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The Effects of a Still-Photo Computer Module without Feedback on Ergonomic Behaviors

Rhiannon M. Fante

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THE EFFECTS OF A STILL-PHOTO COMPUTER MODULE WITHOUT FEEDBACK ON ERGONOMIC BEHAVIORS

by

Rhiannon M. Fante

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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I was too busy with school. Todd, you are my best friend and soul mate and I couldn't have done this without you. I love you!

Rhiannon M. Fante
The purpose of the present study was to examine the effects of a still-photo computer training module without feedback on safe positioning of individuals performing an assembly task and a lifting task using a multiple baseline design across behaviors and tasks. The study took place in an analogue office setting and participants were 6 college students. The dependent variable was the percentage of observations scored as safe and each session was recorded via a hidden camera. During each session, participants completed a 5 minute assembly task followed by 2 lifts and this task sequence was repeated a minimum of four times during each session. Prior to the beginning of baseline, participants received information regarding safe positions and also demonstrated the positions, they then received a safety information sheet at the beginning of every session. At the start of each session in the still-photo module without feedback phase, participants were asked to evaluate 10 still-photos of safe postures and 10 still-photos of at-risk postures for the target behavior(s). Increases in safe performance occurred when the still-photo module without feedback was implemented. The possible behavioral functions responsible for this change, the implications for these findings, and future research are discussed in detail.
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INTRODUCTION

In 2003, there were a total of 4.4 million injury cases reported by organizations, resulting in a rate of 5 cases per 100 full-time equivalent workers (Bureau of Labor Statistics, 2005a). Of the 4.4 million injuries, approximately 2.3 million injuries required recuperation away from work, transfer to another job, restricted duties at work, or some combination of these actions. Nearly one-third of all serious occupational injuries resulted from overexertion and repetitive motion. The annual costs of overexertion and repetitive motion injuries alone total as much as $20 billion in direct cost and billions more in indirect costs (Safety and Health News, 2004).

For the cases involving days away from work in 2003, approximately 705,800 cases (32%) were the result of overexertion or repetitive motion. Specifically, there were 367,424 injuries due to overexertion in lifting and 92,576 injuries or illnesses due to repetitive motion, including typing or key entry, repetitive use of tools, and repetitive placing, grasping, or moving of objects other than tools (Bureau of Labor Statistics, 2005a). Repetitive motion injuries result in the longest absences from work with an average of 23 days, whereas overexertion injuries from lifting result in an average of 9 lost days of work (Bureau of Labor Statistics, 2005a).

When the nature of the work-related injury or illness is sprains, strains, tears, back pain, carpel tunnel syndrome, hernia, connective tissue diseases and disorders and when the event or exposure that leads to those injuries or illnesses is bending, climbing, crawling, reaching, twisting overexertion, overexertion when lifting, or repetitive motion, those injuries are classified as musculoskeletal disorders (MSDs). The U.S. Department
of Labor (Bureau of Labor Statistics, 2005b) defines a musculoskeletal disorder (MSD) as an injury or disorder of the muscles, nerves, tendons, joints, cartilage, or spinal discs. MSDs affect about 1 million workers and cost the nation between $45 billion and $54 billion in compensation expenditures, lost wages, and decreased productivity each year (National Research Council, 2002). Given the high frequency and severity (as measured by days away from work) of events related to MSDs, it seems clear that interventions to address these events are warranted.

Behavioral Safety

A widely used approach to reducing worker injuries is called behavioral safety. The behavioral safety process utilizes the principles of applied behavior analysis and performance management to increase occupational and personal safety. The behavioral safety process is a systematic approach that relies on the identification and monitoring of critical behaviors (often termed “at-risk” behaviors) which occur before an injury, so that these behaviors can be changed (thereby reducing employee exposure to risk) using behavioral techniques such as goal-setting, feedback, and reinforcement (Geller, 2001; Krause, 1997; McSween, 1995; Sulzer-Azaroff & Austin, 2000).

The behavioral safety approach has proven to be extremely effective over the years across various settings and populations. A review of the literature conducted by Krause, Seymour, and Sloat (1999) examined the effect sizes of the behavioral safety approach implemented by 73 industrial companies. The effect sizes were estimated from the average percent reduction in injuries over baseline for one, two, three, four, and five years after safety observations began. The results showed that the average reductions in
injuries from baseline were 26% in the first year, 42% in the second year, 50% in the third, 60% in the fourth, and 69% in the fifth year.

Another review of the literature conducted by Grindle, Dickinson, and Boettcher (2000) reviewed 18 behavioral safety programs implemented in manufacturing settings. The studies reviewed were categorized as singular interventions (e.g., feedback, token economies), package interventions (e.g., feedback, goal-setting, praise, training), or component analyses. The magnitude of effects of the singular and package interventions were reported in terms of the percent improvement over baseline, and for the component analyses percent improvement over each preceding phase. The results showed that for singular interventions percent improvements over baseline ranged from 9% to 157%, for package interventions percent improvements over baseline ranged from 32% to 59%. The results from the component analyses suggested that the most effective treatment combination appears to be training, goal-setting and feedback.

A third review conducted by Sulzer-Azaroff and Austin (2000) found that 32 out of 33 articles reviewed reported reductions in injuries in various settings that included construction sites, electrical and gas utilities, shipyards and transit systems, manufacturing plants, grocery distributions, mines, railroads, and police departments. Twenty studies reported a percentage of reduction in accidents and injuries (range: 2.2%-95%), 7 of the studies reported the reduction in accidents and injuries by listing the number of lost days or number of accidents, 2 studies calculated accident rates, and 3 studies that used a group comparison design reported information on statistical significance.
Each of the reviews described above focused on safety studies that reported changes in different dependent variables. Krause et al. (1999) reviewed studies that used the number of recordable injuries as the dependent variable, while Grindle et al. (2000) reviewed studies that used the percentage of behavioral change over baseline as the dependent variable, and finally Sulzer-Azaroff and Austin (2000) reviewed studies that reported various measures on reduction in accident and incident rates.

An application of the behavioral safety process can vary in form and in focus with each implementation or location, but in every case the fundamental concepts remain essentially the same. Extensive scientific examination of the behavioral safety approach has resulted in the identification of the key components of an effective behavioral safety process (e.g., Komaki, 1986; Komaki, Heinzmann, & Lawson, 1980; Sulzer-Azaroff & Fellner, 1984). These important elements usually include: assessment and identification of behaviors, conditions, and systems targets (i.e., variables that impact safety); development and implementation of a peer observation process that targets and tracks behavior, conditions, and systems improvements; review of observation data; and implementation of a behavioral feedback and reinforcement process.

The majority of behavioral safety studies appear to use the components listed above, but there is limited research on any one component alone. However, recent research has been conducted on the observation component of the behavioral safety process.
Peer Observations

The research that has been conducted to date has examined the effects of peer observations on the person being observed (Rohn, 2003, 2004) and the effects of peer observations on the behavior of the observer (Sasson & Austin, 2004). Rohn (2003) conducted a study in order to determine the effects of safety observations on the safety performance of 6 participants. Using a hidden camera, the effects of safety observations were evaluated by examining the safety behavior occurring immediately prior to, during, and after overt observations. The overall mean safety performance of participants during observation intervals was 70%, whereas mean safety performance during observer absent intervals was 43%. Increases in safety performance that occurred in observer present intervals decreased quickly during observer absent intervals. The results of the study suggest that the participants performed more safely in the presence of an overt observer and less safely when no observer was present.

Another study by Rohn (2004) was conducted in order to examine some of the possible behavioral functions responsible for increases in safety performance in the presence of an observer. A within-subject, multi-element, with a non-concurrent multiple-baseline across participants design was used to assess the effects of (a) an observer present/absent condition, and (b) a performance-contingent observation termination contingency. In other words, participants were exposed to both observer present and absent conditions and were allowed to terminate the 10 min observation period after 5 min if they met safety or productivity goals. The participants' performance met the criterion for termination for 93% of termination sessions, and when given a
choice between observer present and observer absent conditions, participants chose to work alone in 92% of sessions. The results of this study suggest that there may be an aversive function of observer presence.

Research has also been conducted on the effects of peer observations on the behavior of the observer (Sasson & Austin, 2004). Sasson and Austin used a multiple baseline design to assess the effects of information, feedback, and conducting peer observations in a hospital office setting. Following baseline, participants received information on safe typing behaviors. Six participants were then randomly selected and trained to conduct peer observations while the remaining 5 participants received no further treatment until the feedback phase. During the feedback phase, all participants received written feedback based on researcher observations and all but one peer observer continued to conduct observations during this phase. The safety performance of all participants improved during the feedback phase, but the participants who had earlier conducted the peer observations had performance improvements that resulted in effect sizes twice as large as non-observers. In addition, there was a strong positive correlation between the amount of performance improvement and accuracy of observations for some observers. The results of this study suggest that conducting safety observations has an effect on the safe performance of the observer (i.e., the observer effect), and conducting peer observations may enhance the effects of feedback for those who conduct observations.

Although peer observations have been demonstrated to be an effective intervention for changing behavior, they have some limitations. One possible limitation
is the effectiveness of peer observations in the absence of the observer. Rohn (2003) found that participants performed more safely when an observer was present, but less safely when the observer was absent. In addition, observations may be potentially aversive for the person being observed. The study conducted by Rohn (2004) found that participants, after having been exposed to an observer present condition and an observer absent condition, almost always selected the observer absent condition over the observer present condition when given the choice. Another limitation is that, because of the costs in lost productivity, many employers are not comfortable with employees leaving their workspace in order to conduct the peer observations. The wages paid during observation sessions and the lost productivity associated with the time it takes to conduct observations are reasons why employers may be reluctant to allow employees to interrupt work to monitor the safety behavior of their peers. In addition, peer observations are not a reasonable option for employees who work alone. The often impractical nature of peer observations establishes a clear need for the development of other effective safety interventions. One possible alternative to peer observations is video observations.

Video Observations

Few studies have been conducted to examine the effects of behavioral observations of video recordings (rather than in vivo peer observations) on the performance of those who conduct behavioral safety observations. One of these few studies was conducted by Alvero and Austin (2004) to determine if employees who conduct safety observations of videotaped confederate performance work more safely as a result of conducting those observations. A multiple baseline design counterbalanced
across office work-related postural behaviors was used to evaluate the effects of conducting observations of a video depicting a confederate’s safety performance. After a baseline phase, participants were exposed to an information phase that consisted of giving them a handout that contained the definition of the target behaviors and how to perform them safely. The overall safety performance averaged 13.1% for participants in group A and a 10.1% for the participants in group B resulting in increases of 6.4% and 0%, respectively, above baseline averages. During the observation phase (i.e., phase C), the participants conducted observations of a video depicting an experimental confederate engaging in work tasks. Overall safety performance averaged 77.2% for group A and 74.4% for group B resulting in increases of 70.5% and 64.4%, respectively, above baseline averages.

Another study by Nielsen (2006) was conducted in order to determine the effects of video scoring and feedback on scoring, on staff performing patient transfers in a nursing facility within an acute-care hospital setting. An ABCA multiple baseline design across individuals was used to evaluate the effectiveness of video scoring and feedback on scoring, on safe patient transfers. After a baseline phase, participants were exposed to an information phase that consisted of giving the participants the scoring checklist while the researchers discussed the components of the patient transfers. During the video scoring phase participants individually reviewed one videotape showing a model completing one patient transfer and then scored the transfer using the checklist. Participants' scoring was then compared on an item-by-item basis to checklists completed for each model video by the researchers. The participants then received
private feedback on their scoring of each item on the checklist. The results of this study showed that a slight improvement in performance occurred for all participants who were exposed to the information phase. Further improvement in performance was observed for 5 out of 6 participants in the video scoring phase.

Research has demonstrated that conducting peer or video observations has an effect on the safety performance of the observer. However, it is not clear why the safety performance of the participants in both the Alvero and Austin (2004) and Sasson and Austin (2004) studies increased after observing and scoring the safety performance of either another peer or a video. In addition, it is also not clear why the performance of the participants generally did not improve after receiving information of the safety targets. That is, both studies found that safety performance improved only when the participants observed and evaluated the other’s (either confederate or peer) safety performance. The lack of effects from information alone could be because the information was simply not detailed enough, and that conducting observations served to clarify the definitions and model safe behavior. However, perhaps because these studies were concerned with demonstrating the effects, neither study directly addressed the cause(s) of the effects.

A second study by Alvero and Austin (2006) was conducted in order to examine some of the possible causes (i.e., behavioral mechanisms) responsible for the “observer effect.” The exit interviews conducted with the participants in the Alvero and Austin (2004) study suggested that the participants self-monitored, self-evaluated, or generated safety rules regarding their safety performance as a result of conducting safety observations. Based on these exit interviews Alvero and Austin (2006) used protocol
analysis (Ericsson & Simon, 1993) and the “silent dog” method (Hayes, White, & Bissett, 1998) in order to investigate whether participants engaged in self-verbalizations regarding their safety performance and whether those verbalizations were functionally related to their safety performance.

The results of the study suggested that the three control conditions of the silent dog method were satisfied, providing support for a strong relationship between increases in safety performance and safety-related verbalizations. Even though the results also suggest that conducting safety observations may serve a rule generating function and/or a self-monitoring function, additional research is needed.

Although conducting peer or video observations appear to be effective in changing behavior, the often impractical nature of peer observations establishes a clear need for the development of other effective safety interventions. Although one possible alternative is video observations, practically it is easier to use photographs over video when designing instructional material. Photographs cost less to produce and it is easier to update behavioral targets because it takes little time when putting together the observational materials. In addition, photos should theoretically produce the same effect, if not a larger effect than the videos since it may be easier for observers to attend to specific dimensions of the behavior being targeted in photos, whereas it may be difficult to attend to only one dimension of behavior when many are occurring simultaneously, as in video. Further, because of the cost effectiveness and practicality of the photos it may be easier to individualize behavioral interventions (i.e., to target the unique behavioral deficits of each individual). Finally, since scoring photos requires less time than does
scoring video, photos may allow us to develop interventions that give observers more opportunities to make discriminations between safe and unsafe behavior. Although our review found no published research examining the effects of scoring photos on the behavior of the observer, the effects of still-photos as a training tool have been evaluated in several safety training packages.

Safety Training

Komaki et al. (1980) conducted a study to examine if training alone would be sufficient to substantially improve and maintain safety performance or if feedback was necessary to maintain the safety performance. Following baseline, a training only condition was introduced. During this phase employees attended a 30-45 min training session (similar to that described in Komaki, Barwick, & Scott, 1978) that consisted of: assessing their knowledge of the organization’s safety regulations, showing them a series of slides and requesting that the employees identify what they thought was unsafe in each slide, discussing the hazards that were portrayed in the slides, encouraging them to suggest safety rules that may have been overlooked, and finally portraying the slides depicting the unsafe behaviors followed by slides depicting the correct safety performance. Following the training only condition, a training plus feedback condition was introduced. During this phase, the slides and safety regulations were reviewed and in addition, the supervisor announced that he would randomly conduct daily safety observations and post the results on a graph. Following the training only phase the employees’ safety behavior increased 9 percentage points over baseline and during the training and feedback phase the employees’ safety behavior increased 16 percentage
points over the training only phase and 26 percentage points over baseline. These results suggest that training alone was not sufficient to substantially increase safety behavior.

Ray, Bishop, and Wang (1997) also examined the individual effectiveness of training, performance feedback, and goal setting on the safety behavior of employees who worked in an automobile manufacturing company. A multiple baseline design was used to evaluate the effects of training only, training and feedback, and goal setting. The training only phase consisted of a 30-minute session during which the employees were shown photographs of safe and unsafe behaviors and were asked to discuss each picture. No feedback on the employees’ safety performance was given during this phase. Following the training only phase, a safety representative informed the employees that their average safety performance would be posted in the lunch room every week. The final phase of the study consisted of reviewing the employees’ safety performance and determining a daily goal for the employees’ average safety performance. The results indicated that for the training only phase, the employees’ safety behaviors improved slightly over baseline; however, the employees’ behavior improved considerably during the feedback phase. The goal setting phase resulted in a considerable improvement in the employees’ safety behavior over the feedback only phase. This study suggests that training alone does not produce any significant improvements in the employees’ behavior, but the implementation of weekly posted feedback and the addition of goal setting each does improve safety performance.

These studies seem to suggest that safety training alone produces small improvements in safety behavior. However, the type of safety training procedure used in
the studies described above consisted of a one-time informational session that all employees attended and during which they were made aware of the target behaviors, and were then expected to perform them safely when returning to work. One possible limitation of using such a procedure is that while employees may get information on how to perform the target behaviors correctly, they may not be able to discriminate whether their own behavior is safe or unsafe. The results of these studies also seem to indicate that passive training procedures (employees were not required to respond to and interact with the training materials) alone is not an effective instructional tool and such an approach produces little or no behavior change.

Komaki et al. (1978) and McCann and Sulzer-Azaroff (1996) used safety training as one of the components in a package intervention. Komaki et al. (1978) assessed the effects of a safety program that consisted of training, feedback, and supervisor praise on the safety behaviors of workers in two departments of a food manufacturing plant. Following baseline, employees attended a 30 minute training session, where they were shown several slides that depicted unsafe behavior and then were asked to verbally state what was unsafe in each picture. Once the unsafe behavior was identified, employees were shown the same behavior being performed safely and a safe conduct rule for the behavior was stated. At the end of the training session, employees were shown a graph of their baseline performance, a departmental goal was set, and the graph was posted in a conspicuous place in the employees' work area. Following training, employees received graphic feedback on their safety performance immediately after an observation. In addition, supervisors were instructed to praise those employees who they saw performing
the job safely. The results indicated that while the employees were already performing their job safely at least two thirds of the time, their safe performance increased dramatically during the treatment.

McCann and Sulzer-Azaroff (1996) conducted a study to evaluate the effects of a package intervention consisting of training, self-monitoring, feedback, goal setting, and reinforcement on six postures (back, shoulders, neck, legs and feet, arms, and wrists) of 6 full time secretaries. A multiple baseline across participants design was used to evaluate the effects of the intervention. Following baseline, discrimination training and self-monitoring were implemented together. Training consisted of showing the employees a series of photographs depicting various correct and incorrect postures. The employees were then shown 10 photographs and were asked to score each posture as correct or incorrect. The employees received immediate feedback for each photograph and were required to demonstrate a minimum of 80% correct. At the end of each session, the employees were asked to estimate the percentage of time their postures were safe during the session. Based on the data from the previous sessions, feedback on the accuracy of participant self-monitoring, goal-setting, and reinforcement were then added and provided at the beginning of each session. The percentage of safe behavior increased with discrimination training and self-monitoring, but further improvements in safe behavior were observed when feedback on the accuracy of participant self-monitoring, goal-setting, and reinforcement were added.

Although the safety training procedures used in these studies appeared to be effective, they were implemented in conjunction with other interventions. For example,
Komaki et al. (1978) used a discrimination training procedure and then gave the employees graphic feedback of their current safety performance and set performance goals. Therefore, it is not clear if the outcome was a result of the safety training, the feedback, or some combination of the two. The results of the training portion of the McCann and Sulzer-Azaroff (1996) study are confounded by the fact that self-monitoring was implemented at the same time training was conducted.

Another possible limitation is that the safety training procedures implemented were passive (employees were not required to respond to and interact with the training materials) rather than an interactive (employees are required to respond to and interact with the training material) training format (with the exception of McCann & Sulzer-Azaroff, 1996). The results of the Komaki et al. (1980) and Ray et al. (1997) studies indicated that safety training alone only improved safety performance slightly and suggested that training alone is not sufficient to improve behavior. However, because the training was delivered to all of the employees at once and they were not required to respond to or interact with the training materials, it is not possible to determine if all or any of the employees were attending to the training material. It may be possible that performance improved only slightly because only some of the employees were attending to the material during training and others were not. Therefore, safety training may be more effective if it is individualized (targeting specific behavioral deficits of the individual) and interactive (the person is required to respond and interact with the training materials).
Given that the results of the studies examining the effectiveness of safety training seem to be mixed, these mixed results could be due to the various types of training methods used. To date, little research has been conducted to evaluate the effectiveness of specific training methods (discussion, lecture, media, individual, group, etc.). Arthur, Bennett, Edens, and Bell (2003) conducted a meta-analysis of the relationship between the skill or task characteristic targeted and the training delivery method. Because of the wide variety of skill and task characteristics targeted by training programs, Arthur et al. classified the skills and tasks targeted into three broad categories: cognitive, interpersonal, and psychomotor. Skills and tasks that were categorized as cognitive were related to thinking, idea generation, understanding, problem solving, or the knowledge requirements of the job. Skills and tasks that were categorized as interpersonal were related to interacting with others in a workgroup, or with clients or customers. Finally, skills and tasks that were categorized as psychomotor involved the use of the musculoskeletal system to perform behavioral activities associated with the job. In addition to categorizing the skills and tasks targeted, the researchers also used Kirkpatrick's (1959) four-level model of training evaluation criteria, which include: reaction criteria, learning criteria, behavioral criteria, and results criteria. Studies were categorized as having reaction criteria if they evaluated their training programs by using self-report measures, learning criteria if they evaluated their training programs with learning outcome measures (e.g., paper and pencil tests), behavioral criteria if they evaluated their training programs with actual on-the-job performance measures, and results criteria if they evaluated their training programs by using utility analyses.
After coding all of the studies, the $d$ statistic was calculated as the common effect size metric. As a reference for interpreting effect sizes, Cohen (1988) recommended that effect sizes of .2-.49 should be considered small, .5-.79 should be considered medium, and effect sizes of .8 or greater should be considered large. The results of the meta-analysis showed that the studies that evaluated training programs using actual on-the-job performance measures (behavioral criteria) and that targeted psychomotor skills or tasks using equipment simulators as the training delivery method had the largest effect (1.81), followed by audiovisual (1.45), lecture (.91), lecture, audiovisual, and teleconference (.88), discussion (.67), lecture, discussion and equipment simulators (.42). Although the magnitude of the effect sizes appear to be generally favorable for all training delivery methods (large to medium effects), these results should be interpreted with caution since many of the effect sizes for each of the training delivery methods were calculated with a small number of studies (range: 2-4). In addition, few of the studies actually manipulated or compared training methods in a systematic way to assess their effects on the training effectiveness.

Although many of the commonly used training delivery methods can be effective, there is evidence suggesting that individualized tutorials (which target the unique behavioral deficits of each individual and that present learning trials based on the responses of the learner) (Merrill, Reiser, Merrill, & Landes, 1995) and interactive techniques (requiring the person to respond to and interact with the training materials) (Eckerman et al., 2002) can be the most effective approach to changing behavior. However, safety trainers have few tools to produce effective customized training. It is
not surprising that there is little research on individualized training procedures since it is often not feasible or cost effective to do so (unless the training is computer-based), and because most organizations need large numbers of employees trained. One possible solution to this problem is to use a computer-based training procedure.

Computer-based Training


Eckerman et al. (2002) compared the effectiveness of an interactive computer-based training condition with (a) a book only condition, (b) a computer monitor without quizzes condition, and (c) a passive yoked control group condition on the acquisition of proper respiratory protection procedures. The interactive computer-based training format used cTrain software and consisted of: information screens containing the content and quiz screens that contained four-item multiple choice questions about the content in the preceding information screens. There were a total of 58 information screens and 60 quiz screens. Following the selection of a final answer on a quiz screen, the participants were provided feedback. If the participants answered incorrectly, the quiz screen returned to the first information screen in the information set and the participant was required to repeat that information set until the missed question was answered correctly. The
participants in the control condition were yoked to the participants in the interactive group. That is, the participants in this control group viewed the information and quiz screens, quiz answers, and feedback on a monitor at the pace of the interactive participant to whom they were yoked. The participants in this group were not able to control the process in any way. Participants in the computer monitor only condition were only exposed to the information screens and participants in the book condition were given a booklet with the same information as that on the cTRAIN information screens.

The results showed that the participants in the interactive condition had the highest mean performance on both the posttest and the 1 week retest, followed by the passive yoked control group, book only group, and computer monitor only group, respectively. When expressed as effect size ($d$), the change from pretest to posttest for the interactive group was substantial (6.35) and well above the effect sizes for the other three groups (range: 3.26-4.76). In addition, the mean performance of the participants in the interactive and yoked control conditions who viewed both the information and quiz screens was superior to the mean performance of the participants in the book only and computer monitor only condition and were exposed to only the information. These results suggest that an interactive training format is more effective than passive and informational only training formats.

Eckerman et al. (2004) examined the effects of an interactive computer-based safety training program on the safety behavior of food service workers in a hospital. The training was administered by a computer-based instructional training program, which was based on behavioral principles, called cTRAIN. The program consisted of three sections;
an instructional section that taught the user how to use the program, information sections consisting of text and pictures or a movie, and test sections consisting of multiple-choice questions. Answers to test sections were followed by feedback that let the user know whether they were correct or incorrect. When all of the informational sections were completed a final test followed and no feedback was provided. Trained observers recorded the safety performance of the employees before and after the training as either safe or unsafe according to criteria specified on a checklist. The results indicated that the interactive computer-based instruction improved safe work practices without the use of supervisor feedback or praise. This study suggests that a well designed computer-based training program is effective in changing behavior. Although the interactive computer-based instruction used in this study was effective, there is little research on its effectiveness in changing behavior in other occupations and settings and further research is needed.

Purpose of the Current Study

The purpose of the current study was to evaluate the effects of an interactive and individualized still-photo computer-based training module on the percentage of safe observations of assembling and lifting behaviors. The computer-based training module was analogous to conducting peer observations to determine if the “observer effect” (Alvero & Austin, 2004) could be produced using photos instead of video. The current study controlled for performance difficulties in performing the dependent variables by providing information and having the participants demonstrate the safe behaviors prior to
baseline. Reactivity to observation was controlled for by using a hidden camera to measure treatment effects.
METHOD

Participants and Setting

The participants for this study were 6 college students recruited from a mid-western public university using a recruitment script that was read to students during their classes (see Appendix A, based on Rohn, 2004). Students were then asked to fill out a sign-up sheet (see Appendix B) if they were interested in participating in the study. To be included in the study, participants had to be available for the entire academic semester. Students were also asked whether they had any knowledge regarding the purpose of the study and whether they had previously participated in observational studies conducted in the Performance Management Lab. Only students that reported not having any knowledge of the study and who reported not having previously participated in observational studies in the PM labs were considered for participation in the study.

Announcements at various undergraduate psychology courses were made until enough participants volunteered.

This study took place in a research lab located on the university’s campus. The lab consisted of one room that was analogous to a work setting and was equipped with the following: a hidden video camera, two tables and a chair, a computer, two cardboard boxes, and a bin of nuts, washers and bolts. A second room was used for video monitoring and recording and was equipped with a color television, a VCR, and a remote control. In order to reduce variability due to the workstation set up an ergonomic assessment that was based on the Occupational Safety and Health Association (OSHA) Workstation Posture Checklist (OSHA, 2004) was conducted with each participant prior
to the start of the participant’s first session. The workstation was adjusted according to the recorded results of the assessment each time the participants attended a session. Students were paid $5 for each hour they participated in the study, or they received extra credit in one class, regardless of their levels of performance.

Apparatus and Materials

The study took place in an analogue work setting and consisted of the following: a hidden camera (X10 Wireless Technology, Inc., Xcam2) that was used for data collection purposes, two tables and a chair, a 2-way monitor that experimenters used to cue the change in tasks, and a computer that was used for the still-photo computer module. The still-photo computer modules were run on computer software called E-Prime. E-Prime is a comprehensive suite of applications offering audited millisecond-timing precision, which enables researchers to develop a wide variety of paradigms that can be implemented with randomized or fixed presentation of text, pictures and sounds. The assembly materials consisted of a bin of bolts, a bin of washers, a bin of nuts, and an empty bin. The lifting materials consisted of two cardboard boxes with 50 pieces of paper in each box. A second room was used for data collection purposes and video recording and consisted of the following: a color television, a DVD player, and a remote control.

Dependent Variables

Participants were asked to perform two tasks during each session: an assembly task and a lifting task. The assembly task involved assembling “widgets.” To assemble a “widget,” the participant was asked to secure two washers on a bolt with a nut. The
lifting task required the participants to place a box on a table, remove a piece of paper from the box, place the box back on the ground, and place the piece of paper on the table.

The primary dependent variables for the assembly task was the percentage of intervals scored as safe for each of four postures, including: head, shoulders, back, and arms (see Appendix C for a sample of the experimental data sheet). Ergonomic reports from the Occupational Safety and Health Administration (OSHA, 2004) were reviewed to determine the appropriate safe definitions for each dependent variable.

Assembly head position. The head is in line with the torso and facing forward and the chin is parallel to the floor.

Assembly shoulder position. The upper arms are tucked close to the body and hanging relaxed, not extended out to the side. Shoulders are relaxed, not hunched or rolled forward.

Assembly back position. The lower back (lumbar) is touching the chair, the back is straight, and the angle of the back and the thigh is between 100-110 degrees.

Assembly arm position. The upper arm and elbow angle is between 90-120 degrees.

The primary dependent variables for the lifting task were five positions including: feet, knees, back, chin, and arms. The dependent variable was the percentage of opportunities scored as safe for each position. The Center for Disease Control’s National Ag Safety Database’s (National Ag Safety Database, 2005) ergonomic reports were reviewed to determine the safe definitions for each dependent variable.
**Lifting feet position.** The feet should be shoulder width apart, with one foot beside and the other foot behind the object that is to be lifted.

**Lifting knee position.** The knees should be bent, not straight. Lift by pushing up with the legs.

**Lifting back position.** The back should be straight, but not vertical. Back should not twist while carrying the load.

**Lifting chin position.** Chin should be level with the horizon and the eyes looking forward.

**Lifting arm position.** The arms and elbows should be kept close to the body while lifting.

Data were collected using a momentary time sampling procedure wherein each behavior was scored consecutively, with a 2.5 second recording pause between each behavior. Therefore the observation interval for each posture was 12.1 seconds. The momentary time sampling procedure was not used to collect data on the lifting behaviors, so time sample data collection began each time the participants touched the assembly materials. Because it was not possible to detect lifting behaviors with a momentary time sampling procedure, data were collected for every lift, regardless of when it occurred. Experimental sessions were approximately 20 min and participants were allowed to complete a maximum of 2 sessions per day. Participants who chose to complete more than one session a day were required to take a 1-hour minimum break between sessions.

Each session was videotaped and scored at a later time by undergraduate research assistants who were blind to the goals and conditions of the experiment. The research
assistants used a checklist containing the definitions for all target behaviors and how to perform them safely. A behavior was scored as safe when it satisfied the definition on the checklist and was scored as unsafe if it did not satisfy the definition on the checklist.

Assembly behaviors were reported as a percentage of safe intervals and were calculated by dividing the number of intervals in which safe behavior occurred divided by the total number of observational intervals and then multiplying by 100. Each lifting posture was reported as the percentage of occasions that it was performed safely across the eight lifting opportunities in each session.

Productivity was considered a secondary dependent variable. Productivity was measured for assembly by counting the number of “widgets” completed and placed in the bin at the end of each session. Productivity was measured for lifts by counting the number of required documents retrieved at the end of each session.

Accuracy of the still-photo evaluations was compared to the percentage of safe intervals, in order to determine if there was a correlation between evaluation accuracy and safety percentage. An accuracy score was calculated for each session by taking the number of photos scored correctly divided by the total number of photos scored and then multiplying by 100. In addition, latency of the still-photo evaluations was compared to the percentage of safe intervals, in order to determine if there was a correlation between latency and safety percentage. A latency score was calculated for each session by taking the latency time for each photo scored and dividing by the total number of photos scored and then multiplying by 100.
Interobserver Agreement

A second undergraduate research assistant scored 35% of all observation sessions to assess interobserver agreement. For each interval, either an agreement or a disagreement between the two assistants was scored. An agreement was calculated when both assistants scored a behavior as safe or unsafe. Interval by interval agreement was calculated for each behavior for occurrence agreement by taking the number of agreements and dividing by the number of agreements plus disagreements and then multiplying by 100.

Procedure

Informed consent process and screening. The informed consent process occurred prior to the initial session for each participant and occurred a second time after the study had been completed (for consent to use hidden camera data). Participants were told that the purpose of the study was to use a discomfort survey to examine pain or discomfort caused by work tasks. The researcher read an informed consent script (see Appendix D, adapted from Rohn, 2004) and reviewed the consent form (see Appendix E, adapted from Rohn, 2004) with each participant individually. Participants were given the option to sign, or refuse to sign, the consent form and were informed that they would not be penalized in any way if they decided not to sign the form.

If the participant decided to sign the consent form he or she was then asked if he or she had any knowledge regarding the purpose of the study and whether he or she had previously participated in observational studies conducted in the Performance Management Lab. Only students that reported not having any knowledge of the study
and reported not having previously participated in observational studies were considered for participation in the study. Participants were asked to complete the Postural Discomfort Survey (see Appendix F) and were screened for current and/or historical pain or discomfort. If an overall score of 5 or higher was reported on the discomfort survey or if a history of pain or discomfort when engaging in tasks similar to those used in this study was reported, the individual was excluded from the study.

Upon completion of the study, all participants were debriefed using a debriefing script and consent for the use of data was requested using the Consent for Use of Data Script (see Appendix G, adapted from Rohn, 2004) and the Consent for Use of Data Form (see Appendix H, adapted from Rohn, 2004).

**Baseline.** The purpose of this condition was to establish the level of safe performance prior to the intervention and to control for information effects or demand characteristics. Prior to the beginning of the study, participants were given information on safe ergonomic behaviors. The information was presented orally by the experimenter using an information sheet (see Appendix I). Following presentation of the information, participants were asked to physically demonstrate the safe behaviors. They were given corrective feedback for any at-risk behaviors and were asked to demonstrate the behavior again, until the correct behavior was performed.

At the beginning of each session during this phase, participants were given instructions to perform an assembly task and a lifting task. Either the graduate researcher or undergraduate research assistant followed a script (see Appendix J) when delivering the instructions and then handed the list of instructions to the participant at the start of the
session. This was done to ensure the consistency of the instructional set. The two tasks that were included were: (1) Assembling widgets and placing them into a container; (2) Picking up two cardboard boxes containing 50 pieces of paper and placing them onto a table, removing a specific piece of paper and then placing the boxes back onto the ground.

In order to simulate the work a person might do in an office, each task was repeated a minimum of 4 times during each observation session. Participants were asked to complete a 20 minute session, during which they were asked to assemble widgets for 5 minutes and then perform two lifts so that this task sequence was repeated a minimum of 4 times. The graduate researcher or an undergraduate assistant cued the change in tasks by using a wireless intercom monitor and either the graduate researcher or an undergraduate research assistant signaled the end of the observation day. Each baseline session was exactly 20 min and was graphed as a single data point for each posture. All participants remained in this phase until performance stabilized, as determined through visual inspection.

At the end of each session, the researcher or undergraduate assistant used a discomfort survey script (see Appendix K) and asked participants to complete a discomfort survey. Although participants were asked to demonstrate safe body positioning, at the beginning of the phase, they were not made aware that safe positioning was being monitored via a hidden camera until the end of the study (during debriefing).

Still-photo module without feedback. After baseline, a still-photo computer module was introduced for the dependent variable with the most stable and lowest
percentage of intervals scored as safe. At the beginning of each session during this phase, participants were asked by the experimenter using a script (Appendix L) to complete a 5-min still-photo computer module. The first section of the still-photo module introduced the safe definition for the selected ergonomic behavior (e.g., head position during assembly; back position during lifting; etc.) involved in the task (either assembly or lifting). During the second section of the still-photo module participants observed 10 safe still-photos and 10 unsafe still-photos of the safe and at-risk ergonomic behavior, which was presented in random order, similar to the one the participants were asked to perform during each session. The third section of the still-photo module required the participants to evaluate 10 safe still-photos and 10 unsafe still-photos, which were randomly presented, of the target ergonomic behaviors the participants were asked to perform during each session. During this section of the still-photo module participants were asked to determine whether the photo was depicting a safe or at-risk ergonomic behavior and then had to click on the word “safe” or “at-risk.” No feedback was given on the accuracy of the participants’ evaluation of the still-photos. The remainder of the session followed the same procedures as those in baseline. Participants remained in this phase until performance stabilized. Phase changes occurred when data were stable, as determined through visual inspection of the data, and phase changes were also based on the financial and time constraints of conducting the study.

Each session was videotaped using a hidden camera and scored at a later time by an undergraduate research assistant. In addition, the still-photo computer module collected data on the following: (1) the amount of time the participant required to
complete the module; (2) the amount of time it took for participants to evaluate each photo; (3) the accuracy of the participants' evaluation of the photos.

**Still-photo module with feedback.** Following the still-photo computer module without feedback phase, a third phase was introduced for participant six. During this phase, the participant was asked by the experimenter using a script (see Appendix L) to complete a 5-min still photo computer module with feedback. The first two sections of the still photo computer module were the same as those in the previous phase. The third section of the still photo computer module required the participant to evaluate 10 safe photos and 10 unsafe photos, which were presented randomly, of the safe and at-risk targeted behavior(s) similar to those the participant performed during each session.

During the third section of the still photo module the participant was asked to determine whether the photo was depicting a safe or at-risk ergonomic behavior and was then prompted to click on the word “safe” or “at-risk.” Feedback on the accuracy of the participant's evaluation of each photo was delivered immediately after each photo scoring response. The feedback consisted of information regarding whether the participant accurately or inaccurately scored the photos and why each photo should have been scored as safe or at-risk (see Appendix M for sample photo). Feedback was given for accurate and inaccurate scoring. For example, if the participant scored a photo as safe, and the photo should have been scored as safe, the feedback informed the participant that the photo was depicting a safe ergonomic position and was give an explanation for why the position was considered safe. If the participant scored the photo as safe, and it should have been scored as at-risk, the feedback informed the participant that the photo was
depicting an at-risk ergonomic position and gave an explanation for why the position was considered at-risk. The rest of the observation session followed the same procedures as those in baseline and the still-photo module without feedback phase.

Exit interview. Upon completion of the study, participants were asked a series of questions regarding the experiment (see Appendix N). An exit interview was conducted in order to obtain as much information as possible about why the participants performed as they did. The information gained from the exit interview helped to determine why the still-photo computer module without feedback was or was not effective at improving safe behaviors.

Debriefing. All participants were debriefed using a script (see Appendix O). Participants who did not complete the study were not debriefed until all participants completed the study in order to ensure the integrity of the measurement system. At this time, participants were told about the presence of the hidden camera and why it was critical for the purpose of the study. In addition, participants were given the option to refuse to allow the use of the videotapes as data. All of the money earned during the entire study was paid to the participant at this time, irrespective of his or her decision regarding consenting to the use of the data.

Experimental Design

A within-subject, AB design (where A is baseline, B is the still-photo computer module without feedback) and sometimes an ABA (where A is baseline, B is the still-photo computer module without feedback, and A is a return to baseline) or ABB (where A is baseline, B is the still-photo computer module without feedback, and B is the still-
A photo computer module with feedback on accuracy of photo scoring was used with a multiple baseline design across behaviors and tasks.

Integrity of the Independent Variables

Scripts were used for all instructions that were given to the participants by either the graduate researcher or an undergraduate research assistant. Following presentation of the ergonomic information, participants demonstrated they had learned the material by demonstrating to the researcher that they could correctly perform each target behavior. In addition, the still-photo computer module collected data on the amount of time it took for the participants to finish the module, the latency of each photo response (in scoring as safe or at-risk), and the accuracy of photo scoring.

HSIRB Approval

Approval from the Human Subjects Institutional Review Board was obtained (see Appendix P for the approval form).
RESULTS

Participant 1

Figure 1 displays the safety and accuracy performance of participant 1 during the course of the experiment.

Figure Caption 1. Solid circles indicate safety performance. Open circles indicate the accuracy of participant 1's evaluation of the still-photos. For lifting behaviors, the figure represents safe lifting behaviors as a percentage of total lifting opportunities. For the assembly behaviors, the figure represents a percentage of intervals scored as safe.

Figure 1. Safety Data for Participant 1.
Figure 2 displays the productivity performance of participant 1 during the course of the experiment.

Figure Caption 2. Solid circles indicate productivity performance. The top graph depicts participant 1's productivity performance for the assembly task and the bottom graph depicts participant 1's productivity performance for the lifting task.

Figure 2. Productivity Data for Participant 1.
Figure 3 displays the latency performance of participant 1 during the course of the still-photo computer module without feedback phase.

Figure Caption 3. Solid circles indicate the average time (in milliseconds) it took participant 1 to evaluate the still-photos during the still-photo computer module without feedback phase. The top graph depicts participant 1's latency performance for the lifting feet computer module, the middle graph depicts participant 1's latency performance for the lifting back computer module, and the bottom graph depicts participant 1's latency performance for the assembly head computer module.

Figure 3. Latency Data for Participant 1.
Safety performance. Feet position averaged 0% safe during baseline and increased to an average of 85.9% (SD: 17.8; range: 50% to 100%) safe in the computer module without feedback phase. Back position averaged 0% safe during baseline and increase to an average of 86.8% (SD: 22.30; range: 37.5% to 100%) safe in the computer module without feedback phase. Head position averaged 1.5% (SD: 3.8; range: 0% to 15%) safe during baseline and increased to an average of 32% (SD: 10.1; range: 15% to 51.6%) safe during the computer module without feedback phase. Graphs for all of participant 1’s postures measured are displayed in Appendix Q.

Productivity performance. As displayed in Figure 2, participant 1 averaged 118 (SD: 13; range: 90 to 133) widgets during each session. Participant 1 also completed 100% of the lifts.

Accuracy of still-photo evaluations. Figure 1 displays the accuracy of participant 1’s evaluations of the still-photos presented in the computer modules. Accuracy for feet position averaged 98% (SD: 2.7; range: 90% to 100%). Accuracy for back position averaged 98.5% (SD: .5; range: 95% to 100%). Accuracy for head position averaged 99.5% (SD: 1.4; range: 95% to 100%).

Latency of still-photo evaluations. Data were also collected on the amount of time it took for participant 1 to evaluate each photo as shown in Figure 3. Latency for the lifting feet computer module averaged 683 milliseconds (SD: 502; range: 306 to 7105). Latency for the lifting back computer module averaged 607 milliseconds (SD: 300; range: 355 to 4991). Latency for the assembly head computer module averaged 611 milliseconds (SD: 311; range: 325 to 3731).
Participant 2

Figure 4 displays the safety and accuracy during the course of the experiment.

Figure Caption 4. Solid circles indicate safety performance. Open circles indicate the accuracy of participant 2’s evaluation of the still-photos. For lifting behaviors, the figure represents safe lifting behaviors as a percentage of total lifting opportunities. For the assembly behaviors, the figure represents a percentage of intervals scored as safe.

Figure 4. Safety Data for Participant 2.
Figure 5 displays the productivity performance of participant 2 during the course of the experiment.

Figure Caption 5. Solid circles indicate productivity performance. The top graph depicts participant 2's productivity performance for the assembly task and the bottom graph depicts participant 2's productivity performance for the lifting task.

Figure 5. Productivity Data for Participant 2.
Figure 6 displays the latency performance of participant 2 during the course of the still-photo computer module without feedback phase.

Figure 6: Latency Data for Participant 2.

Figure Caption 6. Solid circles indicate the average time (in milliseconds) it took participant 2 to evaluate the still-photos during the still-photo computer module without feedback phase. The top graph depicts participant 2's latency performance for the lifting feet computer module, the middle graph depicts participant 2's latency performance for the assembly head computer module, and the bottom graph depicts participant 2's latency performance for the assembly back computer module.
Safety performance. Feet position averaged 0% safe during baseline and increased to an average of 60% (SD: 15.2; range: 37.5% to 100%) safe in the computer module without feedback phase. Head position averaged 0% safe during baseline, increased to an average of 60% (SD: 26.3; range: 10% to 95%) safe in the computer module without feedback phase, and averaged 80% (SD: 8; range: 71.6% to 88.3%) during the return to baseline phase. Back position averaged 24.7% (SD: 29.3; range: 0% to 96.6%) safe during baseline and decreased to an average of 12.6% (SD: 22.1; range: 0% to 63.3%) safe during the computer module without feedback phase. Graphs for all of participant 2’s postures measured are displayed in Appendix R.

Productivity performance. As displayed in Figure 5, participant 2 averaged 175 (SD: 14.4; range: 144 to 215) widgets during each session. Participant 2 also completed 100% of the lifts.

Accuracy of still-photo evaluations. Figure 4 displays the accuracy of participant 2’s evaluations of the still-photos presented in the computer modules. Accuracy for feet position averaged 98.8% (SD: 2.5; range: 90% to 100%). Accuracy for head position averaged 99% (SD: .2; range: 95% to 100%). Accuracy for back position averaged 97.5% (SD: 2.6; range: 95% to 100%).

Latency of still-photo evaluations. Data were also collected on the amount of time it took for participant 2 to evaluate each photo as shown in Figure 6. Latency for the lifting feet computer module averaged 660 milliseconds (SD: 349; range: 320 to 4342). Latency for the assembly head computer module averaged 672 milliseconds (SD: 355;
range: 325 to 4231). Latency for the assembly back computer module averaged 734 milliseconds (SD: 280; range: 357 to 1961).
Participant 3

Figure 7 displays the safety and accuracy performance of participant 3 during the course of the experiment.

Figure Caption 7. Solid circles indicate safety performance. Open circles indicate the accuracy of participant 3's evaluation of the still-photos. For lifting behaviors, the figure represents safe lifting behaviors as a percentage of total lifting opportunities. The arrows indicate the number of lifts completed for that session when fewer than 8 lifts occurred. For the assembly behaviors, the figure represents a percentage of intervals scored as safe.

Figure 7. Safety Data for Participant 3.
Figure 8 displays the productivity performance of participant 3 during the course of the experiment.

Figure Caption 8. Solid circles indicate productivity performance. The top graph depicts participant 3's productivity performance for the assembly task and the bottom graph depicts participant 3's productivity performance for the lifting task.

Figure 8. Productivity Data for Participant 3.
Figure 9 displays the latency performance of participant 3 during the course of the still-photo computer module without feedback phase.

![Lifting Feet Graph](image)

![Assembly Head Graph](image)

![Lifting Arms Graph](image)

Figure Caption 9. Solid circles indicate the average time (in milliseconds) it took participant 3 to evaluate the still-photos during the still-photo computer module without feedback phase. The top graph depicts participant 3's latency performance for the lifting feet computer module, the middle graph depicts participant 3's latency performance for the assembly head computer module, and the bottom graph depicts participant 3's latency performance for the lifting arms computer module.

Figure 9. Latency Data for Participant 3.
Safety performance. Feet position averaged 0% safe during baseline and increased to an average of 25% (SD: 29.2; range: 0% to 83.3%) safe in the computer module without feedback phase. Head position averaged 2% (SD: 3.6; range: 0% to 10%) safe during baseline and increased to an average of 25% (SD: 8.5; range: 11.6% to 43.3%) safe in the computer module without feedback phase. Arm position averaged 18.4% (SD: 25.5; range: 0% to 75%) safe during baseline and decreased to 0% safe during the computer module without feedback phase. Graphs for all of participant 3’s postures measured are displayed in Appendix S.

Productivity performance. As displayed in Figure 8, participant 3 averaged 107 (SD: 15.7; range: 80 to 141) widgets during each session. Participant 3 also completed 84% of the lifts.

Accuracy of still-photo evaluations. Figure 7 displays the accuracy of participant 3’s evaluations of the still-photos presented in the computer modules. Accuracy for feet position averaged 99% (SD: 2; range: 95% to 100%). Accuracy for head position averaged 98.8% (SD: 2.6; range: 90% to 100%). Accuracy for arm position averaged 98.8% (SD: 2.3; range: 95% to 100%).

Latency of still-photo evaluations. Data were also collected on the amount of time it took for participant 3 to evaluate each photo as shown Figure 9. Latency for the lifting feet computer module averaged 733 milliseconds (SD: 372; range: 95 to 5928). Latency for the assembly head computer module averaged 659 milliseconds (SD: 364; range: 320 to 4907). Latency for the assembly arm computer module averaged 726 milliseconds (SD: 380; range: 340 to 2732).
Participant 4

Figure 10 displays the safety and accuracy performance of participant 4 during the course of the experiment.

Figure Caption 10. Solid circles indicate safety performance. Open circles indicate the accuracy of participant 4's evaluation of the still-photos. For lifting behaviors, the figure represents safe lifting behaviors as a percentage of total lifting opportunities. The arrows indicate the number of lifts completed for that session when fewer than 8 lifts occurred. For the assembly behaviors, the figure represents a percentage of intervals scored as safe.

Figure 10. Safety Data for Participant 4.
Figure 11 displays the productivity performance of participant 4 during the course of the experiment.

Figure Caption 11. Solid circles indicate productivity performance. The top graph depicts participant 4’s productivity performance for the assembly task and the bottom graph depicts participant 4’s productivity performance for the lifting task.

Figure 11. Productivity Data for Participant 4.
Figure 12 displays the latency performance of participant 4 during the course of the still-photo computer module without feedback phase.

Figure Caption 12. Solid circles indicate the average time (in milliseconds) it took participant 4 to evaluate the still-photos during the still-photo computer module without feedback phase. The top graph depicts participant 4's latency performance for the assembly head computer module and the bottom graph depicts participant 4's latency performance for the lifting feet computer module.

Figure 12. Latency Data for Participant 4.

Safety performance. Head position averaged 11.4% (SD: 9.8; range: 5% to 33.3%) safe during baseline and increased to an average of 40.6% (SD: 6.9; range: 31.6% to 53.3%) safe in the computer module without feedback phase. Feet position averaged
18% (SD: 29.2; range: 0% to 87.5%) safe during baseline and increased to an average of 40% (SD: 17.5; range: 12.5% to 62.5%) safe in the computer module without feedback phase. Graphs for all of participant 4’s postures measured are displayed in Appendix T.

*Productivity performance.* As displayed in Figure 11, participant 4 averaged 132 (SD: 14.2; range: 97 to 155) widgets during each session. Participant 4 also completed 97% of the lifts.

*Accuracy of still-photo evaluations.* Figure 10 displays the accuracy of participant 4’s evaluations of the still-photos presented in the computer modules. Accuracy for head position was 100%. Accuracy for feet position averaged 99.3% (SD: 1.8; range: 95% to 100%).

*Latency of still-photo evaluations.* Data were also collected on the amount of time it took for participant 4 to evaluate each photo as shown in Figure 12. Latency for the assembly head computer module averaged 950 milliseconds (SD: 621; range: 477 to 4714). Latency for the lifting feet computer module averaged 1037 milliseconds (SD: 1520; range: 399 to 18274).
Participant 5

Figure 13 displays the safety and accuracy performance participant 5 during the course of the experiment.

Figure Caption 13. Solid circles indicate safety performance. Open circles indicate the accuracy of participant 5's evaluation of the still-photos. For lifting behaviors, the figure represents safe lifting behaviors as a percentage of total lifting opportunities. For the assembly behaviors, the figure represents a percentage of intervals scored as safe.

Figure 13. Safety Data for Participant 5.
Figure 14 displays the productivity performance of participant 5 during the course of the experiment.

Figure Caption 14. Solid circles indicate productivity performance. The top graph depicts participant 5's productivity performance for the assembly task and the bottom graph depicts participant 5's productivity performance for the lifting task.

Figure 14. Productivity Data for Participant 5.
Figure 15 displays the latency performance of participant 5 during the course of the still-photo computer module without feedback phase.

Figure Caption 15. Solid circles indicate the average time (in milliseconds) it took participant 5 to evaluate the still-photos during the still-photo computer module without feedback phase. The top graph depicts participant 5's latency performance for the assembly head computer module and the bottom graph depicts participant 5's latency performance for the lifting feet computer module.

Figure 15. Latency Data for Participant 5.

Safety performance. Head position averaged .8% (SD: 1.3; range: 0% to 3.3%) safe during baseline and increased to an average of 22.5% (SD: 5.7; range: 13.3% to 31.6%) safe in the computer module without feedback phase. Feet position averaged
3.5% (SD: 10.3; range: 0% to 37.5%) safe during baseline and increased to an average of 15.3% (SD: 11.1; range: 0% to 37.5%) safe in the computer module without feedback phase. Graphs for all of participant 5's postures measured are displayed in Appendix U.

*Productivity performance.* As displayed in Figure 14, participant 5 averaged 118 (SD: 16; range: 89 to 147) widgets during each session. Participant 5 also completed 100% of the lifts.

*Accuracy of still-photo evaluations.* Figure 13 displays the accuracy of participant 5's evaluations of the still-photos presented in the computer modules. Accuracy for head position was 97.1% (SD: 3.1; range: 90% to 100%). Accuracy for feet position averaged 96.2% (SD: 5.8; range: 85% to 100%).

*Latency of still-photo evaluations.* Data were also collected on the amount of time it took for participant 5 to evaluate each photo as shown in Figure 15. Latency for the assembly head computer module averaged 830 milliseconds (SD: 516; range: 370 to 3851). Latency for the lifting feet computer module averaged 907 milliseconds (SD: 802; range: 489 to 9459).
Participant 6

Figure 16 displays the safety and accuracy participant 6 during the course of the experiment.

Figure Caption 16. Solid circles indicate safety performance. Open circles indicate the accuracy of participant 6’s evaluation of the still-photos. For lifting behaviors, the figure represents safe lifting behaviors as a percentage of total lifting opportunities. The arrows indicate the number of lifts completed for that session when fewer than 8 lifts occurred. For the assembly behaviors, the figure represents a percentage of intervals scored as safe.

Figure 16. Safety Data for Participant 6.
Figure 17 displays the productivity performance of participant 6 during the course of the experiment.

Figure Caption 17. Solid circles indicate productivity performance. The top graph depicts participant 6's productivity performance for the assembly task and the bottom graph depicts participant 6's productivity performance for the lifting task.

Figure 17. Productivity Data for Participant 6.
Figure 18 displays the latency performance of participant 6 during the course of the still-photo computer module without feedback phase and still-photo computer module with feedback phase.

Figure Caption 18. Solid circles indicate the average time (in milliseconds) it took participant 6 to evaluate the still-photos during the still-photo computer module without feedback phase and still-photo with feedback phase. The top graph depicts participant 6's latency performance for the lifting feet computer module, the middle graph depicts participant 6's latency performance for the lifting chin computer module, and the bottom graph depicts participant 6's latency performance for the assembly arms computer module.

Figure 18. Latency Data for Participant 6.
**Safety performance.** Feet position averaged 0% safe during baseline and increased to an average of 4.6% (SD: 7.5; range: 0% to 25%) safe in the computer module without feedback phase. Chin position averaged 0% safe during baseline, 0% safe in the computer module without feedback phase, and 0% safe in the computer module with feedback phase. Arm position averaged .3% (SD: .8; range: 0% to 3.3%) safe during baseline, increased to 5% (SD: 1.3; range: 3.3% to 6.6%) safe during the computer module without feedback phase, and decreased to 2% (SD: 2.9; range: 0% to 5%). Graphs for all of participant 6’s postures measured are displayed in Appendix V.

**Productivity performance.** As displayed in Figure 17, participant 6 averaged 98 (SD: 18.2; range: 71 to 128) widgets during each session. Participant 6 also completed 93% of the lifts.

**Accuracy of still-photo evaluations.** Figure 16 displays the accuracy of participant 6's evaluations of the still-photos presented in the computer modules. Accuracy for feet position averaged 98.9% (SD: 2.1; range: 95% to 100%) for the computer module without feedback phase and increased to 100% for the computer module with feedback phase. Accuracy for chin position averaged 99.5% (SD: 1.5; range: 95% to 100%) for the computer module without feedback phase and increased to 100% for the computer module with feedback phase. Accuracy for arm position averaged 91.2% (SD: 4.8; range: 85% to 95%) for the computer module without feedback phase and increased to 100% for the computer module with feedback phase.

**Latency of still-photo evaluations.** Data were also collected on the amount of time it took for participant 5 to evaluate each photo as shown in Figure 18. Latency for
The lifting feet computer module without feedback averaged 800 milliseconds (SD: 482; Range: 390 to 6719) and averaged 900 milliseconds (SD: 368; range: 499 to 2528) for the lifting feet computer module with feedback. Latency for the lifting chin computer module without feedback averaged 687 milliseconds (SD: 290; range: 400 to 2256) and averaged 761 (SD: 333; range: 464 to 2286) for the lifting chin computer module with feedback. Latency for the assembly arm computer module without feedback averaged 1247 (SD: 691; range: 465 to 4218) and averaged 1218 (SD: 498; range: 618 to 3144) for the assembly arm computer module with feedback.

Accuracy of Still-Photo Evaluations

Overall participant still-photo evaluation accuracy was correlated with overall percent safe scores. Correlations were calculated between the average percent safe score and the accuracy score obtained form the computer modules. The Pearson correlation coefficient (r) between percent safe and accuracy was $r = -.11$, $p = .44$ for participant 1; $r = .27$, $p = .030$ for participant 2; $r = .04$, $p = .73$ for participant 3; $r = -.24$, $p = .40$ for participant 4; $r = .25$, $p = .24$ for participant 5; and $r = -.10$, $p = .51$ for participant 6.

There is a statistically significant weak correlation between safety and accuracy for participant 2. The relationship for these variables for all other participants was not statistically significant, therefore no correlation exists. However, these results should be interpreted with caution due to the restricted range on the accuracy variable.

Exit Interviews

Below is a list of questions asked of each participant after the last session and a summary of their answers. Each question listed is followed by the answers given by each
participant. Often the same answers were given by more than one participant, and each set of answers is represented by the letter "A" and the numbers "1" through "6".

Q1 (Question #1): What did you think this study was about? (Answer 1) given by participants 1 and 4: body posture, (A2) participants 2 and 5: productivity, (A3) participants 3 and 6: discomfort related to repetitive work tasks.

Q2: What did you think was being measured? (A1) participants 2, 3, 4, and 5: body posture, (A2) participants 2 and 5: the number of widgets produced, (A3) participants 1 and 6: discomfort level.

Q3: What did you think the purpose was behind the computer module? (A1) participant 1: to help me see what I was supposed to do and so I would start doing it to help not have so much pain, (A2), participant 2: a learning tool, a visual for the definitions, (A3), participant 3: to self-correct body posture, to keep in mind safety while performing, (A4), participant 4: to show me what was the correct and incorrect body posture, so you know how to do it, (A5), participant 5: to get me to sit safely, (A6), participant 6: no idea.

Q4: Do you think your performance changed throughout this study? (A1), participant 1: yes, I tried to look like the pictures, (A2), participant 2: yes, an increase in the number of widgets produced and body posture, (A3), participant 3: not in a gradual way, not really, (A4), participant 4: yes, my head performance changed, I tried to keep my head up, (A5), participant 5: yes, at first I tried to be safe, then later I stopped, (A6), participant 6: yes, but I had minor back pain so I did what was most comfortable.
Q5: Your performance did/did not change throughout the course of the study. Why do you think this occurred? (A1), participant 1: because of the computer modules, the safety information didn't make much sense, but seeing it help me know what I was supposed to do, (A2), participant 2: I was concentrating/focusing more on my body posture after completing the computer modules, (A3), participant 3: at the beginning I thought I should complete the tasks the right way, then later I did what was comfortable and getting money was not dependent on my performance, (A4), participant 4: the computer modules prompted thoughts about safe posture, (A5), participant 5: at first I thought I was being monitored so I tried to do it the right way, then I figured I wasn't so I did what was comfortable, (A6), participant 6: no conscious effort, except I thought once or twice about trying it the way the computer modules had showed me, but mostly completed the tasks in a manner that was most comfortable for me.

Q6: Did you find yourself thinking about what you had to do correctly throughout each session? (A1), participant 1: I thought about lifting safety, I gave myself instructions/safety rules, such as do that not this, (A2), participant 2: yes, I thought about keeping my posture in line with the definitions, (A3), participant 3: at different times, I thought about it more at the beginning of sessions and when I felt discomfort I thought about the correct posture, (A4), participant 4: yes, I was constantly thinking and monitoring my performance, (A5), participant 5: I focused more on the widgets, I thought there was a number I had to reach and I set personal goals, (A6), participant 6: not really, but after the arm computer module I started to think about the arm angle and I tried to improve, I also set widget goals.
Q7: (If performance changed) Was there something that occurred that made you change your performance? If yes, what was it? (A1), participant 1: the computer module and I had less neck pain when I straightened my head, (A2), participant 2: I kept setting more and more goals to make widgets and after seeing the computer modules I had more of a visual and it helped me understand the correct position, (A3), participant 3: because of the computer modules, I thought about my posture more, (A4), participant 4: The computer modules influenced it, (A5), participant 5: I stopped trying to follow the definitions after I decided I wasn't being monitored, but after seeing the computer module I tried to keep my head safe, (A6), participant 6: I had no idea I changed my feet position, I wasn't trying, I just did what was most comfortable, with arm position, I just wanted to try it out.

Q8: Did you try to perform more safely after you completed the computer module? If yes, why? (A1), participant 1: yes, because the computer module would help me with the correct posture and would lessen pain during tasks, (A2), participant 2: yes, I tried to model the module, (A3), participant 3: I changed when I noticed I was unsafe, when I felt some discomfort I thought about the photos in the module and when I changed I felt better, (A4), participant 4: yes, I figured I was supposed to model the module, (A5), participant 5: I tried with my head, but with feet I did it a few times, but the box was way too light, (A6), participant 6: not with my feet, but tried with arms because I was curious as to why that was the right position.

Q9: Was there something you said to yourself during each session? Did this change throughout the course of the study? (A1), participant 1: I thought mostly about
my schedule, I did think about lifting safely, but not assembly, (A2), participant 2: If I felt discomfort I changed to match the module, I thought about back and head and I felt like back was okay because it felt comfortable, (A3), participant 3: in the beginning I thought about my head and back and I thought about them more when head was introduced, (A4), participant 4: not really, but after the module was introduced I thought more about posture, (A5), participant 5: I had no thoughts about safety, (A6), participant 6: no, but after arm module I tried to match back and arm position.

Q10: Did you find yourself wanting to be given feedback about your performance? (A1), participants 1, 2, 3 and 4, no not really, (A2), participant 5: I wanted to know how many widgets I made, (A3), participant 6: initially I wanted to know the purpose of the computer module and whether I was scoring the photos correctly.

Q11: How do you think receiving this feedback would have changed your performance? (A1), participant 2: might have improved a little bit, but not that much, (A2), participant 3: I would have completed the lifts or might have done them more often, (A3), participant 4: if I had been given feedback I would have changed, (A5), participant 5: if I would have been given feedback on my posture I would have changed, (A6), participant 6: not sure, I would have tried, but if it wasn't comfortable I would have stopped.

Q12: Did you notice a hidden camera in the observation room? (A1), participants 1, 2, and 6: no, (A2), participant 5: at first I suspected I was being observed, but then figured I wasn't, (A3), participants 3 and 4: I suspected I was being monitored.
Interobserver Agreement

Interobserver agreement was assessed for 35% of all observation sessions and averaged 90% (SD: 7.6; range: 66% to 100%) for safe posture and 93% (SD: 5; range: 77% to 100%) for at-risk posture.
DISCUSSION

The purpose of this study was to evaluate the effects of an interactive and individualized still-photo computer-based training module on the percentage of safe observations of assembling and lifting behaviors. The computer-based training module was analogous to conducting peer observations to determine if the "observer effect" (Alvero & Austin, 2004) could be produced using photos instead of video. Although the trends in safety performance varied, overall there were substantial improvements in performance during the computer module without feedback phase. The results suggest that the "observer effect" can be produced using still-photos and that a still-photo computer training module without response-based feedback is a viable solution for improving safe postures during assembly and lifting.

The Overall Effects of the Still-photo Computer Module without Feedback

There were four observable trends in performance as a result of completing the still-photo computer modules without feedback: no improvements, small improvements, gradual improvements, and large improvements. No improvements were observed for participant 2 on back position for assembly, participant 3 on arm position for lifting, and participant 6 for both chin position for lifting and arm position for assembly. Because small to no improvements occurred in the still-photo computer module without feedback phase, the still-photo computer module with feedback phase was implemented with participant 6 on feet position for lifting, chin position for lifting, and arm position for assembly. Following the implementation of the still-photo computer module with feedback phase, no improvements were observed for all three of participant 6's behaviors.
Although these data seem to suggest that feedback on the accuracy of the still-photo evaluations does not improve safety performance, these data should be interpreted with caution since this phase was only implemented with one participant. It is important to mention that there appeared to be covariation between head position for assembly and back position for assembly for participant 2. When participant 2 had safe head position he usually had an at-risk back position, and when he had a safe back position he usually had an at-risk head position. Since participant 2 had been exposed to the computer module without feedback on head position for assembly for a longer period of time, that module was withdrawn so that he was exposed to only the computer module without feedback on back position for assembly. This resulted in no improvement in back and performance in head position remained the same. It is also important to mention that participant 2 and participant 6 reported that they performed the tasks in a manner that was most comfortable for them, and that following the safety definitions for some behaviors was not comfortable for them.

Small improvements (i.e., less than a thirty percentage point increase in safety behavior over baseline) in performance were observed for seven behaviors out of sixteen that were exposed to the computer-module. These improvements were observed for participant 3 on feet position for lifting and head position for assembly, participant 4 on head position for assembly and feet position for lifting, participant 5 on head position for assembly and feet position for lifting, and for participant 6 on feet position for lifting. It is important to mention that participants 3, 4, and 5 reported that they had difficulty maintaining the proper head position while engaging in the assembly task. The safe
definition for head posture required that the head be in line with the torso, facing forward while the chin is parallel to the floor. This is a very strict definition and slight movements of the head would result in the head position as being marked at-risk. All three of these participants showed a large improvement in their head posture following the computer module without feedback; however because of the strict definition for safe head posture those improvements were not detected. It is also important to note why participant 6 had an initial improvement in feet position for lifting and then showed no improvement for the remainder of the study. Participant 6 reported feeling minor back pain after sitting for the assembly task, so she performed the lifts in a manner that was most comfortable for her instead of performing them in accordance with the safety definitions.

Gradual improvements (i.e., an initial increase of twenty percentage points over baseline and a steady increase to a fifty percentage point or greater increase in safety behavior over baseline) were observed for two behaviors out of sixteen that were exposed to the computer-module. These improvements were observed for participants 1 and 2 on head position for assembly. Head position increased gradually across each session during the computer module without feedback phase. Head position for both participants remained low around zero percent safe during baseline, and gradually improved to an average of 32% and 60% safe for participants 1 and 2, respectively.

Substantial improvements (i.e., greater than a fifty percentage point increase in safety behavior over baseline) were observed for three behaviors out of sixteen that were exposed to the computer-module. These improvements were observed for participant 1 on feet position for lifting and back position for lifting, and participant 2 on feet position
for lifting. The most dramatic of these improvements can be seen in the lifting performance for participant 1 (Figure 1). Back position for lifting averaged 0% safe during baseline and increased to an average of 86.8% during the computer module without feedback phase.

Productivity for all six participants maintained in the still-photo computer module phases as compared to baseline. Accuracy of the still-photo evaluations was compared to the percentage of safe intervals, in order to determine if a relationship exists between evaluation accuracy and safety percentage, since research findings on this topic are mixed (Sasson & Austin, 2004). A statistically significant weak correlation between safety and accuracy was found for one participant, while the relationship for these variables for all other participants was not statistically significant. These results should be interpreted with caution due to the restricted range on the accuracy variable. That is, the restricted range of accuracy may make it impossible to detect a correlation, should one exist. The latency of the still-photo evaluations was also collected to determine if a relationship existed between the time it took for each participant to score the photos and safety percentage. However, since there was limited to no variability on the latency variable a correlation analysis could not be conducted.

Possible Behavioral Functions

In short, it appears that, at least for the majority of behaviors, completion of a still-photo computer module without feedback increased safety behavior. What is not clear is why these increases occurred, or why they did not occur when participants were presented with information alone. There are several behavioral mechanisms that could be
responsible for the effects. Some of these possible explanations for the effects include: (a) an instructional tool function, (b) a rule generating function, (c) a self-monitoring function, and (d) a motivating operation.

**Instructional tool function.** When a participant is asked to observe several examples and non-examples of safe and at-risk behavior and is then asked to evaluate several examples and non-examples of safe and at-risk behavior, doing so may clarify performance expectations. Viewing the intervention procedure in this way would mean that the effectiveness of the computer module would be determined by the degree to which the module helped participants discriminate between safe and at-risk behaviors. During exit interviews participant 1 specifically stated, "...to help you see what you were supposed to do, so you would start doing it" and "my performance changed because of the module, the information didn't make much sense, but seeing it helped me know what I was supposed to do," participant 2 stated, "I thought the computer module was a learning tool, a visual for the definitions," and participant 4 reported "the computer module showed me the correct and incorrect ways to perform the tasks so I would know how to do it." If the computer module serves as an instructional tool (i.e., clarifies visually how a person is expected to perform) for the observer, the number of examples and non-examples that must be included in order to have an effect would be an interesting area for future research.

**Rule generating function.** There are several theories of rule-governed behavior that offer possible explanations for the effectiveness of the computer module used in this study. One theory by Malott and Trojan-Suarez (2004) suggests that rules describe
indirect-acting contingencies, and that the behavior is controlled by direct-acting escape contingencies. These direct-acting escape contingencies are based on the theory that rule statements are establishing operations that establish noncompliance with the rule as an aversive condition (Malott & Trojan-Suarez). For example, you state the following rule to yourself: If I don't start writing this paper now, I'm going to miss the deadline for submission. After you have stated the rule, any behavior (i.e., behavior other than writing) produces an aversive condition (e.g., fear, anxiety or guilt) and working on your paper is the escape response. Using this analysis, changes in performance may be explained in the following manner: After viewing the computer module, the participant stated a rule to him/herself that described an indirect-acting contingency (e.g., "If I perform these tasks safely I will feel less or no pain while performing them" or "If I perform these tasks safely I will being completing the tasks like the researcher wants me to"). The rule statement then established noncompliance with that rule as an aversive condition. In other words performing the assembly task and lifting task unsafely became an aversive condition of fear or guilt of being injured or feeling pain or of displeasing the researcher. In order to reduce or eliminate the aversiveness of performing unsafely the participants engage in the escape response of performing the tasks safely.

Self-monitoring function. The verbal statements made by some of the participants during the exit interviews indicate they self-monitored their safety performance after completing the computer modules. Some examples of safety related verbalizations that support this theory include: "my feet position should be like this and not like that," "I need to keep my head up," "I kept thinking about whether my posture was in line with the
definitions," and "I was constantly thinking about and monitoring my performance." In addition to making safety related verbalizations, some of the participants would physically check their posture to make sure they were performing safely. For example, participant 2 would place the back of his hand underneath his chin to try to determine if his head posture was in the safe position when performing the assembly task. Participants also reported that if they felt they were performing unsafely they would self-correct. For example, participant 4 stated, "the computer module helped me learn to self correct my body posture." This indicates that participants were self-delivering consequences contingent on their safety performance. These self-delivered consequences could be responsible for the change and maintenance of their safety performance.

**Conditioned establishing/motivating operation function.** An establishing/motivating operation is a motivative variable that has two effects: (1) alters the value of consequences, and (2) momentarily increases the frequency of behavior that has in the past been associated with those consequences whose value has been altered (Michael, 1993). When the participants perform the assembly and lifting tasks safely or at-risk the participants come into contact with certain proprioceptive stimuli. If the computer module has a motivating operation effect, the proprioceptive stimuli that result from the participants engaging in the correct posture would become more reinforcing, and participants would engage in behaviors that have in the past produced those stimuli.

The computer module was clearly associated with the experimental conditions and experimenter, and perhaps through that pairing, became a conditioned motivating operation (CMO) that increased the reinforcing effectiveness of the proprioceptive...
stimuli to the point where they became sufficiently reinforcing to maintain the safe postures. In other words, the proprioceptive stimuli may have been somewhat reinforcing due to the demand characteristics of the study, but not sufficiently reinforcing to maintain safe postures prior to introduction of the computer module. Some of the verbal statements made by the participants during the exit interviews that may support this theory include: "...to help me see what I was supposed to do and so I would start doing it," "to get me to sit more safely," "I tried to look like the pictures," "I tired to model the module," and "I figured I was supposed to model the module." These statements suggest that before the computer module was introduced, the proprioceptive stimuli that resulted from sitting in the correct posture were not functioning as reinforcers or were not reinforcing enough to maintain safe posture, but after the computer module was introduced, there was an increase in the reinforcing value of those stimuli and there was an increase in the frequency of safe behaviors, because the safe behaviors have produced those safety-related proprioceptive stimuli in the past.

Strengths and Limitations of the Study

This study is the first to systematically evaluate the effects of an interactive and individualized still-photo computer-based training module on the percentage of safe observations of assembling and lifting behaviors. It was also the first to attempt to determine if the "observer effect" (Alvero & Austin, 2004) could be produced using photos instead of video. Although this question cannot yet be answered, the results of this study provide support for an affirmative answer. The laboratory setting was both a strength and limitation of the study. Applicability to the "real world" was sacrificed, but
the control exerted over possible confounding variables was a strength. One major limitation of the study was that it failed to eliminate the presence of demand characteristics, in which participants change their performance merely to “please the experimenter.” Although the purpose of the discomfort survey and hidden camera was to help eliminate these effects it is not clear if the increases in safety performance occurred because the participants learned what the experimenter "wanted" to see. Therefore, it is difficult to hypothesize exactly why a change in behavior occurred.

The performance data for each participant provide important strengths of the current study. Although future research is required to determine the behavioral function(s) of the computer module, this study suggests that ergonomic safety procedures do not negatively affect productivity. The performance data of all six participants showed that performance did not decrease as safety behaviors increased. The use of exit interviews is a strength of the study, since these provide critical information concerning the possible reasons for behavior change. The answers provided by the participants helped the experimenter develop hypotheses regarding the possible behavioral functions responsible for the increases in safety performance. Strengths also lie in the clear effects demonstrated in the computer module without feedback phase. These effects seem to indicate that the "observer effect" can be produced using still photos and that a still-photo computer training module without response-based feedback is a viable solution for improving safe postures during assembly and lifting.
Future Research

Although the current research suggests that the "observer effect" can be produced with still photos and that a still-photo computer training module without response-based feedback increases safety performance, future research should build on this laboratory experiment to provide stronger conclusions. For example, a study similar to this one could be conducted in an applied setting. If safety performance increases as a result of completing an interactive and individualized still-photo computer-based training module, then other studies may attempt to deconstruct the computer module to determine what part of the process is responsible for the change and why. For instance, a difference may exist between observing and evaluating. Would safety performance increase as a result of observing safe examples and non-examples alone, or is the key the actual evaluating of the safe and at-risk photos? Moreover, a study comparable to this one could be conducted using verbal protocol analysis to help determine if the computer module has a self-monitoring or rule generating function. Additionally, future research could include actual pain or discomfort measures to determine if safety behavior is directly reinforced as a result of a reduction in pain or discomfort.

It may also be of practical importance to know how long the effects of the computer module last. Knowing the durability of the effects produced by the computer module would significantly aid future research, as more research could be conducted on the exposure schedule needed to maintain the effects. In addition, future studies could be conducted to determine the minimal amount of material needed to produce the effect. Furthermore, researchers could examine the effects of the computer module in
conjunction with other interventions, such as self-monitoring, feedback, or peer observations, in order to determine whether the effects produced by the computer module can be improved or maintained. Knowing the answers to the questions above may help aid practitioners in the application of the most effective, least intrusive, and most cost effective computer-based training interventions.
Appendix A

Recruitment Script
Participant Recruitment Script
To be read aloud by the student investigator at undergraduate classes.

“Hi, my name is Rhiannon Pante and I am graduate student at Western conducting a research study. The purpose of my visit to your classroom is to recruit 8 participants for the study. In order to qualify as a participant, you will need to be available during the Spring semester for a total of at least 2 hours each week for 3-8 weeks. Participation will involve completing a simple assembly task and a simple lifting task during each session. Sessions will last between 20 to 30 minutes and will be held in Wood Hall. You will attend 2-4 sessions each week for a total of 3-8 weeks and you can schedule up to 2 sessions a day, with a minimum of a 2 hour break between sessions. To be included in the study you must not have participated in any research studies conducted by members of Dr. Austin's PM lab. Participants must also not have any pain or discomfort or any other conditions that may preclude them from doing typical office work for a short period of time. Participants must also not have had a history of such problems.

You will earn $5.00 per hour or extra credit in one class (if available) for your participation. If you are interested in participating, please put your name on the sign-up sheet that I will pass around the class. Thank you for your time.”
Appendix B

Recruitment Sign-up Sheet
Research Study Sign-up Form

If you are interested in participating in this study, please sign up below. I will contact you by phone or email to see if you are interested in coming to a one-on-one meeting to learn more about participation in the study.

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Appendix C

Experimental Data Sheets
# Observation Sheet

**Observer:** __________________________

**Participant #:** __________

**Behavior**

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|   | **S = Safe** | **A = At Risk** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
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Observation Sheet

Observer: ___________________________  Date Scored: ___________  Reliability Observer: Y  N
Participant #: _______  Date: ___________  Session Number: _______

Behavior  
S = Safe  A = At Risk

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Appendix D

Informed Consent Script
SCRIPT FOR CONSENT PROCESS
To be read aloud by either the student investigator or research assistant

“Before you begin participation in this study you must carefully read a consent form. I will read over the consent form with you. If you have any questions concerning the information we go over, please feel free to ask them. After you have read the consent form, you may either sign it or choose not to participate by not signing. If you choose not to sign, you will not be penalized.

{Hand participant a consent form and read it aloud to them}

Then ask, “Do you have any questions regarding the consent form? Please sign a copy of the consent form for my records and keep the other copy for your records.”
Appendix E

Informed Consent Form
Purpose. You are invited to participate in a research study that will evaluate comfort levels in a work setting. The intent of this study is to determine the effects of repetitive work tasks on comfort levels.

Duration. You may be asked to participate in approximately 25-35 20-minute experimental sessions over 10-15 weeks. The length of your participation in the study will vary depending on your availability. You may schedule sessions as often as two times per day with a minimum of two hours in between sessions. Sessions can be scheduled any day from Monday through Sunday.

Explanation of Study Procedures. You will be asked to engage in an assembly task and a lifting task that will simulate the type of work a person might perform in a work setting. You will perform the task in a simulated work environment in the Performance Management laboratory located in Wood Hall. The assembly task will involve putting together 2 washers and a nut on a bolt while at a workstation. The lifting task will involve picking up a small cardboard box that contains 50 pieces of paper, placing the box on the table, removing a specific piece of paper and placing it into a basket. Following each session, you will be asked to fill out a discomfort survey. At the conclusion of the study, you will be given an exit interview.

Compensation. You will receive $5.00 for each hour that you attend or you can choose to receive extra credit in one class if it is offered by the professor. Your money or extra credit earned will not be penalized or forfeited should you choose to withdraw from the study.

Benefits. You will not receive any direct benefits from this study, however, you may be able to perform some tasks related to assembly and lifting more efficiently. Data gained from your participation in the study may benefit the general scientific community by providing information on the efficacy of a discomfort survey.

Risks and Protections. The nature of the tasks is one that requires little physical exertion, and should not expose you to risks greater than those presented by your everyday activities. During sessions you may experience minor fatigue. To lessen fatigue, you are allowed and encouraged to take breaks if you feel tired or experience any physical discomfort. The study will take a total of 10 to 12 hours to complete cumulatively. To minimize this concern, you will be able to schedule sessions at times that are convenient.
for you and you can decide to no longer participate if the study takes too much of your time.

As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency procedures will be taken; however, no compensation or additional treatment will be made available to you except otherwise stated in this consent form.

Confidentiality. All of the information collected from you and about your performance is confidential. That means that your name and other identifying information will not appear in any publications or presentations of the data collected. Both group and individual data will appear in publications and presentations of this research. However, each student will be assigned a code number when his or her data are entered into an electronic database for analysis purposes.

Any presentations or publications will use code numbers to label individuals. Any forms with identifying information will be retained by Rhiannon Fante over the course of study and entered into the database using code numbers. Rhiannon Fante will keep a separate master list with the names of participants and the corresponding code numbers. Once the data are collected and analyzed, the master list will be destroyed. Data gathered from the study will be kept in a locked cabinet in the primary investigator’s office for at least three years.

Rhiannon Fante and Dr. John Austin are prepared to meet personally with any student who wishes to discuss any aspect of this research project and answer questions about the way data may be or are presented. As mentioned above, any information that could identify individuals will be removed from the data used in any publications or presentations.

Your participation in the study is completely voluntary. You are free to withdraw at any time without penalty, and you will receive cash payment or extra credit for the amount of time you participated. At the end of the study, the experimenter will answer any questions you have and explain how your data helped us learn more about discomfort in a work setting.

Who to Contact with Questions. If you have any questions about this study you may call Rhiannon Fante at 586/634-6550. In addition, Dr. John Austin can be reached at 269-387-4495 or the Vice President for Research, 269-387-8298 if questions or problems arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate if the stamped date is more than one year old. Your signature below indicates that you read the above information and agree to participate in the study.
Appendix F

Postural Discomfort Survey
POSTURAL COMFORT SURVEY

Purpose: Determine the level of pain or discomfort at an individual or department level

First Name ___________________ Last Name ___________________

Department Name ___________________ Date ___________________

Supervisor ___________________ Time on This Job ___________________

Shift ___________________ Job Causing Discomfort ___________________

Instructions: Complete each of the measures of discomfort

# 1 Assess your overall comfort or discomfort in the top box
# 2 Rate discomfort for specific body parts in the left box
# 3 Shade the body parts in pain or discomfort in the right box

THINK ABOUT HOW YOU FEEL RIGHT NOW

What is your overall level of discomfort?

1 2 3 4 5 6 7 8 9 10
very comfortable some discomfort uncomfortable very uncomfortable intolerable

Indicate your comfort in the box below using a 1-10 scale, 1 being very comfortable to 10 being very uncomfortable.

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Shade in the area you are feeling discomfort. Darker shading indicates more pain or discomfort.
Appendix G

Consent for Use of Data Script
SCRIPT FOR CONSENT FOR USE OF DATA
To be read aloud by either the student investigator or research assistant.

“We are required to ask you for your consent to use the data from the videotapes. If you do not give your permission for the use of these data, you will not be penalized in any way, and we will destroy your videotapes or give them to you so that you may dispose of them in any way you deem appropriate. I will read over the consent form with you. If you have any questions concerning the information we go over, please feel free to ask them.

After you have read the consent form, you may either sign it or choose to not sign it. If you choose to not sign it, you will not be penalized.”

{Hand the participant a consent form and read it aloud to them.}

Then ask, “Do you have any questions regarding the consent form? At this time, you can either sign or choose not to sign the form, and keep the other copy for your records.”
Appendix H

Consent for Use of Data Form
Thank you for your participation in this study. We are required to ask you for your permission to use the data gathered from your videotapes. We assure you that the videotapes and all identifying student information will be held in the strictest confidence. Dates and times on videos will be obscured or erased so that individuals cannot be identified by this information. Further, at no time will the videotapes themselves be used for public presentations of any sort.

By signing this form you are giving us permission to use only the data obtained from the videotapes. If you choose not to give your permission for the use of data obtained from the videotapes, you may do so without penalty.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate if the stamped date is more than one year old.

Your signature below indicates that you read the above information and agree to allow us to use data gained from the videotapes in this research project.

Participant Signature ___________________________ Date ____________

Please keep the attached copy of this form for your records.
Appendix I

Safety Information Sheet
Safe Postural Definitions When Working:

Assembly

*Head Position:* Your head should be in vertical position such that your neck is aligned with your back; your head should be facing forward and your chin should be parallel to the floor.

*Shoulder Position:* Your upper arms should be tucked close to your body and hanging relaxed, not extended out to the side, or forward or backward. Your shoulders should be relaxed, not hunched or rolled forward.

*Back Position:* Your lower back (lumbar) should be supported by the chair. That means you should be resting your back against the chair and the angle of your back and the thigh should be between 100-110 degrees.

*Arm Position:* Your upper arm and elbow angle should be between 90-120 degrees.

*Leg Position:* Your legs should not be crossed and your knees should be bent forming an angle between 90-120 degrees.

Lifting

*Feet Position:* Your feet should be shoulder width apart, with one foot beside the object to be lifted and the other foot behind the object to be lifted.

*Knee Position:* Your knees should be bent and not straight. Lift the object by pushing up with your legs and not your back.

*Back Position:* Your lower back (lumbar) should be straight, but not vertical. You should not twist your back while carrying the load.

*Chin Position:* Your chin should be level with the horizon and your eyes should be looking forward.

*Arm Position:* Your arms and elbows should be kept close to your body while lifting the object.
Appendix J

Instructions for Tasks Script
INSTRUCTIONS FOR TASKS SCRIPT
To be read aloud by the student investigator or research assistant.

“For the purpose of the study, you will be required to do the following:

1. Assemble Widgets:

   Secure two washers on a bolt with a nut and then place the widget into the bin provided. Continue to assemble widgets until you are prompted by the experimenter to perform the lift.

2. Perform a Lift:

   Place the small cardboard box on the table, remove the required document from the box, place the box back on the ground, and place the document on the table. After you have finished the lift wait until you are prompted by the experimenter to begin assembling widgets.

You will repeat each task four times. After you have finished the last lift wait until the researcher signals that the session is over.”

{Hand the participant the instructional set and read it out loud.}
Appendix K

Discomfort Survey Script
DISCOMFORT SURVEY SCRIPT
To be read aloud by the student investigator or research assistant.

"During the study you will be asked to complete an assembly task and a lifting task in a private room. Throughout the study we will evaluate your discomfort at the end of each day using a survey. At the end of the study, we will ask you to evaluate your overall level of discomfort. Do you have any questions?"

{All question answers will remain consistent with the plan of telling participants we are evaluating their discomfort level under various conditions.}
Appendix L

Still-photo Computer Module Script
STILL-PHOTO COMPUTER MODULE SCRIPT
To be read aloud by the student investigator or research assistant.

“Before beginning your tasks today, I’d like you to complete this 5 minute computer module. You will need to complete all 3 sections of the computer module. The first section will introduce a safe definition for an ergonomic behavior [e.g., back posture]. During the second section of the computer module you will observe 10 safe still-photos and 10 unsafe still-photos of the <target> ergonomic behavior. The third section of the computer module will require you to determine whether each photo shown is depicting a safe or at-risk ergonomic position. You will advance through the computer module at your own pace. Please read each screen before moving on to the next screen. If the module prompts you for a response you will not be able to advance to the next screen until you make the required response. After you complete the module, wait until I come in and give you your instructions for your tasks.”

{Conduct a brief tutorial of computer module to make sure the participant can use the program}
Appendix M

Still-photo Computer Module Screen Shot
Press '1' for Safe,
Press '0' for At-risk
Appendix N

Exit Interview
EXIT INTERVIEW
To be read aloud by the student investigator or research assistant.

1. What did you think this study was about?

2. What did you think was being measured or observed?

3. What did you think the purpose was behind the computer module?

4. Do you think your performance changed throughout the study?

5. Your performance did/did not change throughout the course of the study. Why do you think this occurred?

6. Did you find yourself thinking about what you had to do correctly throughout each session?

7. (If performance changed) Was there something that occurred that made you change your performance? If yes, what was it?

8. Did you try to perform more safely after you completed the computer module? If yes, why?

9. Was there something you said to yourself during each session? Did this change throughout the course of the study?

10. Did you find yourself wanting to be given feedback about your performance?

11. How do you think receiving this feedback would have changed your performance?

12. Did you notice a hidden camera in the observation room?
Appendix O

Debriefing Script
PARTICIPANT DEBRIEFING SCRIPT

This script is to be read aloud to all participants following the completion of the study by either the student investigator or research assistant.

“This is a brief explanation of the purpose of the study. Please feel free to ask any questions you may have after the explanation.

The purpose of the study was to determine the effects of a repeated still-photo computer module on your safety performance. Behavioral safety is a process that requires employees to identify and monitor the critical behaviors that occur before an injury. A few studies have been conducted to examine the effects of behavioral observations on the performance of those who conduct behavioral safety observations. Based on the results of those studies it appears that the safe performance of the observer increases as a result of conducting safety observations. The studies investigating the "observer effect" had participants score videos, so we wanted to see if we would get a similar effect using still-photos. Additionally, some of the behaviors seemed to increase immediately and some increased gradually. So, the study evaluated which behaviors would change with minimal training and which behaviors need further training.

The practical significance of this is that it will help us determine what techniques to use when trying to change a discrete or continuous behavior. We can begin to investigate more thoroughly why certain stimuli produce behavior change with certain behaviors and some don’t. That way, we can more effectively design behavior change solutions.

Research suggests that behavior changes when an observer is present, so in order to evaluate the intervention we needed to monitor your performance unobtrusively in order to get a “true” sample of your safe behavior. In order to do this, we needed to monitor your performance covertly using a hidden camera. Only research assistants have viewed your performance on tape.

We assure you that the videotapes and all identifying information will be held in the strictest confidence. Dates and times on the videos will be obscured or erased so that individuals cannot be identified by this information. Rhiannon Fante will maintain the security of all data collection forms and videos gathered over the course of data collection by storing them in a locked cabinet inside of a locked office (2530 Wood Hall) for at least three years. Only Rhiannon Fante and Dr. John Austin will have access to the locked cabinet, but 6 graduate student members of the PI’s research laboratory have access to the locked office space.

You are free to view the videotapes of your performance and we invite you to do so. We also invite you to examine your own performance data gathered from the video
observation process. If you chose to do so, you may make arrangements with Rhiannon Fante following this explanation and after asking any questions you may have about the study. We are required to ask for your consent to use the data from the video tapes. If you do not consent to the use of these data, you will not be penalized in any way and we will destroy your videotapes or give them to you so that you may dispose of them in any way you deem appropriate.

{Hand the participant the consent form}

Do you have any questions?

{Answer the questions the participant has}

Thank you for participating in this study. Your help is greatly appreciated.”
Date: June 13, 2006

To: John Austin, Principal Investigator
    Rhiannon Fante, Student Investigator
    Antonio Sala, Student Investigator
    Megan Hybza, Student Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 06-05-13

This letter will serve as confirmation that your research project entitled "The Effects of a Still Photo Computer Module with and without Feedback on Ergonomic Behaviors" has been approved under the expedited category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: June 13, 2007
Appendix Q

Participant 1 Graphs
Assembly Graphs

Baseline

Computer Module w/o Feedback

Accuracy

Head

Shoulder

Back

Arm

Sessions
Lifting Graphs

Baseline

Computer Module w/ Feedback

Accuracy

Feet

Back

Percentage of Safe Opportunities

Knee

Arm

Chin

Sessions
Appendix R

Participant 2 Graphs
Assembly Graphs

Baseline

Computer Module w/o Feedback

Accuracy

Baseline 2

Head

Percentage of Safe Intervals

Baseline

Computer Module w/o FB

Accuracy

Back

Arm

Sessions

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33

0 10 20 30 40 50 60 70 80 90 100

100 90 80 70 60 50 40 30 20 10 0

Baseline Computer Module w/o FB Accuracy

Sessions

115
Lifting Graphs

Baseline - Computer Module w/o Feedback

Accuracy

Feet

Back

Percentage of Safe Intervals

Knee

Arm

Chin

Sessions

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
Appendix S

Participant 3 Graphs
Assembly Graphs

Baseline Computer Module w/o Feedback

Accuracy

Head

Shoulder

Back

Arm

Sessions

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31

118
Lifting Graphs

Baseline CM w/o FB

Accuracy

Percentage of Safe Intervals

Baseline

CM w/o FB

Accuracy

Sessions

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31

100 90 80 70 60 50 40 30 20 10 0

100 90 80 70 60 50 40 30 20 10 0

100 90 80 70 60 50 40 30 20 10 0

100 90 80 70 60 50 40 30 20 10 0

100 90 80 70 60 50 40 30 20 10 0

100 90 80 70 60 50 40 30 20 10 0
Appendix T

Participant 4 Graphs
Assembly Graphs

Baseline

Computer Module w/o Feedback

Accuracy

Head

Shoulder

Back

Arm

Sessions
Appendix U

Participant 5 Graphs
Assembly Graphs

Baseline

Computer Module w/o Feedback

Accuracy

Head

Percentage of Safe Intervals

Shoulder

Back

Arm

Sessions
Appendix V

Participant 6 Graphs
Assembly Graphs

P6

Head

Shoulder

Back

Baseline

CM w/o FB

CM w/ FB

Accuracy

Arm

Sessions
BIBLIOGRAPHY


