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Investigating the Effects of Real-Time Visual Feedback on Computer Workstation Posture

Sigurdur Oli Sigurdsson
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INVESTIGATING THE EFFECTS OF REAL-TIME VISUAL FEEDBACK
ON COMPUTER WORKSTATION POSTURE

by

Sigurdur Oli Sigurdsson

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Doctor of Philosophy
Department of Psychology
Dr. John Austin, Advisor

Western Michigan University
Kalamazoo, Michigan
April 2006
INVESTIGATING THE EFFECTS OF REAL-TIME VISUAL FEEDBACK ON COMPUTER WORKSTATION POSTURE

 Sigurdur Oli Sigurdsson, Ph.D.
 Western Michigan University, 2006

The purpose of this study was to examine the effects of a package intervention that included discrimination training, real-time visual feedback, and self-monitoring on postural behavior at a computer workstation in a simulated office environment. A total of 21 participants were screened for participation, and eight of those participated throughout the study. A non-concurrent multiple baseline design across participants was used to assess the effects of the interventions across three postural variables. Following an information-only phase, participants were exposed to the intervention for the lowest stable postural variable. For most targeted postural variables, the intervention implemented in this study led to substantial improvements in safety behavior. A reversal to information-only for two participants did not lead to decreases in safety. A statistically significant correlation ($r = .79; p > .001$) was observed between self-monitoring accuracy and safety levels. Furthermore, an additional analysis revealed that occurrences of self-monitoring resulted in more frequent improvements in posture in the interval following monitors than would be expected by chance alone. The possible behavioral functions responsible for these performance improvements are discussed.
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ACKNOWLEDGMENTS

I offer my sincere gratitude and thanks to the following individuals:

To Dr. John Austin, my advisor for his invaluable guidance on this research project, his insights, his patience, his attention to detail, for his years of trying to shape me into an organized and neat person, and for his dedication to making me a competent behavior analyst.

To my committee members, Dr. Alyce Dickinson, Dr. Mark Alavosius, and Dr. Keith Ruckstuhl, for all their freely given help and feedback throughout the course of this research project.

To my colleagues in the PM lab: Rhiannon Fante, Nicki Gravina, Angie Lebbon, Shannon Loewy, Don Nielsen, and Krystyna Orizondo for their suggestions and continuous support in and outside of our weekly research meetings.

To my good friends, Eyjolfur Sightor Gardarsson, for his invaluable help in designing and creating the self-monitoring user-interface for this study, and Erick K. Marmolejo and Kristen Rost for always being willing to give me feedback.

To my research assistants, Brian Argo, Ben Bushkuhl, Dave Eisenhart, Karl Freese, Julie Lavender, Ron Mitchell, and Sadie Lovett, for being flexible and conscientious in all their work on this project.

To my parents, Siggi and Magna - last, but not least. Without my parents' unwavering and unconditional support, I would never have come close to finishing anything worthwhile in my educational career.

Sigurdur Oli Sigurdsson
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Introduction

The main purpose of the current study was to explore the extent to which innovations in multi-media computer interfacing can be utilized to deliver feedback and self-monitoring forms automatically. The current study explored the effects of real-time visual feedback with a built-in self-monitoring procedure on postural behavior. It was hypothesized that participants would improve their posture as a result of: a) seeing a real-time feed of their own posture and, b) self-monitoring their posture, as they sat at a computer workstation. Participants were instructed to self-monitor the postural location of key body parts while conducting a transcribing task on a computer.

The present study may also shed some light on the momentary effects of self-monitoring and self-evaluation of one's behavior. It is possible that the self-monitoring involved in the experimental procedure set the occasion for participants to assume better posture than was observed immediately prior to self-monitoring. Furthermore, another question that was addressed through the research design in this study is to what extent participants' own assessments of the appropriateness of their posture correlated with observations of the same behavior by research assistants (RAs).
Review of Literature

In 2003, approximately 4.4 million injuries and illnesses were reported in private industries in the US (Bureau of Labor Statistics, 2004). This translates to a rate of 5.0 cases per 100 equivalent full-time workers. Nearly one-third of all nonfatal injuries resulting in days away from work are musculoskeletal disorders (MSDs) (Occupational Safety and Health Administration [OSHA], 2004a), which are soft-tissue injuries or disorders of the muscles, nerves, tendons, joints, cartilage, and/or spinal discs. It has been estimated that the direct cost of MSDs to American private industries may range from $15-$18 billion a year (OSHA, 2004a), as well as up to three to four times that amount in indirect costs.

Kroemer and Grandjean (1997) argue that computer workers, also referred to as video display terminal (VDT) operators, are especially at risk for MSDs:

... a VDT operator is tied to the machine system. His or her movements are restricted: attention is concentrated on the screen and hands are linked to the keyboard. VDT operators are more vulnerable to ergonomic shortcomings: they are more susceptible to the effects of constrained postures, repetitive activities, poor photometric display characteristics and inadequate lighting conditions. This is the reason why the computerised office calls for ergonomics; consequently the VDT workstation has become the launch vehicle for ergonomics in the office world. (p. 84)

Kroemer and Grandjean (1997) provide an overview of research that indicates that workstation setup can have an effect on self-reported physical well-being of office employees working at computer workstations for extended periods of time.

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For example, Grandjean and Burandt found in 1962 that desktops that are too high or low can result in shoulder and neck pain among computer workers, chairs that are set too high from the floor for individual users can result in pain in knees and feet, and the lack of proper wrist support can lead to pain in wrists and forearms (as cited in Kroemer & Grandjean). Furthermore, the setup of chairs and desks for office workers affects physiological measures of muscle activity and pressure on spinal discs, which is important because both increased muscle activity and spinal disc pressure can increase the probability of the emergence of MSDs. Andersen and Ortengren also found in a series of studies in 1974 that intense typewriting can lead to raised shoulders, and an increase in the muscle activity in the back, which indicates added stress on certain back muscles, and that office chair variables, such as the presence of proper back support and armrests, can also function to reduce spinal disc pressure (as cited in Kroemer & Grandjean).

Recent research has further established a link between MSDs, and repetitive motion and/or improper posture at computer workstations (Gerr, Marcus, & Monteilh, 2004; Matias, Salvendy, & Kuczek, 1998), suggesting that interventions designed to improve posture could lead to prevention of MSDs. For example, workers that use computer keyboards in their work are more likely to develop occupational cumulative trauma disorders of the wrist than workers in other industries that engage in repetitive manual tasks for extended periods during their workday (Matias et al.). Gerr et al.'s 2004 review cited five cross-sectional and one prospective study that concluded that hand and arm MSD outcomes were related to time spent at computer workstations. Relationships between MSD outcomes for neck and shoulder and time at computer
were less consistent. Polanyi et al. (1997) found that 11% of people who spent less
than 30 minutes daily at a time sitting continuously at computer workstations reported
bodily pain, compared with 22% if sitting 30-120 minutes. Twenty-three percent of
those sitting daily more than 120 minutes continuously at computer workstations
reported bodily pain. Bodily pain was defined very broadly, from moderate to
unbearable, "either once per month or for longer than a week over the past year" (p.
622). The most common causes for pain cited by participants in the Polanyi et al.
survey study included incorrectly set up workstations, and working without breaks.

Matias et al. (1998) created a prediction model for carpal tunnel syndrome
(CTS) based on a number of possible causal variables, including job exposure
(percentage of workday spent at computer workstation), anthropometry (measurement
of body parts), and posture factors. Matias et al. used questionnaires on body
discomfort, direct observation, and video recording to gather data on a sample of 100
office workers. The authors reported that the percentage of workday spent working at
a computer workstation accounted for 60% of the variance in the CTS variable,
suggesting that time spent at computer workstation was a strong independent
predictor of developing CTS. Matias et al. calculated conditional probabilities of
developing CTS based on exposure to computer workstation work, and found that the
risk of developing CTS was close to zero if people did no computer work, whereas
the risk of developing a CTS was 95% if a worker spent eight hours per day at a
computer workstation. Matias et al. also observed that if a person spent less than an
hour working on a computer, the odds were relatively low of developing CTS.
Furthermore, exposures in excess of two hours were correlated with sharp increases in the risk of developing CTS.

In addition, Matias et al. (1998) stated that the main cause for developing CTS was job design, which ranked higher than posture associated with workplace design, and individual anthropometric make-up. However, it must be noted that posture is highly dependent on workplace design, and a sub-optimal workstation setup can force a worker to adopt an incorrect posture. The inverse relationship does not necessarily hold, that is, optimal workstations do not necessarily lead to perfect posture. Rohn (2003, 2004) for example, found in his laboratory research that participants demonstrated incorrect posture even while working at workstations that were adjusted to be ergonomically correct for each individual participant.

The relationship between incorrect workstation design, improper posture at computer keyboards and MSDs appears to have been demonstrated fairly well across a number of correlational survey studies, especially for disorders of the arm and the wrist. Effective methods to improve posture at computer workstations would therefore be likely to improve both the health and well-being of workers in the US, and reduce costs associated with MSDs to the private sector and society at large.

Behavioral safety has been successfully applied to postural behavior at computer workstations, both in the lab (e.g., Alvero, 2003; Alvero & Austin, 2004), as well as in applied settings (e.g., Culig, 2002; McCann & Sulzer-Azaroff, 1996; Sasson & Austin, 2004/2005). Behavioral safety is an approach to injury reduction that focuses on observable phenomena as they occur in real time, particularly on critical safety behaviors and safety conditions. By focusing on observable events and
conditions, behaviors can be managed through, for example, regular performance feedback, goal setting, and rewards (Reber, Wallin, & Chhokar, 1984). Krause, Seymour, and Sloat (1999) analyzed up to 9 years of injury data from 73 companies in 12 industries that had implemented behavioral safety in some form. On average, injury reductions of 26% were observed in the first year after starting a behavioral safety process, and continued reductions were observed in each of the subsequent years the programs were maintained, up to 5 years, post-implementation.

Behavioral safety has been demonstrated to be effective in a wide variety of settings (Sulzer-Azaroff & Austin, 2000), such as at construction sites, grocery distributorships, manufacturing plants, shipyards, and many more. For example, Komaki, Barwick, and Scott (1978) used a feedback procedure to reduce the frequency of at-risk behaviors in a food manufacturing plant, Lingard and Rowlinson (1997) used a combination of feedback and goal setting to increase the frequency of safety behaviors and conditions at construction sites, and Alavosius and Sulzer-Azaroff (1990) increased the number of client-transfer tasks completed safely among nursing staff through a training and feedback intervention.

The behavioral approach to safety typically involves the following five steps (Sulzer-Azaroff & Austin, 2000):

1. Identify behaviors that impact safety.
2. Define these behaviors precisely enough to measure them reliably.
3. Develop and implement mechanisms for measuring those behaviors in order to determine their current status and set reasonable goals.
4. Provide feedback.
5. Reinforce progress.

Behavioral feedback can vary in terms of its form (Alvero, Bucklin, & Austin, 2001). For example, feedback can be delivered in the form of a graph, a verbal statement, or a written statement. Feedback may also involve people watching videotapes of their own prior performance.

Culig (2002) examined the effects of workstation improvements on safe posture, and the additive effects of introducing an intervention package incorporating ergonomic information, graphic feedback and praise. Only two of seven participants improved safe posture following ergonomic assessments, but all seven demonstrated marked additional improvements in safety when the behavioral safety treatment package was introduced.

Behavioral feedback is commonly used in applied behavior analysis interventions, and has been demonstrated to be effective in and of itself (Alvero et al., 2001) in a wide variety of applied organizational settings. Moreover, feedback is frequently included in treatment packages with other intervention components such as goal setting, social praise, monetary rewards, prompts, etc. Performance feedback enjoys popularity in organizational research, most likely because it is relatively easy to administer, and it has repeatedly been associated with improvements in targeted behavior. Balcazar, Hopkins, and Suarez (1985/1986), in a review of feedback research studies published in Academy of Management Journal, Journal of Applied Behavior Analysis, Journal of Applied Psychology, and Journal of Organizational Behavior Management between 1974 and 1984, came to the conclusion that: "(1) feedback does not uniformly improve performance; (2) adding rewards and/or goal-
setting procedures to feedback improves the consistency of its effects; and (3) some characteristics of feedback are more consistently associated with improved performance than others" (p. 65). Alvero et al. updated the review by Balcazar and colleagues for articles in the same journals published from 1985 to 1998, and reported that interventions in their review were more likely to combine feedback with other independent variables.

Biofeedback is one type of feedback that has been applied in a wide variety of settings, and as a therapeutic technique across a wide variety of disorder types, including attention deficit hyper-activity disorder (Kropotov, Ponomarev, & Grin-Yatsenko, 2001), hypertension (Blanchard, Miller, Abel, Haynes, & Wicker, 1979), migraine (Sturgis, Tollison, & Adams, 1978), affective and anxiety disorders (Hammond, 2005), persistent pain (Middaugh & Pawlick, 2002), and respiratory dysfunctions (Yorkston, Spencer, & Duffy, 2003). Biofeedback involves training a patient or client to monitor a signal from a feedback device that provides information on physiological responses in real-time. Common types of feedback devices include electro-encephalograms (EEG), blood pressure, and heart-rate monitors.

Azrin, Rubin, O'Brien, Ayllon, and Roll (1968) utilized a type of biofeedback to improve back posture (slouching) using a device developed on the basis of behavioral engineering. Azrin et al. described the elements of behavioral engineering as follows:

(1) Behavioral definition: define the undesired behavior in specific behavioral terms; (2) Apparatus definition: isolate some essential aspects of that behavior that can be physically sensed by an apparatus; (3) Response precision: the
response output of the apparatus must be made selective so that it is activated by all instances of the undesired behavior (no false negatives) but by no instances of normal behaviors (no false positives); (4) Effective stimulus consequence: discover some stimulus event that is reinforcing or aversive, and that can be delivered physically; (5) Programming the stimulus consequence: program that stimulus as a consequence for the undesired response; and (6) Portable device: construct a portable device that performs the response definition and stimulus delivery and which allows the patient to engage in his normal activities. (p. 100)

The device utilized in Azrin et al. (1968) provided the person wearing it with a warning stimulus if he or she was slouching. The warning stimulus functioned to signal that an aversive tone would be sounded if the person did not straighten his or her back. Azrin et al. speculated that the tone had aversive functions because it was distracting, and that it was embarrassing for the wearer to be the source of a tone in the presence of other people. Results indicated that all 25 participants reduced the amount of time they slouched per day. Improvements ranged from 62-97%, and an average of 86% reduction in slouching was observed. The behavioral mechanisms operating to improve posture were hypothesized to be punishment of slouching by the tone, escape from the tone, and avoidance of the warning stimulus. Another possible explanation for the results obtained by Azrin et al. could be that the device led to participants' self-monitoring their back posture.

Self-monitoring, of which biofeedback is one sub-category, involves a person collecting data on some dimension of his or her own behavior, or physiological
responding in the case of biofeedback. Not only has self-monitoring been proven to
be useful as a data collection procedure, it has also been found to be effective in its
own right as an intervention across a wide variety of settings (Olson & Austin, 2001).
When a monitoring procedure by itself changes the rate or duration of behavior (for
example), the self-monitoring procedure is termed to be reactive (Nelson & Hayes,
1981). Reactivity, as a threat to internal validity of experimental research, is
observed when some dimension of behavior changes purely as a function of a
participant being observed by an external agent (e.g., another person, video camera).
Reactive behavior change in self-monitoring, however, occurs as a result of a person
attending to his or her own behavior.

Historically, there has been considerable debate on what behavioral
mechanisms are responsible for reactivity to self-monitoring. There is general
agreement that self-monitoring involves at least two separate acts: observing one's
own behavior, and recording one's own behavior (Nelson & Hayes, 1981). Kanfer
(1970) proposed that a third response, self-reinforcement, was responsible for the
effects of self-monitoring. Self-reinforcement, according to Kanfer, can be effective
because of two separate behavior principles. If the self-monitored response meets
some pre-set criterion, the person will reinforce his or her own behavior either by
self-praise or by granted access to some reward. Conversely, if the self-monitored
behavior fails to meet the performance criterion, Kanfer argues that the person will
engage in some type of self-punishment that can be either covert or overt.

Rachlin's (1974) account of reactivity to self-monitoring puts primary
emphasis on the cuing function of self-monitoring, and he argues that reactivity will
occur regardless of whether a person actually engages in self-administered consequences. According to Rachlin, the self-recording response and/or the self-administration of rewards function as antecedents to make salient (or cue) for the self-monitoring person the consequences that control behavior in his or her everyday environment. Nelson and Hayes (1981) criticized both Kanfer and Rachlin's accounts for overemphasizing behavior as the sole initiator of reactivity to self-monitoring, and argued that reactivity may occur as a result of a host of possible events that can potentially be effective cues or prompts. In addition to self-monitoring and self-consequation, Nelson and Hayes also suggested that instructions, training, self-monitoring devices could function as potential cues.

Olson and Austin (2001) expanded on the behavioral mechanisms that may be responsible for reactivity to self-monitoring. According to Olson and Austin, self-monitoring may function to simply (1) clarify or prompt for the person engaging in self-monitoring what is expected, or what constitutes normal behavior. The task-clarification or prompting function of self-monitoring may therefore, in some cases, be sufficient alone to generate behavior change. Olson and Austin further argued that self-monitoring may (2) have effects analogous to reinforcement, (3) that self-monitoring may lead to the generation of rules that come to exert control over the self-monitored response, and lastly, (4) that self-monitoring can serve to change the function of certain environmental events so that they become more or less reinforcing or punishing.

Olson and Austin (2001) utilized the concept of analogs to reinforcement (e.g., Malott & Suarez, 2003) as one possible explanation of reactivity to self-
monitoring. If a person scores his or her performance as being either sufficiently
good or sub-par, recording may function respectively to reinforce or punish the target
behavior. Olson and Austin speculate that self-monitoring may also function to
generate verbal rules. A person self-monitoring may come to develop rules such as,
"If my behavior exceeds this goal, I will be rewarded," or, "If I fail to work for X
hours, I will be punished." The fourth possible behavioral mechanism responsible for
reactivity to self-monitoring could be a conditioned establishing operation (CEO),
according to Olson and Austin. Citing Michael (e.g., Michael, 1993), Olson and
Austin argued that during self-monitoring, some stimulus may evoke a rule-statement
related to the behavior that is being monitored. The stimulus that evoked the rule, or
the rule itself, can then function as a CEO, and the CEO has the effect of changing the
reinforcing or punishing effectiveness of stimuli that follow the self-monitored
behavior. The CEO also has the effect of changing the frequency of the behavior that
has in the past resulted in the presentation of those consequent stimuli.

Experimental research seems to favor the explanation that self-monitoring has
the effect of cuing or prompting behavior as an antecedent, as opposed to the theory
that persons that are self-monitoring engage in self-delivery of consequences (Nelson
& Hayes, 1981). Furthermore, Nelson, Boykin, and Hayes (1982) observed that the
reactive effects of self-monitoring were apparent only when self-monitoring was in
effect. According to Nelson et al., the failure of reactivity to be maintained in the
absence of self-monitoring supported a non-mediational cuing interpretation of the
behavioral mechanisms responsible for reactivity, as opposed to a mediational or self-
evaluative interpretation. When self-monitoring was withdrawn, behavior
immediately returned to baseline, whereas a self-reinforcement account would predict an extinction curve following withdrawal of self-monitoring. Furthermore, research in behavioral safety indicates that self-monitoring alone produces effect sizes that are comparable to antecedent-only safety interventions (Olson & Austin, 2001).

Alvero (2003) conducted two experiments aimed at clarifying the possible relationship between engaging in verbal behavior while self-monitoring, and safety performance. Alvero theorized that observing and evaluating other people's safety performance would result in observers' engaging more frequently in verbal behavior about their own posture, which would then lead to improvements in the safety performance of the observers. During both experiments, Alvero collected data on participants' verbalizations during all experimental sessions in which they were encouraged to talk aloud. Safety-related verbalizations emitted in the first study during experimental phases in which participants conducted observations were used to construct safety rules. In Alvero's second experiment, another set of participants was provided with the safety rules generated based on the first experiment, in order to gauge to what extent stating those rules would lead to improvements in safety. The results of both Alvero experiments provided support that a functional relationship existed between statements related to safety (be they complete contingency-specifying rules or not), and observed safety levels. Conducting observations improved the safety performance of participants, and Alvero argued that the improvements were a result of increases in self-monitoring and/or (collateral) increases in generation of safety-related rules.
Self-monitoring has been utilized in OBM, as well as the field of behavioral safety. Richman, Riordan, Reiss, Pyles, and Bailey (1988) investigated the effects of a self-monitoring procedure with minimal supervisory involvement on the frequency of scheduled activities and duration of on-task behavior by employees in a human services setting. Adding feedback to self-monitoring was necessary to reach high levels of performance for some participants, but there was otherwise not much improvement when feedback was added above what was achieved with self-monitoring alone, although variability in behavior decreased when feedback was added.

McCann and Sulzer-Azaroff (1996) used self-monitoring in a treatment package aimed at improving safe sitting posture (back straight, shoulders relaxed, neck aligned with back, feet flat on floor, and forearms parallel to the floor) and hand-wrist position. Results indicated that training involving safety information combined with self-monitoring was enough to generate improvements on body posture variables. Training and self-monitoring led to modest improvements in hand-wrist performance, and adding rewards, feedback, and goal-setting to the intervention led to additional improvements.

Overall, posture variables were more easily improved than hand-wrist position, and ceiling effects were observed in the intervention phases for posture, but not for hand-wrist position. Another interesting finding of the McCann and Sulzer-Azaroff (1996) study was that self-monitoring hand-wrist position led to improvements in posture, which further indicated that posture variables were more amenable to change than hand-wrist position. McCann and Sulzer-Azaroff argued
that one of the possible reasons for the difference across behaviors in resistance to change may have been that an ergonomically sound workstation setup served to cue correct posture. As opposed to the McCann and Sulzer-Azaroff study, Culig (2002) however found the most dramatic improvement in safety for hand-wrist position and arm position as a result of a treatment package that incorporated task clarification, feedback and praise, as opposed to ergonomic workstation setup.

Olson and Austin (2001) pointed out that there appears to be a relative dearth of experimental evaluations of behavioral safety applications aimed at lone workers. Behavioral safety processes usually rely heavily on peer observation and peer influence techniques. However, when a person works alone for a significant proportion of the day, it is not possible to program regular peer safety observations. One of the possible solutions proposed by Olson and Austin to this dilemma was to have the same person function as an observer and an observee through self-monitoring, which was one of the treatment components in McCann and Sulzer-Azaroff (1996). Olson and Austin trained bus operators to self-monitor critical safe driving behaviors, and the drivers estimated twice a day how safely they had driven prior to completing the self-monitoring form. Improvements in safety were modest, but consistent, and Olson and Austin pointed out that the effects observed were comparable to those obtained in studies that only used antecedents to generate behavior change. Probes further demonstrated that self-monitoring was less effective in improving safe behavior than the reactive effects of having a supervisor present on the bus. An interesting demonstration of the reactivity to supervisor presence was
that improvements in behavior were only observed for behavior that supervisors were observing at any given time.

When behavioral safety is implemented in the workplace, observations of worker safety performance are usually included in the injury-prevention package (Agnew & Snyder, 2002; McSween, 2003). The observer can either be the worker's peer, or the worker's supervisor, and the data gathered in these observations can be, and often are, used as a source of feedback. The feedback can be delivered verbally by the observer following the observation, and/or the data can be used as a source for graphic or written feedback. Feedback to a performer on his or her own safety performance has been demonstrated to be highly effective across feedback modalities, participants and settings. Two questions surrounding the effectiveness of behavioral safety have lately received considerable attention. Firstly, does the observer benefit from conducting the observation, and secondly, how safely do people perform when there is no-one present to watch them?

Alvero and Austin (2004) evaluated in a laboratory setting the effects of conducting safety observations on the safety performance of the observer. Participants observed a confederate perform the same tasks as the participants themselves engaged in during the study. Results indicated that observing and evaluating through a checklist the safety performance of another person led to improvements in safety over and above safety levels observed during baseline and information-only phases. Alvero and Austin further speculated that observing alone was not enough to effect a behavior change; observation and evaluation of safety performance were both necessary in order for safety to improve. Exit interviews
suggested that conducting safety observations led participants to self-monitor their own safety performance when given the opportunity to perform the targeted behaviors.

Sasson and Austin (2004/2005) examined the effects of conducting safety observations on office workers' postural behavior in an applied setting. Safety behaviors of two groups of employees were observed, and both groups of employees received instructions on how to perform targeted behavior safely following baseline. One group of employees was exposed to safety-related feedback, whereas the other group conducted safety observations on the behavior of peers before feedback was introduced. Sasson and Austin averaged effect sizes across the two groups, and found that employees that only conducted safety observations of peers increased safe performance as compared to baseline, and that the improvements were very similar to improvements observed for employees that only received feedback.

Rohn (2003) asked the question, "How safe are people when nobody is there to observe them?" Put another way, the question can be stated as, "Does the presence of a safety observer produce a reactive effect"? Reactivity is observed when behavior levels change systematically as a function of observer presence. If safety observations produce a reactive effect, the efficacy of behavioral safety applications is at question, because even though workers may be safe when observed, it is by no means guaranteed that they perform safely during the majority of the workday when they are not being observed. Using a hidden camera, Rohn found that safety behavior changed systematically as a function of observer presence. Participants consistently performed more safely in the presence of an observer that was there ostensibly to
observe safety than they did in the absence of such an observer. In a second study, Rohn (2004) attempted to further examine the behavioral function of being observed and argued that observer presence most likely functioned as a discriminative stimulus for punishment for the person observed. In Rohn's 2004 study, reactivity to observation was not replicated, most likely because the participants were not able to tact specifically what behavior the observer was observing.

The current study addressed the extent to which a treatment package consisting of real-time visual feedback with built-in self-monitoring is effective at improving posture of participants working at a computer workstation. A video camera was directed at participants, and served as the source of a real-time video feed that appeared at regular intervals in a pop-up window on a computer screen at which participants worked. When the feedback window opened, participants were prompted to self-monitor their posture, and the self-monitoring response closed the feedback window.

Video feedback has been used extensively in the area of developmental disabilities (Dowrick, 1999) as a therapeutic tool, and has been found to be effective across a variety of client populations and behavior types. Wittkopp, Rowan, and Poling (1990) applied video feedback in an organizational setting. They showed participants video recordings of themselves engaging in a specific task, and coupled the video feedback with written and verbal feedback, which resulted in marked improvements on a key organizational variable. The intervention package in the present study differed from the video feedback studies cited above in that feedback was delivered in real-time, which allowed participants to adjust posture on-the-spot.
The presence of a video camera in the environment may alone function as an antecedent prompt for safe behavior (Olson & Austin, 2001), and may therefore effect a change in safe posture as participants most likely were able to deduce that the purpose of the camera was to collect data on their safety. Requiring an evaluative self-response on behalf of participants may have facilitated participants' evaluations of their own posture. Alvero and Austin (2004) reported that observing alone was not enough to effect a behavior change; observation and evaluation of safety performance were both necessary in order for posture to improve. The self-monitoring component in the present study should therefore have increased the likelihood of the intervention package being effective in improving posture.

Incorporating self-monitoring in the proposed feedback procedure could have served two possible functions. Self-monitoring may be reactive, and lead by itself to changes in behavior. Furthermore, requiring a self-monitoring response may ensure that participants attend consistently to the video feedback, and will not come to ignore it after repeated feedback presentations. Accuracy of self-monitoring was separately analyzed for each participant, and accuracy was correlated with possible improvements in posture, as it is possible that higher levels of accuracy resulted in higher levels of safe behavior, although it must be noted that experimental data on the importance of accuracy in self-monitoring are not conclusive (Sasson & Austin, 2004/2005).

An extensive search of the OBM literature did not reveal any articles involving real-time visual feedback as an intervention component. Center-of-Gravity (COG) feedback, however, is a commonly used tool in the health and rehabilitative
sciences, for example to help stroke victims (Rougier, 2004), and patients with diabetic-related sensory neuropathy (Wu, 1997) to regain a proper sense of balance. Patients stand on a disc that detects weight distribution, and watch on a computer screen in real-time how weight is distributed across the areas of the soles of their feet. This method has proven to be consistently effective in improving balance. Real-time visual feedback with normative guides for body posture has been used as a training tool for golfers (Swinglab, Inc., 2005), although no scientific studies have been conducted on the effectiveness of such training.

This study may pave the way to a solution to the problem of safety management for the lone worker. That is, the lone worker can not receive feedback from others during the regular course of his or her workday, making peer observations impossible. If multimedia technology can be utilized to change postural behavior of a lone worker at a computer workstation, it may become feasible to study the applicability of real-time feedback technology in other settings, such as for work at conveyor belts or other workstations that require long durations of relatively static posture.

The goal of multimedia applications is to give the user the impression that he or she is immersed in a computer-generated environment (He & Agah, 2001). To achieve this end, multimedia environments utilize high resolution visual and feedback to the user, as well as audio and textual feedback. In the current study, a high performance personal computer delivering a high resolution feed through a digital video camera was used, in order to maximize the probability that the feedback component would be effective.
To summarize, the primary goal of the present study was to evaluate the use of multimedia technology to improve posture at a computer workstation. The study was also aimed at investigating the relationship between self-monitoring accuracy and improvements in safety, as well as investigating the momentary effects of intervention delivery on posture change.
Method

Participants

Eight participants were recruited from undergraduate psychology classes at Western Michigan University. Informed consent was secured from participants prior to their participation in the study. Participants were randomly assigned a number by the SI.

Screening of Participants

In order to be eligible to participate in the study, participants had to be able to touch-type, type at least 30 words per minute, and must not have had participated in any other research studies conducted in Dr. Austin's Performance Management lab (see Appendix A for a script for the consent and screening procedure). Prior to any experimental data collection, the SI scheduled a session with each participant that lasted for approximately 20 minutes, and participants were paid $2.50 for attending. During this initial session, informed consent was sought, and screening took place. Participants' touch typing skills were tested by asking them to type at least 150 words over the span of five minutes, while not looking at the keyboard. Participants were screened for chronic back problems, existing MSDs, or any other conditions that might increase the risk of injury associated with participating in the study. No participants had a history of such problems. Participants were asked to complete a postural comfort survey (see Appendix B for a copy of the postural comfort survey) during the consent and screening meeting, and once during the intervention phase.

During the screening and consent session, the SI used a digital video camera to capture still photographs of each participant while he or she was seated at the
computer workstation. The camera was in full view of the participants, and they were
told that they were being videotaped. Participants were asked to demonstrate both
safe and at-risk postures for periods ordering on seconds during the photographing
session, and were given immediate feedback on whether they were in a safe or at-risk
posture. Participants were verbally and/or physically guided to demonstrate a safe
posture, if necessary.

A participant was not exposed to the intervention and his/her participation was
terminated if none of the five postural variables had low and stable levels of safe
posture during the information-only phase.

A total of 21 participants were screened for participation in the current study.
Three participants served as pilot participants, and their data are not published herein.
Two participants did not meet the typing criterion, and one participant did not want to
be involved in a study in which a video camera was constantly aimed at the
participant. Five participants were excused from participation after they expressed a
desire to terminate their participation because of time constraints, and two
participants did not have low and stable levels of safe posture during the information-
only phase. The remaining eight participants were exposed to the intervention, and
completed their participation in this study.

Task

Participants were observed for approximately 20 minutes per session for up to
two sessions per day (with at least a one hour break between sessions) as they
transcribed a text while seated at a computer workstation. Participants were asked to
leave cell-phones with RAs during experimental sessions.
Apparatus

All experimental sessions were recorded digitally using a JVC® JV569 MiniDV digital video camera, and a Panasonic® DMR-ES10 DVD burner was used to record all experimental sessions in their entirety. A Dell Inspiron 8600® laptop computer simultaneously ran a Microsoft Word® word processor program, and a webcam program throughout all experimental sessions. WebcamDV® for personal computers (OrangeWare Corporation, 2005) was used to convert video feed into a webcam browser, and the Willing Webcam® (Detisov, 2005) webcam browser was used to manage feedback windows. Pop-up windows containing feedback and self-scoring forms were displayed through an Internet Explorer web browser®. Self-scoring data were collected through a PHP® database, that ran on an Apache webserver®.

Participants sat in an office chair with armrests, and a foot-rest was made available if needed. Participants sat at a desk with an adjustable keyboard tray.

Computer Workstation Setup

The computer workstation was adjusted to fit each individual participant before the start of each session, based on OSHA recommendations (2004b).

Chair Height. Chair height was set so the user’s feet rested comfortably on the floor or footrest, while the upper body was high enough to work comfortably at the workstation. Thighs were to rest on front edge of chair's seat.

Monitor Position. Monitor was positioned directly in front of and centered on the user, the center of the computer monitor was located 15 to 20 degrees below
horizontal eye level and distance from user's eye to monitor was at least 20" to 40", so that the participant did not have to lean back or forward to read.

*Keyboard Position.* Keyboard was centered in front of user, and was flush with user's seated elbow height. Keyboard tray was sloped away from the user (i.e., tilted downward). A foam-pad was placed in front of keyboard to elevate wrists to a neutral position, if needed.

*Mouse Arrangement.* A mouse was placed on the same level as the keyboard. The mouse tray was sloped away from the user to keep the hands and wrists in neutral positions.

All linear dimensions were measured using a tape measure and all angular dimensions were measured using a goniometer. Recording these measures after the initial workstation setup allowed the SI to arrange the room exactly as planned each time each participant arrived for a session.

*Experimental Design*

A non-concurrent multiple-baseline across participants design was utilized in the present study. Every participant was exposed to the two phases of the experiment: information, and live visual feedback coupled with self-monitoring. Participants were exposed to the intervention for the postural behaviors that had the most stable low safety performance during the information-only phases. The delivery of the intervention was staggered temporally across participants. Two participants were exposed to the treatment package for arm position only. Three participants were exposed to the intervention for head/neck position, and one of the three also received feedback and self-monitoring for arm position. The last three participants were
exposed to the intervention for back position only, and one of the three was exposed to a withdrawal of the intervention, to test for maintenance of treatment effects.

_Safety Information._ Following the initial screening and consent meeting, the SI read to each participant an introductory script for the safety information phase (see Appendix C for a copy of the script). The introductory script informed participants that the camera in the experimental room was being used to collect data on their posture.

During the information-only phase, participants read and initialed a handout containing definitions of safe posture (see Appendix D) during the first five minutes of each session. Initialing served to indicate that the participants had read the definitions. The information-study session took place in the same room in which participants performed the transcription task. Participants were allowed to start the transcription task only after the five-minute information-study period had elapsed. During the transcription task, each participant was alone in the laboratory room, and a digital camera was pointed diagonally at his or her upper body.

After the information study session, participants were told to work at their own pace for 20 minutes, and instructed to take micro-breaks if they felt fatigued (see Appendix C for information phase script). At the end of each session, an RA saved the document that the participant was working on, and recorded the number of words transcribed during that session.

_Safety Information, Visual Feedback, and Self-monitoring._ Participants continued to receive safety information at the start of each session, as described above. Before the first session of the intervention phase, participants were shown two
to four slides of themselves in a safe posture for the postural variable to be intervened on, and two to four slides of at-risk posture. They were then asked to discriminate between safe and at-risk slides, based on the operational definitions of safe posture contained on the information sheet. If a participant was not initially able to discriminate between safe and at-risk instances, the experimenter gave him/her feedback on scoring until the participant expressed a confidence in being able to accurately discriminate between safe and at-risk slides.

The source of the live video feed appearing on the computer screen was a digital camera pointed diagonally at the upper body of participants, in full view of the participants. The feedback was broadcast in a 'pop-up' window that appeared at regular intervals on the right side of the computer screen. Every time the feedback window appeared, participants were required to score certain dimensions of their own posture as 'safe' or 'at-risk' by mouse-clicking in designated spaces contained in another window. Participants were instructed to make judgments about their posture based on the image they saw of themselves the first time they looked at the feedback window. The act of self-scoring closed the feedback window. Fifty seconds after self-scoring, the feedback window re-appeared, and self-scoring was again required. Feedback was provided on this schedule for the duration of the entire session.

Participants were told to work at their own pace for 20 minutes, and instructed to take micro-breaks if they felt fatigued (see Appendix E for script). At the end of each session, an RA counted the number of words transcribed during that session, and downloaded the self-scoring data from that session. At the end of the study, an exit interview was conducted with each participant.
Independent Variable Integrity. Independent variable integrity data were collected on the number of self-monitoring responses during each session by counting the number of self-monitoring responses per intervention session.

Duration of Experimental Sessions

All experimental sessions were approximately 20 minutes in duration. When postural behavior had become stable or was downtrending for a postural behavior in the information phase, the feedback and self-monitoring components were introduced.

Independent Variables

All participants were exposed only to safety information for the first sessions. Real-time visual feedback was then added to information. In addition, each participant was asked to evaluate his or her performance as safe or at-risk each time he or she was exposed to the visual feedback by completing a self-monitoring form at approximately 50 s intervals (see Appendix E for a script of instructions for feedback and self-monitoring).

Dependent Variables

The dependent variables in the study were based on ergonomic guidelines and recommendations issued by the Occupational Safety and Health Administration (OSHA, 2004b).

Back Supported. To be considered safe, lower back (lumbar) must be supported, and the angle of the back and the thigh must be between 100-110 degrees while seated.
Head/Neck. To be considered safe, head must be upright, or in line with the torso (not bent down/back), or head facing slightly forward of the plane of the upper body.

Arms. To be considered safe, inside angle of elbow between must be 90-120 degrees. This dependent variable will not be scored when participants are using the computer's mouse.

Hand-Wrist Position. To be considered safe, wrists must be flat (not bent up or down) when typing on keyboard. This dependent variable will not be scored when participants are using the computer's mouse.

Leg Position. To be considered safe, knees must be bent forming an angle between 90-120 degrees.

Measurement of Dependent Variables

During each session, video files of the session in its entirety were fed to a computer and an external DVD burner for digital storage and later scoring. The current study utilized a 10-second momentary time-sampling procedure, where each sample consisted of a snapshot, or electronic picture, captured at 10 s intervals during each session. Each session yielded 120 samples. In order for a sample to be scored as 'safe' for a given dependent variable, a participant had to meet the definition of safe for that variable. If a participant demonstrated at-risk behavior in a sample for a given dependent variable, the sample was scored as at-risk for that dependent variable. Research assistants used observational data sheets to score posture as safe or at-risk (see Appendix G for sample data sheets).
Interobserver agreement was calculated for 32.64% of all sessions by dividing the number of agreements by the total number of agreements and disagreements, and then multiplying by 100.

For each session, an overall safety score was calculated for each dependent variable. The safety score was calculated by dividing the number of samples scored as safe (numerator) by the total number of samples scored as safe or at-risk (denominator).

Informed Consent

Participants consent was formally sought before this study was carried out, and participants each signed an informed consent form prior to participating (see Appendix H).

HSIRB Approval

Protocol clearance from the Human Subjects Institutional Review Board was obtained (see Appendix I).
Results

Head/Neck Position

Figure 1 depicts results for the three participants exposed to the intervention for head/neck position. During three information-only sessions, participant 18 averaged 4% safe for head/neck position (range: 2%-5%; $sd = 1.73\%$), and 97.64% safe (range: 92%-100%; $sd = 1.95\%$) during the intervention. For the period of six information-only sessions, participant 12 averaged 22.17% safe for head/neck position (range: 0%-57%; $sd = 27.84\%$), and 95.67% safe (range: 83%-100%; $sd = 5.41\%$) during the intervention. During eleven information-only sessions, participant 10 averaged 8.62% safe for head/neck position (range: 0%-30%; $sd = 9.26\%$), and 77.93% safe (range: 22%-93%; $sd = 21.17\%$) throughout the intervention. During session 19, participant 10 did not receive feedback due to a software malfunction. However, participant 10 was able to self-monitor targeted behaviors during session 19 without the feedback component.
Figure 1. Safety Performance across Sessions for Participants Exposed to the Intervention for Head/Neck Posture.

*Back Position*

Figure 2 depicts results for the three participants exposed to the intervention for back position. For the duration of four information-only sessions, participant 9 averaged 18.5% safe for back position (range: 0%-54%; $sd = 25.48\%$), and 93.80% safe (range: 63%-100%; $sd = 11.18\%$) during the intervention. In the course of a reversal to information-only phase that lasted four sessions, participant 9 averaged 96.33% safe (range: 93%-99%; $sd = 3.06\%$), and a follow-up session conducted 3 weeks following the last withdrawal phase session yielded a safety percentage of 98%. During seven information-only sessions, participant 17 averaged 1.86% safe.
for back position (range: 0%-8%; \( sd = 3.29\% \)), and 45.00% safe (range: 1%-85%; \( sd = 30.68\% \)) throughout the intervention. Participant 17 was the only participant to show a dramatic initial effect, followed by a gradual decline in safe performance, back to information-only levels. During fourteen information-only sessions, participant 16 averaged 36.14% safe for back position (range: 0%-100%; \( sd = 48.55\% \)), and 51.6% safe (range: 5%-99%; \( sd = 43.11\% \)) during the intervention.

Figure 2. Safety Performance across Sessions for Participants Exposed to the Intervention for Back Posture.

Arm Position

Figure 3 depicts results for the two participants exposed only to the intervention for arm position. During four information-only sessions, participant 11
averaged 0% safe for arms (range: 0%-0; sd = 0%), and 97.47% safe (range: 94%-99%; sd = 1.36%) for the duration of the intervention. During eight information-only sessions, participant 6 averaged 16.19% safe for arms (range: 0%-99%; sd = 34.84%), and 97% safe (range: 95%-99%; sd = 1.63%) during the intervention. The final session for participant 6 involved a reversal to the information-only phase, which yielded a safety percentage of 100%.

![Graph showing safety performance across sessions for participants exposed to the intervention for arm posture.]

Figure 3. Safety Performance across Sessions for Participants Exposed to the Intervention for Arm Posture.

Participant 10 was also exposed to the intervention for arms, but since that participant was exposed to the intervention for head/neck before arms, her data are not included on Figure 2. During 16 information-only sessions, safe performance for arms averaged 69.86% (range: 0%-99%; sd = 43.90%) for participant 10, and 39.30% during five intervention sessions (range: 0%-97%; sd = 46.33%).

Table 1 contains effect size analyses comparing information-only phases with intervention phases across participants. Only initial information-only phases were
used in the analysis. Not included in the analyses were reversal phases. Cohen's $d$ was calculated for all targeted postural variables by subtracting information-only phase means from intervention phase means, and dividing by the pooled standard deviation from both phases (Cohen, 1969). Average effect size, weighted by number of data points per postural variable, was 16.42 (range: -0.69-78.98; $sd = 28.12$).

Table 1

Effect Size Measures for All Targeted Postural Variables

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Targeted Posture</th>
<th>Effect Size ($d$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>arms</td>
<td>3.28</td>
</tr>
<tr>
<td>9</td>
<td>back</td>
<td>4.71</td>
</tr>
<tr>
<td>10</td>
<td>head/neck</td>
<td>4.23</td>
</tr>
<tr>
<td>10</td>
<td>arms</td>
<td>-0.69</td>
</tr>
<tr>
<td>11</td>
<td>arms</td>
<td>78.98</td>
</tr>
<tr>
<td>12</td>
<td>head/neck</td>
<td>4.27</td>
</tr>
<tr>
<td>16</td>
<td>back</td>
<td>0.33</td>
</tr>
<tr>
<td>17</td>
<td>back</td>
<td>1.81</td>
</tr>
<tr>
<td>18</td>
<td>head/neck</td>
<td>48.72</td>
</tr>
</tbody>
</table>

Interobserver agreement data for all postural variables by participant are presented in Table 2. Overall, interobserver agreement data were collected during 47 sessions out of 144 total sessions, or 32.64% of all experimental sessions. Agreement averaged 94% ($sd = 6.25$) overall for all postural behaviors across all participants. Average agreement was lowest 87.89% ($sd = 5.44$) for head/neck posture, and highest 97.92% ($sd = 1.90$) for back posture. Agreement averaged 90.62% ($sd = 7.77$) for hand wrist position, 96.90% for arm position ($sd = 3.24$), and 96.66% for leg position ($sd = 4.76$).
Table 2

Interobserver Agreement across Participants for All Postural Variables

<table>
<thead>
<tr>
<th>Postural Variable</th>
<th>Participant Number</th>
<th>6</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back</td>
<td>99.29</td>
<td>98.11</td>
<td>94.00</td>
<td>97.80</td>
<td>99.75</td>
<td>97.83</td>
<td>96.83</td>
<td>99.75</td>
<td></td>
</tr>
<tr>
<td>Head/Neck</td>
<td>79.86</td>
<td>82.44</td>
<td>89.00</td>
<td>91.25</td>
<td>86.43</td>
<td>87.40</td>
<td>89.00</td>
<td>97.75</td>
<td></td>
</tr>
<tr>
<td>Arms</td>
<td>99.43</td>
<td>98.00</td>
<td>97.57</td>
<td>99.40</td>
<td>98.00</td>
<td>93.20</td>
<td>90.60</td>
<td>99.00</td>
<td></td>
</tr>
<tr>
<td>Hand/Wrist</td>
<td>93.57</td>
<td>97.22</td>
<td>95.88</td>
<td>97.25</td>
<td>89.00</td>
<td>87.00</td>
<td>73.80</td>
<td>91.25</td>
<td></td>
</tr>
<tr>
<td>Legs</td>
<td>100.00</td>
<td>99.89</td>
<td>94.38</td>
<td>90.25</td>
<td>100.00</td>
<td>99.80</td>
<td>89.00</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Appendix J contains graphs that depict safety performance for all five postural behaviors analyzed in this study for all eight participants, as well as productivity data (words typed per minute).

Table 3 summarizes productivity data by participant, across experimental phases. On average, productivity decreased by 9.75% ($sd = 11.92$), or by $d = -0.76$ on average, following the introduction of the intervention.

Table 3

Productivity Data across Participants and Experimental Phases

<table>
<thead>
<tr>
<th>Average Number of Words Typed per Minute</th>
<th>Participant</th>
<th>Information</th>
<th>Intervention</th>
<th>Difference (%)</th>
<th>Difference ($d$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>34.23</td>
<td>31.06</td>
<td>-9.26</td>
<td>-0.88</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>32.33</td>
<td>35.28</td>
<td>9.12</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>36.03</td>
<td>32.78</td>
<td>-9.02</td>
<td>-0.94</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>41.93</td>
<td>36.69</td>
<td>-12.50</td>
<td>-1.06</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>36.38</td>
<td>33.28</td>
<td>-8.52</td>
<td>-1.12</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>63.94</td>
<td>63.83</td>
<td>-0.17</td>
<td>-0.02</td>
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</tr>
<tr>
<td>17</td>
<td>39.94</td>
<td>27.07</td>
<td>-32.22</td>
<td>-1.63</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>41.25</td>
<td>34.88</td>
<td>-15.44</td>
<td>-1.00</td>
<td></td>
</tr>
</tbody>
</table>
Independent variable integrity data were collected on the number of self-monitoring responses during each session. On average, participants completed 20.84 ($sd = 1.23$) self-monitoring responses per 20 m session. Table 4 summarizes self-monitoring data by participant, and targeted postural variable.

Table 4
Summary of Self-Monitoring Accuracy Data for All Targeted Postures

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Targeted Posture</th>
<th>Average Number of Self-Monitoring Responses per Session</th>
<th>Number of Valid Intervention Sessions</th>
<th>Overall Self-Monitoring Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>arms</td>
<td>21.75</td>
<td>6</td>
<td>96.00</td>
</tr>
<tr>
<td>9</td>
<td>back</td>
<td>19.44</td>
<td>9</td>
<td>92.78</td>
</tr>
<tr>
<td>10</td>
<td>head/neck</td>
<td>22.00</td>
<td>9</td>
<td>71.36</td>
</tr>
<tr>
<td>10</td>
<td>arms</td>
<td>22.00</td>
<td>5</td>
<td>40.74</td>
</tr>
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<td>11</td>
<td>arms</td>
<td>20.92</td>
<td>12</td>
<td>96.48</td>
</tr>
<tr>
<td>12</td>
<td>head/neck</td>
<td>21.20</td>
<td>10</td>
<td>81.40</td>
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<tr>
<td>16</td>
<td>back</td>
<td>21.20</td>
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<td>42.52</td>
</tr>
<tr>
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<td>back</td>
<td>18.30</td>
<td>10</td>
<td>53.82</td>
</tr>
<tr>
<td>18</td>
<td>head/neck</td>
<td>20.79</td>
<td>10</td>
<td>94.40</td>
</tr>
</tbody>
</table>

Overall, self-monitoring accuracy averaged 74.33% across all participants during the course of the study ($sd = 23.30$). Pearson correlation coefficients between session-wise participant self-monitoring accuracy and session-wise safety level were calculated for each targeted behavior. A total of nine correlations were calculated. In order to control for family-wise error rate due to multiple correlations, a Bonferroni correction was applied to the family-wise alpha level of significance. The experiment-wise Type 1 error rate of 0.05 was divided by the number of correlations, which yielded a family-wise alpha critical level of 0.006. Table 5 summarizes significance tests off the relationship between safety levels and accuracy by
participant (see Appendix K for scatterplots depicting the relationship between accuracy and safety for each participant).

Table 5
Correlations between Self-Monitoring Accuracy and Safety by Participant

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Targeted Posture</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>arms</td>
<td>0.39</td>
</tr>
<tr>
<td>9</td>
<td>back</td>
<td>0.39*</td>
</tr>
<tr>
<td>10</td>
<td>head/neck</td>
<td>0.58</td>
</tr>
<tr>
<td>10</td>
<td>arms</td>
<td>0.7</td>
</tr>
<tr>
<td>11</td>
<td>arms</td>
<td>0.3</td>
</tr>
<tr>
<td>12</td>
<td>head/neck</td>
<td>0.29</td>
</tr>
<tr>
<td>16</td>
<td>back</td>
<td>0.99</td>
</tr>
<tr>
<td>17</td>
<td>back</td>
<td>0.33</td>
</tr>
<tr>
<td>18</td>
<td>head/neck</td>
<td>-0.27</td>
</tr>
</tbody>
</table>

*p < .006

Figure 4 depicts the relationship between self-monitoring accuracy and safety level by session for all participants. The correlation between accuracy and safety was significant \( r = 0.79, p < 0.001 \).
Figure 4. Scatterplot Depicting the Relationship between Self-monitoring Accuracy and Safety Performance across All Participants.

Table 6 summarizes instances of improvements in posture across participants, and the percentage of improvements in posture preceded by a self-monitoring response. A total of 253 improvements were observed, of which 55 were preceded by a self-monitoring response. Averaged across participants, 21.77% ($sd = 18.82\%$) of improvements in posture were preceded by a self-monitoring response.
Table 6

Summary of Self-Monitoring Data and Postural Improvements for Targeted Postures

<table>
<thead>
<tr>
<th>Participant</th>
<th>Targeted Posture</th>
<th>Total Number</th>
<th>Preceded by Self-Monitoring</th>
<th>Percentage Preceded by Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>arms</td>
<td>16</td>
<td>2</td>
<td>12.50</td>
</tr>
<tr>
<td>9</td>
<td>back</td>
<td>13</td>
<td>3</td>
<td>23.08</td>
</tr>
<tr>
<td>10</td>
<td>head/neck</td>
<td>81</td>
<td>9</td>
<td>11.11</td>
</tr>
<tr>
<td>10</td>
<td>arms</td>
<td>11</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>11</td>
<td>arms</td>
<td>27</td>
<td>5</td>
<td>18.52</td>
</tr>
<tr>
<td>12</td>
<td>head/neck</td>
<td>32</td>
<td>5</td>
<td>15.63</td>
</tr>
<tr>
<td>16</td>
<td>back</td>
<td>24</td>
<td>16</td>
<td>66.67</td>
</tr>
<tr>
<td>17</td>
<td>back</td>
<td>49</td>
<td>15</td>
<td>30.61</td>
</tr>
<tr>
<td>18</td>
<td>head/neck</td>
<td>28</td>
<td>5</td>
<td>17.86</td>
</tr>
</tbody>
</table>

In order to determine whether the rate of improvements preceded by self-monitoring exceeded the rate of improvements expected by chance alone, a chi-square analysis was conducted between (1) the expected chance rate of improvements preceded by self-monitoring, and (2) the observed rate of improvements preceded by self-monitoring. The expected rate of improvements preceded by self-monitoring was obtained by estimating the percentage of times that self-monitoring should precede improvements by chance. Based on an average number of self-monitoring responses (20.84) per 20 m session, it was expected that improvements should occur 14.76% of the time following self-monitoring. Out of the total 253 improvements observed in this study, 37 should therefore have been preceded by self-monitoring. The chi-square analysis comparing the observed and expected rates of improvement preceded by self-monitoring yielded a statistically significant difference, $\chi^2 = (1, N = 253) = 4.39, p < .05$. 

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Discussion

Overall, the intervention, consisting of real-time visual feedback and self-monitoring, was effective in improving safety performance for almost all targeted behaviors. Some variability in levels of improvement was observed across participants, and the intervention did not result in improvements in arm posture for participant 10. Most participants demonstrated safe posture for the majority of postural variables during the information-only phases (see Appendix J for complete data sets for each participant, including untreated postural variables). Due to low and stable safety levels during information-only phases, and large stable improvements in safety following the introduction of the intervention, effect size measures are too large to be easily interpretable. Therefore, a summary of the visual analysis of the time-series data gathered in the current study is presented below.

Results were most consistent for head/neck outcomes, as all three participants demonstrated high levels of stable safe performance during intervention, as compared to low levels of safe posture during information-only phases. Participants 6 and 9 were exposed to the intervention only for arm position, and their posture improved considerably from low and stable during information-only to high and stable levels of safe posture. Participant 10 was exposed to the intervention for arms after first being exposed to the intervention for head/neck posture, and that participant was the only participant in the study to demonstrate a decrease in safety performance. Three participants were exposed to the intervention package for back position. Participant 9 demonstrated high and stable levels of back posture following the intervention. Participant 17 demonstrated an immediate improvement in posture following the
introduction of the intervention, but steady declines in posture were observed during the intervention phase. Participant 16 demonstrated quite variable performance in back position during the information-only phase, and the intervention was only moderately effective, as the difference between the means of the information phase and the intervention phase was 15 percentage points.

Two participants were exposed to withdrawals of the intervention. No decreases in safety performance were observed during the withdrawal sessions, although it must be noted that participant 6 only experienced one withdrawal session, whereas participant 9 experienced five withdrawal sessions.

The only postural variable to fail to respond to the intervention was arm posture for participant 10. It must however be noted that the intervention was introduced to arm posture after the participant had started the intervention for head/neck posture, and that the participant had to self-monitor both postures at the same time. It is possible that the failure of arm position may be due to some sort of failure to attend to two elements of the visual array in the feedback window at the same time.

Another explanation for the failure of the intervention to be effective in improving arm posture for participant 10 may be that participant 10 did not demonstrate high levels of self-monitoring accuracy for arms. Participant 10 self-monitored head/neck posture with over 97% accuracy, whereas arm posture was self-monitored with approximately 41% accuracy by participant 10. Furthermore, participants 16 and 17 respectively self-monitored back posture with approximately 43% and 54% accuracy, and modest improvements in back posture were observed.
during the intervention for both of these participants. All postures that consistently improved during intervention phases were self-monitored with relatively high levels of self-monitoring accuracy. Participants self-monitored postures that improved consistently with over 70% average accuracy, and of those, four postures that improved were self-monitored with over 90% average accuracy.

Lack of self-monitoring accuracy may therefore explain the failure of some postural variables to improve consistently. Logically speaking, a failed effect in this study could also have been due to the fact that a given posture can not be easily self-monitored with high accuracy, and is therefore more resistant to improvements than other postures. However, this is unlikely because the less successful applications of the intervention occurred across two different postural variables (although the possibility exists that both postures could be hard to accurately self-monitor).

Participant 17 demonstrated a gradual downtrend in back posture during intervention, but self-monitoring accuracy for participant 17 fluctuated across time. During the first five sessions of the intervention phase, accuracy averaged 57%, but increased to 92.31% and 94.12% respectively, for sessions six and seven of the intervention phase. During the last three sessions of the intervention phase, accuracy averaged 22.25% for participant 17. During sessions in which participant 17 demonstrated the highest levels of self-monitoring accuracy, safety levels were low, which suggests that the participant accurately self-monitored at-risk posture, or that he may have been unsafe only during the times he was not self-monitoring. Failure to demonstrate safe posture during those sessions may therefore have been due to some motivative variable, such
as safe posture feeling awkward or uncomfortable for that participant. The exit interview with participant 17 seemed to confirm this hypothesis.

In order to analyze whether participants were more likely to be more conservative or more liberal in their scoring of posture than research assistants, a separate analysis was conducted for sessions in which participants' self-monitoring accuracy was low. During five sessions in which self-monitoring accuracy was below 20%, 100% of all disagreements in scoring were a result of participants' scoring themselves as safe, as opposed to at-risk scoring by research assistants. During seventeen sessions in which accuracy ranged from 20%-80%, 66.43% of disagreements were a result of participants' scoring themselves as safe, as opposed to at-risk scoring by research assistants, and in 33.57% of cases of disagreement, participants scored themselves as at-risk, as opposed to a safe observation by research assistants. It would therefore appear that participants were more likely to demonstrate a bias towards scoring themselves as safe, than a bias towards scoring themselves as being at-risk.

Participant 16 had the highest proportion of improvements preceded by a self-monitoring response, in spite of demonstrating relatively low levels of self-monitoring accuracy overall. Furthermore, participant 16 did not improve back posture to a large degree following the introduction of the intervention. Although self-monitoring may have served to prompt improvements in back posture for participant 16, it is possible that safe posture may have felt uncomfortable or awkward for participant 16, or been difficult to maintain for long periods of time for some other reason. Participant 16 reported during the exit interview that she did not
like the intervention, and would not like to experience it if she were working at a computer workstation on a regular basis. Researchers conducting this type of research in the future may therefore find it beneficial to ask participants during exit interviews whether safe posture felt awkward or uncomfortable, or whether some other variable may have affected their ability to adopt a safe posture.

Participants that were exposed to a withdrawal phase did not revert to pre-intervention safety levels following the removal of the intervention. Participant 9 continued to demonstrate high levels of safe posture during the reversal phase, and also during a follow-up session conducted 27 days after the last intervention session. Kanfer (1970) suggested that self-reinforcement may be responsible for the reactive effects of self-monitoring. If some type of self-reinforcement is indeed a variable that influences self-monitoring, a withdrawal of the self-monitoring intervention should have resulted in a gradual downtrend in performance over time. Participant 9's safety levels did not decrease following the withdrawal of the intervention, which would seem to suggest that a self-reinforcement account is not an adequate explanation of reactivity to self-monitoring in the present study.

Participant 6 demonstrated high levels of safe posture during a withdrawal session conducted three days after the last intervention session. It is possible that lower safety levels could have been observed had follow-up data been collected for a longer period of time. Another possibility is that safe posture was more comfortable for those participants whose performance maintained at high levels during withdrawal phases than an at-risk posture, and that kinesthetic stimuli associated with safe
posture therefore had more reinforcing value than those associated with at-risk posture.

The intervention in the current study may have been effective because it functioned to get participants to experience kinesthetic stimuli they otherwise would not have come into contact with, and those kinesthetic stimuli then came to control postural behavior. Yet another question is what motivative variables functioned to make those "safe" kinesthetic stimuli more reinforcing than "at-risk" kinesthetic stimulation.

The term motivative operation (MO) has been used to conceptualize the effects certain environmental events or stimulus conditions have on the behavioral processes of reinforcement and punishment. These effects were characterized as follows in a recent article, "In sum, MOs have two defining effects. They alter (a) the effectiveness of reinforcers or punishers (the value-altering effect) and (b) the frequency of operant response classes related to those consequences (the behavior altering effect)" (Laraway, Snycersky, Michael, & Poling, 2003, p. 412). Furthermore, MOs are categorized as being either conditioned or unconditioned. Conditioned MOs are effective because of an individual organism's unique behavioral history, whereas unconditioned MOs do not require a prior learning history to be effective.

The term motivative operation was introduced as a modification to an earlier account of motivative events, namely the establishing operation (Michael, 1993). Michael distinguished between three types of learned motivative events: surrogate conditioned establishing operations (CEOs), reflexive CEOs, and transitive CEOs. A
reflexive CEO can for example be a stimulus that has in the past been correlated with the onset of painful stimulation. The termination of the accompanying stimulus (the reflexive CEO) will then come to function as reinforcement, and behavior that has in the past resulted in the termination of the CEO will increase in frequency (the behavior-altering effect). Of course, in order for the reflexive CEO to function as such, the termination of the stimulus has to reliably prevent the painful stimulation.

The intervention in the current study may have been effective because the kinesthetic stimulation associated with safe posture produced a more comfortable seating position for some participants. The kinesthetic stimulation associated with safe posture may have therefore signaled the prevention of the onset of muscle or joint discomfort. The reinforcing value of the "safe" kinesthetic stimuli increased, and behavior that produced the stimuli increased in duration. A reflexive CEO account of the behavioral mechanisms responsible for the behavior changes observed in the current study may therefore explain both the effectiveness of the intervention, as well as why the removal of the intervention did not result in decrements in safe posture.

Another possible explanation of the behavioral mechanisms responsible for the behavior changes observed in the current study is that the kinesthetic stimulation associated with safe posture acquired a reinforcing value through some kind of verbal mediation. Participants were able to tact the correct verbal definition of safe posture because of the information sheet they reviewed at the start of every session, and were also asked to demonstrate very briefly each posture safely before the first intervention session. Most participants appeared to be able to reliably discriminate safe and at-risk
posture after seeing samples of safe and at-risk posture at the onset of the intervention phase, as witnessed by self-monitoring accuracy data. Improvements may therefore have occurred because of the added motivation to comply with the definition of safe posture following the introduction of the intervention. Possible rules that participants may have stated include: "If I am safe, I will be complying with what the experimenter is expecting from me", or "I will be a good participant if I am in a safe posture". This type of conformity has been termed "demand characteristics" (Orne, 1962) by psychologists. Demand characteristics are considered to be a threat to the internal validity of psychological research, because participants may respond to cues in the experimental environment that communicate the intent of the study.

Malott and Suarez's (2003) account of rule-governed behavior may explain in behavioral terms how verbal mediation could make kinesthetic stimuli associated with safe posture more reinforcing than kinesthetic stimuli associated with at-risk posture. A host of variables may have functioned as cues to communicate what was normative behavior in the experimental setting, for example, the title of the study, the safety information handouts at the start of every session, and video camera presence in clear view of participants at all times. If a participant stated a rule such as "If I am in a safe position, I am doing what is expected of me", the kinesthetic stimuli associated with at-risk posture could have created an aversive condition for that participant. The aversive condition could be avoided by adopting a safe posture, and experiencing the associated kinesthetic stimulation. A rule-governed account of safe postural behavior may explain why many participants consistently demonstrated safe posture for four out of five postural variables during the information-only phases.
Participants may have been able from the outset to associate the kinesthetic stimulation associated with safe posture with the verbal definitions of safe for the majority of the postural variables. A rule statement such as "I will be a good participant if I am in a safe posture" may have created an aversive condition during the information-only phase that was avoided by adopting a safe posture.

It is very unlikely, however, that rule statements can alone explain why improvements in safe posture were observed during intervention phases in the current study. A more likely explanation would be that rules about safe postural behavior may have interacted with the intervention components to produce improvements in postural variables that were consistently at-risk prior to the onset of the intervention. The fact that improvements were consistently observed immediately following the introduction of intervention further suggests that the information participants received through self-monitoring and visual feedback was a critical factor for improvement.

With the exception of participants 9 and 18, exit interviews were not suggestive of participants’ having created rules about safe performance. It is possible that the other participants may not have been able to tact whatever rules they may have generated, or were unwilling to disclose them.

The proportion of improvements associated with a self-monitoring response was more than was expected by chance, which suggests that the appearance of the feedback and self-monitoring browser windows may have functioned to prompt improvements in posture. However, it is unlikely that a prompt alone would be as effective as the intervention package, as the real-time visual feedback and self-monitoring most likely served a discrimination function, and accurate self-monitoring
appeared to be prerequisite for improvements in posture to occur in this study. The self-monitoring episode may also have functioned to give participants the opportunity to correct their posture, and then check their posture in the feedback window before submitting the self-monitoring checklist.

A high correlation was obtained when self-monitoring accuracy data and safety percentages were pooled across participants and correlated by session. The low number of data points per intervention phase, and lack of variability, most likely explain why only one correlation between accuracy and safety levels yielded a statistically significant outcome when targeted postures were analyzed independently. Some debate has surrounded the issue of whether self-monitoring accuracy is a prerequisite for self-monitoring to be effective (see, for example, Kanfer, 1970, and McCann & Sulzer-Azaroff, 1996).

McCann and Sulzer-Azaroff (1996) used an intervention package consisting in part of self-monitoring to improve posture at a computer workstation. The self-monitoring component of the intervention involved participants' estimating at the end of a session the percentage of time they thought they were in a safe position during that entire session. McCann and Sulzer-Azaroff reported that increased self-monitoring accuracy was associated with improvements in posture. The current study extends McCann and Sulzer-Azaroff's study by analyzing the relationship between self-monitoring accuracy and safety levels in a more molecular fashion. Whereas participants in McCann and Sulzer-Azaroff's study gave a global estimate of safety for each session, participants in the current study self-monitored on average over 20 times per session. Therefore, in this study it was possible to analyze agreement
between experimental scoring and participant scoring in a more fine-grained fashion. The current study also extends McCann and Sulzer-Azaroff's work by statistically correlating accuracy scores and safety data.

Maag, Reid, and DiGangi (1993) used a self-monitoring intervention to improve three types of classroom behaviors among elementary school children, and found that self-monitoring one variable sometimes resulted in improvements in other untargeted variables. These findings suggest that when people are required to self-monitor one element, improvements in other performances may emerge. Participant 9 clearly improved head/neck posture following the introduction of the intervention for back posture only (see Appendix J for a complete set of postural data for participant 9). It is possible that self-monitoring of the untargeted head/neck posture increased in frequency for participant 9 following the introduction of the intervention for back, which would explain the improvements observed for the untargeted head/neck variable concurrently with improvements in the targeted postural variable. Another potential explanation of the observed covariance in responding for participant 10 is that adopting a safe posture for back made safe posture for head/neck more comfortable than before.

Yet another interesting observation in the self-monitoring literature is that self-monitoring more than one behavior at the same time may reduce the effects of self-monitoring (Hayes & Cavior, 1977). Participant 10 was the only participant to self-monitor two behaviors at any time, and the second postural variable that was intervened on (arms) failed to improve. The failure to observe an improvement across the second of the two targeted postures for participant 10 may therefore be
explained by the fact that it was not possible for that participant to monitor two postures at a time, and/or the fact that self-monitoring accuracy remained very low for the second posture.

Overall, participants' productivity decreased to some degree following the introduction of the intervention, as measured by the number of words typed per minute. A decrease was perhaps to be expected in productivity during intervention, as participants' work was interrupted on average approximately every 55 s. Every interruption involved a self-monitoring response, finding the correct placement again in the text both in the computer file as well as the hard-copy, in addition to all mouse movements associated with these tasks. Seven of eight participants further suggested that the intervention would have worked better for them had the interval between self-monitoring requirements been longer. Future research can control for this decrement by asking participants to engage in a self-monitoring response during baseline.

Independent variable integrity data seem to suggest that overall, participants complied with the instructions given to them by the experimenter, as participants self-monitored on average approximately every 55 s. As the interval between a completed self-monitoring response and the next presentation of the self-monitoring checklist was 50 s, it can be deduced that the average response time to the self-monitoring checklist was approximately 5 s. Our analysis detected no systematic pattern across participants between the average number of self-monitoring responses per session and improvements in safe posture.

With the exception of participant 17, no consistently low safety performances were observed for leg position and hand/wrist position. Correct posture for legs may
be reliably accompanied by stimuli that are clearly distinct from stimuli associated with at-risk posture for legs, or safe posture of the legs may be a "natural" and comfortable position to be in. High levels of safe posture for hand/wrist position were most likely due to the setup of the workstation. The keyboard tray was tilted away from participants, and a foam wrist guard was placed in front of the keyboard. The wrist guard most likely functioned to deliver tactile feedback associated with safe posture. That is, as long as participants rested their wrists on the wrist guard, the wrists were in a neutral, safe, position.

Exit interviews were conducted with all participants, and all questions and answers can be found in Appendix L. The presence of the camera was only reported to be aversive by one participant, and seven out of eight participants indicated that they would rather have the camera as a source of feedback than an actual person. All participants believed that their posture had improved following the start of the intervention. Five participants felt that self-monitoring had interrupted their transcription work, whereas the other three did not. Six participants liked the intervention, and two were ambivalent in their appraisal of the intervention. Four participants reported that they would want to get video feedback on their posture if they were working at a computer workstation on a regular basis as a part of their job. Three reported not wanting this type of intervention in their workplace, and one participant said it depended on who had access to the visual materials. Seven participants indicated that they would have wanted the feedback to appear less frequently, two indicated they would have liked the feedback window to be constantly on the screen, and two participants suggested that the self-monitoring
component may have been redundant. Six participants reported that when they observed themselves in an at-risk posture, they scored themselves as being at-risk, but adjusted to a safe posture before submitting the checklist. Two participants reported that they did not comply with the instructions every time, as they sometimes scored their posture as safe, even though they observed themselves initially as being at-risk.

Some strengths of the current study include that this is the first study that focuses on real-time visual feedback and self-monitoring checklist delivery through a computer browser window environment, and it represents the application of new technology to the problem of MSDs resulting from computer work. Another strength of the current study is its molecular approach to addressing the question of whether a correlation exists between self-monitoring accuracy and safety performance. This study also suggests a host of other future studies in which the delivery system and/or the components of the intervention could be manipulated to discover the most economical, yet effective way to achieve improvements in posture through a computer interface.

For example, the intervention may be made more effective by superimposing transparent normative guides on the feedback window to demonstrate to participants where body parts should be located in a two-dimensional space in order to demonstrate safe posture. Another potential study could examine over longer periods of time how resistant postural behavior is to decrements in safety performance following the withdrawal of the intervention.

One possible limitation of the study may be that the work environment was somewhat artificial in appearance, as participants sat in an office chair with an
attached camera. Another limitation of the study may have been that the workstation was individually set up to be compliant with OSHA guidelines for each participant, which may not represent the conditions prevalent in the average workplace. For example, Culig (2002) found that workstations in an actual office setting had overall very low levels of compliance with accepted workstation setup guidelines. However, in this study, it was necessary to limit variability in safety posture attributable to workstation variables.

Another potential limitation of the intervention is that productivity decreased considerably during intervention phases, as compared to information phases. A ten percent decrease in performance is a substantial decrease, and can most likely be attributed to the dense schedule of self-monitoring utilized in the current study. Future research may focus on the extent to which the schedule of intervention delivery could be thinned, without a corresponding decrement in improvements in posture.

A third possible limitation of the current study is its use of a package intervention. Future research may focus on breaking down the components involved in the delivery system of the intervention, so that, for example, visual feedback alone could be compared to self-monitoring without visual feedback. Yet another question that future research may address is whether a simple safety prompt delivered on a given schedule through a computer browser window may effect improvements in posture.

The current study demonstrated convincingly that a computer delivery system for real-time visual feedback and self-monitoring can be effective in improving
posture at computer workstations in a laboratory environment. When the optimal parameters for intervention effectiveness and durability of behavior change have been discovered, future applications of the intervention should surely involve computer workstation workers in actual office settings. If consistent and durable improvements can be achieved outside the laboratory as was done in this study, progress could be made in battling the prevalence of MSDs among computer workers.
Appendix A

Script for Screening and Consent Process
SCRIPT FOR SCREENING AND CONSENT PROCESS

To be read aloud by either SI or RA

1. "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 the participant a consent form and read it aloud to him/her]

2. "Do you have any questions regarding the consent form? Please sign the copy of the consent form from my records, and keep the other copy for your records."

[After receiving the signed consent form, ask following questions]

3. "Have you participated in any other studies conducted by members of Dr. Austin's PM lab?"

[If participant says "Yes" to this question, go to item #7 in this script. If the participant answers "No", go to item #4]

4. "Do you suffer from chronic pain, for example, in the back, have musculo-skeletal disorders, or any other condition that may result in pain when sitting at a computer workstation?"

[If participant says "Yes" to this question, go to item #7 in this script. If the participant answers "No", hand participant Postural Comfort Survey, and go to item #5]

5. "Please complete the following Postural Comfort Survey."

6. "We will now ask you to demonstrate for me that you can touch type. We will test your touch typing by asking you to type at least 30 words per minute over the span of five minutes, while not looking at the keyboard."

[Lead participant to experimental room, and ask him/her to demonstrate touch-typing proficiency]

[If participant does not meet any of the inclusion criteria, read the following to him/her]

7. "Thank you for your willingness to participate in this study. This study has certain inclusion criteria, that are both for research purposes and for your own
You have not met this study's criteria for participation. We would like to thank you for your time. We will contact you again after all participants have completed participation. We will then schedule an exit review meeting, and you will then receive the $2.50 for this session.
Appendix B

Postural Comfort Survey
POSTURAL COMFORT SURVEY

Purpose: Determine the level of pain or discomfort

Name____________________________________________________

Time ____________________ Date_________________________________

Instructions: Complete each of the 3 methods (each within a box) to rate your comfort
Method # 1 is used for overall comfort or discomfort
Method # 2 allows rating specific body parts in pain or discomfort
Method # 3 allows shading the body parts in pain or discomfort

THINK ABOUT HOW YOU FEEL RIGHT NOW
1. Are there any areas of pain or discomfort?
   Comfort Score Scale:
   1  2  3  4  5  6  7  8  9  10
   very comfortable  some discomfort  uncomfortable  very uncomfortable  intolerable

USING THE 1 - 10 SCALE, INDICATE YOUR COMFORT IN THE APPROPRIATE BOX BELOW: 1 being very comfortable to 10 being very uncomfortable

<table>
<thead>
<tr>
<th>Area of Body</th>
<th>Left Front</th>
<th>Left Back</th>
<th>Right Front</th>
<th>Right Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdomen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Back</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Back</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Back</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Arm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forearm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist</td>
<td></td>
<td></td>
<td></td>
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<td>Foot</td>
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Appendix C

Information Phase Script
INFORMATION PHASE SCRIPT

This script is to be read aloud by either the SI or RA prior to each Information phase session.

"Prior to doing any work at the computer workstation, you are requested to look over the safety definitions on this handout. I will leave the room, and come back in five minutes and take you to your workstation."

[Hand the participant the Safety Information Handout, leave, and re-enter after 5 minutes]

"Please initial the Safety Information Handout."

[Lead the participant to computer workstation]

"Your task for this session will be to transcribe the article positioned in the document tray on the side of the computer screen. We will monitor the number of words you transcribe. We will also monitor your posture through the camera that is attached to your office chair. Please do not exit the Word program you are working in, or open other programs, or change any computer or workstation settings.

Please work at your own pace for the next 20 minutes. Take a 30 second break if, at any time, you feel any fatigue or discomfort. I will knock on the door to signal the end of the session. Restrooms and water fountains are located outside of the lab entrance on the left. I can also show you their location if you wish.

Do you have any questions?"
Computer Workstation Posture Guidelines

Please review this safety handout for 5 minutes. When you have finished, please initial the handout on the line at the bottom of the page to verify that you have read the handout.

- **Back supported** – lower back (lumbar) supported and reclined posture producing an angle of the back and the thigh between 100-110 degrees.
- **Head/Neck** – head upright, or in line with the torso (not bent down/back), or head facing slightly forward of the plane of the upper body.
- **Arms** – inside angle of elbow between 90-120 degrees.
- **Hand-wrist position** – wrists flat (not bent up or down) when typing on keyboard.
- **Leg position** – knees bent forming an angle between 90-120 degrees.

Initials   Date
Appendix E

Information, Self-Monitoring, and Feedback Phase Script
INFORMATION, SELF-MONITORING, AND FEEDBACK PHASE SCRIPT

This script is to be read aloud by either the SI or RA prior to each Information and Feedback phase session.

"Prior to doing any work at the computer workstation, you are requested to look over the safety definitions on this handout. I will leave the room, and come back in five minutes and take you to your workstation."

[Hand the participant the Safety Information Handout, leave, and re-enter after 5 minutes]

"Please sign the Safety Information Handout."

[Lead the participant to computer workstation]

"Your task for this session will be to transcribe the article positioned in the document tray on the side of the computer screen. We will monitor the number of words you transcribe. We will also monitor your posture through the camera that is attached to your office chair.

During this work session, you will see a window appear on your computer desktop every 50 seconds. The window will contain real-time video of yourself. The image will look something like this."

[Show participant a picture captured from a feedback window on computer screen]

"At the same time as when you see the real-time video feed of yourself, you will be prompted to complete a safety checklist. The safety checklist will appear in another window on your desktop at the same time as the video feed. The checklist will require you to score whether some of your body parts are in a 'safe' or 'at-risk' position. The checklist may require you to make judgments about the safe positioning of one or more body parts at a time based on the safety information you have been studying at the beginning of the sessions. You should try to make those judgments based on the image you saw of yourself the first time you looked at the feedback window. You can have the feedback window open as long as you need to in order for you to score your behavior accurately.

When you have completed the checklist based on your own posture, you will click the 'Submit' button. Clicking the 'Submit' button will close the feedback window. The feedback window will re-appear after a certain amount of time, and you will again be requested to score your posture. This procedure will continue until the end of the session.

After you have completed the checklist, and the feedback window has disappeared, you will have to re-activate the Word processor window by clicking on
the window with the mouse. If you do not activate the window, the input from the keyboard will not appear in the Word Window.

Now I want to ask you to show me how you would complete a sample checklist."

[Start the computer program, and help participant complete more checklists, if needed]

Now that you are ready to start, I would like to ask you to please work at your own pace for the next 20 minutes. Take a 30 second break if, at any time, you feel any fatigue or discomfort, and please realize that you might still feel some discomfort, even though you are in a safe position. I will knock on the door to signal the end of the session. Restrooms and water fountains are located outside of the lab entrance on the left. I can also show you their location if you wish.

Do you have any questions?"
Appendix F

Exit Interview Questions
EXIT INTERVIEW
To be read by either SI or RA

1. What do you think was the purpose of the study?

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

3. Was the presence of the video camera unpleasant for you?

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?

6. Do you think your posture was unsafe before you started getting the video feedback?

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?

11. Did you like getting the video feedback?

12. If you were working at a computer workstation on a regular basis as a part of your job, would you want to get video feedback on your posture like was done in this study?

13. What would you change about the video feedback to make it work better for you?
   -Frequency: Make it appear more or less often.
   -Presence: Have feedback on the screen all the time.
   -Self-monitoring: Remove or modify self-scoring component.
   -Anything else?

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14. What did you say to yourself, if anything, during the session and when you saw the video feedback?

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
Appendix G

Safety Checklist for Research Assistants
<table>
<thead>
<tr>
<th>Participant:</th>
<th>Session:</th>
<th>Date:</th>
<th>Observer:</th>
<th>Scoring: MTS / Wi</th>
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<tbody>
<tr>
<td>Chapter 1 Start Time:</td>
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<td>Back</td>
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angle of the back and the thigh between 100-110
degrees | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Head/neck | head upright, or in line with the torso, or facing slightly forward | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Arms | inside angle of elbow between 90-120 degrees | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Hand/wrist | wrists flat (not bent up or down) when typing on keyboard | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Legs | knees bent forming an angle between 90-120 degrees | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |

| Chapter 2 Start Time: | | | | |
| Back | 
angle of the back and the thigh between 100-110
degrees | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Head/neck | head upright, or in line with the torso, or facing slightly forward | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Arms | inside angle of elbow between 90-120 degrees | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Hand/wrist | wrists flat (not bent up or down) when typing on keyboard | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |
| Legs | knees bent forming an angle between 90-120 degrees | 2:00 FB | 2:10 FB | 2:20 FB | 2:30 FB | 2:40 FB | 3:00 FB | 3:10 FB | 3:20 FB | 3:30 FB | 3:40 FB | 3:50 FB | 4:00 FB | 4:10 FB | 4:20 FB | 4:30 FB | 4:40 FB | 5:00 FB | 5:10 FB | 5:20 FB | 5:30 FB | 5:40 FB | 5:50 FB | 6:00 FB | 6:10 FB | 6:20 FB | 6:30 FB | 6:40 FB | 6:50 FB |

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Appendix H

Consent Form to Participate in Study
WESTERN MICHIGAN UNIVERSITY

Department of Psychology

Investigating the Effects of Real-time Visual Feedback on Computer Workstation Posture

John Austin and Sigurdur Oli Sigurdsson
WESTERN MICHIGAN UNIVERSITY

**Purpose.** You are invited to participate in a research study that will evaluate performance in a simulated office environment. The intent of the study is to determine the effectiveness of feedback and self-observations on work safety.

**Duration.** Sessions will last approximately 20 minutes, and you will be asked to participate in approximately 20-25 sessions over 6-8 weeks. You may schedule up to 2 sessions per day, with a minimum 30-minute break between sessions. Sessions can be scheduled any day from Monday to Sunday. No sessions in this study will exceed 30 minutes.

**Criteria for participation.** In order to participate in this study, you must be able to touch-type. You must not have participated, or currently be a participant, in any studies conducted in Dr. Austin's lab. You must also not have any chronic bodily pain (or history of such pain), such as back pain or a musculo-skeletal disorder (for example, carpal-tunnel syndrome), or any other bodily condition that may increase the risk of getting injured while sitting at a computer workstation for the duration of the study.

**Explanation of study procedures.** You will be asked to transcribe a written text on a computer. You will be working at a computer workstation in the Performance Management Lab in Wood Hall. The setting is intended to simulate a real-life office work environment.

**Compensation.** You can earn up to approximately $5 per hour for participating in this study. The money earned during the course of the study will not be forfeited should you choose to withdraw from the study. We would also like to remind you that the money earned in the study will be paid at the end of your participation.

**Benefits.** You will not receive any direct benefits as a result of participating in this study, aside from the monetary compensation. Data gathered from your participating in the study may benefit the general scientific community by providing information on the effectiveness of feedback and self-observations on posture.

**Risks and Protections.** Potential risks to you may include mild uneasiness associated with being observed through a video camera. You may also experience mild uneasiness and/or fatigue associated with the transcription task. This risk will be minimized by the fact that each session is relatively short in duration, and you are strongly encouraged to take micro-breaks of about 30 seconds if you feel uncomfortable or fatigued.

You are free to schedule sessions at any time during workdays that suits your schedule, and you will be free to withdraw from the study at any time if participation is taking up too much of your time.

As in all research, there may be unforeseen risks to you. 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 information collected in this study from you and about your performance is confidential. That means that neither your name nor any other type of identifying information will

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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 computer databases for analysis purposes. If any still pictures or video of your performance will be publicly displayed for any reasons, your facial features will be sufficiently occluded to prevent identification, and all time and date stamps on pictures or video will be removed.

Any presentations or publications will use code numbers to label individual data. You will be randomly assigned a number by Sigurdur Oli Sigurdsson. All data will be entered into databases using identification numbers. Sigurdsson will maintain a master list of your name and identification number until data collection is completed. The master list will be destroyed when data collection is completed. Sigurdsson will maintain the security of all data collection forms throughout the duration of the study. The data collection forms will be stored in a locked cabinet inside a locked office (2532 Wood Hall). Only Sigurdsson and Dr. John Austin will have access to the locked cabinet. Upon completion of the study, all your forms will be stored in a locked cabinet inside a locked office (2532 Wood Hall) for at least three years and then destroyed.

Sigurdur Oli Sigurdsson and Dr. John Austin are prepared to meet personally with you if you wish to discuss any aspects of this research project and answer questions about the way data may be or are presented. As mentioned above, any information that could identify you will be removed from data used in any publications or presentations.

Voluntary Participation. Your participation in this study is completely voluntary. You are free to withdraw at any time without penalty, and you will receive a cash payment for the amount of time you participated. Your participation in this study, or withdrawal from it will not affect your grades in any courses. At the end of the study, the experimenter will answer any questions you have and explain how your data helped us to learn more about feedback and office safety.

Who to contact with questions. If you have any questions about this study, you may call Sigurdur Oli Sigurdsson at 296-598-6450. In addition, Dr. John Austin, my faculty advisor, can be reached at 269-387-4495. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293, or the Vice President of Research at 269-387-8298 if questions or problems arise during the course of the study.

Your signature below indicates that you have read the above information and agree to participate in the study. Your signature below also indicates that you agree to have visual media in which you appear used for presentation or educational purposes, given that all identifying features will be blurred, and time and date stamps will be removed.

X

Participant Signature Date

Please keep the attached copy of this form for your records

This consent form has been approved for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped data and signature of the board chair in the upper right corner. Subjects should not sign this document if the corner does not show a stamped date and signature.
Appendix I

HSIRB Approval Form
Date: February 23, 2005

To: John Austin, Principal Investigator
   Sigurdur Sigurdsso, Student Investigator for dissertation

From: Mary Lagerwey, Ph.D., Chair

Re: HSIRB Project Number: 05-02-08

This letter will serve as confirmation that your research project entitled “Investigating the Effects of Real-time Visual Feedback on Computer Workstation Posture” 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: February 23, 2006
Appendix J

Complete Data Sets for All Participants
Information, Video Feedback and Self-Monitoring

Percentage of Safe Samples

Information

3 wk.

Follow up

Back

Head/Neck

Arms

Hand/Wrist

Leg

Productivity

Sessions

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Appendix K

Scatterplots for Accuracy and Safety by Participant
Appendix L

Exit Interview Questions and Answers
PARTICIPANT 6 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   
   Evaluate posture in a work setting.

2. What do you think was being measured or observed?
   
   My arm angles, and overall posture.

3. Was the presence of the video camera unpleasant for you?
   
   No.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   
   No.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   
   No.

6. Do you think your posture was unsafe before you started getting the video feedback?
   
   Yes.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   
   Yes.

9. (If answer to #8 was yes) How much did your posture improve?
   
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    
    No.

11. Did you like getting the video feedback?
    
    Yes. It was helpful to monitor and see yourself.

12. If you were working at a computer workstation on a regular basis as a part of your job, would you want to get video feedback on your posture like was done in this study?
Yes, I would - I think it is very helpful.

13. What would you change about the video feedback to make it work better for you?
   - Frequency: Make it appear more or less often. Less often. Every 1.5-2 minutes. Variable would be ok, but not too variable.
   - Presence: Have feedback on the screen all the time. Yes.
   - Self-monitoring: Remove or modify self-scoring component. No.
   - Anything else? No.

14. What did you say to yourself, if anything, during the session and when you saw the video feedback?
   I do not remember anything specific about that.

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
   If I saw myself as at-risk, I scored myself like that, and then I adjusted.
PARTICIPANT 9 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   It changed throughout the experiment. First I thought there was a hidden camera and you were watching me for the first 5 minutes. Then I thought you were going to see if I typed it right, and then I just thought it was posture only.

2. What do you think was being measured or observed?
   Posture.

3. Was the presence of the video camera unpleasant for you?
   I did not think about it - I actually forgot about it, but then I remembered it during the pop-up phase.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   I was a waitress in a bar for 5 months, and there were public safety cameras there.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   No way. That would have made me really nervous.

6. Do you think your posture was unsafe before you started getting the video feedback?
   No. I figured if I was alright if I was comfortable.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   Yes.

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    Yes.
11. Did you like getting the video feedback?
   Yes, because it improved my posture, specially during the first 2 sessions. Then it got annoying.

12. If you were working at a computer workstation on a regular basis as a part of your job, would you want to get video feedback on your posture like was done in this study?
   Yes.

13. What would you change about the video feedback to make it work better for you?
   -Frequency: Make it appear more or less often. Have it pop-up randomly, so I could "get caught", and I would think I did not realize I was sitting like that.
   -Presence: Have feedback on the screen all the time. No.
   -Self-monitoring: Remove or modify self-scoring component. Remove it, I do not know though. In a regular work situation, I do not think it would add anything, in my opinion.
   -Anything else? I do not think so.

14. What did you say to yourself, if anything, during the session and when you saw the video feedback?
   God, will this thing just stop - the pop-up. I just thought it was annoying. But I saw my back posture improve. "Keep your lower back against the backrest" - I said that to myself. That started in the pop-up phase.

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
   I would usually correct afterwards.
PARTICIPANT 10 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   Would I correct my posture if I realized it was wrong.

2. What do you think was being measured or observed?
   My posture - what you told me - or it could have been something entirely.
   Measuring my reaction to something else.

3. Was the presence of the video camera unpleasant for you?
   It was fine.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   My last job at a bookstore - I worked in the coffee-store and I had a camera on me the whole time.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   No, I would prefer the camera.

6. Do you think your posture was unsafe before you started getting the video feedback?
   Yeah - pretty much all unsafe all the time.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   Yeah - and I still think about it, even in class. I thought about it, but I did not change it.

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    Yes, I felt I was a lot more productive when I was not getting the feedback.

11. Did you like getting the video feedback?
    Yes.
12. If you were working at a computer workstation on a regular basis as a part of your job, would you want to get video feedback on your posture like was done in this study?
   Yes.

13. What would you change about the video feedback to make it work better for you?
   - Frequency: Make it appear more or less often. Less often. I started to know the timing. Every 5 mins would be better.
   - Presence: Have feedback on the screen all the time. No
   - Self-monitoring: Remove or modify self-scoring component. I would not change it.
   - Anything else? No.

14. What did you say to yourself, if anything, during the session and when you saw the video feedback?
   God, I look terrible! My posture looks worse than it feels. Maybe it is because my back is curved. It became a bit uncomfortable to be completely straight.

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
   I adjusted in between scoring and submitting.
PARTICIPANT 11 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   Maybe monitor typing speed. Something to do with your posture.

2. What do you think was being measured or observed?
   Posture and typing speed.

3. Was the presence of the video camera unpleasant for you?
   No.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   When I was a manager for a pizza store, I had a supervisor who said she was watching us on video, but she never watched them and we got away with everything.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   Probably not.

6. Do you think your posture was unsafe before you started getting the video feedback?
   Yes, according to sheet.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   Yes.

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    Not too much.

11. Did you like getting the video feedback?
    Sure.

12. If you were working at a computer workstation on a regular basis as a part of your
    work...
job, would you want to get video feedback on your posture like was done in this study?
   No. Because it interrupts you and makes you feel like you are being watched.

13. What would you change about the video feedback to make it work better for you?
   -Frequency: Make it appear more or less often. Make it appear less often.
   -Presence: Have feedback on the screen all the time. Have it all the time.
   -Self-monitoring: Remove or modify self-scoring component. Yes, because people get the idea that they should be watching their posture.
   -Anything else? No.

14. What did you say to yourself, if anything, during the session and when you saw the video feedback?
   I guess I have to move my arms a little bit. Sometimes if I got bored I tried to finish the whole thing I was supposed to type.

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
   I changed afterwards.
PARTICIPANT 12 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   To improve posture for people that work at computers, prevent injury.

2. What do you think was being measured or observed?
   Body placement.

3. Was the presence of the video camera unpleasant for you?
   No, kind of fun.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   No.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   No. Not initially, anyway. Maybe after I got used to the camera - I was able to see myself what I was doing.

6. Do you think your posture was unsafe before you started getting the video feedback?
   Yes.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   Yes.

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    I lost my place a few times, but it was not too bad most of the time.

11. Did you like getting the video feedback?
    Yes.

12. If you were working at a computer workstation on a regular basis as a part of your job, would you want to get video feedback on your posture like was done in this
study?

Maybe periodically.

13. What would you change about the video feedback to make it work better for you?
   - Frequency: Make it appear more or less often. **Less often, every 5 mins or so.**
   - Presence: Have feedback on the screen all the time. **No.**
   - Self-monitoring: Remove or modify self-scoring component. **No.**
   - Anything else? **It would have to be smaller to fit into an office.**

14. What did you say to yourself, if anything, during the session and when you saw the video feedback?
   **I kind of laughed at it first - laughing at myself. Not much else.**

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
   **I think I did both. Sometimes before, sometimes after.**
PARTICIPANT 16 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   To look at posture.

2. What do you think was being measured or observed?
   The posture on the handout. How many words were typed.

3. Was the presence of the video camera unpleasant for you?
   No.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   No.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   No, I would rather have the camera.

6. Do you think your posture was unsafe before you started getting the video feedback?
   Yes.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   I think so - hopefully

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    No.

11. Did you like getting the video feedback?
    A little.

12. If you were working at a computer workstation on a regular basis as a part of your job, would you want to get video feedback on your posture like was done in this study?
13. What would you change about the video feedback to make it work better for you?
   - Frequency: Make it appear more or less often. **Less often.**
   - Presence: Have feedback on the screen all the time. **Come up randomly.**
   - Self-monitoring: Remove or modify self-scoring component. **Remove it.**
   - Anything else? **No.**

14. What did you say to yourself, if anything, during the session and when you saw the video feedback?
   **Not really - just looked to see what my posture was like.**

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
   **After.**
PARTICIPANT 17 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   I am a paranoid persons - I thought it has something to do with the topic of what I was typing. I also wondered it it was about posture.

2. What do you think was being measured or observed?
   My back posture - like on the handout. Was this about self-correction?

3. Was the presence of the video camera unpleasant for you?
   I am anxious when people watch me. I prefer solitude. I want to stretch and relax by myself.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   Yeah - I worked at a game store and Meijer, and they type some parts of the store. That was different from this - I knew I was being studies. In the workplace it is only watched when something goes wrong.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   Either way would have been fine. I can not really tell because I did not experience it.

6. Do you think your posture was unsafe before you started getting the video feedback?
   It was alright, but needed improvement.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   A little bit. It helps so you realize what you are trying to do.

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    A little bit. You begin to complete it faster though as you go through the experiment.
11. Did you like getting the video feedback?
   Ambivalent. Benefits my posture perhaps, lets me see how I sit. Made me
   feel a little bit nervous.

12. If you were working at a computer workstation on a regular basis as a part of your
    job, would you want to get video feedback on your posture like was done in this
    study?
   It depends. Depends on the level of trust I have with people there. If it is
   just about posture, I would be ok with it. If it was not my boss, but
   somebody outside the company, I would feel better.

13. What would you change about the video feedback to make it work better for you?
   - Frequency: Make it appear more or less often. No idea.
   - Presence: Have feedback on the screen all the time. Variable intervals
     would be fine. When one is not expecting it.
   - Self-monitoring: Remove or modify self-scoring component. When I self-
     monitored, it was a reflection of my mood. If I wanted to feel better
     about myself, I think I tried to score myself more safe.
   - Anything else? Type something more work-related. Some of the texts
     were uninteresting. I am sensitive to that kind of stuff.

14. What did you say to yourself, if anything, during the session and when you saw
    the video feedback?
   I have not such great posture - this is better posture.

15. When you scored how safe your posture was, did you adjust before or after you
    completed the checklist?
   Sometimes I adjusted. Depending on how aversive it was - how
   uncomfortable it felt.
PARTICIPANT 18 EXIT INTERVIEW

1. What do you think was the purpose of the study?
   Study posture. Changes from when I was seeing myself compared to when I was.

2. What do you think was being measured or observed?
   Posture.

3. Was the presence of the video camera unpleasant for you?
   No.

4. Do you have any experience with your work being taped or observed, for example, through a closed-circuit television?
   No.

5. Would you rather have had to have a real person in the room giving you feedback than the video camera?
   No, I liked the video camera.

6. Do you think your posture was unsafe before you started getting the video feedback?
   I did not think it was that bad.

7. (If answer to #6 was yes) How 'at-risk' do you think your posture was before you started getting the video feedback:
   1) very much at-risk
   2) somewhat at-risk
   3) not very much at-risk

8. Do you think your posture improved as a result of getting the video feedback?
   Yes.

9. (If answer to #8 was yes) How much did your posture improve?
   1) a lot
   2) somewhat
   3) a little bit

10. Did the video feedback and self-scoring interrupt your transcription work?
    Yeah, I was really annoyed.

11. Did you like getting the video feedback?
    It was alright, because I corrected my posture, but I would not mind if I did not have it.

12. If you were working at a computer workstation on a regular basis as a part of your
job, would you want to get video feedback on your posture like was done in this study?

Probably not. Because it would be interrupting what I was doing all the time.

13. What would you change about the video feedback to make it work better for you?
   - Frequency: Make it appear more or less often. Less often. Every few minutes maybe.
   - Presence: Have feedback on the screen all the time. All the time, because then I could look every time I wanted to.
   - Self-monitoring: Remove or modify self-scoring component. No.
   - Anything else? No.

14. What did you say to yourself, if anything, during the session and when you saw the video feedback?
   I did not realize how slouched I was. I have to sit up straight because it is better for you.

15. When you scored how safe your posture was, did you adjust before or after you completed the checklist?
   Before, but I checked the list as I was before I adjusted.
References


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