A Comparison of Instructor-Led vs. Web-based Training for Detecting Deception[1]

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Introduction

Deception, defined by Buller and Burgoon (1996, p.205) as "a message knowingly transmitted with the intent to foster false belief or conclusions", occurs everyday. While "little white lies," such as showing appreciation for a gift that we actually do not like, may be relatively harmless and even considered a social politeness, deception executed with malicious intent has the potential to harm individuals, organizations, or even nations if it remains undetected. Therefore, it is important for people to be able to accurately detect deception, especially in critical situations. Although people often think that they are good "lie detectors," research shows that this is generally not the case. In reality, people have many biases and shortcomings that severely limit their ability to accurately detect deception. In fact, research results show that people are generally poor at detecting deception, achieving little more than 50 percent accuracy (Kraut, 1980; Miller & Stiff, 1993). Consequently, it is critical to help people in high risk positions or circumstances to improve their accuracy of deception detection in order to reduce potential threats to security.

In general, people are poor deception detectors due to a lack of real knowledge of reliable deception cues, combined with their over-reliance on a few "unauthenticated" cues (Levine, Park, & McCornack, 1999). As researchers authenticate more deception cues, training becomes a more valid way to help individuals understand the nature of deception and thereby improve their ability to detect it. However, prior attempts at training people in deception detection resulted in mixed findings. In fact, some training efforts actually resulted in a reduction in detection accuracy (DePaulo & Pfeifer, 1986). Furthermore, although information technology has been applied to education for a long time, none of the earlier deception detection training attempts used information technology (IT)-supported training tools. Therefore, it is an immense challenge to develop both effective training curricula and IT-supported training tools for deception detection. The study described in this paper attempted to design, develop, and test such a deception detection training curriculum and its Web-based implementation.

Guided by research findings related to cues of deception and deception detection training, we developed the training curriculum to incorporate three components: 1) specific instruction on deception detection knowledge, 2) practice with real-life examples of deception, and 3) analytical feedback regarding the examples. Creating such a training curriculum involved selecting reliable cues of deception, organizing and explaining these cues, and finding examples of real human communications to illustrate these cues. The training curriculum was implemented with two training methods: 1) a traditional instructor-led, lecture-based training and 2) a Web-based, learner-centered, multimedia training system called AGENT99 Trainer. The study expected that the training curriculum would be able to effectively improve the subjects' detection accuracy. In addition, the study anticipated that the Web-based training tool would be at least as effective as the traditional lecture-based training in improving detection accuracy, while providing benefits such as anytime and anywhere accessibility and repeatability for learners. The initial experiment tested the effectiveness of the training curriculum by measuring the learners' deception detection accuracy before and after receiving training. Pre and post tests in the form of judging the veracity of human communications were specially created for measuring learners' deception detection accuracy. The experiment also compared the training effectiveness of the two delivery methods. Results of this experiment supported our hypotheses.

In the following sections of this paper, we first introduce some of the background research for

Abstract

Research has long recognized that many biases and shortcomings of humans severely limit their ability to accurately detect deception, and this may lead to great risks in government or military operations. One possible method to improve humans' deception detection ability is to train them to recognize cues of deception. To do this, we need to create effective training curricula and educational tools. This paper focuses on describing how we used existing research on deception detection to guide the design, development and evaluation of such a training curriculum. Research-authenticated cues of deception were selected, organized and presented as the core of the training curriculum. Real-life examples and their analyses were created to illustrate the cues and provide learners with immediate feedback in detection practice. Besides traditional instructor-led, lecture-based training, we also implemented this curriculum with a Web-based, learner-centered multimedia training system called Agent99 Trainer. Experiments were conducted to study the effectiveness of our training curriculum and to compare the two training implementations. The initial results showed that our training curriculum significantly improved the accuracy of human deception detection and the Agent99 Trainer system provided training as effective as the instructor-led, lecture-based training.

Keywords: deception detection, deception detection training, Web-based training, training curricula, evaluation, computer-assisted instruction

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both deception detection and training for detecting deception. Next, we describe the development of our training curriculum.Then the implementation of the curriculum within the Agent99 Trainer system is introduced briefly. Afterward, we present the study design and procedures for the evaluation of the training curriculum and the comparison between the two training delivery methods. Finally, we provide a summary of our findings, as well as a discussion of the findings and the need for future research.

Background

Detecting deception is difficult for humans because they lack real knowledge of unfailingly reliable cues and they are heavily influenced by biases or over-reliance on a few "unauthenticated" cues (Levine et al., 1999). Therefore, from a theoretical standpoint, it should be possible to train people to detect deception more accurately, as long as there are research-authenticated cues available.

Research studies on deceptive communication have already authenticated many behavioral cues that may distinguish a deceptive communication from a truthful one based on the communicators' verbal or nonverbal behaviors. In 1981, Zuckerman, DePaulo, and Rosenthal published the first comprehensive meta-analysis on deception cues. They analyzed all research studies reporting verbal and nonverbal cues of deceptive communications and summarized them into 19 behavioral cues of deception (Zuckerman, DePaulo, & Rosenthal, 1981). They grouped these cues into four different categories: attempted control, arousal, affective/emotional states, and cognitive complexity. That is, deceivers may try to control their verbal and nonverbal displays, they may be aroused, they may experience specific affects (e.g. guilt), and they also may be engaging in a cognitively more demanding task than people who are telling the truth. The Zuckerman team (1981) suggested that cues associated with these four categories might be the most likely indicators of deception. In a recent extension of the initial Zuckerman meta-analysis, DePaulo, Lindsay, Malone, Muhlenbruck, Charlton, & Cooper (2003) analyzed more studies, resulting in a more comprehensive list of 158 behavior cues of deception, each of which has a measure indicating its reliability. The 158 cues were grouped according to the applicability of the following five questions:

1) Are liars less forthcoming than truth tellers?
2) Do liars tell less compelling tales than truth tellers?
3) Are liars less positive and pleasant than truth tellers?
4) Are liars tenser than truth tellers?
5) Do deceptive self-presentations include fewer ordinary imperfections and less unusual content than truthful ones?

The DePaulo and Zuckerman meta-analyses mentioned both focused on behavioral cues that may indicate deception. In addition, recent studies have pointed out that there may be linguistic indicators of deception such as *group references, qualifiers,* and *vague language* in communication text (Zhou, Burgoon, Nunamaker & Twitchell, 2004). All these research studies provide a good knowledge base for training people to improve their deception detection accuracy.

Although research has shown that it is *possible* to increase people's ability to detect deception through training, not all training programs are effective (Kassin & Fong, 1999). Different training content may result in different training effects. Prior to the Zuckerman study in 1981, no research-authenticated cues were available, so earlier attempts of deception detection training used a "practice" and "self-taught" strategy, in which either 1) the observer evaluated the veracity of a communication after viewing a "normal", truthful communication of the subject/potential deceiver (Brandt, 1980a; 1980b), or 2) the observer evaluated the veracity of a communication and immediately received outcome feedback (true or false) on the correctness of his or her judgment (Zuckerman, Koestner, & Alton, 1984). Improvement gained from this type of training is limited and is not generalizable because observers can only become better at detecting deception in the subjects they study. Observers can even "learn" erroneous cues during the self-taught learning process. If erroneous "knowledge" is not corrected it may result in a negative training effect (DePaulo & Pfeifer, 1986), i.e., deception detection accuracy actually decreases after training. After research-authenticated cues became available, investigators began adding explicit instruction about the cues of deception to their training programs (DeTurck, Harszlak, Bodhorn, & Texter, 1990; DeTurck, 1991; Fiedler & Walka, 1993; Vrij, 1994). However, it was still uncertain which cues should be used to train people. In the early 1990s, instruction typically focused on nonverbal cues of deception. Only recently have attempts been made to provide instruction in the use of both nonverbal and verbal

[2]For a detailed description, please refer to (Lin, Crews, Cao, Nunamaker, & Burgoon, 2003).

cues (Porter, Woodworth, & Birt, 2000). Training including both types of cues resulted in a post-training average deception detection accuracy of 76.7%, the highest result found in the research we reviewed. This indicates that the most effective deception detection training includes instruction on both verbal and nonverbal cues of deception.

In addition to developing effective training content, we also wanted to examine the effect of training methods on training effectiveness. Deception detection training research indicates that the most effective training is obtained when instruction is combined with practice judging the veracity of real communications, followed by outcome feedback on the judgments (Vrij, 1994). Therefore, explicit instruction, practice, and feedback are three critical components of effective deception detection training and training combining these three components creates results superior to that of either "instruction only" training or "practice only" training. However, what is the best training method to incorporate all three critical components? Previous research has investigated only one type of deception detection training: instructor-led, lecture-based training in a classroom setting. The use of high-tech instructional technology in such training programs has been limited to showing communications videos. Nevertheless, it is widely accepted that properly designed computer systems can be excellent training tools (Rosenberg, 2000). We believe that a Web-based, multimedia, learner-centered training system can be an invaluable instructional tool for deception detection training by providing such advantages over instructor-led training as self-paced learning, and unlimited access, anytime and anywhere.

Testing the effectiveness of a deception detection training program is another challenge. Earlier research studies have described the design and procedure of their evaluations. However, although many studies have used pretest-posttest comparison on the communication veracity judgment tests, at the time of this study no evaluation tool was available in the literature. As a result, we had to create our own. As Frank and Feeley point out in their meta-analysis on deception detection training (Frank & Feeley, 2002), many potential pitfalls can complicate the seemingly easy pretest-posttest design and inject bias into the evaluation results. For example, if the same communicator (person who participates in the communication that is to be judged by the subjects) appears repeatedly in the same test (pretest or posttest) or appears in both tests, the subjects may learn to recognize cues specific to that communicator rather than recognizing the generalized cues learned from the training curriculum. As a consequence, the evaluation results could be biased by factors other than training. To avoid this kind of bias and ensure experiment validity, there must be a sufficient number of different communicators in both the pretest and the posttest. Frank and Feeley recommended 10 as a minimum number of communicators for the total two tests, taking into consideration some statistical requirements and the time limit for the judgment tests (If the test takes more than 30 minutes, subjects usually become tired and stop concentrating on their judgments.). These research studies and recommendations guided us through the creation of judgment tests and the design of the evaluation of our training program, as will be discussed in the *Judgment Test Creation* and *Experiment* sections.

Training Curriculum Development

As has been discussed, an effective deception detection training program should be a combination of three critical components: explicit instruction, practice, and feedback. To avoid a negative training effect caused by erroneous cues (DePaulo & Pfeifer, 1986), the instruction and feedback must be based on research-authenticated cues of deception. Therefore, we first studied and selected cues of deception reported in the research literature. Based on the results, we developed our training curriculum content to include: (1) a videotaped lecture on cues of deception, (2) real communication examples extracted from the records of previous deception research studies, and (3) analyses for each example based on the cues taught in the lecture. Both the instructor-led, lecture-based training and the Agent99 Trainer system used the same curriculum, so that the effectiveness of the instructional methods could be compared. In addition, to avoid instructor bias, the same instructor presented the lecture under both conditions.

A description of the creation of judgment tests for evaluation is included in this section as a special component of content development. The judgment test cases were extracted from the same sources as the practice examples in the training curriculum. A pilot study was conducted to help us select and organize the test cases into two separate tests and to ensure that the two tests were statistically equivalent. This is discussed in further detail below.

Lecture on Cues of Deception

The content of the lecture included a definition of deception, basic methods of deception detection, categories of behavioral cues of deception, and groups of linguistic indicators. The behavioral cues were selected primarily from the previously mentioned DePaulo meta-analysis (DePaulo et al., 2003). The meta-analysis provided a comprehensive list of cues, including the effect size and significance of each cue. Therefore, we chose significant deception cues ($p < .05$) having the largest effect sizes ($d > |.20|$) to be explained in detail in our training lecture.

To provide scaffolding for learners (Soloway, Guzdial & Hay, 1994), we summarized these cues into five categories: *arousal, emotion, cognitive effort, memory process*, and *communication tactics*. These categories were based on the cues' etiologies, i.e., the underlying causes for the deceptive behaviors. For example, "*more negative statements*" is listed in the *emotion* category, because it is attributed to a behavior arising from a deceiver's negative or guilty emotion for deceiving (DePaulo et al., 2003). For each category of cues, definitions and other relevant information about the cues were extracted from original research referenced in the meta-analysis by DePaulo, et al (2003).

In addition to these behavioral cues, we also selected several linguistic indicators for inclusion in the training curriculum from a recent study about deception detection in text-based, computer-mediated communication (Zhou et al., 2004). Based on definitions from that study, each indicator was explained in detail and one or two sentences were presented as examples illustrating each indicator.

For the training, a set of PowerPoint slides was developed as an outline of the lecture on cues of deception. The definitions and explanations of cues and indicators selected were written into a script. For the purpose of putting the lecture into the Agent99 Trainer system, an instructor presented the lecture based on the slides and the script in a studio. The presentation was videotaped as a 34-minute lecture video. The same instructor presented the lecture to the lecture-based training sessions using the same set of slides and script.

Examples of Deception Cues and Analyses

Because deception detection is a complex problem, deep understanding of the cues of deception requires extensive experience and high levels of cognitive processing (Zuckerman, 1984). Consequently, practice is a "must-have" component of deception detection training. In practice, learners typically are allowed to watch real-life examples of deceptive or truthful communications and make judgments on the veracity of the examples. In fact, research has shown that providing practice, even without additional instruction, may improve human's accuracy of deception detection (Brandt, 1980a, 1980b; Zuckerman et al., 1984) and that providing outcome feedback (indicating whether the judgment is true or false) can result in even greater improvement of detection accuracy (Zuckerman et al., 1984). However, simple outcome feedback does not point out the reasons for an outcome, and thus cannot offer explicit directions for improvement (Azevedo & Bernard, 1995). Therefore, in our lecture we included not only real-life examples illustrating the cues but also analytical feedback for each example in order to help learners develop a deep understanding of each cue. Specifically, the analytical feedback consisted of a written, "expert" analysis of the cues presented in each example communication.

The practice examples in our curriculum were selected from a series of research studies about interpersonal deception detection (Burgoon & Buller, 1994; Burgoon, Buller, Ebesu, Rockwell & White, 1996; Burgoon, Buller, White, Afifi & Buslig, 1999; Zhou et al., 2004). We chose examples in different media types (video, audio, and text) to support learners in learning to detect deception under various communication conditions. *Video* and *audio examples* were selected from the video records of the first three Burgoon studies (Burgoon et al., 1994, 1996, 1999). In these studies, pairs of subjects conducted face-to-face interviews and the interview process was videotaped. In each interview, the interviewee was asked several questions about his/her job, life, attitude or feelings, and some interviewees were also told to lie when answering specific questions. Based on the original data of these experiments (e.g., the interviewees' self-ratings of their veracity on each question), we chose those deceptive or truthful conversations that illustrated the cues taught in the lecture. Each example contained the conversation about one question, making it short enough (1-3 minutes) to keep the attention of learners.

Text examples were selected from a recent study about computer-mediated deception (Zhou et al., 2004). In this study, subjects were

randomly assigned to one of two conditions, deceptive or naïve (truthful), and then participated in group problem solving activities. The deceptive subjects were explicitly instructed to deceive the naive subjects. All conversations occurred through email messages or a computer chat program, such as Microsoft NetMeeting. In selecting text examples, we reviewed the recorded text conversations and extracted paragraphs of deceptive or truthful messages.

A group of deception detection researchers reviewed several candidate examples in each media to decide which examples best illustrated the training cues and thus should be incorporated into the curriculum. Specifically, each candidate example was assigned to and reviewed by three researchers to ensure the validity of these examples. We would not include an example as the illustrator of certain cues unless all three researchers agreed on those cues. Furthermore, the researchers provided an "expert" analysis for each example, which described the deception detection cues that were presented. Considering our desire to limit the training duration to approximately one hour in the evaluation stage, we selected 21 examples, including16 video and audio examples and 5 text examples, covering all five categories of cues. All 21 examples were listed in the Agent99 Trainer system with accompanying analyses presented textually. In the lecture-based, classroom training, the instructor presented the same 21 examples to learners and the analyses were presented vocally and on slides by the instructor.

Judgment Tests Creation

We decided to test the effectiveness of our training curriculum using a pretest-posttest design, in which learners would be assessed on the accuracy of their deception detection prior to training and then after receiving training. In most studies of deception detection, human detection accuracy is measured as the percentage of correct judgments in a set of judgment tasks (i.e., judging the veracity of a short conversation). Two judgment tests therefore needed to be created. Following the recommendations of Frank and Feeley (2002) described in the *Background* section, we designed the pretest and posttest so that each test consisted of 6 test cases (short conversations) from 12 different pairs of communicators. Each test took about 15 minutes to complete, and learners judged the veracity of each test case. To make the judgment tests consistent with the training content, all test cases were extracted from the same sources and had the same format as the practice examples in the training curriculum; however, none of the communicators in the test cases appeared in the training examples in order to ensure that the learners' detection accuracy would not be biased by previous exposure to specific communicators. To test the learners' ability to detect deception under various communication conditions, the test cases were presented in different media types, two of each in text, audio, and video formats. Half the test cases were deceptive and half were not, enabling us to control for guessing and easily determine whether scores were above or below chance (Frank & Feeley, 2002).

A pilot study was conducted to help us choose the test cases, group them into two separate tests, and ensure that they had the same difficulty level. Candidate test cases were extracted and reviewed by the researchers to ensure that the cases represented cues taught in the lecture. The researchers also estimated the detection difficulty level for each candidate case, and then grouped the cases by media type, veracity, and detection difficulty level into two balanced sets. The test cases were randomly ordered within each set, based on those characteristics. In the pilot study, two groups of untrained undergraduate students (15 students in each group) took the two tests separately. The average detection accuracy scores for each test and each test case were then calculated. We expected no significant differences between the average detection accuracy scores for the two tests, but we were prepared to check the score of each test case to determine the case's actual difficulty level and make some adjustments, if there were significant differences. Since the pilot results showed that the scores for the two candidate tests were not significantly different, this indicated that the two tests were had the same levels of difficulty, so we used them as the pre-test and post-test for our experiment.

Agent99 Trainer Implementation

The effect of a training curriculum can be different under different delivery methods. Research has shown that computer-assisted instruction systems, and in particular Web-based training systems, can be as effective as, or more effective than traditional, lecture-based training methods for delivering training (Cornell, 1999; Zhang, Zhao, Zhou & Nunamaker, 2004). Therefore, we implemented our training curriculum in a Web-based training system called Agent99 Trainer, which was adapted from a previously

Figure 1. Interfaces of the *Watch* Lecture module (a) and the *View Example with Analysis module* (b)

developed system called LBA (Learning by Asking) (Zhang, 2004). LBA, designed as a general training tool, provides learner-centered training and has the time and space independence of Web-based technologies, as well as the richer information channel of multimedia technologies. We adapted this general training tool to fulfill the special requirements of deception detection training, such as incorporating explicit instruction, practice and feedback. LBA supported only one of these critical components, explicit instruction, by providing multimedia online lectures in a module called *Watch Lecture*. Consequently, another module called *View Example with Analysis* was incorporated to deliver the practice examples and provide analytical feedback to learners. These two modules were implemented in Agent99 Trainer as follows (Figure 1 shows the interfaces of these two modules):

The ***Watch Lecture*** module presented the lecture on deception cues through a combination of digital media that includes a video stream of the lecture, a set of presentation slides, and a script of the lecture video. In our application, the lecture was virtually segmented into different topics, and each segment of the video was then synchronized with one slide and the segment of the script talking about the same topic. Therefore, when learners played the video sequentially, the associated slides and script would automatically be displayed just as an instructor does when changing slides for a lecture in a classroom. In addition, navigation buttons and pull-down menus were provided so that users could switch to any topic or its associated practice examples on demand, with no restriction on the sequence of the video.

The View Example with Analysis module linked the 21 practice examples in the curriculum to the relevant cues taught in the lecture. Each category of cues could have multiple examples linked to it. Learners could choose to view the same example in three different media types (video, audio and text), so that they could focus on cues in different communication channels (visual, vocal, and textual or linguistic cues) for the same example. After viewing an example, learners were instructed to make a judgment regarding the veracity of that example. Then, learners could click on a link to an expert analysis of the cues present in that example, providing learners access to immediate, but impersonalized, analytical feedback. Again, buttons and menus in this module were designed to help learners easily jump between different examples, as well as between examples, analyses, and the lecture.

Experiment

We tested the effectiveness of our deception detection training curriculum by assessing improvement in learners' deception detection accuracy. Since the development of our training curriculum was guided by previous research findings for deception detection and deception detection training, we expected learners to improve their detection accuracy significantly after being trained with our curriculum; no matter which delivery method was used. We also expected Agent99 Trainer to be at least as effective a training method as the lecture-based, training method. This leads to the following hypotheses.

H1: Learners receiving our training curriculum will improve their deception detection accuracy,

i.e., our training curriculum would have a positive training effect.

H2: Learners receiving training through Agent99 Trainer will improve their deception detection accuracy as much as learners receiving instructor-led, lecture-based training.

These two hypotheses were tested in a pretest-posttest cross-treatment experiment that was conducted at a research university in the Southwest. Twenty-nine undergraduate students registered in summer classes in the Management Information Systems department were recruited as participants and randomly assigned to two treatment groups. There was no control group in the experiment because of the limited number of participants. However, a pilot study was conducted before the experiment, and its demonstrated that the pre-test and post-test had significantly equivalent difficulty levels, and that no practice effects occurred between the pre-test and post-test. Therefore, the difference between the post-test and the pre-test scores for each treatment group in this study can be attributed to the effect of the training curriculum.

We tested the first hypothesis by comparing the difference of the pretest and posttest scores for all participants. The second hypothesis was tested by comparing the learners' detection accuracy improvement between the two treatment groups. One treatment group (N = 15) received training by Agent99 Trainer, while the other group (N = 14) received traditional instructor-led, lecture-based training. The experiment lasted about two hours. In the first half-hour the pre-test was administered to both groups. The pre-test consisted of a judgment test (15 minutes) and a few questions about learners' demographics and communication styles (another 15 minutes). After a one-hour training session, subjects were given another 15-minute judgment test as a posttest and were asked to complete a survey about their satisfaction with the training program. During the one-hour training period, the students in the Agent99 Trainer group were asked to watch the lecture and practice deception detection with the examples by themselves, through the Agent99 Trainer system in a computer lab with Internet connection. At the same time, the instructor who presented the video lecture presented the same lecture and examples (using the same set of PPT slides and lecture scripts) to the students in the lecture group in a classroom setting. The analyses of the examples were also presented to the subjects by the instructor (vocally and also in the PPT slides). The only difference between the two treatment groups was the different delivery methods for the training curriculum.

Results

In the analysis, the deception detection accuracy for each judgment test was measured by the number of correct judgments divided by the total number of test cases (6 in our experiment). This dependent measure was calculated for each subject for both the pre-test and post-test. Two independent variables were used in this experiment: *treatment* (Agent99 or Lecture) and *time* (pre or post). One-way ANOVA analysis of the pre-test scores on the *treatment* factor verified that the groups were statistically homogeneous before treatment, $F(1, 27) = .067$, $p < .798$. We conducted a 2 by 2 ANOVA of the treatment groups with repeated measures on the *time* factor. Results revealed a significant main effect for the *time* factor, $F(1, 27) = 32.29$, $p < 0.001$, eta square = 0.545. This indicates that the post-test deception detection judgment test scores were significantly greater than the pre-test scores for both groups (average improvement = 23.5 %), supporting the first hypothesis. The training curriculum improved learners' deception detection accuracy.

No significant interactions between *treatment* and *time* factors were found in this experiment, $F(1, 27) = .607$, $p < .443$, indicating that there was no statistically significant difference in the pre- to post-test improvements of the Agent99 and Lecture groups, even though the detection accuracy of the Agent99 group did improve slightly more than did the lecture group. Thus, the second hypothesis was also supported; learners receiving training by Agent99 Trainer improved their deception detection accuracy as much as learners receiving the same training curriculum by instructor-led, lecture-based training. See Table 1 for means.

Table 1. Detection Accuracy Means as a function of the *treatment* and *time* factors

		time		Improvement
treatment	**N**	**pre***	**post***	**Pre to Post**
Agent99	15	.4222 (.1651)	.6889 (.2077)	.2667
Lecture	14	.4405 (.2129)	.6429 (.1582)	.2024

* Numbers are means (standard deviations).

Discussion

Overall, the results of this initial evaluation of our training curriculum and the Agent99 Trainer implementation were encouraging. The training curriculum was shown to be effective at improving learners' deception detection accuracy.

In the past, research findings regarding attempts to improve detection accuracy with training have been mixed, with training often resulting in no better detection (Kassin & Fong, 1999). This study provides additional evidence that training on deception cues has the potential to improve detection accuracy. Furthermore, the study shows that the training curriculum can be delivered online, even under highly constrained conditions, with equal effectiveness to delivering the training via an instructor-led lecture. These are both important results.

Although not fully unexpected, it is somewhat disappointing that the Agent99 Trainer did not provide learning effects that were better than the traditional lecture-based training, as is our ultimate objective. However, we believe several research factors may have contributed to this result. First, Agent99 Trainer was only partially implemented in this experiment; some functions involving instructor-learner interactions (e.g., question answering or discussion forum) are still in the conceptual design stage; therefore, Agent99 Trainer does not currently support such interactions. Since lecture-based training settings facilitate such interactions with the human instructor, students may more easily and readily get explanations of what they do not understand, resulting in more effective training. Secondly, we evaluated Agent99 Trainer in a controlled laboratory environment. Access was limited to a one-hour session, which was equivalent to the instructional time in the lecture-based training condition. While a strong advantage of a Web-based training system is assumed to be its capability of providing self-paced, repeatable training with unlimited access time, our research controls necessarily removed the occurrence of this learning advantage from this experimental study. A longitudinal field study instituting self-paced learning with unlimited access is needed to investigate possible learning advantages of a Web-based system for deception detection training. Furthermore, future research needs to be conducted to determine if particular parts of the training curriculum (lecture, practice, and/or feedback) make more important contributions to improved performance. Similarly, we need to investigate which cues of deception are the most reliable or useful to improve learners' deception detection accuracy when included in training regimens.

Finally, this study sample is small and composed entirely of undergraduate students. In reality, the target audience of our training curriculum will be primarily military or government officers who need to make decisions about deception in their everyday work. The training effects of the curriculum might be different for these officers. It is therefore important to increase both the sample size and the sample diversity in the future research.

Despite the constraints of this study, our research findings have practical implications for both research and practitioners. The results indicate that a training program for deception detection can be effective using either traditional instructor-led training or a Web-based training tool. In the future, it will be necessary and important to study the design of Web-based training tools based on both learning theories and deception detection requirements. It will also be important to focus research on curriculum development, including the selection of reliable cues of deception. The success of Web-based tools in deception detection training may have enormous impacts on practice. With today's pervasive Internet technology, the Web-based training tool can provide anytime-anywhere training on the cues that point to deception and overcome the lack of human instructors of deception detection. Deception detection training will thus be able to be embedded in every security-related worker's daily life using tools such as a Web-based training tool. In an era when homeland security is becoming more and more important for a nation, the benefit of such an on-the-job training program seems obvious.

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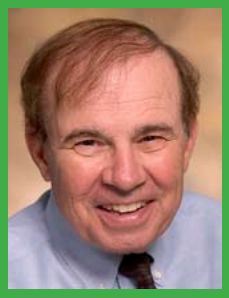

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