonal skills is through the use of coaching (Sparrow, 2006). Coaching has been claimed to be especially well suited to helping individuals develop their interpersonal skills (Berriman, 2007). The coach observes the employee's behavior and offers advice on how to approach situations. More specifically, individuals assigned as coaches utilize skills such as active listening, purposeful questioning, providing helpful and objective feedback (Berriman, 2007), and role modeling appropriate behaviors (Chakrabarty, Oubre, & Brown, 2008). Some drawbacks of coaching are that it is very time intensive, there is focus on only one person at a time, and little to no evaluation is conducted to determine whether interpersonal skills have improved. In addition, coaching has the potential to cause stress, thus care has to be taken to decide which employee would benefit most from such an intrusive approach (Berriman, 2007).

A newer approach being adopted to expand interpersonal skills is known as the scenistic method. This approach involves the use of incidents, scenarios, scripts, and episodes during the training.

The goal of this training approach is to help learners practice skills such as questioning, making assumptions, defining issues and problems, problem finding, and problem solving (Lyons, 2006).

Lyons (2006) conducted a training evaluation to determine the effectiveness of a case-based modeling or type of scenistic method compared to traditional training. A case-based modeling approach consists of eight steps. These steps are: (1) providing participants in written form a case situation or scenario, (2) allowing participants to review information for understanding and any necessary clarifications are sought through small-group discussions, (3) a discussion in an open forum is conducted to reach consensus about the critical issues, (4) participants brainstorm potential interventions for treating the issues, (5) participants identify the several elements necessary to address the issues, (6) rehearsal of the behavioral script of the job or task, (7) develop qualitative and quantitative evaluations of effective, skillful intervention practices and (8) continue rehearsing until the participant is prepared to field test the intervention.

Once the case-based modeling was developed and conducted, participants were rated on their performance in comparison to a traditional group. Performance was assessed by a panel of judges using a behaviorally anchored rating scale. Participants met with a panel of judges for 20 minutes and were asked to explain how they would plan and manage a sales call with customers. Results of the training evaluation showed that the case-based modeling group had higher performance. However, there were several issues with the design of the research and with this form of training. First, the different training groups were trained by different trainers in different locations who were able to design their own curriculum. Also, details of the traditional group process only included that the trainers used traditional training approaches. Furthermore, an issue with this form of training is that it requires a lot of preliminary work. Rating scales such as behaviorally anchored rating scales need to be developed and validated before they can be used during the training (Murphy & Cleveland, 1995). A lot of time and resources are required from the organization to conduct this training.

Lastly, the method of role-playing is still very popular in the interpersonal skills training field. Role-playing is a learning activity in which participants act out a set of defined role behaviors. A role-playing scenario can include mimicking, demonstration or illustration of specific concepts, problems or situations (Sogunro, 2004). A common set-up for a role-playing training includes lectures, question-and-answer periods, small group discussions, case studies, structured experiences, and role-playing. This form of training may require some previous experience in role-playing. Experience is needed because the stage of running the role play may be too complex for beginners because they must pay attention to verbal and nonverbal aspects of the conversation and at the same time have to control emotions and deal with the pace of the exchange (Holsbrink-Engels, 1997). Furthermore, because there is little or no time to reflect on the actions that occurred during the interaction, it is difficult for students to keep track of what they learned and in the order in which it was learned. Novices may also fail to build the intended skills due to a lack of repeated exposure (Holsbrink-Engels, 1997). Researchers have also stated that a major issue with training methods such as role playing or discussions is that asking inexperienced trainees to work out the interpersonal skill together is a potentially serious problem in that the necessary concepts and skills that are not effectively learned are probably

learned on the job, where the cost of mistakes is much greater (Ross, Pollman, Perry, Welty, & Jones, 2001).

Overall, the previous training approaches for teaching interpersonal skills have been shown to be time-consuming, costly, and ill-equipped to respond to the complexity of learning interpersonal skills. Interpersonal skills are complex cognitive skills (Van Merrienboer, Kester, & Paas, 2006) and learning them may create a high cognitive burden. For these reasons, modern training approaches must be able to respond and adapt to the different needs of interpersonal skills training.

Computer-Based Adaptive Training for Interpersonal Skills

In defining the type of medium used during training it is common for the literature to use computer-based training, simulations, games, and adaptive training interchangeably. However, there are some differences among these media. Computer-based training requires that instruction be through the use of a computer terminal (Wexley & Latham, 1991). A type of computer-based training can involve a game. A game is an artificially constructed, competitive activity with a specific goal, a set of rules and constraints that are located in a specific context (Hays, 2005). An example of a computer-based game is TETRIS, a classic puzzle game. In Tetris the individual must change the shape of falling blocks to complete horizontal rows of blocks, which disappear once completed. The objective is to clear as many rows as possible to receive points. It is also possible for a game to be made as a simulation. A simulation attempts to recreate relevant aspects of some topic or phenomenon so learners can interact with it and observe the consequences of their interactions (Hays, 2005). An example of a simulation is the Combat Flight Simulator, which simulates military aircraft and their operations. In the simulator, players learn how to fly an aircraft of their choice. Adaptive training is a form of computer assisted instruction that automatically adjusts stimuli, problems, or tasks presented to trainees in accordance with their performance level (Wexley & Latham, 1991). There are three basic elements of adaptive training. First, performance is continually measured. Second, the problem or task can be changed in difficulty for the learner. Third, the scenario varies in relation to how a trainee is currently performing (Wexley & Latham, 1991). According to the TRADOC Pamphlet 525-3-7 (2008), adaptive training is a useful element to include in videogame-based training for the Army because it increases tailorability and efficiency of training. The ability to adapt training to the individual needs of a specific Soldier reduces the time and cost to achieve training objectives. Furthermore, the TRADOC Pamphlet 525-3-7 (2008), suggests that adaptive training enables Soldiers to learn ways that are most effective for them and that will meet future challenges using the most flexible solutions possible. The current research will be examining and using a combination of these media. The focus of this research is computer-based training, which involves a simulation game that can adapt to an individual's responses.

The use of computer-based training began with the idea of Programmed Instruction, which was influenced by B.F. Skinner in the late 1950s. This involved mostly rigorously controlled experiments. This approach presented information, provided questions, and the learner was given feedback based on responses in an attempt to share specific knowledge gradually (Kamouri, 1983-84). Programmed Instruction was more commonly used for the acquisition of

general text information, specific-task related information, and job skills and procedures (Shoemaker & Holt, 1965). There were several benefits from the use of this medium such as significant savings in training time and scheduling flexibility (Shoemaker & Holt, 1965). Still, there were serious limitations such as the lack of motivation from the trainee, the need for individualized feedback, limited applications, expensive and large equipment, and the need for technically competent personnel that were not readily available (Kamouri, 1983-84). This approach was then followed by a technological boom that supported the spread of technology-driven training. This boom expanded the field in terms of the type of research and function of computer-based training.

The next approach towards computer-based training stemmed from human factors research. In this field, researchers examined the factors affecting human performance in the context of man-machine interaction. Furthermore, researchers and practitioners studied the various aspects of a system's interface such as hardware, administration of training, and software development (Kamouri, 1983-84). The growth of technology-driven training was further accelerated with the inclusion of learning theory and individual differences considerations. Learning theory and the study of individual differences were incorporated into the program design of computer-based training to enhance training performance (Kamouri, 1983-84). Cognitive theory researchers also played a role in the development of the current computer-based training systems. The influence of this field was acknowledging the importance of complex information processing (Goldstein, 1980). Cognitive theory was being incorporated into computer assisted instruction programs in education (Block, 1979). Now computer-based programs train the operation of complex equipment and assist in developing highly specialized skills such as flight procedures and engineering principles (Kamouri, 1983-84).

As the cost of technology continues to decline and the cost of face-to-face training increases, more organizations are beginning to implement computer-based training applications such as simulations, videogames, Web-based training, and distance learning (Bell & Kozlowski, 2002) to help combat the issues found with traditional training methods. Research supports the notion that superior and more rapid learning is associated with more personalized, self-paced, and self-directed computerized instruction especially when training adults (Kamouri, 1983-84).

The key to computer-based adaptive training for interpersonal skills is its ability to overcome shortcomings of other methods. For example, computer-based adaptive training can accommodate individual learning differences. Some trainees require more time or more sessions to better acquire the necessary skills and concepts. However, the format of traditional training techniques and the high cost do not always make this possible. Computer-based adaptive training simulates work experiences in a setting where trainees can experiment with new behavioral styles, and it has the capability of teaching as many trainees with as many sessions needed. This is an important feature because the direct experience of a learning activity is key to bringing about real understanding and desired change in people (Sogunro, 2004). This form of training might better help trainees learn to recognize important decision points and apply the theory when making decisions (Ross et al., 2001). Furthermore, computer-based adaptive training can provide individualized immediate feedback for each trainee.

Another important feature needed in interpersonal skills training is the ability to reflect on one's actions and performance and to plan ahead (Holsbrink-Engels, 1997). Traditional interpersonal skills training does not always include this ability, however. For example, role-playing requires constant interaction. On the other hand, computer-based adaptive training provides opportunities to control what is learned and record-keeping facilities for monitoring and recording the contributions of individual trainees (Holsbrink-Engels, 1997). It is a technique that provides the trainee with an opportunity for active participation, trying out new behaviors in a safe environment, feedback, and practice (Wexley & Latham, 1991). Computer-based adaptive training also solves the issue of having an inexperienced trainer (Crosbie, 2005).

One popular form of computer-based training is videogames. The use of videogames has become a popular medium of training because some research shows that games can be effective tools for learning and understanding complex subject matter (Ricci, Salas, & Cannon-Bowers, 1996). Videogames have also been found to be immersive and engaging in ways that traditional workbooks or manuals are not (Garris, Ahlers & Driskell, 2002). Another reason for the widespread interest among practitioners is that research has shown that skills learned in videogame-based training environments do transfer to real-life situations (Gopher, Weil, & Bareket, 1994; Knerr, Simutis, & Johnson, 1979). Thus, research supports the notion that people can learn from videogames.

Although research shows that videogames can be an effective tool for training, most of the tasks trained have been math, electronics, and economics (Hays, 2005). A comprehensive literature review on videogames that included over 270 documents was conducted by Hays (2005). In this literature review only 48 of the studies provided empirical data of the instructional effectiveness of games and there were no studies that included training interpersonal skills. The review did find that videogames that were embedded in instructional programs and included performance evaluation, debriefing, and feedback were effective in enhancing cognitive learning (Hays, 2005). A previous study reviewing business games used to teach strategic management skills found more positive results (Wolfe, 1997). The review was conducted on studies between 1966 and 1988, and found evidence that computer-based general management games are effective in producing knowledge gains. Wolfe (1997) also found that the only alternative instructional approach that was similar to games was case studies. Although both methods produced learning, the games appeared to be superior (Wolfe, 1997). Similarly, Whitehall and McDonald (1993) and Ricci et al. (1996) found that training incorporating game features leads to improved learning. Thus, there is potential for videogames to be used for training interpersonal skills.

There has been some recent movement in the development of videogame-based interpersonal skills training. For example, ELECT BILAT (Hall et al., 2006) is a videogame-based simulation used for Soldiers to practice conducting bilateral engagements in a cultural context. In BILAT, the trainees have meetings concerning the cultural context, gather information, conduct meetings and negotiate whenever necessary. Additionally, the participants are given targeted feedback by a coach. Although this training tool shows potential, there has been no formal evaluation to determine whether learning occurs.

Another videogame-based interpersonal skills training used and evaluated is the McGill Negotiation Simulator designed to teach negotiation skills during a sales negotiation scenario (Ross et al., 2001). The simulator allowed for the trainee to choose from several responses during a negotiation scenario. Then, the preprogrammed opponent responds in a way that is consistent with the underlying negotiation theory. The researchers found that with the use of a computer-based adaptive interpersonal skills videogame, trainees demonstrated a significant increase in learning relative to a control group. Not only did the students learn more compared to a control group but they also enjoyed the simulator. Similar results were found in their replication of the study (Ross et al., 2001). Additional research evaluating computer-based adaptive interpersonal skills training program was done by Torney-Purta (1998) for the ICONS Computer-Assisted Simulation. The ICONS simulation was designed to teach international concepts, content, and negotiation strategies and skills. The simulation combined a lecture format with a small-group "seminar" type learning environment. The small group discussions were used to prepare students for participation in the negotiation simulation. Participants negotiated with peers at overseas institutions. The study found that later in the semester the students showed more elaborate thinking in dealing with international issues and seeing linkages between problems. The evaluation also showed that not only were students able to negotiate in an international setting but they were thoughtful about their reasons for choosing a specific negotiation style. Lastly, the majority of students became highly involved in the program and valued learning using the computer technology.

Another computer-based simulation that trains interpersonal skills was developed by a telecommunications firm with the goal of encouraging managers to take more responsibility for leadership, and to increase managers' understanding and knowledge of the industry (Drew & Davidson, 1993). The computer-based game was made up of four teams of usually four participants who would make decisions on new products, marketing, sales force, customer service, and operations. Each team member was assigned a role such as VP of marketing and VP of product introduction. The game required each team to search for data and decide about issues such as new products, pricing, and budget allocations between departments. The game required participants to work together and be able to come to consensus on many decisions. Furthermore, the simulation provided an opportunity to share experiences and discussions. At the end of the simulation, participants received feedback on their behavior.

The previous discussion has shown that computer-based adaptive training for interpersonal skills is still a growing and emerging field as practitioners and researchers alike have recognized its benefits. Although minimal research has been conducted in this area, studies have shown that videogame role-playing enhances interpersonal skills development by providing practice in a conversational scenario, offering opportunities for reflection, and capturing individual contribution and learning (Holsbrink-Engels, 1997).

Although preliminary research has found potential for the use of videogames, simulations, and computer-based adaptive training for teaching interpersonal skills there are still some issues with this form of training. First, expecting trainees to learn from trial and error with the virtual human is problematic because errors may go unrecognized. Trainees may come to believe they were successful when in fact there was a problem with their response that deserved attention (Core et

al., 2007). Second, advanced technologies offer flexibility, customization, and speed but it is important to ensure that the instructional integrity of these programs is maintained and evaluated. There is still little consensus in the research on game features that support learning (Garris, Ahlers, & Driskell, 2002). Researchers have also suggested that simulators are ineffective because they do not directly measure the instructional objectives of the training or ensure that the learner has met these objectives (Hays, 2005). In his review, Hays (2005) stated that the current instructional games literature is made up of ill-defined terms and methodological flaws. To help resolve these issues, the current literature needs to examine a fundamental element of training: feedback. Feedback is information concerning one's performance. Feedback is necessary for correcting mistakes and learning. Nevertheless, the computer-based adaptive training literature rarely discusses the use of feedback even though most programs include some form of feedback. Furthermore, research has not compared which types of feedback are the most effective in teaching interpersonal skills in a computer-based adaptive training environment. The present research seeks to address this gap in the literature by testing competing feedback theories to determine the most effective instructional design for training interpersonal skills.

Feedback and Training Design

The primary goal of training is to improve performance and to achieve this it is critical for trainees to be provided with feedback. Feedback is information given by an external agent regarding some aspect of one's task performance (Kluger & DeNisi, 1996). Feedback is essential in training because it serves three major functions in promoting learning and motivation. First, it tells trainees whether their performance is correct thus allowing them to make any necessary corrections to their subsequent behavior. Second, feedback makes the learning process more interesting, which increases a trainee's willingness to learn, and third, feedback leads to the setting of goals to improve performance (Wexley & Latham, 1991). Training researchers suggest providing trainees with debriefing and feedback that clearly states how their behaviors helped them meet the instructional objectives (Hays, 2005). The feedback provided to the trainee should result in the development of better mental models that will more likely be transferred to applied settings (Heimbreck, Frese, Sonnentag, & Keight, 2003). Furthermore, research shows that training characteristics such as practice, behavior modeling, part- versus whole-task learning, and feedback are positively related to performance (Alvarez, Salas & Garofano, 2004). Regardless of these suggestions and findings, few studies have directly looked at the impact of feedback in training. Feedback in training is a commonly considered training design feature, as are learning principles such as massed versus spaced practice, but feedback is rarely examined for its own unique contribution to the instructional design process. Even less is known about feedback in a computer-based adaptive training environment. There has been some research examining the differences between face-to-face feedback versus computer mediated feedback (Earley, 1988; Kluger & Adler, 1993; Kluger & DeNisi, 1996; Markus, 1994b; Sproull & Kiesler, 1986). Generally, studies have found that people prefer to seek or receive feedback from computers rather than face-to-face. However, exactly what kind of feedback and how often it is given is rarely examined in the computer mediated feedback literature. For this reason, the current effort will attempt to close this gap by examining the effect feedback frequency and feedback sign will have in a computer-based adaptive training environment.

Feedback Frequency

Feedback frequency refers to the number of times a feedback intervention is provided during training. In this investigation, "frequent" feedback is defined as feedback given to an individual immediately at the end of each interaction within the mission and again at the end of the mission. "Infrequent" feedback is given once per mission, at the end. Several conflicting theories have been proposed to help predict an individual's performance based on the frequency of the feedback they received. According to the feedback intervention theory, frequent feedback is considered detrimental to the acquisition of a complex skill. On the other hand, the ACT-R model suggests that frequent and immediate feedback is essential for acquiring any skill. These competing theories are discussed in more detail below.

Feedback intervention theory. In most cases, feedback has been found to accomplish its intended purpose, which is to provide information about current job performance to facilitate and motivate performance improvements; however, there have been instances where this does not occur. Kluger and DeNisi (1996) noticed these inconsistencies and conducted a meta-analysis on the effect of feedback interventions on performance. The authors found that in a third of the studies feedback decreased or had no effect on performance. Not much has changed in the feedback literature since this meta-analysis. There is still a debate regarding whether feedback improves performance (London, 2003) and under what conditions. To help clarify these contradictions Kluger and DeNisi (1996) proposed the feedback intervention theory.

The feedback intervention theory assumes that behavior is goal-directed and is based on five assumptions: (1) behavior is regulated by a comparison of feedback with a goal or standard, (2) these goals are ordered hierarchically, (3) attention is limited so only feedback that demonstrates a gap between the current level of performance and the goal will regulate behavior, (4) attention is normally directed to a moderate level in the hierarchy, and (5) feedback interventions can alter the location of attention and in doing so can affect behavior. Given that these assumptions are true, the framework of the theory consists of a three-level hierarchy where feedback may focus the individual's attention at any of these levels. When feedback directs attention away from the task at hand to factors associated with the self or ego it is viewed as working at the highest level in the hierarchy, the self or meta-task level. The middle or moderate level is known as the motivation level. Feedback directed at the motivation level provides an indication of how well individuals are meeting their goals and presumably will inspire motivation and persistence. The lowest level is the task learning level, which occurs when the attention is brought to the specific details of the task. This occurs when working harder (task motivation level) does not lead to the desired performance level and the individual must focus on specific processes or strategies to improve performance.

This theory states that the moderate or task motivation level is where attention is normally directed. The goals at this level are related to actual task performance. At the task motivation level the primary focus is on the task itself and working to reduce the discrepancy between the

desired goals and the current state. This, in essence, is the motivational (persistence and direction) impact of feedback. It is believed that most feedback interventions are focused at this level and only when the person is not able to reduce the discrepancy does the attention shift up (meta-task level) or down the hierarchy (task learning level). Furthermore, interventions that focus attention at this level are the most likely to produce the desired effect on performance (DeNisi & Kluger, 2000).

The highest level of the hierarchy refers to the self-level where the goals relate to an individual's self-concept. Feedback interventions focus attention at this level when success at the task is equated with some higher order goal or when performance is central to our self-concept (DeNisi & Kluger, 2000). At this level it is unlikely that the individual will abandon goals but instead concern over reasserting or defending one's self-image could interfere with the ability to focus on the task and thus decrease performance (DeNisi & Kluger, 2000).

Lastly, the lowest level is the task learning level where the attention is brought to the details of the task or the actions involved in performing the task. If attention shifts to the task learning level the concern may turn to the tone of voice one used to speak to someone rather than the approach used to explain a concept. Thus, if feedback causes a person to focus too much on the details of the process it may cause performance to decrease.

The feedback intervention theory helps explain how feedback frequency, or how often feedback is provided by a source, can influence behavior. Although it is generally believed that the more frequent the feedback, the better (Ilgen, Fisher, & Taylor, 1979), this theoretical framework claims that this may not always be the case. In their meta-analysis, Kluger and DeNisi (1996) found that feedback interventions associated with complex tasks were more likely to result in declines in performance. A decline in performance may occur because during a complex task, frequent feedback diverts attention to the task learning level and performance will decline if that feedback does not provide sufficient information needed to develop specific strategies for improvement. Thus, the feedback would serve as a distraction from the task at hand during a time when the person's full attention is needed (DeNisi & Kluger, 2005).

The concept of too much feedback being a distraction is also supported by the notion of performance feedback overload. Performance feedback overload refers to "a perception by an individual that he or she has so much accessible performance feedback that it is not longer possible to use it effectively" (Salvati, Gosselin, & Morin, 2003). The theoretical ground for this concept is based on the notion that individuals have limited information processing capabilities. Salvati et al. (2003) identified several antecedents and consequences to feedback overload. Antecedents included feedback value and job experience while important consequences were the desire to respond to feedback, stress, and job performance. The authors suggest that the well-accepted premise that more feedback will help individuals is not necessarily true and instead too much feedback may have detrimental effects on an individual.

There is research that shows support for the view that frequent feedback can be detrimental to performance during a complex skill (Buchwals & Meager, 1974; Chokkar & Wallin, 1984; Ilgen et al., 1979; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997; Renn & Prien, 1995; Swinnen

et al., 1990). Ilgen et al. (1979) explain that when learning a complex skill, such as an interpersonal skill, the relationships between events are not perfectly correlated as they are when an individual is being trained to estimate distances between objects. Because the relationship is not perfectly correlated, feedback after each trial can be very misleading and detrimental to learning the relationship. Thus, the authors suggest caution when recommending the use of frequent feedback especially when individuals must learn complex skills. This has been demonstrated in skill acquisition laboratory studies (Swinnen et al., 1990) and field studies where more frequent feedback did not lead to greater performance (Chhokar & Wallin, 1984). Similarly, Buchwals and Meager (1974) found that delayed feedback improved performance if individuals remembered the original response. That is, if the activities between the response and the delayed feedback did not interrupt the individual's ability to recall information, then the delayed feedback had no detrimental effects on performance.

In another study, Janelle et al. (1997) examined whether participants who could control the amount of feedback they received would perform differently than those who had a rigid feedback schedule or those who received more feedback while learning a complex task. Results showed that when participants were given the opportunity to control the amount of feedback they received they asked for less feedback or infrequent feedback to learn their skills at a level equal to or greater than groups not provided that option. Infrequent feedback had the same results for a study conducted by Renn and Prien (1995). Researchers examined employee responses to performance feedback from the task and found that more frequent performance feedback may not always be associated with higher performance.

Similarly, studies in the error-detection field have found that compared to delayed feedback, frequent feedback can be detrimental to performance. Swinnen et al. (1990) found that frequent knowledge of results degraded learning as measured on a delayed retention task. This may occur because a short time lag between performance and knowledge of results may degrade the acquisition of error-detection capabilities.

Overall, past research has shown that frequent feedback may bring attention to the task details and in turn cause an unnecessary distraction while learning a complex or interpersonal skill. This may be especially true in a computer-based adaptive environment where the use of advanced technologies may require additional attention while learning a complex skill. In line with the previous studies the following hypothesis is proposed:

> **Hypothesis 1:** Following the feedback intervention theory, trainees in the infrequent feedback group will have a higher change in performance for the pre- and post-test and Mission 1 and Mission 2 scores than trainees in the frequent feedback group.

Feedback in ACT-R theory. Anderson's ACT-R theory (1983; 1996; 2000) consists of a detailed theory of skill acquisition. According to the theory, skill acquisition occurs in three phases: interpretive, procedural, and automatization. In the interpretive stage, individuals learn the necessary declarative knowledge and act upon general problem-solving strategies. The procedural stage is when individuals form procedures based on the compilation of the specific

episodes they encounter. Lastly, the automatization stage refers to the point where the learned information and compiled procedures are strengthened and thus apply automatically.

More specifically, the ACT-R model of skill acquisition consists of a hierarchy of goals related to the learning process. The theory suggests that to encourage the learner to solve problems, a goal structure should be used that will be useful for later learning and performance. For example, a task can be decomposed into hierarchical goals and eventually actions that will form an outline for subsequent behavior. In essence, tasks should be broken down to their elemental components to prevent incorrect or unnecessary steps being formed.

Another important element of the ACT-R model is the need for the learner to actually perform the task rather than just being told about the procedure. Because learning takes place when there is previous behavior that can be compiled upon, simply having the declarative knowledge will not be enough for the skill to be acquired. Thus, performing the tasks allows for integration of the material.

Therefore, the ACT-R theory suggests several guidelines for the design and use of feedback. For the initial stages of skill acquisition, feedback should include an indication of the goal structure of the performance. When there is an error in the learner's performance the feedback should contain the correct information, including any necessary steps needed to accomplish the goals. Additionally, feedback should take place immediately after the error has occurred and be placed within the context of the problem. Delayed feedback slows down the process of compiling correct information and can result in learning procedures that are incorrect and then later applied to future problems.

Most of the research based on the ACT-R model has centered around "hard skills" or well-defined domains such as science, geometry, mathematics, and programming (Anderson, Boyle, & Yost, 1985; McKendree, 1990). However, its application for complex or ill-defined situations has been examined (Connelly, 2001; Mascha, 2001) and other studies have shown support for the need for immediate and frequent feedback in learning new skills (Anderson, Kulhavy, & Andre, 1971; Cook, 1968; Ivancevich, Donnelly, & Lyon, 1970).

Anderson et al. (1971) conducted a study using a computer-based instructional system and found that subjects who received feedback immediately after they responded learned significantly more than subjects who received delayed feedback. Similarly, research has found that the frequency of feedback given to managers is directly related to their attitudes and performance. In Cook's (1968) study, frequent feedback was defined as feedback received in the form of quarterly reports and delayed feedback was feedback in the form of yearly reports. The results indicate that managers given frequent feedback in the form of quarterly reports had higher performance and attitude ratings than those given delayed feedback in the form of yearly reports. Furthermore, contrary to the feedback intervention theory, McKendree (1990) found that more complex or ambiguous tasks require a greater degree of feedback that provides detailed information about one's performance than more well-defined domains such as science and geometry.

Mascha (2001) also examined the effects of task complexity and feedback types on knowledge acquisition. Results show that participants receiving either type of procedural knowledge feedback performed better than those who received no feedback. This lends to the support of the ACT-R prediction of a positive relationship between feedback or procedural cues and outcomes.

The previous studies contradict the notion that frequent feedback is detrimental to learning and instead provide support for the contention that frequent feedback can be beneficial for teaching various types of skills. According to the ACT-R model, trainees learning interpersonal skills through a computer-based adaptive environment should be given frequent feedback throughout the videogame. Frequent feedback will allow constant revision and learning during the interactions in the videogame. Thus, the following hypothesis will be examined:

> **Hypothesis 2:** Following the ACT-R theory of skill acquisition, trainees in the frequent feedback group will have a higher change in performance for the pre- and post-test and Mission 1 and Mission 2 scores than trainees in the infrequent feedback group.

Feedback Sign

Feedback is widely used in modern organizations to develop and train employees. However, the effectiveness of positive versus negative feedback is still in question. Positive feedback indicates that the standard (goal) has been met or exceeded. Negative feedback indicates a discrepancy between the standard (goal) and performance that indicates the goal has not been attained (Ilies, Pater, & Judge, 2007). The decision whether negative or positive feedback should be used seems simple but the current literature is ill-equipped to answer it, particularly within a formal training context. Similar to the feedback frequency literature, there are theories explaining the relationship between feedback sign and performance that directly oppose each other. Social cognitive theory (Bandura, 1986) helps explain the area of research that shows positive feedback enhances performance. Contrary to this is the control theory perspective (Carver & Scheier, 1998), which supports the notion of negative feedback enhancing performance. This effort will attempt to clarify the contradictions in the literature by testing the two competing theories, which are discussed in more detail below.

Social cognitive theory. Social cognitive theory is a learning theory based on the idea that people learn by observing others, people behave in certain ways to reach goals and behavior is motivated and regulated by one's cognitions (Bandura, 1986). One important set of cognitions is self-efficacy, or judgments of how well one can accomplish a task at designated levels. Efficacy judgments are task-specific and whether accurate or faulty they influence behavior by determining task choices, effort, and persistence in the face of obstacles. The belief is that the higher the level of self-efficacy, the higher the performance accomplishments.

According to self-efficacy theory, people avoid activities that they believe are beyond their coping capabilities, but they undertake and perform activities they judge themselves capable of managing. Therefore, receiving positive feedback may motivate individuals to continue increasing their performance to reach their goals because it is an indication of success and that

the ability to accomplish the task is present. On the other hand, negative feedback may cause avoidance of the task because it causes one to believe the task is beyond one's capability.

There is research supporting social cognitive theory; however, not many studies have focused on applying this theory to training interpersonal skills. Regardless, research suggests positive feedback is necessary to enhance performance (Becker & Klimoski, 1989; Chakrabarty, Oubre, & Brown, 2008; Ilgen, 1979; Jaworski & Kohli, 1991; Kluger & DeNisi, 2005; Martocchio & Webster, 1992; Shrauger & Rosenberg, 1970; Van-Dijk & Kluger, 2004) and negative feedback can have detrimental effects (Ilgen & Davis, 2000; Waldersee & Luthans, 1994) or no effect (Jaworski & Kohli, 1991) on performance.

There is a general conclusion that positive feedback is more pleasant and may enhance one's self-image and thus it tends to be recalled and perceived more accurately than negative feedback (Ilgen et al., 1979; Shrauger & Rosenberg, 1970). It has also been suggested that feedback may affect performance through the behavioral reward properties inherent in positive feedback (Waldersee & Luthans, 1994). According to the behavioral paradigm, because receiving positive feedback is considered desirable it is a positive reinforcer.

In line with this notion, Martochio and Webster (1992) examined performance feedback and self-efficacy reactions. The authors found that positive feedback resulted in higher test performance than negative feedback. Furthermore, positive feedback increased software self-efficacy beliefs where negative feedback decreased software efficacy beliefs. Similarly, positive feedback was also found to indirectly influence performance in a field experiment examining the main and interactive effects of feedback and self-efficacy on performance. Karl, O'Leary-Kelly & Martocchio (1993) found that the more positive the performance feedback received, the greater the increase in individual self-efficacy. These studies lend support for the notion that social cognitive theory provides insight into the mechanisms by which feedback influences learning and performance.

Further supporting the use of positive feedback, Becker and Kilmoski (1989) examined the relationship between the perceived organizational feedback environment and performance. The researchers found that positive feedback from a supervisor related to higher performance whereas negative feedback from the supervisor related to lower performance. Positive feedback has also been found to have a stronger positive effect on salesperson performance than negative feedback, which had no effect (Chakrabarty et al., 2008; Jaworski & Kohli, 1991).

Moreover, studies examining the interactive effect of feedback sign and task type on motivation and performance have found support for the use of positive feedback (Kluger & DeNisi, 2005; Van-Dijk & Kluger, 2004). In two studies, researchers found that individuals involved in a promotion task (i.e., creative or complex task) increase their motivation and subsequent performance with positive feedback rather than negative feedback. Additionally, individuals who were in a promotion focus (fulfilling a desire) also increased their motivation with positive feedback rather than negative feedback (Kluger & DeNisi, 2005; Van-Dijk & Kluger, 2004).

Relationships between feedback sign and other variables that indirectly influence performance have also been found (Ilies et al., 2007; Karl et al., 1993). Ilies et al. (2007) found that positive feedback increased positive affectivity while negative feedback increased negative affectivity. These affective reactions can be expected to influence an individual's performance. Furthermore, previous studies suggest that people process positive and negative feedback information differently (Ilies et al., 2007). Because learning interpersonal skills in a computer-based adaptive environment is a creative and complex task it may be that positive feedback will be more effective in improving performance. In a highly interactive and challenging environment positive feedback will serve as a signal of good performance and in turn provide the motivation necessary to continue working toward the goal. Therefore, if positive feedback is necessary to increase performance then the following hypothesis will be supported:

> **Hypothesis 3:** Following the social cognitive theory, trainees in the positive feedback group will have a higher change in performance for the pre- and post-test and Mission 1 and Mission 2 scores than trainees in the negative feedback group.

Control theory. Research also suggests that negative feedback is necessary to enhance performance, contradicting the results discussed in the previous section. This is explained by control theory (Carver & Scheier, 1981). The main focus of control theory is the negative feedback loops made up of four components: input function, standard, comparator and output function. The input function senses information outside of the system and brings it into the loop. This is synonymous with one's current state or behavior. The standard is the goal that the individual has set up. The function of the comparator is to evaluate the input and the standard to determine whether there are any discrepancies. If there is a discrepancy, the output function is activated to bring input in line with the standard and in turn eliminate any discrepancy. Another option instead of changing the input is to change the standard or goals the individual may have. If the comparator does not find a discrepancy then the system stays at the same level.

Additionally, a central tenet of control theory is that goals are hierarchically arranged. Short-term behavioral goals are regulated by feedback loops at the bottom of the hierarchy while long-term abstract goals are regulated by feedback loops at the top of the hierarchy. These goals are interrelated such that lower goals represent the means by which higher level goals are achieved. In general, this theory provides a causal explanation between feedback sign and performance. Lord and Levy (1994) proposed a hybrid version of control theory by incorporating control theory principles with various elements of human information processing theory to explain coordination in cognition, motivation, and behavior. They suggested a flexible and more loosely constrained system as opposed to the mechanical responses of the control system. In this hybrid version other constraints from tasks, social environments, or a person's physical or affective systems are considered in explaining how goals emerge at the hierarchical levels. In line with control theory, the authors suggested that feedback needs to interrupt processing in order to shift attention and improve performance. This interruption of processing will more likely occur if the feedback is negative.

Studies have shown support for the contention that negative feedback increases performance. However, little research has been conducted during the learning of an interpersonal or complex

skill. Most of the literature has been conducted within a training design that consists of simple tasks or motor tasks (Chadda, 1991; Kluger & DeNisi, 2005; Mesch, 1994; Wiener, 1963; Wiener & Attwood, 1968). The few studies that involved the influence of negative feedback on interpersonal or complex skills have focused on performance appraisals or upward feedback programs (Atawater, 1995; Johnson & Ferstl, 1999; Reilly et al., 1996; Smither et al., 1995; Walker & Smither, 1999).

Studies that have examined upward feedback, which occurs when subordinates provide feedback to a manager or supervisor, refer to negative feedback as the discrepancy between the supervisor's self-ratings and the ratings given to them by a subordinate. In other words, if a supervisor's self-ratings are high but the feedback provided by the subordinates indicates low ratings then this is considered negative feedback. In a study by Johnson and Ferstl (1999), employees rated their supervisors under the categories of leadership, people management (e.g., coaching evaluation, counseling), people development, and communications. The study showed that mangers who received "negative" upward feedback improved performance from one year to the next.

Similar findings have been found in longitudinal upward feedback studies. Managers who received lower performance ratings from subordinates in comparison to their self-ratings (i.e., negative feedback) had increased performance during a 2.5 year program than did managers who received higher performance ratings (i.e., positive feedback) (Reilly et al., 1996). These results were also found in a 5-year program with annual administrations of upward feedback. Managers initially rated poor or moderate showed significant improvements, as compared to managers rated highly (Walker & Smither, 1999). Consistent with the previous studies, Smither et al. (1995) and Atwater, Roush, and Fischthal (1995) found that managers and student leaders with initial low or moderate performance had a greater improvement in their performance after receiving negative feedback than did managers with high performance.

The positive influence of negative feedback on performance has also been found with individuals working in groups. Mesch, Farh, and Podsakoff (1994) and Podsakoff and Farh (1989) examined the effect of feedback sign but on group goal-setting, strategy, and performance. Participants were provided with positive and negative feedback. Both studies found that negative feedback groups performed at higher levels, set higher goals, and developed more strategies than did the positive feedback groups.

The previous studies support the notion that negative feedback will inform individuals of the discrepancy between their goals and performance and in turn motivate individuals to improve their performance. Based on the implications of control theory, the following hypothesis will be tested:

> **Hypothesis 4:** Following the control theory, trainees in the negative feedback group will have a higher change in performance for the pre- and post-test and Mission 1 and Mission 2 scores than trainees in the positive feedback group.

Feedback Orientation

Researchers suggest that training effectiveness may be improved by focusing on the training design features and the interaction of the design features with individual differences (Baldwin & Ford, 1988; Noe & Schmitt, 1986). This is because training methods may be differentially effective for different individuals. Furthermore, the usefulness of feedback in general and its influence on performance has been shown to depend upon both the nature of the feedback stimulus and the recipient (Herold, Parsons, & Rensvold, 1996; Ilgen et al., 1979). Research has demonstrated that considering personality factors is an important part of training because it can impact the ability to acquire skills (Oakes, 2001). Oakes (2001) found that some personality factors (reasoning and apprehension) positively correlate with skill acquisition, and skill acquisition can predict the level of job performance. Thus, interpretation of the feedback sign and feedback frequency may depend on individual differences and this will influence how the feedback is used for development. Although there have been calls for this type of research (Fedor, 1991) relatively few studies have focused on how responses to feedback may differ across individuals (Herold & Fedor, 1998; Renn & Prien, 1995).

Furthermore, the areas of research that have examined individual characteristics have been mixed on which characteristics are most important. Studies in the feedback and training literature have differed on the individual characteristics that are focused on, which makes generalizability of the findings difficult.

For example, feedback researchers have looked at the impact of age (Chadda, 1991), feedback source credibility and feedback quality (Steelman & Rutkowski, 2003), and personality characteristics such as pessimism and optimism of the feedback receiver (Szalma, Hancock, Dember, & Warm, 2006). On the other hand, the training literature has looked at trainee characteristics such as ability, personality, motivation (Baldwin & Ford, 1998), locus of control, conscientiousness, anxiety, cognitive ability, learning goal orientation (Klein, 2006), and instrumentality (Tziner, Fisher, Senior, & Weisberg, 2007), which have been found to influence both motivation and performance. Additionally, in a literature review conducted by Cheng and Ho (2001) the authors found that the most studied individual characteristics in the training literature were locus of control, self-efficacy, motivation, career/job attitudes, organizational commitment, and decision/reaction to training. However, the issue with all of these trainee characteristics is that none of them directly take into account the role of one's proclivity to value, accept, and use feedback. It is necessary to study individual characteristics more closely related to feedback to better understand how individual differences may influence the feedback process (Linderbaum & Levy, 2007).

Feedback orientation in general refers to an individual's receptivity to feedback (London & Smither, 2002). Feedback orientation blends the typical training characteristics studied such as ability (using the feedback received), valence, and instrumentality (belief that the feedback offers insight and is useful) but it allows more focus on the feedback aspect of the training. People who have strong feedback orientations value feedback; they welcome feedback naturally and they seek out feedback. Individuals with a strong feedback orientation process feedback carefully and deeply and they want to know what it means. Also, these individuals want to know why people

feel the way they do about their performance (London & Smither, 2002). London and Smither (2002) described feedback orientation as a multi-dimensional construct. The dimensions include: liking feedback or an overall positive affect toward feedback, behavioral propensity to seek feedback, cognitive propensity to process feedback mindfully and deeply, sensitivity to others' view of oneself, perceived value of feedback or belief that feedback offers insight that may help them become more effective, and feeling accountable to use the feedback.

Linderbaum and Levy (2007) developed and validated a feedback orientation scale. They examined the previous dimensions suggested by London and Smither (2002), as well as included additional dimensions after further literature review. The authors tested this model and concluded that four dimensions make up the Feedback Orientation Scale. These dimensions are: utility, accountability, social awareness, and feedback self-efficacy. Utility refers to an individual's tendency to believe that feedback is instrumental in achieving goals. Accountability is an individual's tendency to feel a sense of obligation to act on the feedback given to them. Social awareness refers to an individual's tendency to use feedback to be aware of other's views of oneself and to be sensitive to these views. Lastly, feedback self-efficacy is an individual's tendency to have confidence in dealing with feedback situations and feedback itself.

An individual with high feedback orientation is similar to those with high learning goal orientations where learners focus on gaining competence, developing new skills and learning from experience (Klein, 2006). Research has shown support for this relationship. Linderbaum and Levy (2007) found a positive relationship between feedback orientation and learning goal orientation. They also found that feedback orientation was positively correlated to job involvement, protestant work ethic, general self-efficacy, and positive affect. These results further support the notion that personality characteristics closely related to feedback may be related to motivation and performance.

Although few studies have been conducted examining the role of feedback orientation, researchers suggest that improvement in performance is more likely for some feedback recipients than others (Smither et al., 2005). Performance improvements are more likely to occur when participants react positively towards feedback, when they take actions that lead to skill improvement, and when they have a positive feedback orientation.

Moreover, researchers suggest a relationship exists among feedback orientation, feedback frequency, and feedback sign that warrants the study of feedback orientation within a training context. London and Smither (2002) wrote that feedback is not only a one-time event; but instead it is a frequent intervention. The effects of feedback occur over time as the individual receives, absorbs, and uses the feedback. The way the individual responds to frequent feedback is further influenced by an individual's feedback orientation, which may play a role in the individual's anticipation of feedback, interpretation of feedback, and goal setting based on feedback. Thus, the researchers support the notion that the frequency of feedback (infrequent feedback versus frequent feedback) may motivate trainees differently depending on their feedback orientation. That is, those who value feedback (have a high feedback orientation) may be less motivated when receiving infrequent feedback than when receiving frequent feedback during training. On the other hand, those who do not value feedback (have low feedback

orientation) may be less motivated when receiving frequent feedback rather than infrequent feedback.

Additionally, London and Smither (2002) suggested that feedback orientation may influence the effect of feedback sign on performance. Individuals are not always receptive to feedback, in other words, they may have low feedback orientation. Individuals with low feedback orientation may require more negative feedback to find the feedback meaningful enough to alter their performance. This may be especially true if the feedback is referring to a personality trait. Therefore, the authors indicate that reactions to negative feedback would be related to the strength and consistency of the feedback and the individual's feedback orientation. Whereas people with high feedback orientation may value both negative and positive feedback, those with low feedback orientation may be less motivated by negative feedback rather than positive feedback.

> **Hypothesis 5:** Feedback orientation will moderate the relationship between training design (feedback sign and feedback frequency) and performance.
> **Hypothesis 5(a):** Individuals with high feedback orientation in the frequent feedback condition will have a higher change in performance for the pre- and post-test and Mission 1 and Mission 2 scores than individuals with high feedback orientation in the infrequent feedback condition. Individuals with low feedback orientation in the infrequent feedback orientation will have higher change in performance for the pre- and post-test and Mission 1 and Mission 2 scores than individuals with low feedback orientation in the frequent feedback condition.
> **Hypothesis 5(b):** Individuals with high feedback orientation in the positive condition will perform at the same level as high feedback orientation individuals in the negative feedback condition. Individuals with low feedback orientation in the positive feedback condition will have a higher change in performance for the pre- and post-test and Mission 1 and Mission 2 scores than individuals with low feedback orientation in the negative feedback condition.

London and Smither (2002) proposed that an interaction may occur between feedback sign and feedback frequency. They suggested that individuals with low feedback orientation may require a higher frequency of negative feedback to improve their performance in comparison to those with high feedback orientation. Furthermore, previous studies have shown that feedback sign may interact with other factors such as task type (Kluger & Van-Dijk, 2005; Van-Dijk & Kluger, 2004). For this reason, as an exploratory approach this research will examine the interaction between feedback sign and frequency.

Methodology

The training program used for the current research was the Virtual Environment Composable Training for Operational Readiness (VECTOR) developed for the U.S. Army Research Institute for the Behavioral and Social Sciences by Chi Systems, Inc. VECTOR is designed to provide game-based adaptive training in interpersonal skills through the application of experiential,

scenario-based training in a virtual environment. This platform was chosen because it serves as a generic interpersonal skills training environment. It provides content management tools that allow editing and authoring of scenario interactions. More specifically, VECTOR provides direct control of the behavior, dialog, emotional state, and predispositions of the characters within the scenario, which allows the trainer to design training scenarios around specific learning objectives. The authoring capabilities also include when and where the characters will appear in the game and the feedback that can be given to the trainee. Overall, due to its authoring capabilities VECTOR was found to be an ideal platform for this research application.

The simulation used in VECTOR is based on real world events and input from military experts. The purpose of the simulation was to improve an individual's interpersonal skills, which include communication and negotiation. The simulation reinforced essential skills when negotiating or interacting with other individuals, such as developing relationships over time, building and gaining the partner's trust, and planning what to accomplish, when to escalate, and when to walk away. More specifically, the training objectives in the videogame were based on a hierarchical tree-structure (See Figure 1 below).

The highest-level of abstraction were the Terminal Training Objectives, which represent the core aspects of the knowledge, skills, and abilities being trained. These were: (1) understanding the proper order of a negotiation event or conversation, (2) knowing proper communication etiquette, and (3) ability to build cooperation. The lower-level decompositions of the Terminal Training Objectives are the Subordinate Training Objectives, which are linked to the terminal objectives. These were: (1) understanding the proper order of a negotiation event or conversation, (2) knowing proper communication etiquette, and (3) ability to build cooperation. The lower-level decompositions of the Terminal Training Objectives are the Subordinate Training Objectives, which are linked to the terminal objectives. These were: (1) displaying appropriate greeting and small talk, (2) knowing how to follow the lead in a conversation, (3) being able to acknowledge someone's perspective in a conversation, (4) showing patience in a conversation, (5) developing a "Win/Win" negotiation strategy, and (6) serving as a peacemaker. Table A1 offers a detailed explanation of each of the Subordinate Training Objectives. The lowest-level of the hierarchy is the Enabling Objectives. These represent all the objectives given to the player in the game that must be satisfied in order for the linked sub-ordinate training objective to be satisfied. An example of an objective is "To get participation in getting medical supplies." VECTOR tracks player performance through the accomplishment of these objectives.

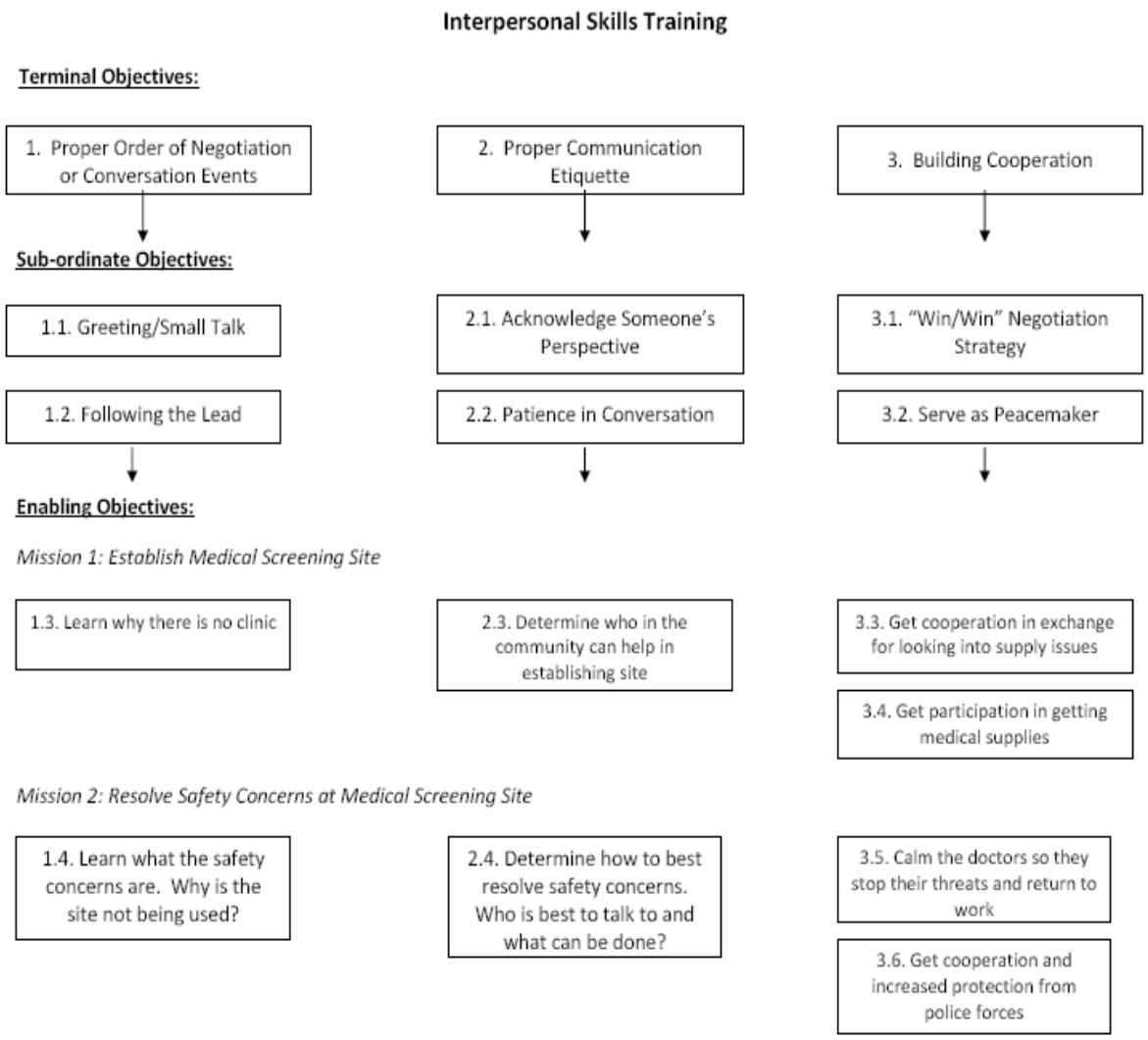

Figure 1. Overview of training objectives

Overview of Structure of the Game

The videogame for this research consists of two missions. Both missions were the same length and trained the same objectives (See Table 1). The only difference between the two missions is the Enabling Objectives that were given to the trainee. The game began with a Mission Statement that included the details of the goals and background information. The first mission was to establish a medical screening site in the village of Kahzar to establish rapport and build confidence with the local populace. Trainees were told that the medical screening station would provide basic medical screening and first aid to local women, infants, and children. To succeed in the mission participants were told they must observe local customs and courtesies. Additionally, participants were required to meet and establish rapport with the local populace. In the second mission the medical screening site has been set up but they are told there are security issues. The doctors and nurses are scared to go to the clinic and it is rarely ever open. The

trainee must resolve the safety concerns at the medical screening site and get it operating again. Once the mission objective was reviewed the next step was the tutorial screen. The tutorial screen introduced the trainee to interpersonal skills training. It reviewed important elements of the interpersonal skills training (i.e., terminal objectives) and went into detail about the sub-ordinate objectives that the trainee was expected to accomplish (Table 1). The tutorial screen also explained the meaning of the performance measures that were provided at the end of the game. Both missions included the same tutorial screen. After reviewing the mission statement and the tutorial screen the trainee began the simulation.

Each mission consisted of six interactions between the trainee and a town resident. The trainee had to move the avatar through the environment to find a town resident to speak with. During each interaction, the trainee was expected to accomplish the Enabling Objectives by successfully using the appropriate interpersonal skills (sub-ordinate objectives). The response of the town resident adapted to the behavior and choices the trainee made. For example, the first interaction with a town resident in Mission 1 required the trainee to find out why there was no medical screening site. However, the trainee had to accomplish this while demonstrating the appropriate response to greetings and small talk. When the trainee approached the town resident they were greeted with "Hello." Then, the trainee was given four response options: (1) greet the character using a customary local greeting by clicking on the "[Greet in Arabic]", (2) begin the conversation by saying, "Hello, do you know why a clinic has not been established in this village?" (3) use the local greeting "[Greet in Arabic]" in addition to saying, "I would like to fix the problem with the clinic, but I would like your cooperation to do so," or (4) "Hello. I hope you are doing well today." If the player chose an appropriate response such as response number 1: "[Greet in Arabic]", then the town resident responded with, "This is good yes. Thank you for this sign of respect." On the other hand, if the trainee chose an incorrect option such as response number 2: "Hello. Do you know why a clinic has not been established in this village?" then the town resident responded with "Let's take the time and just be social. Please it's a hot day outside and we haven't taken the time to know each other". Overall, if the player continued to display the appropriate greetings and small talk then the town resident remained happy and directed the trainee towards another town resident who would know why no clinic had been established. However, if the trainee did not meet the objectives and upset the town resident then this had a negative influence on the interaction with the next town resident. The second interaction was with a local doctor. The greeting from the doctor depended on the results of the first interaction. For example, if the first interaction ended positively by accomplishing the objective then the doctor would greet the trainee with, "Hello, Galeb tells me good things about you." Thus, the characters in the game respond in relation to the interpersonal skills that the trainee exhibited. Furthermore, feedback could be provided at the end of each interaction. The feedback was positive or negative depending on whether the objective was accomplished. The feedback was provided in the form of a voice-over that served as a coach. More details on the feedback intervention will be provided in subsequent sections of this document. At the end of the mission or the sixth interaction, a summary screen was provided to the trainee titled *Training Objective Results*. This screen lists the sub-ordinate training objectives and for each objective whether the trainee succeeded or failed. It also included the feedback that was provided as a voice-over after every interaction.

Table 1. Detailed Description of Sub-Ordinate Objectives

Sub-Ordinate Objective	Description
Responding to Greetings/Small Talk	Demonstrate the appropriate response to greetings and small talk during a formal or informal situation.
Following the Lead in Conversation	In a new setting, take the lead from the other person in a social conversation. What he/she brings up should be the topic of discussion after that. Refrain from switching the topic.
Acknowledge Someone's Perspective	Identify when you are not in agreement with the other person's statement or perspective without insulting or upsetting the person.
Patience in Conversation	Demonstrate patience in conversation by refraining from getting upset or irritated during a heated conversation. Stay focused on the topic of conversation.
"Win-Win" Negotiation Strategy	Use a "win-win" negotiation strategy where the interests and positions of both parties to the negotiation closely align. This leads to accomplishing multiple issues and building relationships.
Serve as Peacemaker	Demonstrate the ability to reduce tension and conflict between people during a cooperative effort.

Research Design

Participants. Participants were recruited by posting flyers around campus at two universities in Florida. Recruitment also included posting information about the experiment on a university online forum and on www.craigslist.org. Participants were compensated $10 per hour for their participation. A total of 159 participants were included in this research. The ages ranged from 18 - 31 with a mean of 22. The sample was 62% male and 54% Caucasian. In the sample, 98% of the participants stated they did not have previous experience with interpersonal skills training and 20% stated they never played computer-based videogames.

Design. The design of the research was based on the voice-over feedback that was provided to the trainee after each interaction with a town resident. The design was a 2 x 2 mixed-design with the dependent variable as a performance change score. Participants were assigned to one of four conditions: (1) frequent positive feedback, (2) infrequent positive feedback, (3) frequent negative feedback, or (4) infrequent negative feedback. Participants were randomly assigned to the conditions using a research randomizer tool from Research Randomizer (Urbaniak & Plous, 1997-2010) website. The tool generates randomized number sets using the "math.random" method within the JavaScript programming language.

All feedback provided was veridical, that is feedback was based on the trainee's actual performance. Those in the positive feedback conditions received favorable feedback when they performed well; they did not receive negative feedback when they performed poorly. Those in the negative feedback conditions received unfavorable feedback when they performed poorly but did not receive positive feedback after performing well. Those in the frequent feedback condition received feedback after every interaction, as well as the summary screen feedback if their performance corresponded to the positive/negative condition to which they were initially randomly assigned. Additionally, participants in the infrequent feedback condition only received feedback as the summary screen for their performance that corresponded to the positive/negative condition to which they were initially randomly assigned. For example, participants in the infrequent feedback condition who failed the objectives would only receive feedback if they were assigned to the negative feedback condition. Similarly, if they performed well they would only receive positive feedback if they were assigned to the positive feedback condition. Otherwise, they would not receive any feedback. For the frequent feedback condition, participants who received less than 3 of the 12 available feedback interventions were removed from subsequent data analysis. There were a total of 14 feedback interventions with 2 of the interventions given automatically regardless of the participants' performance in the form of the summary screen.

An example of positive feedback based on the "Win-Win Negotiation Strategy" objective is, "Good work. You performed better than average. You exhibited a "win-win" negotiation strategy. You considered the interests of both parties and worked towards finding a solution." It is important to note that negative feedback may have an effect on performance. Furthermore, depending on its frame it may also have a negative affect. However, in order to provide sufficient information for the individual to determine how they were performing, negative content was used to operationalize negative feedback. Additionally, a normative portion was included in the

feedback to ensure that individuals recognize they are deviating from the standard. An example of negative feedback for the same objective is, "Your performance was poor. You performed below average. You did not consider the other person's position. As a result, you did not solve the problem or build a relationship with the local. Go speak to Ameen." Participants who received negative feedback were instructed on whom to speak to next. This is not included in the positive feedback because if the appropriate interpersonal skills were used, then the town resident would notify the trainee where to go next. The performance feedback for each objective remained the same for both missions.

Procedure. Prior to the investigation, a pilot test was conducted to test the procedures and methods of the focal investigation. More specifically, the pilot test assessed the programming for all the interactions to ensure the videogame ran appropriately and was understood by the participants. It also assessed the effectiveness of the manipulations as well as the usefulness of the measures chosen. Any issues with the program, procedures, or methods were corrected prior to conducting the focal investigation.

The focal investigation was conducted at the U.S. Army Research Institute research laboratories in Orlando, Florida. The room used contained three long tables with six computers placed against the walls. Each computer station was equipped with the videogame VECTOR, headphones and an instruction packet on how to use VECTOR.

First, participants were given informed consent forms that included a description of the research. Following this, participants were given the self-efficacy scale, which took 5 minutes to complete. Then, they were given the VECTOR scenario questionnaire pretest, which took 15 minutes to complete. This test assessed their knowledge of interpersonal skills prior to training. After completion of the test, participants were given a hand-out that reviewed what keyboard keys could be used to move around the virtual environment. They were allowed to keep this hand-out for reference during the game. Once trainees were familiar with the keys the simulation began. Trainees went through the mission statement screen, tutorial screen, and completed Mission 1 and Mission 2 consecutively. At the completion of the game, trainees were given the Feedback Orientation Scale, which took 15 minutes to complete. Afterwards, participants completed the manipulation check scale and presence scale, which took less than 5 minutes to complete. The last part of the experiment was the posttest which took 15 minutes to complete. The entire experiment took between 1 and 2 hours.

Measures.

Pretest and Posttest VECTOR Scenario Questionnaire. The pretest and posttest were made specifically to measure the learning objectives of VECTOR and was used as a measure of training performance. It is a scenario-based questionnaire. This test was developed specifically for this research thus no reliability or validity data is available. However, the development of this scale involved the input of subject matter experts (SME) to determine the content validity of the scenarios. The SME's had previously been deployed and had similar incidents occur during their deployment. Participants read the scenarios that were developed based off of the objectives of

the game and determined which response option described the most appropriate action for the situation. There were eight items, which were identical for the pretest and posttest.

VECTOR Performance Measures. Each interaction in VECTOR was aligned with a training objective and was scored as a dichotomous pass/fail for that objective. A final performance score for each participant was calculated as the difference between Mission 2 and Mission 1 scores summed across all interactions.

Feedback Orientation Scale. Feedback orientation was measured using the 24 item multi-dimensional Feedback Orientation Scale from Linderbaum and Levy (2007). The items were scored on a 6-point Likert-type scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). A higher score indicated a stronger feedback orientation. The dimensions of the scale are utility, accountability, social awareness and feedback self-efficacy. A sample utility item is: "Feedback is critical for improving performance." An item from the accountability dimension is: "I feel obligated to make changes based on feedback." A sample item from the social awareness dimension is: "Feedback helps me manage the impression I make on others." A feedback self-efficacy item is: "I believe that I have the ability to deal with feedback effectively." The overall Cronbach alpha found by Linderbaum and Levy (2007) was .86. The Cronbach alpha for this experiment was .89.

Manipulation Check. The manipulation check was developed to assess the effectiveness of the experimental design components. The survey consisted of 14 questions on a 6-point Likert-type scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). A sample feedback sign question is, "The information given to me about my performance showed that I did well interacting with the characters." A sample feedback frequency question is, "I was not provided with information about my performance during the game." The manipulation check includes an additional sheet with demographic questions. The Cronbach alpha for each set of items was: .89 for the positive feedback items, .87 for the negative feedback items, .76 for the frequent feedback items, and .82 for the infrequent feedback items.

Presence Questionnaire. A presence scale was used to assess involvement in the videogame. This was measured using four questions on a 7-point Likert-type scale from Slater, Usoh, and Steed (1994). A sample question is, "Please rate your sense of being in the computer-generated world, where 7 represents your normal experience of being in a place." This survey was adapted for this research, thus no previous reliability or validity data were available. However, the only changes made from the original survey were changing the task type to "computer-generated world." The Cronbach alpha for this research was .77.

Self-efficacy scale. Self-efficacy was measured using a scale developed specifically for the research, thus no previous reliability or validity data were available. However, the scale was developed following the guidelines for developing self-efficacy scales set by Bandura (2006). The scale consisted of 10 statements of tactics used when communicating with someone. Participants were asked to rate their confidence in successfully using each tactic. The scale ranged from 0 (*cannot do at all*) to 100 (*highly certain can do*). A sample item is, "Look for an agreement that maximizes both of our interests." The Cronbach alpha for this research was .84.

On- and Off-task attention scale. An on- and off-task attention scale was developed to assess where participants directed their attention during the task. The measure was from Kanfer, Ackerman, Murtha, Dugdale, and Nelson (1994) and it was shortened and adapted for this research. The scale consisted of 16 questions on a Likert-type scale ranging from 1 (*never*) to 8 (*constantly*). A sample on-task attention item is, "I paid close attention to the kind of errors I was making." A sample off-task attention item is, "I lost interest in the task for short periods." The scale was adapted to fit this research by removing questions that were specific to previous studies. Additionally, the task was changed from 'flying planes' to 'accomplishing the task'. In the Kanfer et al. (1994) study the Cronbach alpha for on-task attention items was .81 and for off-task attention items was .59. The Cronbach alpha for the entire scale for this research was .70.

Results

Preliminary Results

Descriptive statistics. Descriptive statistics such as mean, standard deviation, skewness, kurtosis and confidence interval are presented in Table 2 for all of the variables for the entire sample and in Table 3 for the variables by feedback condition. Additionally, all the scales (feedback orientation scale, presence questionnaire, self-efficacy scale and attention scale) reached or exceeded a reliability of .60 thus they were considered acceptable (Nunally, 1978). Table 4 shows the correlations for all the variables in this research.

Prior to conducting hypothesis testing, decision rules were set to determine the criteria for removing data. Participants assigned to the frequent feedback conditions were removed if they received less than three feedback interventions. Participants assigned to the infrequent feedback conditions were removed if they did not receive any feedback. Cases were also removed if more than 10% of the survey and mission score data were missing. Any remaining missing data were replaced using series mean. Following these decision rules, 26 participants were removed leaving a final sample size of 159 with 36 in the frequent positive condition, 48 in the frequent negative condition, 38 in the infrequent positive condition and 37 in the infrequent negative condition.

Testing assumptions. Assumptions for MANOVA and regression analysis were tested to determine if these statistical analyses were appropriate. The MANOVA assumptions that were tested were independence of observations, random sampling of data, multivariate normality and homogeneity of covariance matrices. There was no violation of independence of observation or random sampling. Normality was determined by examining skewness and kurtosis, histogram plots, normal Q-Q plots and detrended normal Q-Q plot. The plots, skewness and kurtosis scores indicate that the distribution slightly deviates from normality for the pre-test scores, post-test scores and off task attention scale scores. However, it was not expected that this would influence the results due to the large sample size and MANOVA's robustness against violations of this assumption (Tabachnick & Fidell, 2001). Homogeneity of covariance matrices was tested using Box's M test. This statistics tests the null hypothesis that the variance-covariance matrices are homogeneous. If Box's M is non-significant then the null hypothesis cannot be rejected. This assumption was upheld (Box's M = 12.44, $p = .20$).

The assumptions tested to determine if a regression analysis was appropriate were linear relationship between the independent variable and the dependent variable, homogeneity of variance and covariance, normal distribution of measures, uncorrelated residuals, normality of the residuals, and that the independent variables were not substantially correlated. These assumptions were tested by examining the plot of the standardized residuals by standardized predicted value. The correlations of the independent variables were also evaluated. The plots for the change scores of the pre and post test showed slight heteroscedasticity. According to Berry and Feldman (1985) and Tabachnick and Fidell (2007) slight heteroscedasticity has little effect on significance tests. For this reason, the moderated regression analysis was conducted.

Manipulation check. The purpose of the manipulation check was to determine whether participants perceived being in the correct feedback intervention group. Composite scores were developed using the items in the manipulation check questionnaire that represented each of the feedback interventions (frequent feedback, infrequent feedback, positive feedback and negative feedback). The composite scores were compared to the feedback group the individuals were assigned to using independent sample t-tests. Overall, participants perceived themselves being in the correct feedback intervention group, providing support for the fidelity of the manipulation. Individuals in the frequent feedback condition scored themselves higher on receiving frequent feedback ($M = 4.26$) than on receiving infrequent feedback ($M = 2.35$, $t = 11.44$, $p < .00$). Individuals in the infrequent feedback condition scored themselves higher on receiving infrequent feedback ($M = 4.72$) than frequent feedback ($M = 2.45$, $t = -12.66$, $p < .00$). Participants in the positive feedback condition scored themselves higher on receiving positive feedback ($M = 4.98$) than negative feedback ($M = 2.69$, $t = 11.89$, $p < .00$). Likewise, participants in the negative feedback group scored themselves higher on receiving negative feedback ($M = 4.15$) than positive feedback ($M = 1.86$, $t = -13.13$, $p < .00$).

Table 2. Descriptive Statistics

Measures	M	*SD*	95% CI	Skewness	Kurtosis
Positive	3.76	1.66	[3.50, 4.02]	-0.21	-1.27
Negative	3.08	1.59	[2.83, 3.33]	0.15	-1.32
Frequent	3.35	1.42	[3.13, 3.58]	0.06	-1.04
Infrequent	3.52	1.59	[3.27, 3.77]	0.04	-1.29
Self-efficacy	80.60	10.55	[78.94, 82.25]	-0.73	1.23
FO	4.99	0.57	[4.90, 5.08]	-0.92	1.41
Presence	4.21	1.31	[4.01, 4.42]	-0.52	0.07
Pretest	26.22	3.49	[25.67, 26.77]	-0.36	3.39
Posttest	28.87	1.94	[28.56, 29.17]	-1.19	1.88
Final test	2.65	3.37	[2.12, 3.17]	-1.19	1.88
Mission 1	9.96	1.19	[9.77, 10.14]	-0.03	-0.58
Mission 2	10.16	1.01	[9.99, 10.31]	-0.36	-0.04
Final mission	0.20	1.44	[-0.03, 0.43]	-0.09	0.12
On task	5.83	1.01	[5.67, 5.99]	-0.31	-0.35
Off task	2.90	1.27	[2.70, 3.10]	0.79	0.89

Note. Positive = Manipulation check scores for positive feedback condition; Negative = Manipulation check scores for negative feedback condition; Frequent = Manipulation check scores for frequent feedback condition; Infrequent = Manipulation check scores for infrequent feedback condition; Self-efficacy = Self-efficacy scale; FO = Feedback orientation scale; Presence = Presence scale; Pretest = Pretest scores on VECTOR questionnaire; Posttest = Posttest scores on VECTOR questionnaire; Final test = Change scores for pretest and posttest; Mission 1 = Mission 1 scores from VECTOR; Mission 2 = Mission 2 scores from VECTOR; Final mission = Change scores for Mission 1 and Mission 2; On task = On task scale; Off task = Off task scale.
N = 159.

Table 3. Descriptive Statistics for Each Feedback Condition

	Positive					Negative				
Measures	*M*	*SD*	95% CI	Skewness	Kurtosis	*M*	*SD*	95% CI	Skewness	Kurtosis
Positive	4.98	1.01	[4.75, 5.21]	-0.99	0.56	2.70	1.36	[2.40, 2.99]	0.55	-0.60
Negative	1.85	0.93	[1.64, 2.07]	1.47	2.67	4.15	1.23	[3.89, 4.42]	-0.85	0.50
Frequent	3.50	1.53	[3.14, 3.85]	0.01	-1.21	3.23	1.31	[2.95, 3.51]	0.04	-0.94
Infrequent	3.32	1.64	[2.94, 3.70]	0.19	-1.25	3.70	1.54	[3.36, 4.03]	-0.08	-1.30
Self-efficacy	80.71	11.07	[78.14, 83.27]	-1.01	2.17	80.50	10.14	[78.31, 82.69]	-0.43	0.22
FO	5.01	0.61	[4.87, 5.15]	-1.21	2.20	4.98	0.53	[4.86, 5.09]	-0.60	0.43
Presence	4.27	1.38	[3.95, 4.59]	-0.56	0.00	4.16	1.25	[3.89, 4.43]	-0.51	0.23
Pretest	26.62	3.18	[25.88, 27.36]	-1.68	4.81	25.87	3.71	[25.07, 26.67]	0.42	3.42
Posttest	29.09	1.81	[28.67, 29.51]	-1.50	3.61	28.67	2.03	[28.23, 29.10]	-0.97	1.09
Final test	2.47	3.07	[1.76, 3.18]	1.68	5.88	2.80	3.62	[2.01, 3.58]	-0.87	6.20
Mission 1	10.17	1.26	[9.88, 10.47]	-0.09	-0.97	9.76	1.10	[9.53, 10.00]	-0.12	-0.16
Mission 2	10.22	1.01	[9.98, 10.45]	-0.29	-0.34	10.10	1.01	[9.89, 10.32]	-0.43	0.26
Final mission	0.04	1.37	[-0.28, 0.36]	0.06	-0.33	0.34	1.50	[0.02, 0.66]	-0.24	0.52
On task	5.93	1.10	[5.67, 6.18]	-0.58	-0.07	5.74	0.91	[5.55, 5.94]	-0.03	-0.67
Off task	2.72	1.29	[2.42, 3.01]	1.29	3.12	3.05	1.24	[2.79, 3.32]	0.40	-0.59

Note. Positive = Manipulation check scores for positive feedback condition; Negative = Manipulation check scores for negative feedback condition; Frequent = Manipulation check scores for frequent feedback condition; Infrequent = Manipulation check scores for infrequent feedback condition; Self-efficacy = Self-efficacy scale; FO = Feedback orientation scale; Presence = Presence scale; Pretest = Pretest scores on VECTOR questionnaire; Posttest = Posttest scores on VECTOR questionnaire; Final test = Change scores for pretest and posttest; Mission 1 = Mission 1 scores from VECTOR; Mission 2 = Mission 2 scores from VECTOR; Final mission = Change scores for Mission 1 and Mission 2; On task = On task scale; Off task = Off task scale.

N = 159.

Table 3 (con't). Descriptive Statistics for Each Feedback Condition

	Frequent					Infrequent				
Measures	*M*	*SD*	95% CI	Skewness	Kurtosis	*M*	*SD*	95% CI	Skewness	Kurtosis
Positive	3.67	1.77	[3.29, 4.06]	-0.09	-1.46	3.85	1.53	[3.50, 4.21]	-0.34	-0.97
Negative	3.31	1.70	[2.94, 3.68]	0.23	-1.28	2.83	1.42	[2.50, 3.16]	0.23	-1.28
Frequent	4.26	1.15	[4.01, 4.50]	0.43	-0.15	2.35	0.93	[2.13, 2.56]	0.43	-0.15
Infrequent	2.45	1.12	[2.21, 2.70]	0.71	-0.19	4.72	1.13	[4.46, 4.98]	-0.85	0.14
Self-efficacy	79.92	10.78	[77.58, 82.26]	-1.13	2.20	81.35	10.3	[78.98, 83.73]	-0.22	-0.22
FO	4.99	0.53	[4.88, 5.11]	-0.82	0.57	4.98	0.61	[4.85, 5.12]	-1.00	1.99
Presence	4.36	1.35	[4.06, 4.65]	-0.56	-0.04	4.05	1.26	[3.76, 4.34]	-0.56	0.38
Pretest	25.48	3.72	[24.67, 26.28]	-0.97	0.89	27.05	3.02	[26.36, 27.75]	1.27	7.26
Posttest	28.98	1.80	[28.59, 29.37]	-1.16	2.22	28.73	2.09	[28.26, 29.21]	-1.17	1.57
Final test	3.51	3.45	[2.76, 4.26]	1.17	1.90	1.68	3.03	[0.98, 2.38]	-2.13	2.22
Mission 1	9.93	1.19	[9.67, 10.19]	0.01	-0.59	9.99	1.20	[9.71, 10.26]	-0.07	-0.53
Mission 2	10.08	1.01	[9.86, 10.30]	-0.31	0.42	10.24	1.01	[10.00, 10.47]	-0.42	-0.44
Final mission	0.15	1.50	[-1.17, 0.48]	0.06	0.37	0.25	1.39	[-0.07, 0.57]	-0.28	-0.61
On task	5.81	0.95	[5.60, 6.02]	-0.37	-0.31	5.38	1.07	[5.61, 6.10]	-0.28	-0.39
Off task	2.83	1.20	[2.57, 3.09]	0.65	-0.04	2.97	0.88	[2.66, 3.28]	0.88	1.51

Note. Positive = Manipulation check scores for positive feedback condition; Negative = Manipulation check scores for negative feedback condition; Frequent = Manipulation check scores for frequent feedback condition; Infrequent = Manipulation check scores for infrequent feedback condition; Self-efficacy = Self-efficacy scale; FO = Feedback orientation scale; Presence = Presence scale; Pretest = Pretest scores on VECTOR questionnaire; Posttest = Posttest scores on VECTOR questionnaire; Final test = Change scores for pretest and posttest; Mission 1 = Mission 1 scores from VECTOR; Mission 2 = Mission 2 scores from VECTOR; Final mission = Change scores for Mission 1 and Mission 2; On task = On task scale; Off task = Off task scale.

N = 159.

Table 4. Correlations Among Studied Variables - Overall Sample

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Positive	----														
2. Negative	-.810	----													
3. Frequent	.172*	.040	----												
4. Infrequent	-.080	-.026	-.733**	----											
5. Self-efficacy	.119	-.074	-.109	.086	----										
6. FO	.103	-.115	.021	-.022	.312**	----									
7. Presence	.124	.027	.113	-.173*	.145	.308**	----								
8. Pretest	.089	-.185*	-.225**	.103	.172*	.118	.007	----							
9. Posttest	.038	-.044	-.115	-.013	.028	.091	.166*	.336**	----						
10. Final test	-.070	.166*	.166*	-.114	-.162*	-.070	.103	-.841**	.227**	----					
11. Mission 1	.366**	-.367**	-.054	.072	.121	.272**	.500	.308**	.199*	-.204**	----				
12. Mission 2	.114	-.242**	-.088	.079	.030	.183*	.008	.152	.109	-.095	.148	----			
13. Final mission	-.222**	.133	-.017	-.004	-.079	-.096	-.035	-.148	-.088	.103	-.722**	.577**	----		
14. On task	.262**	-.188*	.008	-.041	.219**	.421**	.183*	-.020	-.139	-.060	.075	.102	.009	----	
15. Off task	-.204**	.204**	-.056	.190*	-.223**	-.252**	-.062	-.159*	-.172*	.066	-.297**	.032	.268**	-.055	----

Note. For all scales, higher scores are indicative of more extreme responding in the direction of the construct assessed. Positive = Manipulation check scores for positive feedback condition; Negative = Manipulation check scores for negative feedback condition; Frequent = Manipulation check scores for frequent feedback condition; Infrequent = Manipulation check scores for infrequent feedback condition; Self-efficacy = Self-efficacy scale; FO = Feedback orientation scale; Presence = Presence scale; Pretest = Pretest scores on VECTOR questionnaire; Posttest = Posttest scores on VECTOR questionnaire; Final test = Change scores for pretest and posttest; Mission 1 = Mission 1 scores from VECTOR; Mission 2 = Mission 2 scores from VECTOR; Final mission = Change scores for Mission 1 and Mission 2; On task = On task scale; Off task = Off task scale.
*$p < .05$, **$< .01$.

Main Results

Hypotheses 1 through 4 were examined by performing a 2 x 2 mixed-design multivariate analysis of variance (MANOVA) with two dependent variables. The dependent variables (DV) were the change scores for the VECTOR scenario questionnaire (pretest and posttest) and the change score for Mission 1 and Mission 2. The independent variables (IV) were between-subject variables consisting of feedback frequency (frequent and infrequent) and feedback sign (positive and negative).

The Wilks' Lambda omnibus test was used to determine whether there was a significant difference in at least one of the dependent variables. The results showed that the combined DV's were significantly affected by frequency (F (2, 154) = 6.28, $p < .00$), and the interaction of frequency and sign (F (2, 154) = 3.20, $p = .04$), but not by sign (F (2, 154) = .79, $p = .45$). Feedback frequency explained 7.5% of the variance in the DV's and the interaction explained 4.0% of the variance in the DV's. The association was less substantial for the nonsignificant main effect of sign explaining 1.0% of the variance in the DV's.

Hypothesis 1 stated that the feedback intervention theory would be supported if participants in the infrequent feedback group showed better performance than trainees in the frequent feedback group. Hypothesis 2 stated that the ACT-R theory would be supported if participants in the frequent feedback group had better performance than trainees in the frequent feedback group. The results of the between-subject effects showed that there was a significant difference between the feedback frequency groups for the pre and post-test (F (1, 155) = 11.61, $p < .00$, $\eta^2 = .07$), but not the mission scores (F (1, 155) = .46, $p = .50$, $\eta^2 = .003$). Participants in the frequent feedback condition had a greater improvement in post-test scores (M= 3.51) than those in the infrequent feedback condition (M= 1.68), supporting Hypothesis 2 and the ACT-R theory.

Hypothesis 3 stated that the social cognitive theory would be supported if participants in the positive feedback group performed higher than participants in the negative feedback group. Hypothesis 4 stated that control theory would be supported if individuals in the negative feedback group performed higher than individuals in the positive feedback group. The Wilks' lambda criterion indicated there was no significant difference between the feedback sign groups on the DVs (F (2, 154) = .79, $p = .45$). For this reason, the between-subject effects were not further evaluated. Thus, neither Hypothesis 3 nor Hypothesis 4 was supported. The sign of the feedback did not have a significant impact on performance.

Hypothesis 5 stated that feedback orientation would moderate the relationship between feedback intervention (feedback sign and feedback frequency) and performance (pre and post-test and mission scores). The procedures used for the moderated regression analyses were those presented in Baron and Kenny (1986). The following hierarchical regression equations were estimated: (1) regressing the dependent variable on the independent variable, (2) regressing the dependent variable on the moderator, and (3) regressing the dependent variable on the product of the independent variable and the moderator.

The hypothesis would be supported if, when the independent variable and the moderator were controlled, the product of the independent variable and moderator remains significant. The

results of the moderated regression are shown in Table 5 for each feedback intervention and dependent variable. Hypothesis 5 was not supported. Feedback orientation was not found to moderate the relationship between any feedback intervention type and performance.

Table 5. Results of Hierarchical Regression Analyses with Feedback Orientation as Moderator

Predictor	ΔR^2	*F*	β
Feedback Sign (Positive/Negative)			
DV: Final Test			
Step 1: Feedback sign	0.002	0.363	-0.048
Step 2: FO	0.005	0.551	-0.069
Step 3: Feedback sign*FO	0.006	0.662	0.673
DV: Final Mission			
Step 1: Feedback sign	0.011	1.722	-0.104
Step 2: FO	0.009	1.558	-0.093
Step 3:Feedback sign*FO	0.000	1.052	0.175
Feedback Frequency (Frequent/Infrequent)			
DV: Final Test			
Step 1: Feedback frequency	0.074***	12.494***	0.272***
Step 2: FO	0.005	6.690**	-0.073
Step 3: Feedback frequency * FO	0.002	4.545**	-0.386
DV: Final Mission			
Step 1: Feedback frequency	0.001	0.184	-0.034
Step 2: FO	0.009	0.817	-0.096
Step 3: Feedback frequency * FO	0.003	0.679	-0.640

Note. FO = Feedback orientation; Final test = change scores for pre and posttest;
Final mission = change scores for Mission 1 and Mission 2
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Supplementary Results

As an exploratory approach, the interaction between feedback frequency and feedback sign was examined. The Wilk's lambda criterion indicated a significant interaction between feedback frequency and feedback sign (p = .04, η^2 = .04). Results of the test of between-subject effects indicated there was a significant interaction for the mission scores (F(1, 155) = 5.21, p = .02, η^2 = .03) but not the pretest and posttest scores (F(1,155) = 1.77, p = .19). The plot of the interaction for the mission scores is presented in Figure 2. Post-hoc independent sample t-tests were conducted to determine which groups were significantly different within the mission scores. The results indicate no significant differences between infrequent positive feedback (M = .37) and infrequent negative feedback (M = -.13, t = .73, p = .47). However, a significant difference was found between frequent positive feedback (M = -.30) and frequent negative feedback (M = .50, t = -2.51, p = .01). Individuals receiving frequent negative feedback had better performance than those with infrequent positive feedback. Results from the t-test also showed a significant difference between frequent positive feedback (M = -.30) and infrequent positive feedback (M = .37, t = -2.17, p = .03) with infrequent positive feedback leading to better performance. No differences were found between frequent negative feedback (M = .50) and infrequent negative feedback (M = .13, t = 1.11, p = .27).

A moderated regression analysis was also conducted to further explore the relationship between feedback intervention and performance. Moderated regression analyses were conducted to determine if self-efficacy, on-task attention, off-task attention or presence moderated the relationship between feedback intervention and performance. The results of the moderated regression analyses are found in Table A6. None of the variables tested were moderators.

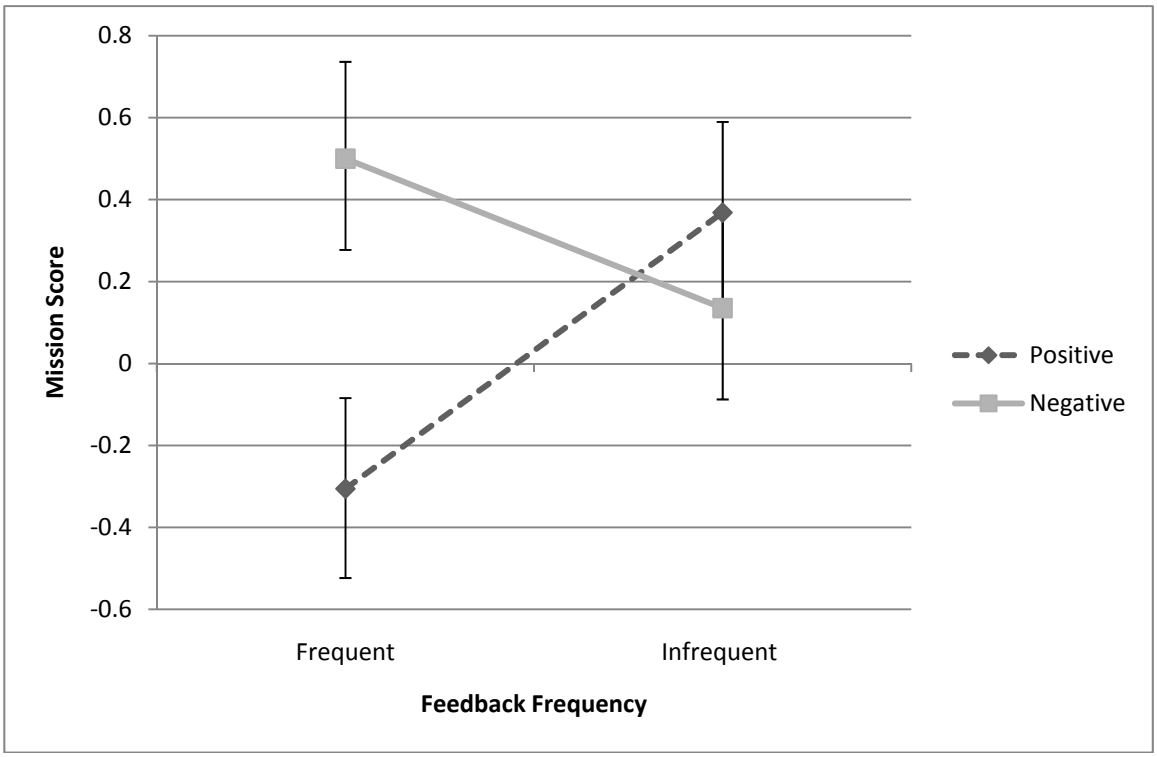

Figure 2. Effects of feedback frequency and sign on mission difference scores.

Table 6. *Results of Exploratory Hierarchical Regression Analyses with Self-Efficacy, On-Task, Off-Task and Presence as Moderator*

Moderators	ΔR^2	*F*	β
Self-Efficacy			
Feedback Sign (Positive/Negative)			
DV: Final Test			
Step 1: Feedback sign	0.002	0.363	-0.048
Step 2: Self-efficacy	0.026*	2.279	-0.161
Step 3: Feedback sign*Self-efficacy	0.004	1.715	-0.476
DV: Final Mission			
Step 1: Feedback sign	0.011	1.722	-0.104
Step 2: Self-efficacy	0.006	1.342	-0.078
Step 3:Feedback sign*Self-efficacy	0.011	1.459	0.800
Feedback Frequency (Frequent/Infrequent)			
DV: Final Test			
Step 1: Feedback frequency	0.074***	12.494***	0.272***
Step 2: Self-efficacy	0.021	8.130***	-0.144
Step 3: Feedback frequency * Self-efficacy	0.003	5.592***	-0.445
DV: Final Mission			
Step 1: Feedback frequency	0.001	0.184	-0.034
Step 2: Self-efficacy	0.007	0.613	-0.082
Step 3: Feedback frequency * Self-efficacy	0.001	0.472	0.276
On-task			
Feedback Sign (Positive/Negative)			
DV: Final Test			
Step 1: Feedback sign	0.002	0.363	-0.048
Step 2: On-task	0.003	0.422	-0.694
Step 3: Feedback sign*On-task	0.002	0.373	0.261
DV: Final Mission			
Step 1: Feedback sign	0.011	1.722	-0.104
Step 2: On-task	0.000	0.883	0.018
Step 3:Feedback sign*On-task	0.002	0.680	0.261
Feedback Frequency (Frequent/Infrequent)			
DV: Final Test			
Step 1: Feedback frequency	0.074***	12.494***	0.272***
Step 2: On-task	0.003	6.472**	-0.054
Step 3: Feedback frequency * On-task	0.004	4.513**	0.363
DV: Final Mission			
Step 1: Feedback frequency	0.001	0.184	-0.034
Step 2: On-task	0.000	0.096	0.008
Step 3: Feedback frequency * On-task	0.002	0.157	0.252

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 6 (Cont'd). *Results of Exploratory Hierarchical Regression Analyses with Self-Efficacy, On-Task, Off-Task and Presence as Moderator*

Moderators	ΔR^2	*F*	β
Off-Task			
Feedback Sign (Positive/Negative)			
DV: Final Test			
Step 1: Feedback sign	0.002	0.363	-0.048
Step 2: Off-task	0.004	0.461	0.060
Step 3: Feedback sign*Off-task	0.000	0.311	-0.025
DV: Final Mission			
Step 1: Feedback sign	0.011	1.722	-0.104
Step 2: Off-task	0.066***	6.479**	0.259***
Step 3:Feedback sign*Off-task	0.004	4.554**	-0.169
Feedback Frequency (Frequent/Infrequent)			
DV: Final Test			
Step 1: Feedback frequency	0.074***	12.494***	0.272***
Step 2: Off-task	0.007	6.804***	0.081
Step 3: Feedback frequency * Off-task	0.008	4.997**	0.235
DV: Final Mission			
Step 1: Feedback frequency	0.001	0.184	-0.034
Step 2: Off-task	0.071***	6.080**	0.267***
Step 3: Feedback frequency * Off-task	0.000	4.043**	0.043
Presence			
Feedback Sign (Positive/Negative)			
DV: Final Test			
Step 1: Feedback sign	0.002	0.363	-0.048
Step 2: Presence	0.011	1.047	0.105
Step 3: Feedback sign*Presence	0.004	0.900	-0.222
DV: Final Mission			
Step 1: Feedback sign	0.011	1.722	-0.104
Step 2: Presence	0.001	0.933	-0.031
Step 3:Feedback sign*Presence	0.001	0.684	-0.126
Feedback Frequency (Frequent/Infrequent)			
DV: Final Test			
Step 1: Feedback frequency	0.074***	12.494***	0.272***
Step 2: Presence	0.005	6.672**	0.072
Step 3: Feedback frequency * Presence	0.001	4.465**	-0.100
DV: Final Mission			
Step 1: Feedback frequency	0.001	0.184	-0.034
Step 2: Presence	0.001	0.168	-0.032
Step 3: Feedback frequency * Presence	0.000	0.122	-0.053

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Discussion

The role of feedback in videogame-based adaptive training is not well understood. The theoretical accounts of the impact of feedback in training or learning a new skill are contradictory and therefore are not frequently used to inform the design of training programs. The purpose of this research was to test four competing feedback theories to determine which type of feedback would lead to better performance in a videogame-based adaptive training environment. It is hoped that ultimately the results of this research can be used by videogame simulation designers to design training and include appropriate performance feedback.

The first set of hypotheses tested competing feedback frequency theories. According to the feedback intervention theory, feedback should be infrequent during a complex task because feedback may overload cognitive capacity at a time when much of the learner's attention is needed (Kluger & DeNisi, 1996). Contrary to this perspective, the ACT-R model suggests that frequent feedback is essential for acquiring any skill because infrequent feedback slows down the process of compiling correct information. The results of the main effect for frequency reinforce Anderson's ACT-R model. That is, in videogame-based training scenarios, frequent feedback leads to higher post test scores than infrequent feedback. It appears that infrequent feedback did not provide enough cues for the participant to detect and reject erroneous hypotheses and this in turn caused the participant to compile incorrect information which decreased performance (Anderson, 1983, 1996, 2000). Complex tasks, such as the scenarios presented in this research, may include rapid changes occurring between learning episodes, which offers several opportunities for unmonitored mistakes. Thus, a long pause between feedback interventions may lead to learning the task incorrectly and later applying this incorrect learning structure to future problems.

Although no support was found for the feedback intervention theory this may be due to the lack of focus in the theory on the individual's learning stage. The current investigation examined a novel, complex task, which may reflect the beginning stages of learning because the participants did not have previous experience learning complex interpersonal skills in an adaptive videogame-based environment. It is possible that while frequent feedback is useful during the initial stages of learning (declarative and procedural) this feedback can become detrimental as the individual becomes more proficient in the task. Future research should examine the possibility of this relationship.

Competing feedback sign theories were also examined. Self-efficacy theory suggests that people avoid activities that they believe are beyond their coping capabilities, but they undertake and perform activities they judge themselves capable of managing. Therefore, receiving positive feedback is more likely to raise self-efficacy and in turn increase performance as opposed to negative feedback. On the other hand, control theory recommends the use of negative feedback because it is more likely to interrupt processing, which will shift attention and improve performance. The results of this research show no support for the main effect of feedback sign on performance, and thus neither theory regarding the role of feedback sign on training performance was supported. This is in line with previous studies that have found it difficult to predict the effects of feedback sign on performance (Kluger & DeNisi, 1996). In their meta-analytic study Kluger and DeNisi (1996) found that feedback sign did not impact the relationship

between feedback and performance on a task. The authors suggest these results are due to the difficulty in predicting a person's response to feedback, particularly negative feedback, without knowing other factors about the person. It is likely that the outcome of feedback sign is more appropriately thought of as a complex interaction among feedback sign, situational factors and individual dispositions.

Another possible reason for the lack of effect of feedback sign on performance may be the type of task. Previous studies have examined feedback sign in a face-to-face environment such as receiving positive or negative feedback from a supervisor (Becker & Kilmoski, 1989; Chakrabarty et al., 2008; Jaworski & Kohli, 1991). However, feedback sign in videogame-based adaptive training may not have the same influence as other tasks. In fact, previous research has found an interactive effect of feedback sign and task type on motivation and performance (Kluger & DeNisi, 1996, 2005; Van-Dijk & Kluger, 2004). An individual completing a computer-based task may find negative feedback more readily acceptable when it is received from the computer rather than face-to-face from a supervisor. Earley (1988) found the source of the feedback, person versus a computer, was directly related to performance. Feedback had a greater impact on an individual's performance if the feedback was provided directly from the computer system than if provided by a supervisor. Similarly, Kluger and Adler (1993) found participants were more likely to seek feedback from a computer rather than a person. Therefore, task type and source may play a larger role in predicting performance than the sign of the feedback. Research should continue to examine the role of computer-mediated feedback in learning and development.

Further, in the videogame-based adaptive training environment participants may have received all the positive and negative feedback they needed through the reactions of the characters, making the mission feedback irrelevant. Kluger and DeNisi (19996) advise that even if the feedback is directed towards the task, if it is redundant with the preexisting knowledge it will have no effect on learning.

The interaction between feedback frequency and feedback sign was also examined. The interaction was significant and further post-hoc analyses indicated that frequent feedback was most beneficial when the feedback was negative rather than positive. Also, positive feedback leads to better performance when it was infrequent rather than frequent. Consistent with these results, previous studies have shown support for the use of infrequent positive feedback instead of frequent positive feedback (Earley, Connolly & Ekegren, 1989; Baumeister, Hutton & Cairns, 1990; Kluger & DeNisi, 1996). According to the feedback intervention theory, frequent feedback that does not give details on improvement (e.g. praise) can distract the individual from the task and bring attention to the self. Attention to the self results in superior performance only if the task is very simple (Kluger & DeNisi, 1996). Similarly, it has been suggested that being overly confident about the task, which can be induced through frequent positive feedback, may lead to experimenting with task strategies and in turn lead to poor performance (Earley, Connolly & Ekegren, 1989). Indeed, results of a study by Earley, Connolly, and Ekegren (1989) showed that an increase in motivation leads to an increase in dysfunctional strategy search. Additionally, Baumeister, Hutton and Cairns (1990) found that praise (a type of positive feedback intervention) impaired the performance of a cognitively demanding task but improved the performance of a simple task. Stone (1994) also found that high self-efficacy, which is induced

through frequent normative feedback, led to overconfidence in one's ability. As a result, individuals with high self-efficacy contributed fewer resources toward the task. Overall, previous research suggests that frequent positive feedback can be detrimental to performance during a complex task. In line with previous research, the results of this investigation show that frequent positive feedback leads to poor performance while infrequent positive feedback leads to better performance. Given these findings, it appears that infrequent positive feedback serves as a motivator but because it is infrequent it will not distract the individual by bringing attention to the self instead of the task.

This investigation also suggests that frequent negative feedback leads to the best performance in mission scores. This is in line with the error management training literature (Aguinis & Kraiger, 2009; Keith & Frese, 2005). Error management training encourages trainees to make errors and engage in reflection to understand why the errors occurred. Additionally, error management training encourages trainees to learn how to develop new strategies to avoid repeating the same errors in the future. Error management training is often duplicated by giving participants frequent negative feedback (Aguinis & Kraiger, 2009). A meta-analysis conducted by Keith and Frese (2005) reported that error management training lead to better performance in comparison to proceduralized error-avoidant training and exploratory training without error encouragement. Thus, frequent negative feedback may lead to a deeper understanding of the task as suggested by the error management literature. Additionally, the improvement in performance for participants in the frequent negative feedback condition suggests support for control theory. Negative feedback results in movement toward the standard and the more instances of the negative feedback, the more chances for that movement. Thus, the control theory suggests that frequent negative feedback leads to performance improvement. Due to the exploratory nature of this analysis, future research should further examine the possible relationship between feedback frequency and feedback sign.

In addition to feedback frequency and feedback sign, it was predicted that feedback orientation would moderate the relationship between feedback intervention and performance such that those with high feedback orientation would perform better with frequent feedback and those with low feedback orientation would perform better with infrequent feedback. Furthermore, individuals with low feedback orientation would perform better with positive feedback while those with high feedback orientation would perform the same regardless of feedback sign. This prediction was not supported. In a training environment, feedback orientation may be less influential because trainees are expecting to receive feedback on their performance. On the other hand, the influence of feedback orientation may be different if examined in a situation such as daily performance on the job. In this situation individuals may not be expecting feedback from their supervisor or co-workers and thus how they interpret and use the feedback may have a larger influence. This is the first effort to look at feedback orientation within a training context; previous studies focusing on feedback orientation have utilized survey designs (Linderbaum & Levy, 2007). While feedback orientation did not moderate as predicted, it did have a significant positive correlation with self-efficacy for learning interpersonal skills. This builds on Linderbaum and Levy (2007) who found general self-efficacy to be positively correlated to feedback orientation.

Exploratory analyses were conducted around the other individual difference variables (self-efficacy, presence and attention to the task) to examine whether they interacted with feedback intervention to impact performance. These variables were not supported as moderators. These results may be due to the short time-frame of the interpersonal skills training and the research design (between-subjects design). It is possible that during training with longer duration, individual differences may have a stronger impact and play a significant role between feedback intervention and performance. In fact, there has been a debate regarding the use of between-subject design and within-subject design to examine the influence of self-efficacy on performance. Vancouver, Thompson and Williams (2001) examined the influence of self-efficacy on performance as a between-person and within-person approach. Participants in the study were asked to take part in an analytical game called Mastermind. Results indicate that high self-efficacy lead to overconfidence and decreased performance in a within-person design. Also, the study found significant positive between-person correlation between self-efficacy and performance. Vancouver, Thompson, Tischner & Putka, 2002; Vancouver and Kendall (2006) replicated the previous study using the Mastermind task and found similar results. At the within-person level, the manipulation increased self-efficacy but decreased subsequent performance. At the between-person level, self-efficacy had no overall relation to performance. Richard, Dieffendorf and Martin (2006) replicated these studies using different tasks, exam performance in a classroom context and a computerized learning task in a lab setting. The researchers found the same relationships between self-efficacy and performance. Overall, the findings of these studies suggest that a longitudinal, within-person design is necessary to properly assess the direction of causality for self-efficacy and performance. This can help explain why the present research did not find significant correlations between self-efficacy, or any of the individual difference variables, and performance.

There were, however, interesting significant correlations among the individual difference variables that should be noted. Pre-test scores and self-efficacy were positively correlated. This provides some support for the usefulness of the pre-test in that those who reported higher interpersonal skills self confidence performed better on a test of interpersonal skills. Also, self-efficacy was positively correlated with reporting of being on-task (i.e. paying attention to the task) during the training. On the other hand, self-efficacy was negatively correlated to off-task attention. These results suggest that individuals with higher self-efficacy were probably more interested and motivated by the task, which may have lead them to pay more attention. The lower an individual's self-efficacy the more they reported being off-task (i.e. not paying attention to the task) during the training. Being off-task was also negatively correlated with pre and post-test scores, which is expected because attention to task usually relates to successful task performance. Lastly, presence and post-test scores were positively correlated. Individuals who felt immersed in the game performed better on the post-test.

Finally, it should be noted that there were different patterns in results for the pretest/posttest and Mission1/Mission2 scores. There was a significant main effect for the test scores; however there was a significant interaction for the mission scores. It was first theorized that the two measures both assessed the domains of interpersonal skills but using different methods. However, the different patterns may be better explained using Kraiger, Ford, and Salas (1993) classification scheme for learning outcomes. In their model, learning may be evaluated as three forms of outcomes. One outcome is cognitive, which includes verbal knowledge, knowledge

organization, and cognitive strategies. Another outcome is skill-based, which includes compilation of information and automaticity of information. The third outcome is affective involving attitudinal and motivational learning. In line with this classification scheme, the current research may have been tapping into knowledge organization and cognitive strategies (i.e., a type of cognitive outcome) through the pretest and posttest, which is paper-based with simplified scenarios. On the other hand, the mission scores may be evaluating proceduralization (i.e., a skill-based outcome) because they are actually learning how to perform the task in realistic scenarios while receiving feedback. The differences between these measures of performance should be further examined in future research.

Implications and Future Research

Ultimately, the aim of this effort was to begin bridging the gap in the feedback and training literature to help researchers revise current theoretical frameworks and assist practitioners in developing more effective training environments. The results reinforce the need to develop theories that take into consideration both feedback frequency and feedback sign when explaining learning and performance. Researchers in the industrial organizational psychology field should borrow from educational psychology and consider how the current theories would apply to different stages of learning. The influence of feedback type may vary depending on the learning stage of the individual. This possibility requires further investigation.

Future research should also replicate the current investigation using a different type of complex task such as problem solving or using a different videogame-based adaptive training. Replicating this investigation can help in extending the generalizability of the results and the theoretical framework. Additionally, researchers should examine and test the interaction between feedback frequency and feedback sign in more detail because this is a poorly defined relationship.

In addition to the theoretical contributions of this effort, there are also implications for practitioners working with videogame-based adaptive training. Instructional designers can use this information to determine what form of feedback is most beneficial to training a complex task. Most guidelines for training are based on commonly held beliefs instead of research. In the Training Multimedia Courseware Development Guide provided by TRADOC ("TRADOC Pamphlet 350-7-2", 2003) the guidelines suggest that only positive feedback be provided because it will build confidence while negative feedback will discourage the student and should not be used. It also suggests that positive feedback enhances learning and builds the learner's self-esteem and provides motivation to learn. However, this was not supported in the current research. Instead, instructional designers need to keep in mind that during a complex task the trainee requires frequent feedback about their performance. Preferably, the feedback provided will be constructive rather than just positive praise and adapt to the trainee's learning and performance. The use of technology such as computer-based training, videogames and web-enabled training is still an emerging field where there is a lack of theoretical background to help develop training. This effort takes a step toward resolving this problem to allow practitioners a framework upon which to base their training design.

Limitations

There are certain limitations that should be considered when interpreting the results. First, like many studies, the sample used was a convenience sample from two universities with ages ranging from 18 to 31. This is not a representative sample of the population and thus raises the question of generalizability.

Another limitation is the use of difference scores as dependent variables. It has been suggested that there are methodological flaws that need to be considered when using difference scores. Some of the problems involve the validity of difference scores, such as ambiguous interpretation and spurious correlations (Edwards, 1994). However, it has been suggested that the use of difference scores is less problematic when used as a dependent variables instead of a within-subjects independent variables with two levels (Edwards, 1994, 2001).

An additional limitation is that the self-report measures used were developed for this research and had not been previously validated. This is also the case for one of the performance measures, the pretest and posttest. Although this is a limitation, care was taken to develop the scales with SME input and appropriate scale development guidelines such as the procedures outlined by Bandura (2006).

Also, there is a threat to internal validity that should be considered when interpreting the results. More specifically, testing is an issue in the current research in that repeatedly measuring the participants on the pretest and posttest may lead to bias. This is especially the case in this research because the time lapse between the pretest and the posttest was usually around 2 hours, which may not be a significant amount of time between the two measurements to prevent a testing threat. Future research should extend the current work using a larger time lapse between the measurements to determine if this is a major threat.

There is also a limitation due to the videogame. During the game, when participants interacted with a town resident, the videogame did not lock the view on the character's face. Depending on where the avatar was placed, some participants were able to see the facial reactions of the characters but other participants only heard the individuals. It is not clear whether this difference influenced how the trainees interpreted the feedback or how this may have influenced the interactions with the town residents.

Furthermore, VECTOR was originally developed for the U.S. Army Research Institute for the Behavioral and Social Sciences and because of this it contains military content. Trainees are identified as Soldiers; they are given two missions in a Middle Eastern-like setting and they have to report to another Soldier. To make it possible for university students to play the game a lot of the military content was removed. Participants did not require previous knowledge of military tactics and procedures to play the game. It is not known if a Soldier would receive different scores on this game, although this is not expected.

Another issue with using VECTOR is the difficulty in determining whether the results are due to the specific type of game or if there would be similar results using other computer-based training. In other words, would these results transfer to another form of computer-based

training? Some gaming research has found that previous experience with general videogames (regardless of the type of videogame previously played) was related to future performance in videogame-based environments (Gagnon, 1985; Young, Broach, & Farmer, 1997). However, specific prior videogame experience that share similar characteristics with the training environment can provide incremental validity over general experience in predicting learning outcomes (Orvis, 2005). Therefore, these studies suggest that the learning that occurs during a specific type of videogame-based training can transfer to other forms of videogame-based training to influence performance. Additionally, research has shown that skills learned in game-based training environments transfer to real-life situations (Gopher, Weil, & Baraket, 1994; Knerr, Simutis, & Johnson, 1979). Thus, there is some support that the results of the current research would be similar in other forms of videogame-based training and real-life situations.

Conclusion

Videogame-based adaptive training has provided flexibility and adaptability for training in cost-effective ways. The military is quickly implementing this training technique without a theoretical background that explains the proper design or methods necessary to improve performance. Clearly, further work is required to build a theoretical framework that can help explain what type of feedback is most beneficial to learn a complex task in a videogame-based adaptive environment. However, this effort serves as a stepping stone towards this goal by testing four competing feedback theories. This was done by examining the role of feedback frequency and feedback sign on performance. Additionally, feedback orientation was examined to determine whether it moderates the relationship between feedback intervention and performance. Although not all predictions were supported, frequent feedback, frequent negative feedback and infrequent positive feedback were found to be beneficial to trainees while learning a complex task in a videogame-based adaptive training. These findings serve as a framework for practitioners in determining the necessary type of feedback needed when designing training in the emerging field of videogame-based adaptive training. Future research should further examine the interaction between feedback frequency and feedback sign and integrate those results into the current theoretical perspectives. In the end, the goal of this effort was to provide a deeper understanding of feedback's role in a videogame-based adaptive training environment.

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Appendix

Survey Measures

VECTOR Scenario Questionnaire (Pre-Post Test)

You will be presented with several short scenarios, followed by several possible actions. For each scenario, choose the action you feel is the most appropriate. Circle the letter to indicate your choice. For the following scenarios you are an Army Soldier stationed overseas.

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1. You were tasked with building a water treatment facility in a small town and maintaining the peace. In talking with the local cleric who basically runs the town, he has agreed to let you build the facility, provided some of his men are paid to help build it. You are not sure his men have any experience in construction, and you are already working on a tight budget. Choose the action you would take.

a.	Replace your contractors with the local workers to please the local cleric.
b.	Wait until the cleric changes his mind and no longer wants you to hire his men. Then build the facility.
c.	Explain you cannot afford to pay his men and build the facility using your contractors.
d.	Allow a few men to work but request they bring a few tools to help off-set the cost.

2. The town in Lieutenant Colonel Bateman's area of operations has been relatively calm after several arguments have occurred between the townspeople and the government concerning the operation of the new hospital. Lieutenant Colonel Bateman has just arrived for a meeting with Hamad to discuss the current state of the hospital. They exchange greetings at the door and walk towards a table. Before the discussion begins, what should Lieutenant Bateman make sure he does?

a.	Remove body armor and helmet.
b.	Get right down to business and question him over what he knows about the hospital; avoid boring Hamad with small talk.
c.	Bestow some praise on Hamad (e.g., compliment house and/or furnishings).
d.	Tell Hamad he is in a hurry so that Hamad does not feel he has to waste time with small talk.

3. You have been assigned with determining who is stealing money from the marketplace, and are talking with a local to obtain information. However, the local insists you purchase some of his goods before he can help you. You explain you do not have the money but that you would greatly appreciate his help. The local does not budge and continues to repeat that you should buy his goods. You still need the information, however. What do you do?

a.	Stay calm and be patient. Offer him help or other services for his cooperation.
b.	Walk away and find someone that will be willing to help.
c.	Be patient and wait. This will show him that you are serious.
d.	Change the topic of conversation in an attempt to distract him from selling his goods.

4. Lieutenant Colonel Converse is meeting Achmed for the first time, and they are getting to know each other. Converse knows that Achmed is an important businessman with influence in this area. To develop rapport with Achmed, what sorts of topics of conversation would be good for Lieutenant Colonel Converse to bring up during the meeting?

a.	How much authority he has as Lieutenant Colonel in the Army.
b.	Ask Achmed for more details about what he does in his line of work.
c.	Discuss the current issues with the construction of the town bridge.
d.	How much he enjoys the local food in this area.

5. Major O'Rourke is about to meet with a local leader for the first time. The Major is concerned about the potential outcome of this meeting where he will try to find out information about suspected security issues in the local market place. What should you tell him?

a.	Remind him that the leader has different views from him. It helps if he acknowledges the leaders perspective before introducing his own thoughts on the matter.
b.	It will help if he has planned for the possible effects of both success and failure of the meeting on the area of operations.
c.	He should be ready to put pressure on the local leader if he does not immediately provide the information needed. That is how business is done in this town.
d.	He should focus on his own goals, and figure out a way to get the local leader to bend to his will. This will speed up the process.

6. Major Collins is meeting the local market sellers for the first time. They have been arguing about the location of their market stalls. The Major is given the assignment to end the feuding so the market can reopen. What sorts of negotiation techniques can he use to end the feud?

a.	Tell the market sellers that if they do not cooperate they will not be allowed to sell their products at the market.
b.	Determine the different interests of all parties and attempt to align everyone's goals. The goal is to have a situation where both parties win and relationships are stronger.
c.	Determine the different interests of the townspeople to decide the quickest solution. It is okay if there is a losing party because the goal is to quickly reopen the market.
d.	Observe and guide the townspeople but remain removed from the situation.

7. The local schools are lacking supplies for the students. You find out that the neighboring town has storage with extra school supplies. You are given the task of meeting with the leader of the neighboring town and getting him to donate some school supplies. You are told he is not a generous man. What can you do to get his cooperation?

a.	Find out what his needs are and attempt to negotiate a solution in exchange for the school supplies.
b.	Remind him that by not helping the relationship between the two towns may greatly deteriorate.
c.	Get to know him and build a relationship before requesting the school supplies.
d.	Offer him additional security for his community in exchange for the school supplies.

8. Lieutenant Rivera has set up a meeting with the local Doctor to determine how to make the clinic more efficient. This is Lieutenant Rivera's first time in this town and meeting the Doctor. What is the best advice you can give her?

a.	Don't waste time with small talk. The Doctor has many patients.
b.	Let him lead the conversation. He will tell you when he is ready to talk business.
c.	Always take full control of the conversation. Interrupt him if you feel he is moving away from the purpose of the conversation.
d.	Begin talking about yourself and afterwards start talking business.

Research Survey 1 (Feedback Orientation Scale)

Please answer each statement by indicating the degree to which you agree or disagree from 1(strongly disagree) to 6 (strongly agree) by circling only **one** answer. There are no right or wrong answers. Please describe yourself honestly. These results will in no way be used at a personal or individual level. Your anonymity is guaranteed.

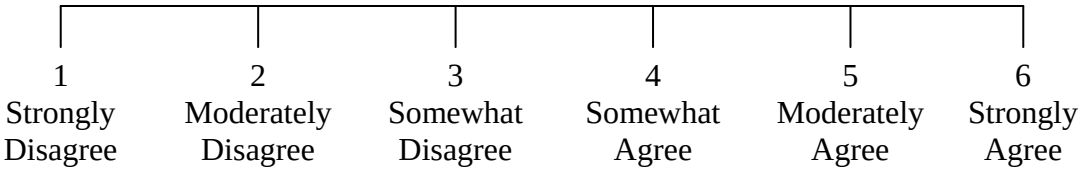
1	2	3	4	5	6
Strongly Disagree	Moderately Disagree	Somewhat Disagree	Somewhat Agree	Moderately Agree	Strongly Agree

The following statements concern your views towards feedback.

1. Feedback contributes to my success at work.	1	2	3	4	5	6
2. To develop my skills at work, I rely on feedback.	1	2	3	4	5	6
3. Feedback is critical for improving performance.	1	2	3	4	5	6
4. Feedback from supervisors can help me advance in a company.	1	2	3	4	5	6
5. I find that feedback is critical for reaching my goals.	1	2	3	4	5	6

1. It is my responsibility to apply feedback to improve my performance.	1	2	3	4	5	6
2. I hold myself accountable to respond to feedback appropriately.	1	2	3	4	5	6
3. I don't feel a sense of closure until I respond to feedback.	1	2	3	4	5	6
4. If my supervisor gives me feedback, it is my responsibility to respond to it.	1	2	3	4	5	6
5. I feel obligated to make changes based on feedback.	1	2	3	4	5	6

1. I try to be aware of what other people think of me.	1	2	3	4	5	6
2. Using feedback, I am more aware of what people think of me.	1	2	3	4	5	6
3. Feedback helps me manage the impression I make on others.	1	2	3	4	5	6
4. Feedback lets me know how I am perceived by others.	1	2	3	4	5	6
5. I rely on feedback to help me make a good impression.	1	2	3	4	5	6

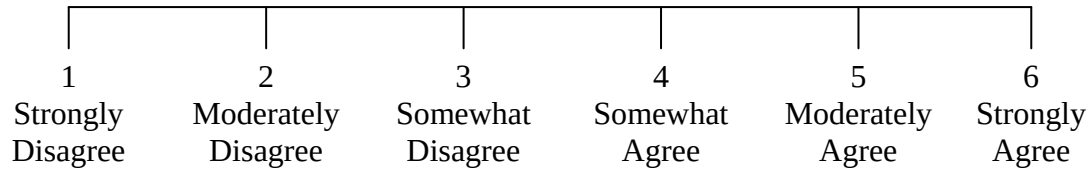


The following statements concern your views towards feedback.

1. I feel self-assured when dealing with feedback.	1	2	3	4	5	6
2. Compared to others, I am more competent at handling feedback.	1	2	3	4	5	6
3. I believe that I have the ability to deal with feedback effectively.	1	2	3	4	5	6
4. I feel confident when responding to both positive and negative feedback.	1	2	3	4	5	6
5. I know that I can handle the feedback that I receive.	1	2	3	4	5	6

Research Survey 2 (Manipulation Check)

Please respond to each statement by indicating the degree to which you agree or disagree from 1 (strongly disagree) to 6 (strongly agree) by circling only **one** answer.



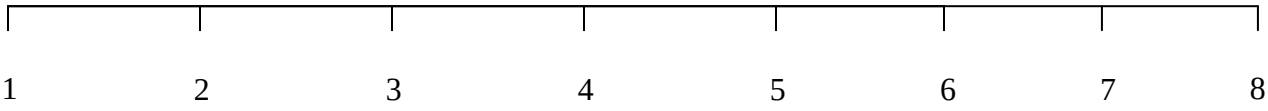
1. After the mission was over, my After Action Review said I did a good job on the mission.	1	2	3	4	5	6
2. The information given to me about my performance showed that I interacted poorly with the characters.	1	2	3	4	5	6
3. The information given to me about my performance showed that I did well interacting with the characters.	1	2	3	4	5	6
4. In general, the voice over information said I did not interact with the characters very well.	1	2	3	4	5	6
5. The information I received about my performance from the After Action Review screen was negative.	1	2	3	4	5	6
6. The information about my performance provided by the voice over was generally favorable.	1	2	3	4	5	6

1. Generally, after my conversation with each character the coach/voiceover gave me information about my performance.	1	2	3	4	5	6
2. I received information about my performance several times during the mission (as a voiceover) and then at the end (After Action Review screen).	1	2	3	4	5	6
3. I knew how I was performing throughout the game and not just at the end of the mission.	1	2	3	4	5	6
4. I was given information about my performance a couple of times during the game.	1	2	3	4	5	6
5. The coach/voiceover rarely provided me with information about my performance while I was playing the videogame.	1	2	3	4	5	6

6. I did not receive any information about my performance until the After Action Review screen at the end of the mission.	1	2	3	4	5	6
7. I generally did not know how well I did on the game until the end of the mission.	1	2	3	4	5	6
8. I was not provided with information about my performance during the game.	1	2	3	4	5	6

Research Survey 3 (Attention Scale)

Please respond to each statement by indicating the degree to which you agree or disagree from 1(strongly disagree) to 8 (strongly agree) by circling only **one** answer.



Never Constantly

1. I paid close attention to the kind of errors I was making.	1	2	3	4	5	6	7	8
2. I focused my attention on whatever was going wrong.	1	2	3	4	5	6	7	8
3. I focused my total attention on learning a specific rule.	1	2	3	4	5	6	7	8
4. I focused my attention on being ready for a change in the conversation.	1	2	3	4	5	6	7	8
5. I focused my attention on responding to the behavior changes of the characters.	1	2	3	4	5	6	7	8
6. I thought about new strategies for improving my performance.	1	2	3	4	5	6	7	8
7. I thought ahead to what I would do next to improve my performance.	1	2	3	4	5	6	7	8
8. I told myself things to encourage me to try harder.	1	2	3	4	5	6	7	8
9. I focused my total attention on how fast I could solve the mission.	1	2	3	4	5	6	7	8
10. I focused my total attention on passing as many objectives as possible.	1	2	3	4	5	6	7	8

1. I took “mental breaks” during the task.	1	2	3	4	5	6	7	8
2. I daydreamed while doing the task.	1	2	3	4	5	6	7	8
3. I lost interest in the task for short periods.	1	2	3	4	5	6	7	8
4. I thought about other things that I have to do.	1	2	3	4	5	6	7	8
5. I wondered about how my performance compared with others.	1	2	3	4	5	6	7	8
6. I thought about the difficulty of the task.	1	2	3	4	5	6	7	8

Presence Questionnaire

For the following questions, please circle the number which best represents your experience.

1. Please rate your sense of being in the computer-generated world, where 7 represents your normal experience of being in a place.

   I had a sense of "being there" in the computer-generated world:

1	2	3	4	5	6	7
Not at all						**Very Much**

2. To what extent were there times during the experience when the computer-generated world was the reality for you?

   There were times during the experience when the virtual environment was the reality for me:

1	2	3	4	5	6	7
At no time						**Almost all the time**

3. When you think back to the experience, do you think of the computer-generated world more as images that you saw or as somewhere that you visited?

   The computer-generated world seems to me to be more like:

1	2	3	4	5	6	7
Images that I saw						**Somewhere that I visited**

4. During the time of the experience, which was the strongest on the whole, your sense of being in the computer-generated world or of being elsewhere?

   I had a stronger sense of:

1	2	3	4	5	6	7
Being elsewhere						**Being in the virtual**

General Information

Gender: Male _____ Female ____

Age: _____

How would you describe yourself?

A. Asian/Pacific Islander
B. African American
C. Hispanic/Latino
D. Caucasian
E. Other _____

Have you previously participated in a videogame based negotiations training (i.e. Elect Bilat) at the University of Central Florida?

A. yes
B. no

Have you ever participated in a computer-based interpersonal skills training before?

A. yes
B. no

If yes, please describe it:

How often do you play computer-based videogames?

A. Never
B. A few times a year
C. 2-3 times a month
D. 2-3 times a week
E. Every day

Appraisal Inventory (Self-efficacy scale)

Think about a situation where you may need to communicate effectively with another person. Rate your confidence in successfully using each tactic listed below when communicating with someone.

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all					Moderately can do				Highly certain can do	

	Confidence (0 – 100)
Establish a high level of rapport with the other person	_____
Convince the other person to agree with me	_____
Find tradeoffs that will benefit both me and the other person	_____
Look for an agreement that maximizes both of our interests'	_____
Use appropriate greetings when meeting the other person	_____
Build a relationship by engaging in small talk	_____
Take control of the conversation by only discussing the topics I choose	_____
Acknowledge the other persons perspective during a disagreement	_____
Remain patient during a heated disagreement	_____
Reduce tension and conflict during a disagreement	_____