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Examining the Effects of Individualized Computer Work Station Adjustments and Performance Management on Safe Behavior

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EXAMINING THE EFFECTS OF INDIVIDUALIZED COMPUTER WORKSTATION ADJUSTMENTS AND PERFORMANCE MANAGEMENT ON SAFE BEHAVIOR

by

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EXAMINING THE EFFECTS OF INDIVIDUALIZED COMPUTER WORKSTATION ADJUSTMENTS AND PERFORMANCE MANAGEMENT ON SAFE BEHAVIOR

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Western Michigan University, 2002

The first purpose of this study was to examine the effects of office ergonomic assessments and resulting computer workstation adjustments on safe behavior. The adjustments were designed to reduce or eliminate barriers to performing safely, thus creating an environment that would allow participants to assume safe behaviors. The second purpose of the study was to examine the effects of a performance management (PM) package, including ergonomic information, graphic feedback, and praise, which targeted those behaviors that did not substantially change as a result of the workstation adjustments. A multiple baseline design across participants was used to assess the effects of the interventions in seven administrative offices on the campus of a midwestern university. Only two participants exhibited substantial improvements in safety performance during the ergonomic assessment phase of the study, whereas safety performance of all seven participants increased substantially during the PM package phase. Follow-up measures indicated performance maintenance for three of four participants observed. The possible behavioral functions responsible for these performance improvements are discussed in detail. Future research is suggested to further examine the effectiveness of this behavioral technology to support and enhance office ergonomic programs and to bring about lasting behavior change.

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INTRODUCTION

The purpose of the present study was to evaluate the effectiveness of ergonomic assessments conducted by senior Occupational Therapy (OT) students. Based on this evaluation, researchers were able to examine the effects of individualized computer workstation adjustments on safe behavior. This study evaluated the adjustments that were suggested and/or made to computer workstations by the OT students. The adjustments were designed to reduce or eliminate barriers to performing safely, thus creating an environment that would allow participants to assume safe behaviors. Participants were also given the option of receiving a performance management package, including ergonomic information, graphic feedback, and praise, to target those behaviors that did not change as a result of the workstation adjustments. Thus, the study also provided a means of assessing the effectiveness of the performance management package in changing persistent at-risk behaviors. The research was conducted in a variety of administrative offices on the campus of a midwestern university. A multiple baseline design across individuals was used to assess the effects of the interventions among seven university employees. Substantial improvements in safety performance occurred after participants received ergonomic training, feedback and praise. Results are discussed in terms of the benefits to organizations attempting to evaluate and improve the effectiveness of their ergonomics programs and their behavior based safety (BBS) observation processes.

REVIEW OF LITERATURE

Work-Related Musculoskeletal Disorders

Each year in the United States thousands of workers report work-related musculoskeletal disorders (MSD). Since 1992, MSD injuries and illnesses have accounted for more than one third of the total lost worktime cases reported in private industry workplaces, according to a survey by the Bureau of Labor Statistics (United States Department of Labor [USDOL], 2001). In 1999, there were more than 580,000 lost worktime cases involving MSDs (USDOL, 2001). Employers pay approximately $20 billion annually in direct workers' compensation costs and another $60 billion in indirect costs related to MSD injuries and illnesses (USDOL, 2001). The prevention of these injuries and illnesses would be beneficial to both the health and well being of workers and the national economy.

The cost of MSD injuries and illnesses can reach staggering proportions because long-term disabilities often result (Blake-McCann & Sulzer-Azaroff, 1996). The U.S. Department of Labor defines an MSD as a soft-tissue injury or disorder of the muscles, nerves, tendons, joints, cartilage, and/or spinal discs (USDOL, 2001). MSDs are also commonly referred to as repetitive stress injuries (CTD News, 2000), cumulative trauma disorders (Blake-McCann & Sulzer-Azaroff, 1996; Hochanadel, 1995; Kroemer, 1989), and repetitive strain injuries (Kiesler & Finholt, 1988). Given the nature of soft-tissue injuries, affected workers may ultimately face a crippling disability that prevents them from doing simple everyday tasks (Occupational Safety and Health Administration [OSHA], 1999).

The U.S. Occupational Safety and Health Administration (OSHA) estimates that 90 percent of all U.S. office workers now use computers and 40 percent work on their computers at least four hours a day (OSHA, 1999). However, ergonomic experts warn that the risk of developing MSDs increases by using the computer as little as one hour a day. And the risk of injury is nine times greater for those who spend four hours a day using the computer than it is for those who spend one hour per day (Hedge, 2002a). As a result of the technological advancements of today's workplace, many office workers no longer need to leave their desks to perform many time-inefficient tasks of the past, such as copying documents, sending and receiving mail and filing. Accordingly, computer terminal workers may now face prolonged periods of sustained seated postures (McLean, Tingley, Scott, & Rickards, 2001). The incidence of MSDs in computerized workstation environments is on the rise (Bergqvist, Wogast, Nilsson, & Voss, 1995; McLean et al., 2001), which is due, among other factors, to the maintenance of sustained postures, which affect the low back, the upper limbs and neck (Nelson & Silverstein, 1998; Sauter & Schleifer, 1991). Repetitive keyboard and mouse use places workers at risk of muscle, tendon, and nerve damage (Marcus, 1996). The risk of injury may be further compounded when workers are using computer workstations that prevent them from employing safe postures. Further evidence supporting a causal link between highly repetitive work and neck and neck/shoulder MSDs is reported in an in depth analysis of over 600 epidemiological studies reviewed by the National Institute of Occupational Safety and Health (National Institute of Occupational Safety and Health [NIOSH], 2000), and the National Academy of Sciences (NAS), (USDOL, 1998). What we don't know is if adjusting the computer workstation to fit the worker leads to lasting behavior change and therefore, reduced risk of MSD.

Ergonomics

Ergonomics literally means the natural law or system of work (Grandjean, 1988; Grimaldi & Simonds, 1989). The ergonomics approach goes beyond productivity, health, and safety. It includes consideration of the total physiological and psychological demands of the job on the worker (Plog, Niland, & Quinlan, 1996). Ergonomics interventions are aimed at establishing compatibility among the worker, the job and the job environment (Grimaldi & Simonds, 1989; NAS, 2001). Ideally, the practice of ergonomics relies on a process that tailors interventions to specific circumstances currently found to be effective, continues to assess the effectiveness of these interventions in the face of changing workplace and worker factors, and evaluates new interventions (NAS, 2001). Practically speaking, the practice of ergonomics in organizations usually does not include ongoing evaluation and assessment of interventions but stops once the ergonomic fix is in place. For example, many employers have approached ergonomics issues related to the office environment by focusing on individual workstation components such as the keyboard, monitor, work surface or chair (Robertson & Courtney, 2001). This is not surprising when considering that much of the scientific research in office ergonomics has focused on the effects of individual workstation components, for example monitor placement (Psihogios, Sommerich, Mirka, & Moon, 2001), keyboard design (Hedge, Morimoto, & McCrobie, 1999; Swanson, Galinsky, Cole, Pan, & Sauter, 1997), desk height (Bhatnager, Drury, & Schiro, 1985), and chairs (Shute & Starr, 1984). The outcomes reported in the office ergonomic literature most commonly focus on employee self-reported measures, using comfort and pain questionnaires. The literature is noticeably silent on the topic of posture/performance relationships (Bhatnager et al., 1985).

Ergonomics research has demonstrated that there is a link between workstation variables and posture. Green, Briggs, and Wrigley (1991) found that working postures are directly related to the workstation, and effective adjustment of the equipment is often required before correct posture can be assumed. In a review of 43 articles, Smith, Karsh, and Moro (1999) concluded that ergonomic interventions appear to have positive effects on musculoskeletal discomfort, CTD incidence, accident incidence, and body posture. The question still remains as to whether adjusting the computer workstation to fit the worker will be sufficient to bring about lasting behavior change.

The results of ergonomics research have provided the scientific basis for the development and implementation of workplace ergonomic programs. Traditional approaches to managing ergonomic risks include strategies to identify and then reduce exposure of employees to ergonomic hazards (Hedge, 2001; Martin & Andrew-Tuthill, 1999; Perdue, 1999; Schneider, 2001). Common features of comprehensive ergonomic intervention programs include (a) an ergonomics hazards analysis of the worksite to identify existing and potential hazards, (b) an effective training program to teach employees to recognize and report the early warning sings of ergonomic-related injuries, understand the basic ergonomic risk factors, and use simple strategies to prevent ergonomic injury, (c) planning and implementing corrective actions to improve the workplace which may include engineering and work practice controls, personal protective equipment, and administrative controls, and (d) implementing program maintenance strategies including periodic refresher training, follow-up analysis, and workstation redesign and adjustment as needed (Martin & Andrew-Tuthill, 1999; Perdue, 1999; Schneider, 2001). Unfortunately, no mechanisms are suggested to encourage or support employees to continue to use ergonomically sound work practices. Even the best designed tools and workstations are frequently misused even after delivery of well-designed ergonomics training (Perdue, 1999). The following section provides evidence and suggestions for how a behavioral observation and feedback process can be used to complement traditional ergonomic techniques.

Behavioral Applications

Over the past 25 years behavior based safety (BBS) has gained visibility and credibility as a method for improving safe behavior in the workplace. Research has demonstrated that BBS interventions have improved safe behavior in many settings including offices (Blake-McCann & Sulzer-Azaroff, 1996), food manufacturing (Komaki, Barwick, & Scott, 1978), farm machinery manufacturing (Reber & Wallin, 1984), roofing construction (Austin, Kessler, Riccobono, & Bailey, 1996), health-care (Alavosius & Sulzer-Azaroff, 1986, 1990) and in professional delivery drivers (Ludwig & Geller, 1997). Research has also demonstrated that feedback and goal setting, both of which are integral components of BBS interventions, produce reliable improvements in the safe conditions of many settings including university laboratories (Sulzer-Azaroff, 1978), health-care facilities (Alavosius & Sulzer-Azaroff, 1990), and paper mills (Fellner & Sulzer-Azaroff, 1986).

Austin, Kessler, Riccobono, and Bailey (1996) examined the effects of feedback and reinforcement on the productivity and safety behavior of a roofing crew. Each day participants received graphic and verbal feedback on their previous day's performance with respect to a specific goal. Safety behaviors were measured daily using a safety checklist and feedback regarding the crew's safety performance was delivered daily. Safety performance as measured by the safety checklist increased following implementation of the feedback and incentive program. The crew improved from average baseline safety compliance levels of 51% on the ground and 55% on the roof to 90% on the ground and 95% on the roof.

Alavosius and Sulzer-Azaroff (1990) studied a nursing staff whose regular on-the-job practices while lifting and transferring patients tended to be risky. Concurrent schedules and multiple baselines across particpants and response classes (transferring or positioning) were used to evaluate the effects of written instructions combined with continuous, intermittent, or no-feedback schedules. The researchers found that instructional training in proper patient lifting and transferring techniques led to slight and unusually brief improvements. Marked improvements were noted after feedback was introduced, with the continuous schedules producing more rapid acquisition.

In a study that focused on reducing the risk of CTDs among keyboard operators, Blake-McCann and Sulzer-Azaroff (1996) used a behavioral approach that combined training, self-monitoring, feedback, goal-setting and reinforcement to increase correct posture and correct hand-wrist position. The results indicated dramatic increases in the percentages of correctly performed postures and neutral hand-wrist positions, for all participants.

The basic model for effecting behavioral change in workers includes the following components (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.

Measurement mechanisms and tools of a BBS process include an observation checklist, observing employees in the actual work setting and identifying safe and at-risk behaviors. Behavior based safety encourages and supports an open dialogue regarding safety.

A BBS process can complement a workplace ergonomics program by serving two distinct and critical functions. First, the observation process can supplement other assessment tools used to identify ergonomically hazardous situations. Secondly, the observation process can serve as a hazard recognition tool by providing individual and group feedback to encourage and support safe work practices (Perdue, 1999).

The purpose of the proposed study was to evaluate the effectiveness of ergonomic assessments conducted by senior Occupational Therapy (OT) students. Based on this evaluation, investigators were able to examine the effects of individualized computer workstation adjustments on safe behavior. When appreciable changes in safe behavior did not result from the workstation adjustments, a performance management package comprised of ergonomic information, graphic feedback and praise was offered to participants to supplement the ergonomic intervention.

METHOD

Participants and Setting

The present study was conducted at participants' offices on the campus of a midwestern university. Participants were recruited from the list of participants who had asked for or been selected for an office ergonomic assessment. The assessments were conducted by senior OT students as described in the section titled Office Ergonomic Assessment. Seven full-time employees (all female) from 3 different departments at Western Michigan University served as participants. Participants indicated that they intended to continue employment at the university for a period of 12 weeks from the beginning of the study, and that they would allow others to observe their behavior on the job. Furthermore, none of the participants were experiencing acute work-related pain symptoms that would have required immediate medical attention.

Participants were observed as they performed normal duties, including computer-related tasks at their individual workstations. Computer-related tasks included keyboarding, using the mouse, composing work on the computer and entering data from copy.

Independent Variables

Training

Senior level OT students enrolled in Occupational Therapy in Work Settings (OT 481) attended a training session conducted by the course instructor and the author during a regularly scheduled class session approximately one week prior to conducting the office ergonomic assessments. The training consisted of two basic components, (1) review of the Office Ergonomic Assessment form (Appendix A), protocol (Appendix B), and checklist (Appendix C), and (2) demonstration and practice of measurement and adjustment procedures.

Office Ergonomic Assessment

Office ergonomic assessments were conducted by senior level OT students enrolled in Occupational Therapy in Work Settings as part of the course requirements. These assessments have been part of the curriculum for three years. The assessments are founded upon a holistic methodology that considers the dynamic relationship between the individual, his/her occupation and environmental factors. This is clearly illustrated by the range and depth of factors considered on the office ergonomic assessment form (Appendix A).

Participants for the assessments were university employees who had either requested or had been referred to the course instructor for an office ergonomic assessment. The course instructor randomly assigned the participants to OT students for the assessment. Students, working in groups of two or three, conducted the assessments at participants' workstations using the office ergonomic assessment form provided by the course instructor.

Prior to the assessment, students agreed to perform the role of interviewer, measurement taker or data recorder for the duration of the assessment. During the assessment, students evaluated the current office arrangement, interviewed the participant, made recommendations for improvement and documented their measures and observations. Recommendations were classified as quick fix, moderate, or optimal based on cost and ease of implementation. Where possible, quick fix (on-thespot) changes were made to the workstation arrangement by the OT students during the assessment. Examples of immediate changes were included on the assessment form to assist students and included: reposition computer monitor to be directly in front of user, collapse keyboard legs to lower keyboard, and adjust chair angle. All recommendations and/or adjustments made to the workstation conformed to scientifically established standards (e.g., Hedge, 2002a, 2002b; Revelle, 2000; Washington Industrial Safety and Health Administration [WISHA], 2000; 3M Corporation, 1998). Each assessment required between 45 and 90 minutes to complete and participants were asked and encouraged to share concerns and suggestions.

After the on-site assessment, students reviewed the information, developed further recommendations for improvement and compiled a final written report. The course instructor and author met with the students during the first class session following the assessments and discussed their observations and recommendations. The course instructor reviewed the final report before it was distributed to the participants. The author distributed the final report to participants approximately 2 weeks after the assessment.

Performance Management (PM) Package

After the ergonomic assessment but prior to implementing the PM package, the author informed participants of the opportunity to receive one-on-one ergonomic information, feedback and praise to improve safe behaviors. The PM package was implemented only after a participant gave her written consent to continue. All participants consented to receiving the PM package.

The PM package was comprised of ergonomic information (written and pictorial), graphic feedback and verbal praise and was introduced only if the computer workstation adjustments did not result in appreciable changes in safe behavior. Appreciable changes in safe behavior were defined as an increase of 50 percentage points above baseline. Thus, any behaviors that did not improve by 50 percentage points above baseline were targeted by the PM package. The PM package targeted only the specific behaviors in need of improvement. The PM package was selected for this study because previous studies have shown that interventions that include training, feedback and praise have been effective in improving ergonomic behavior (Alavosius & Sulzer-Azaroff, 1986, 1990; Blake-McCann & Sulzer-Azaroff, 1996).

Information and Demonstration

The author presented written and pictorial information regarding correct ergonomic behaviors to participants individually at their workstations at the start of the PM package condition. All information was based on scientifically established standards (e.g., Hedge, 2002a, 2002b; Revelle, 2000; WISHA, 2000; 3M Corporation, 1998). Information was presented only for behaviors that had not changed as a result of the workstation adjustments. After looking at the pictures, participants were asked to demonstrate the safe behavior at their workstation. Participants were given a copy of the information sheet(s) for future reference. The information session required no longer than 15 minutes to complete. The information package is presented in Appendix D.

Ergonomic information was not provided for those behaviors that had changed substantially as a result of the workstation adjustments. By excluding these behaviors, the author was able to continue to examine the effects of workstation changes without the interference of potentially confounding variables.

Feedback and Praise

At the start of each observation session during the PM package condition, the author presented, and explained how to read, the graphic feedback to the participant (see example of graphic feedback in Appendix E). The graphic feedback showed the participant's average percent safe performance for each target behavior up to that point in time, including baseline. Graphic feedback was provided only for those behaviors that had not changed as a result of the workstation adjustments. Praise was provided for those behaviors that had improved from the previous observation session when the performance graphs were being reviewed. For example, the investigator would say, "Your performance on safe feet position has improved considerably from yesterday's session, and overall during the course of the study. That's great!" The delivery of feedback and praise took no longer than 1 to 2 minutes to complete. A feedback and praise script is presented in Appendix F. Participants were given a copy of the graph(s) and were asked to initial each of the author's copies, thereby indicating that the feedback was received.

Independent Variable Integrity

Four measures of independent variable integrity were calculated. The first of these was compliance with the office ergonomic assessment protocol. This was measured by counting the actual number of sections completed on the office ergonomic assessment checklist and dividing it by the total number of sections on the checklist, and then multiplying by 100. When possible, the exact nature of deviations from the protocol was noted on the checklist during the assessment. In all instances, an OT student completed the checklist during the assessment. The second measure of independent variable integrity was compliance with the information and demonstration procedures. Compliance was measured by observing the participant's ability to demonstrate the safe ergonomic behaviors after the presentation of pictorial information, and was documented on the information sheet by the author. The third and fourth measures of independent variable integrity involved compliance with feedback procedures. Feedback compliance was measured for each participant and was calculated by counting the number of feedback graphs that were initialed by the participant and dividing that number by the total number of planned feedback exposures for that participant, and then multiplying by 100. Feedback compliance was also measured on a per session basis. This was calculated by counting the number of sessions in which feedback was delivered and dividing that by the total number of sessions in which feedback was planned to occur, and then multiplying by 100.

Dependent Variables

The following behaviors and workstation variables were measured throughout the study using the data collection sheet in Appendix G.

Behaviors

The behaviors have been established as linked to MSDs resulting from extended periods of office work (USDOL, 1998; NIOSH, 2000). Seven behaviors were observed throughout the study and were divided into two categories: (a) typing, and (b) posture.

One dependent variable was included in the "typing" category and was defined as follows:

1. Hand-Wrist Position. Wrists should be flat (not bent up or down) and

straight (not bent right or left) when keyboarding or using the mouse.

Six dependent variables were included in the "posture" category and were defined as follows:

2. Head/Neck Position. Head should be in a vertical position such that the neck is aligned with the back and facing forward.

3. Shoulder Position. Upper arms should be tucked close to the body and hanging relaxed, not extended out to the side, not extended forwards or backwards, and not raised up or hunched.

4. Back Supported. Lower back (lumbar) should be in a supported and reclined posture producing an angle of the back and thigh between 100 and 110 degrees.

5. Arm Position. Upper arms and elbows should be close to the body when keyboarding or using mouse. Inside angle of elbow should be between 90 and 120 degrees to avoid nerve compression at the elbow.

6. Leg Position. Knees should be bent forming an angle between 90 and 120 degrees.

7. Feet Position. Both feet should be flat on the floor or footrest. This means that heels and toes of both feet should be touching the floor or footrest.

Each dependent variable was scored as safe if a participant's performance on that behavior met all of the criteria of the definition. If the participant's performance failed to meet any part of the definition, it was scored as unsafe. A percent safe score for each dependent variable was calculated for each session by counting the number of intervals scored as safe and dividing that number by the total number of intervals scored, and then multiplying by 100.

All dependent variables were marked as having occurred or having not occurred using a 10s whole interval time sampling procedure. A percent safe score was calculated using the occurrence data for each observation session. The participant's behavior was observed for 10 seconds, followed by a 5 second record period in which the behavior was scored as safe or unsafe. A given behavior was scored safe if, and only if, it occurred throughout the entire interval without interruption; otherwise it was scored as unsafe. A portable cassette player was used to sound beeps to cue the appropriate observation and recording behaviors. Each observation session lasted approximately 10 minutes.

Workstation Variables

Physical dimensions and safety dimensions of the workstation were measured throughout the study. Physical dimensions of the computer workstation were measured at the start of the baseline to establish layout of the work area. Additional measurements were taken if any noticeable changes had been made to the workstation, for example, if a different chair was being used, if the mouse had been relocated to the opposite side of the keyboard, etc. During the course of the study, there were no noticeable changes identified requiring additional measures.

Physical dimensions of five workstation variables were measured according to the following definitions:

1. Chair. Height was measured in inches from floor to base of seat.

2. Monitor. Viewing distance was measured in inches from user's eye to monitor. Angle of monitor was measured for participants who wear bifocal lenses or progressive lenses.

3. Keyboard. Height was measured in inches from floor to top of keyboard. Slope of keyboard was measured between bottom of desk, front edge of keyboard

(near user) and back edge of keyboard (near desk).

4. Mouse. Height was measured in inches from floor to top of mouse. Slope of mouse tray was measured between bottom of desk, front edge of mouse (near user) and back edge of mouse (near desk).

5. Desk. Height was measured in inches from floor to top of desk surface.

In addition to the physical dimension measures, workstation variables were evaluated using a safety checklist (see Appendix G: User-Computer Interface). The safety checklist dimensions supplemented the physical dimension measurements and were used to calculate a percent safe score of the User-Computer (UC) interface based on the workstation variables. Safety dimensions related to the UC interface were measured and documented for approximately 50% of observation sessions.

Safety dimensions of four workstation variables related to the UC interface were measured according to the following definitions:

1. Chair. The chair should be set so that the user's feet rest comfortably on the floor or footrest while the upper body is high enough to work comfortably at the workstation.

2. Monitor. The monitor should be positioned directly in front of and centered on the user. The monitor should be positioned so that the user's eyes are in line with a point 2 to 3 inches below the top of the monitor. The distance of the monitor from the user's eyes should be at least 18 inches. If the user wears bifocal lenses or progressive lenses, the monitor should be tilted backwards slightly so he/she can see screen without tilting his/her head.

3. Keyboard. The keyboard should be positioned directly in front of and centered on the user. The keyboard height should be below the user's elbow height when seated. The keyboard should be sloped away from the user (tilted downward) or

parallel to the floor.

4. Mouse. If the mouse is situated above the keyboard, it should be on a flat surface that is 1 to 2 inches above the keyboard and moveable. Or, if the mouse is on the same level as the keyboard, it should be on a mouse tray that is sloped away from the user to keep his/her hand and wrist in a neutral position.

A percent safe score was calculated for the UC interface by dividing the number of workstation variables scored as safe (+) by the number of workstation variables scored as safe (+) plus unsafe (-), and then multiplying by 100.

Observation Procedures

Observers

Two observers, the author and an undergraduate research assistant (RA), collected data on the behavior of participants throughout the study. Observers measured the dependent variables by standing in close proximity to the participant to observe all behaviors and workstation variables. Attempts were made to ensure that the observer's position did not interfere with the participant's work during the observation session.

Observation Sessions

Each participant's behavior was observed daily for ten minutes while she worked at her computer workstation. Observation sessions were scheduled at a time that was convenient for the participant.

Before conducting an observation, the observer asked the participant, "Is it okay if I (we) conduct an observation at this time?" If the participant agreed, the observation session continued. If the participant replied that it was not a good time, the observer asked for an alternate time and returned at that time to complete the observation session. Participants agreed during 99% of sessions.

Reliability

During the reliability sessions, the author and RA completed the behavior checklist independently. The author served as the primary observer for all reliability sessions. To ensure that both observers were observing at the same time, the primary observer was responsible for announcing when to begin the workstation variables safety checklist procedure. Prior to conducting the observation, each observer observed the participant as she worked at her workstation and independently scored each UC interface variable as safe (+) or unsafe (-). Then, the primary observer announced when to begin the observation session. Both observers used the same portable cassette player fitted with an adapter for two headsets, thus ensuring that each observation was synchronized. Reliability sessions were conducted on 33% of all observation sessions evenly spaced over the duration of the study. An agreement was defined as any occurrence in which both observers scored the same mark (safe or unsafe) for a behavior. Interobserver agreement (IOA) was calculated as follows: the number of agreements divided by the number of agreements plus disagreements multiplied by 100.

Experimental Design

A within subject, multiple baseline across individuals design was used to assess the effects of the intervention. The application of the independent variables was staggered across the participants over time. During the baseline condition of the study, participants were observed as they worked at their unadjusted computer workstations. Data were collected with no disruption to the participant or her work arrangement. Participants did not receive performance feedback during baseline. This condition continued for one to two weeks. The OT student office ergonomic assessments were conducted on the last day of the baseline condition and required between 45 and 90 minutes to complete.

On the day following the ergonomic assessment, participants entered the second condition of the study, assessing the effects of OT office ergonomic assessments and were observed daily for 2 to 3 weeks as they worked at their adjusted computer workstations. Participants remained in this condition until they had received and reviewed the OT students' final reports so that we could account for any and all behavior changes that may have resulted from the ergonomic evaluations.

If appreciable changes did not result from the workstation adjustments or from reviewing the OT student recommendations, participants were offered the opportunity to participate in the PM condition that included ergonomic information, feedback and praise. During this condition, ergonomic information was presented at the start of the first observation session only. Participants received feedback and praise daily prior to each observation session. The final condition continued for two to three weeks.

Follow-up observations were conducted approximately 3.5 months after the end of the study to examine the status of the participant's safe behaviors. Follow-up observations were conducted for 4 participants during 3 sessions and utilized baseline condition procedures.

The estimated duration of participation was 20 to 30 sessions (with a maximum of 45) over 6 to 10 weeks per participant. Actual participation ranged from 27 to 38 sessions over 8 weeks.

Informed Consent

Participants' consent was obtained at two separate times in the study. The initial informed consent process occurred prior to each participant's first baseline observation session and included all sessions during the baseline and office ergonomic assessment conditions of the study. The author reviewed the initial consent form (Appendix H) with each participant and informed them of the possibility of receiving ergonomic information and feedback at a later time in the study. Participants were then given the opportunity to sign the consent form. Participation in this study did not begin until the participant read and signed the informed consent document.

The secondary informed consent process occurred prior to a participant's first session in the PM package condition. The author reviewed the secondary consent form (Appendix I) with each participant and explained that they had the opportunity to receive one-on-one ergonomic information, performance feedback, and praise to improve safe ergonomic behaviors. Participants were then given the opportunity to sign the consent form. Participation in the PM condition did not begin until the participant read and signed the informed consent document.

Participants' consent was also obtained prior to conducting post-study observations. The author reviewed the post-study consent form (Appendix J) with each participant and explained that follow-up observations would be useful for interpreting long-term effects of the ergonomic and performance management interventions. Participation in the follow-up condition did not begin until the participant read and signed the informed consent document.

Exit Interviews and Debriefing

At the end of the last session in the PM package phase, participants were asked a series of questions (see Appendix K) concerning the study, and then they were given an explanation about the nature of the study (see Appendix L). The questions and explanation were read to each participant by the author. The purpose of the exit interview was to obtain as much information as possible about why the participants performed as they did. The information gained from the exit interview was helpful in determining some of the potential behavioral factors that contributed to safety performance.

HSIRB Approval

Protocol clearance from the Human Subjects Institutional Review Board was obtained for this project (see Appendix M).

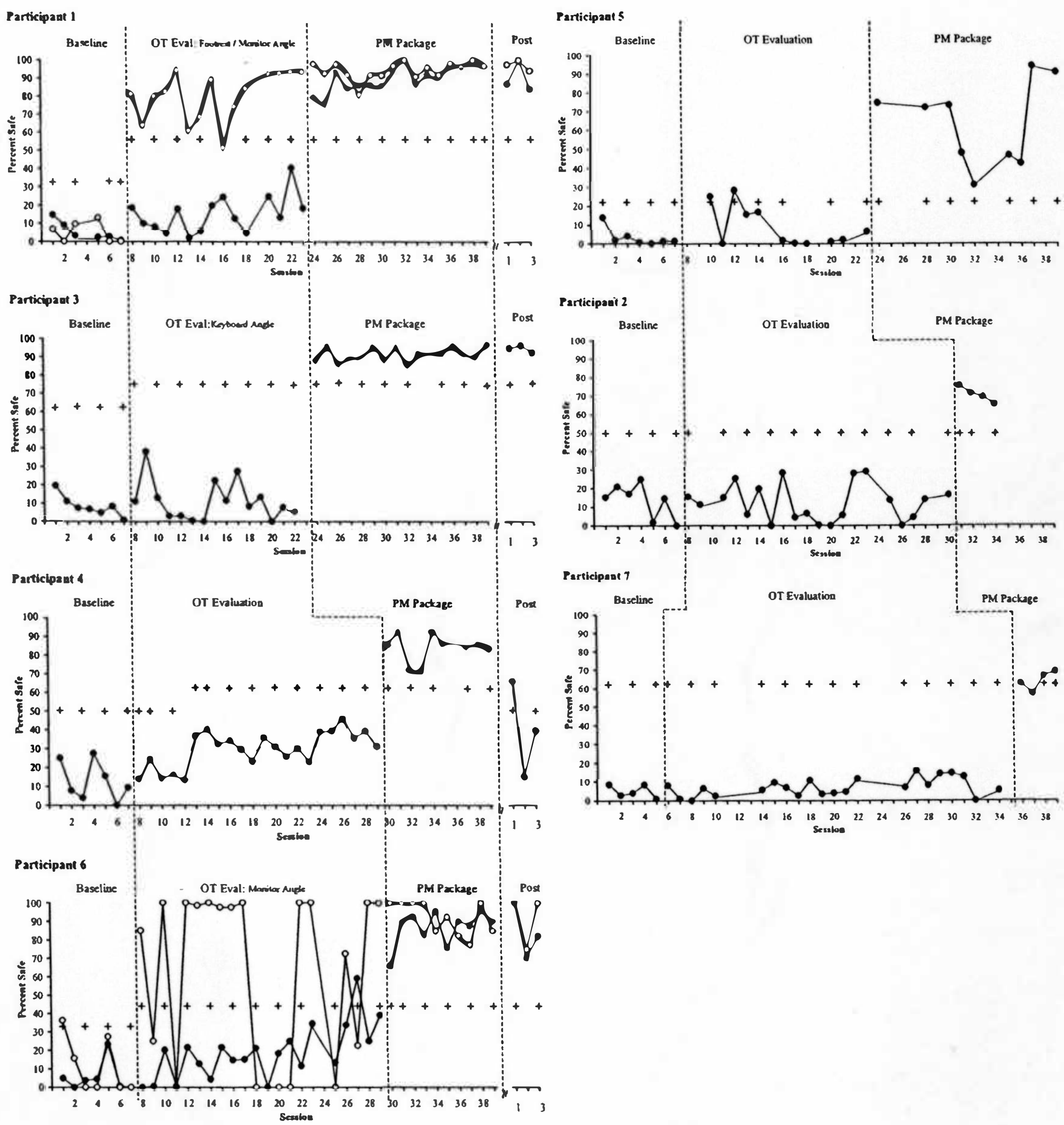
RESULTS

Overall

Figure 1 displays the composite percent safe scores across participants. The composite percent safe score represents overall safety performance during an observation session. Two composite percent safe scores were calculated for Participant 1 and Participant 6; one for the behaviors included in the PM package phase (represented by closed circles "•") and one for the behaviors not included in the PM package phase (represented by open circles "o"). During the OT assessment phase, results were mixed in terms of UC interface percent safe scores and safety performance. Only 2 participants demonstrated substantial improvements during the OT assessment phase. Participant 1 exhibited substantial improvements in safety performance on back, leg and feet position, and participant 2 exhibited substantial improvements in safety performance on leg and feet position during the OT assessment phase. These five behaviors were not targeted in the PM package phase. Overall, safety performance of targeted behaviors of all seven participants increased substantially during the PM package phase of the study. Post-study observation sessions were conducted on the behavior of four participants (1, 3, 4, and 6) 3.5 months after the end of the study.

Participant 1

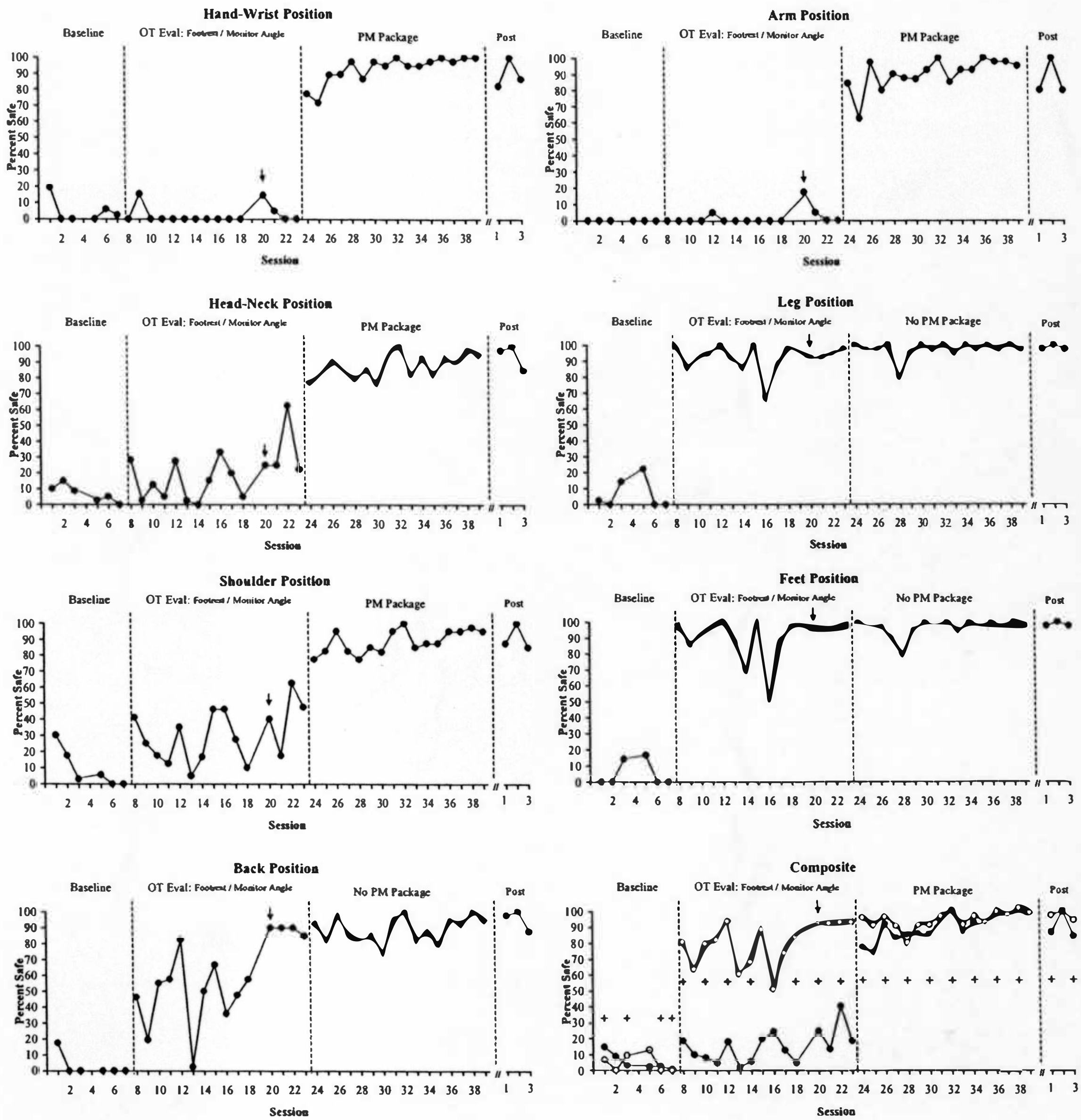
Figure 2 displays the safety performance of participant 1 during the course of the study. Levels of safety performance of hand-wrist position fluctuated across phases. Performance averaged 4.7% (SD: 7.6; range: 0% to 19.4%) safe during



Legend. A "+" represents the percent safe score of the User-Computer Interface. "Post" study observations (participants 1, 3, 4, & 6) were conducted 3.5 months after the end of the study. On the graphs of Participants 1 & 6, a "•" indicates the behaviors targeted in the PM package and a "o" indicates the behaviors not targeted.

Figure 1. Composite Percent Safe Scores Across Participants.

baseline, decreased to 2.3% (SD: 5.3; range: 0% to 15.4%) safe during the OT



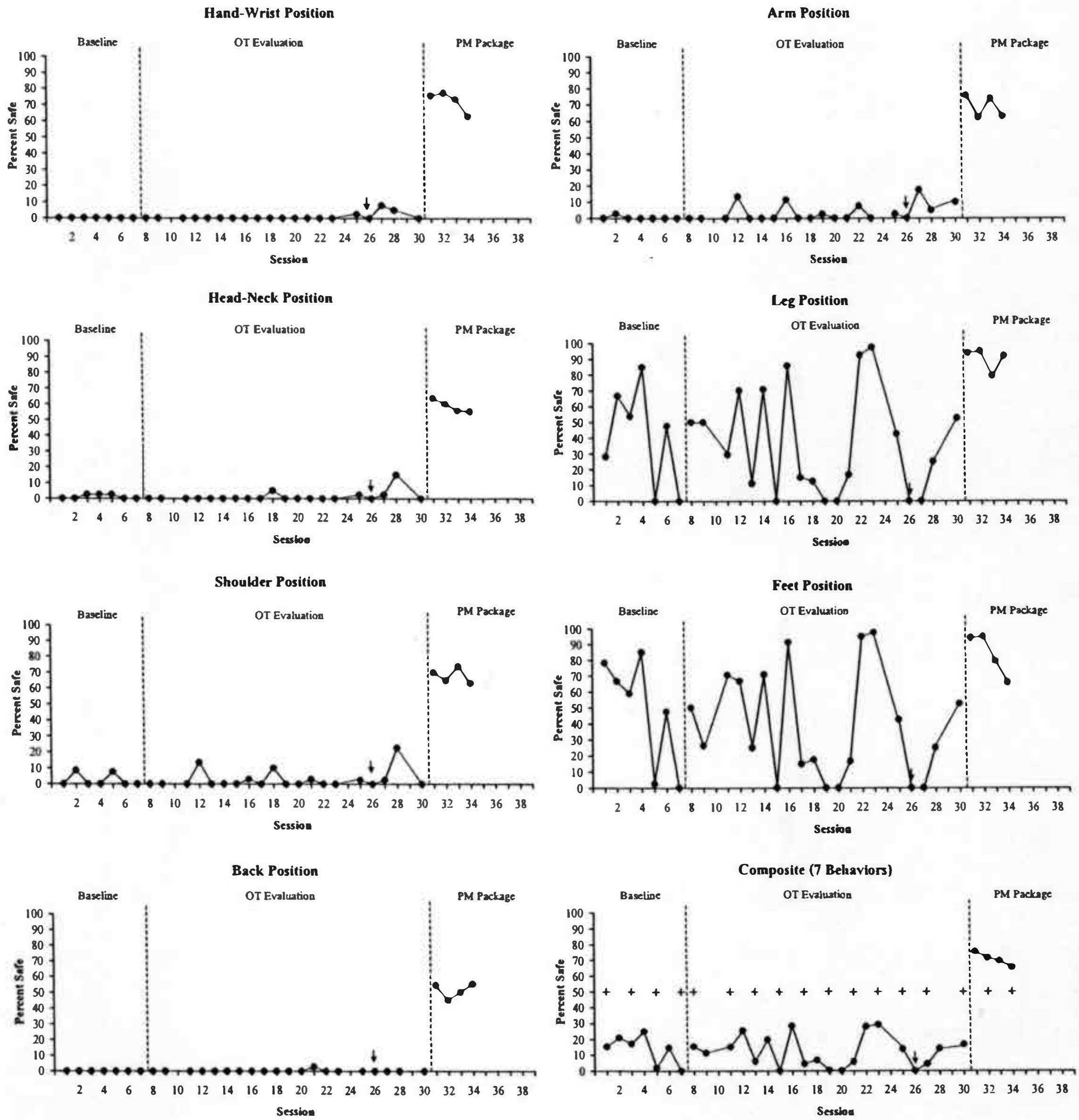
Legend. An arrow indicates the session when the participant received the OT evaluation final report. A "+" represents the percent safe score of the User-Computer Interface. On the Composite graph, a "•" indicates the 4 behaviors targeted in the PM package and a "o" indicates the 3 behaviors not targeted.

Figure 2. Percent Safe Scores for Participant 1.

evaluation phase and increased to 93.1% (SD: 8.3; range: 71.9% to 100%) safe during the PM package phase. Levels of safety performance for the remaining 6 behaviors increased across phases. Head-neck position averaged 6.9% (SD: 5.4; range: 0% to 15.4%) safe during baseline, 19.1% (SD: 16.2; range: 0% to 62.5%) safe during the OT evaluation phase and 87.8% (SD: 7.2; range: 77.5% to 100%) safe during the PM package phase. Average safety levels of shoulder position were 9.3% (SD: 12; range: 0% to 30%), 30% (SD: 16.9; range: 5% to 62.5%), and 88.7% (SD: 7.3; range: 77.5% to 100%) across the three phases. Average safety levels of arm position were 0%, 1.8% (SD: 4.7; range: 0% to 17.5%), and 90.1% (SD: 9.4; range: 62.5% to 100%) across the three phases. Back position averaged 2.9% safe (SD: 7.1; range: 0% to 17.5%) during baseline, 58.4% safe (SD: 26.5; range: 2.5% to 90%) during the OT evaluation phase, and 89.2% safe (SD: 7.8; range: 74.4% to 100%) during the final phase (no PM package). Average safety levels of leg position were 6.5% (SD: 9.5; range: 0% to 22.2%), 92.1% (SD: 8.5; range: 66.7% to 100%) and 97.2% (SD: 4.9; range: 80% to 100%) across the three phases. Average safety levels of feet position were 5.2% (SD: 8; range: 0% to 16.7%), 89.8% (SD: 13.3; range: 51.3% to 100%) and 96.6% (SD: 5.2; range: 95% to 100%) across the three phases. Because the average safety levels for back position, leg position, and feet position in the OT evaluation phase increased by at least 50 percentage points above baseline they were not included in the PM package phase. This means that participant 1 did not receive ergonomics information, graphic feedback or praise on these positions during the PM package phase of the study. Two composite percent safe scores were calculated; one for the four behaviors targeted in the PM package phase, i.e., hand-wrist, head-neck, shoulder and arm, and one for the three behaviors not targeted, i.e., back, leg and feet. Average safety performance of the four behaviors targeted in the PM package phase was 5.4% (SD: 5.4; range: 0.6% to 14.7%), 15% (SD: 10.1; range: 2.0% to 40.3%), and 89.9% (SD: 7; range: 75.7% to 100%) across the three phases. Average safety performance of the three behaviors not targeted in the PM package phase was 4.9% (SD: 5.7; range: 0% to 13%), 80.1% (SD: 13.5; range: 51.3% to 94.2%), and 94.3% (SD: 4.8; range: 80.8% to 100%) across the three phases. During the office ergonomic assessment OT students added footrests and modified the computer monitor angle in the participant's work area. These changes increased the UC interface percent safe score from 33% to 56%. No other physical changes were made to the participant's computer work area during the study. Average safety levels for the seven behaviors and the UC interface during three post-study observation sessions were as follows: (1) hand-wrist position averaged 89.9% (SD: 9.1; range: 82.5% to 100%); (2) head-neck position averaged 94.2% (SD: 8; range: 85% to 100%); (3) shoulder position averaged 90.8% (SD: 8; range: 85% to 100%); (4) arm position averaged 86.7% (SD: 11.5; range: 80% to 100%); (5) back position averaged 95% (SD: 6.6; range: 87.5% to 100%); (6) leg position averaged 98.3% (SD: 1.4; range: 97.5% to 100%); (7) feet position averaged 98.3% (SD: 1.4; range: 97.5% to 100%); (8) the average composite percent safe score for behaviors targeted by the PM package was 90.4% (SD: 8.5; range: 84.2% to 100%); (9) the average composite percent safe score for behaviors not targeted by the PM package was 97.2% (SD: 2.9; range: 94.2% to 100%); and (10) the UC interface percent safe score was 56%.

Participant 2

Figure 3 displays the safety performance of participant 2 over the duration of the study. Levels of safety performance of hand-wrist position were 0% during baseline, 0.8% (SD: 2.1; range: 0% to 7.9%) during the OT evaluation phase, and increased to 72.5% (SD: 6.4; range: 63.2% to 77.5%) during the PM package phase.



Legend. An arrow indicates the session when the participant received the OT evaluation final report. A "+" represents the percent safe score of the User-Computer Interface.

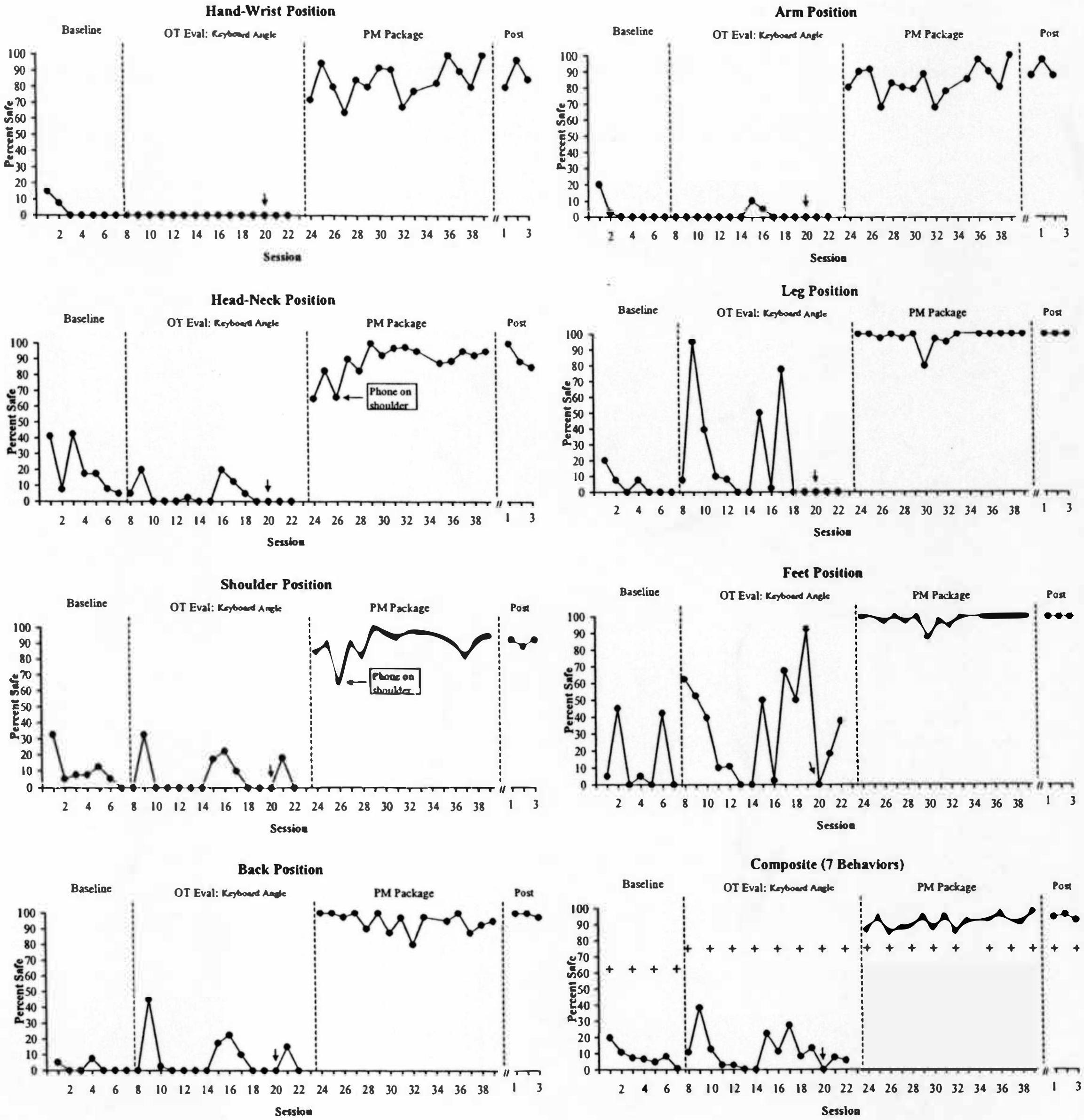
Figure 3. Percent Safe Scores for Participant 2.

Head-neck position averaged 1.1% (SD: 1.3; range: 0% to 2.6%), 1.3% (SD: 3.5;

during baseline, 2.8% (SD: 5.9; range: 0% to 22.5%) during the OT evaluation phase, range: 0% to 15%), and 58.7% (SD: 3.9%; range: 55.3% to 63.6%) during the PM package phase. The mean for safe shoulder position was 2.3% (SD: 3.9; range: 0% to 8.3%) and 67.8% (SD: 4.7; range: 63.2% to 73.5%) during the PM package phase. Safe back position averaged 0%, 0.1% (SD: 0.6; range: 0% to 2.8%), and 51.2% (SD: 4.7; range: 45% to 55.3%) across the three phases. This participant's arm position averaged 0.4% (SD: 1; range: 0% to 2.8%) safe during baseline, 3.5% (SD: 5.5; range: 0% to 17.5%) safe during the OT evaluation phase, and increased to 68.7% (SD: 6.9; range: 63.2% to 75.8%) safe during the PM package phase. Levels of safety performance for leg position and feet position fluctuated across phases. Leg position averaged 40.2% (SD: 32.5; range: 0% to 85%) safe during baseline, decreased to 36.1% (SD: 33.4; range: 0% to 97.5%) safe during the OT evaluation phase and increased to 90.1% (SD: 7.2; range: 79.4% to 95%) during the PM package phase. Average safe levels of feet position were 48.4% (SD: 34.4; range: 0% to 85%), 38.1% (SD: 34.1; range: 0% to 97.5%), and 83.5% (SD: 13.8; range: 65.8% to 95%) across the three phases, respectively. Average safety performance of all seven behaviors, represented by the composite graph decreased from 13.5% (SD: 9.3; range: 0% to 24.8%) during baseline, to 12.1% (SD: 9.9; range: 0% to 29%) during the OT evaluation phase, and then increased to 70.4% (SD: 4.1; range: 65.4% to 75.3%) during the PM package phase. During the office ergonomic assessment OT students did not make any modifications to the participant's work area. The percent safe score of the UC interface remained constant at 50% throughout the study.

Participant 3

Figure 4 illustrates the safety performance of participant 3. Safety



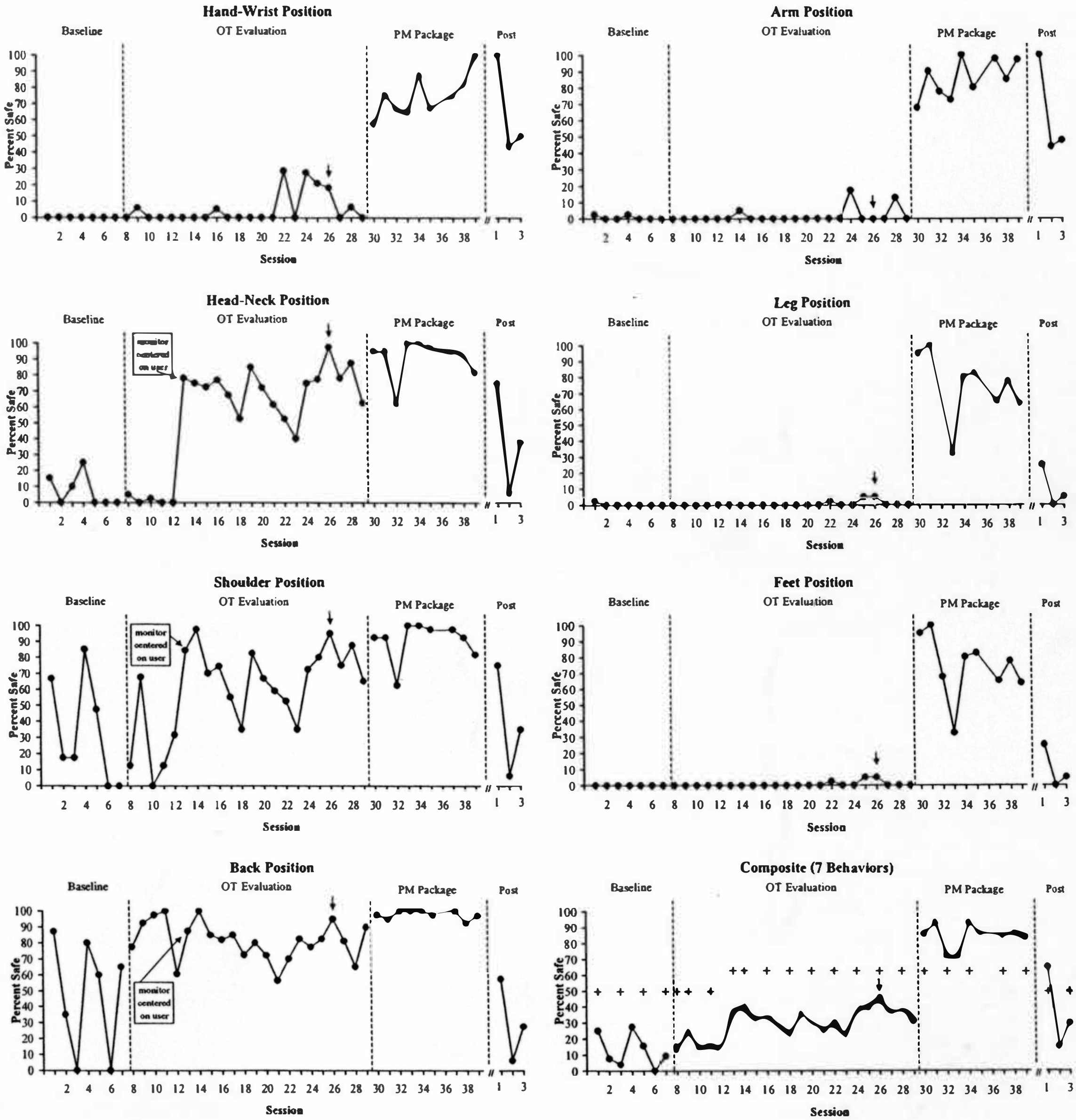
Legend. An arrow indicates the session when the participant received the OT evaluation final report. A "+" represents the percent safe score of the User-Computer Interface.

Figure 4. Percent Safe Scores for Participant 3.

performance for 4 positions fluctuated across phases as follows: (1) hand-wrist position averaged 3.2% (SD: 5.9; range: 0% to 15%) in baseline, decreased to 0% in the OT evaluation phase, and increased to 83.7% (SD: 11; range: 63.9% to 100%) in the PM package phase; (2) head-neck position averaged 19.8% (SD: 15.8; range: 5% to 41%), 4.3% (SD: 0% to 20%), and 88.4% (SD: 10.7; range: 65% to 100%) across the three phases, respectively; (3) average safe shoulder position decreased from 10% (SD: 10; range: 0% to 32.%) in baseline to 6.7% (SD: 10.8; range: 0% to 32.5%) in the OT evaluation phase, and further increased to 90.3% (SD: 8.7; range: 65.8% to 100%) in the PM package phase; and (4) mean safety levels for arm position were 3.2% (SD: 7.5; range: 0% to 20%), 1% (SD: 2.8; range: 0% to 10%) and 83.7% (SD: 9.4; range: 67.5% to 100%) across the three phases, respectively. Average safety performance for the remaining 3 behaviors increased across phases. Back position averaged 1.8% safe (SD: 3.1; range: 0% to 7.5%) during baseline, 7.5% safe (SD: 12.9; range: 0% to 32.5%) during the OT evaluation phase, and 94.6% safe (SD: 6; range: 80% to 100%) during the PM package phase. Average safety levels of leg position were 5% (SD: 7.5; range: 0% to 20%), 19.3% (SD: 31.3; range: 0% to 95%) and 97.8% (SD: 5.2; range: 80% to 100%) across the three phases. Average safety levels of feet position were 13.9% (SD: 20.4; range: 0% to 45%), 32.9% (SD: 29.3; range: 0% to 92.5%) and 98.3% (SD: 3.4; range: 87.5% to 100%) across the three phases, respectively. Average safety performance of the seven behaviors increased from 8.3% (SD: 5.9; range: 0.7% to 19.7%) during baseline, to 10.9% (SD: 10.9; range: 0% to 98%) during the OT evaluation phase, and then to 91% (SD: 4; range: 85.7% to 97.9%) during the PM package phase. During the office ergonomic assessment, OT students changed the keyboard angle so that it was parallel to the floor by collapsing the keyboard legs. This change increased the UC interface percent safe score from 62.5% to 75%. No other physical changes were made to the participant's computer work area during the study. Average safety levels for the seven behaviors and the UC interface during three post-study observation sessions were as follows: (1) hand-wrist position averaged 87.4% (SD: 8.8; range: 80% to 97.1%); (2) head-neck position averaged 91.2% (SD: 7.8; range: 85% to 100%); (3) shoulder position averaged 91.2% (SD: 2.3; range: 88.6% to 92.5%); (4) arm position averaged 90.7% (SD: 5.6; range: 87.5% to 97.1%); (5) back position 99.2% (SD: 1.4; range: 97.5% to 100%); (6) leg position averaged 100%; (7) feet position averaged 100%; (8) the average composite percent safe score was 94.2% (SD: 1.7; range: 92.5% to 95.9%); and (9) the UC interface percent safe score was 75 %.

Participant 4

Performance for participant 4 is shown in Figure 5. Hand-wrist position averaged 0% safe during baseline, 5.1% (SD: 9.5; range: 0% to 28.6%) safe during the OT evaluation phase and 75.3% (SD: 13; range: 57.5% to 100%) safe during the PM package phase. Safe head-neck position averaged 7.2% (SD: 10; range: 0% to 25%), 55.4% (SD: 32.4; range: 0% to 97.5%), and 91% (SD: 12; range: 62.5% to 100%) across the three phases. The mean for safe shoulder position was 33.5% (SD: 33.4; range: 0% to 85%) during baseline, 59.6% (SD: 27.6; range: 0% to 55%) during the OT evaluation phase, and 90.8% (SD: 12; range: 81.8% to 100%) during the PM package phase. Safe back position averaged 46.7% (SD: 36; range: 0% to 87.2%), 81.5% (SD: 12.1; range: 56.4% to 100%), and 97.7% (SD: 2.6; range: 92.5% to 100%) across the three phases. This participant's arm position averaged 0.7% (SD: 1.2; range: 0% to 2.6%) safe during baseline, 1.6% (SD: 4.6; range: 0% to 17.5%) safe during the OT evaluation phase, and increased to 85.2% (SD: 11.7; range: 67.5% to 100%) safe during the PM package phase. Leg position and feet position was unsafe during baseline, averaging 0%. Mean performance increased during the OT



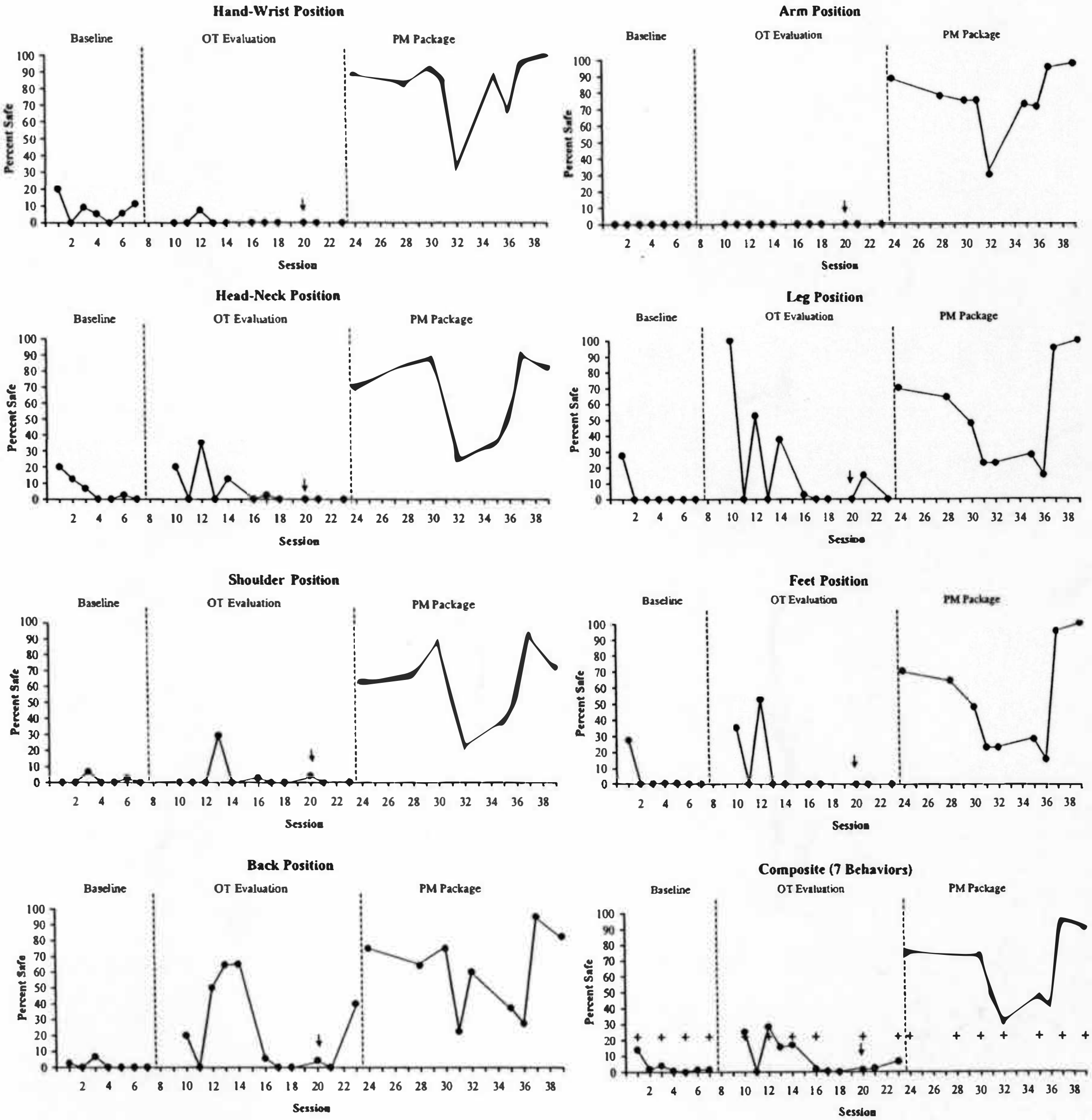
Legend. An arrow indicates the session when the participant received the OT evaluation final report. A "+" represents the percent safe score of the User-Computer Interface.

Figure 5. Percent Safe Scores for Participant 4.

evaluation phase to 0.6% (SD: 1.5; range: 0% to 5%) for both behaviors. Leg position and feet position increased to 73.7% (SD: 20; range: 32.5% to 100%) safe during the PM package phase. Average safety performance of the seven behaviors, represented by the composite graph increased from 12.7% (SD: 10.4; range: 0% to 27.5%) during baseline, to 29.6% (SD: 9.3; range: 13.6% to 45.7%) during the OT evaluation phase, and further increased to 83.9% (SD: 7.5; range: 71.8% to 92.5%) during the PM package phase. During the office ergonomic assessment OT students did not make any modifications to the participant's work area. However, the participant did respond to the students' recommendations and relocated her computer monitor so that it was positioned directly in front of her body (indicated by the text box on the graph). Previously, the monitor was positioned to the left of the participant thereby requiring her to turn her head to view the display. A substantial increase in safety performance of head-neck position was seen when the monitor was relocated. This change was also reflected in the increase of the percent safe score of the UC interface from 50% to 62.5%. Average safety levels for the seven behaviors and the UC interface during three post-study observation sessions were as follows: (1) hand-wrist position averaged 64.6% (SD: 30.8; range: 50% to 100%); (2) head-neck position averaged 39.6% (SD: 34.4; range: 6.25% to 75%); (3) shoulder position averaged 38.8% (SD: 34.5; range: 6.25% to 75%); (4) arm position averaged 3.8% (SD: 31.4; range: 47.5% to 100%); (5) back position 30.4% (SD: 25.7; range: 6.25% to 57.5%); (6) leg position averaged 10% (SD: 13.2; range: 0% to 25%); (7) feet position averaged 10% (SD: 13.2; range: 0% to 25%); (8) the average composite percent safe score was 36.7% (SD: 25.8; range: 15.2% to 36.7%); and (9) the UC interface percent safe score was 50%. The participant was using a different chair at the time of the post-study observations. This was the only change to the workstation and reduced the UC interface percent safe score from 62.5% to 50%.

Participant 5

Figure 6 illustrates the safety performance of participant 5. Levels of safety performance of hand-wrist position fluctuated across phases. Performance averaged 7.3% (SD: 7; range: 0% to 20%) safe during baseline, decreased to 0.7% (SD: 2.3; range: 0% to 7.5%) safe during the OT evaluation phase and increased to 81.4% (SD: 20.2; range: 67.6% to 100%) safe during the PM package phase. Levels of safety performance for 5 of the 6 remaining behaviors increased across phases. Head-neck position averaged 6% (SD: 7.7; range: 0% to 20%) safe during baseline, 6.4% (SD: 11.6; range: 0% to 35%) safe during the OT evaluation phase and 65.2% (SD: 23.9; range: 25% to 90%) safe during the PM package phase. Average safety levels of shoulder position were 1.3% (SD: 2.5; range: 0% to 6.7%), 3.3% (SD: 8.7; range: 0% to 29%), and 60.5% (SD: 22.6; range: 22.5% to 92.5%) across the three phases, respectively. Average safety levels of arm position remained at 0% during baseline and the OT evaluation phase. The mean safe arm position increased to 75.8% (SD: 19.8; range: 30% to 97.5%) during the PM package phase. Back position increased from 1.3% (SD: 2.5; range: 0% to 6.7%) during baseline, to 22.7% (SD: 27; range: 0% to 65%) during the OT evaluation phase, and to 59.9% (SD: 25.4; range: 22.5% to 92.5%) during the PM package phase. Average safety levels of leg position were 3.9% (SD: 10.4; range: 0% to 27.5%), 18.9% (SD: 18.9; range: 0% to 52.5%) and 51.6% (SD: 32.3; range: 15% to 100%) across the three phases, respectively. Average safety levels of feet position were 3.9% (SD: 10.4; range: 0% to 27.5%), 8.8% (SD: 18.9; range: 0% to 52.5%) and 51.6% (SD: 32.3; range: 15% to 100%) across the three phases, respectively. Average safety performance of the seven behaviors, represented by the composite graph increased from 3.3% (SD: 4.8; range: 0% to 13.9%) during baseline, to 8.8% (SD: 10.6; range: 0% to 28.2%) during the OT



Legend. An arrow indicates the session when the participant received the OT evaluation final report. A "+" represents the percent safe score of the User-Computer Interface.

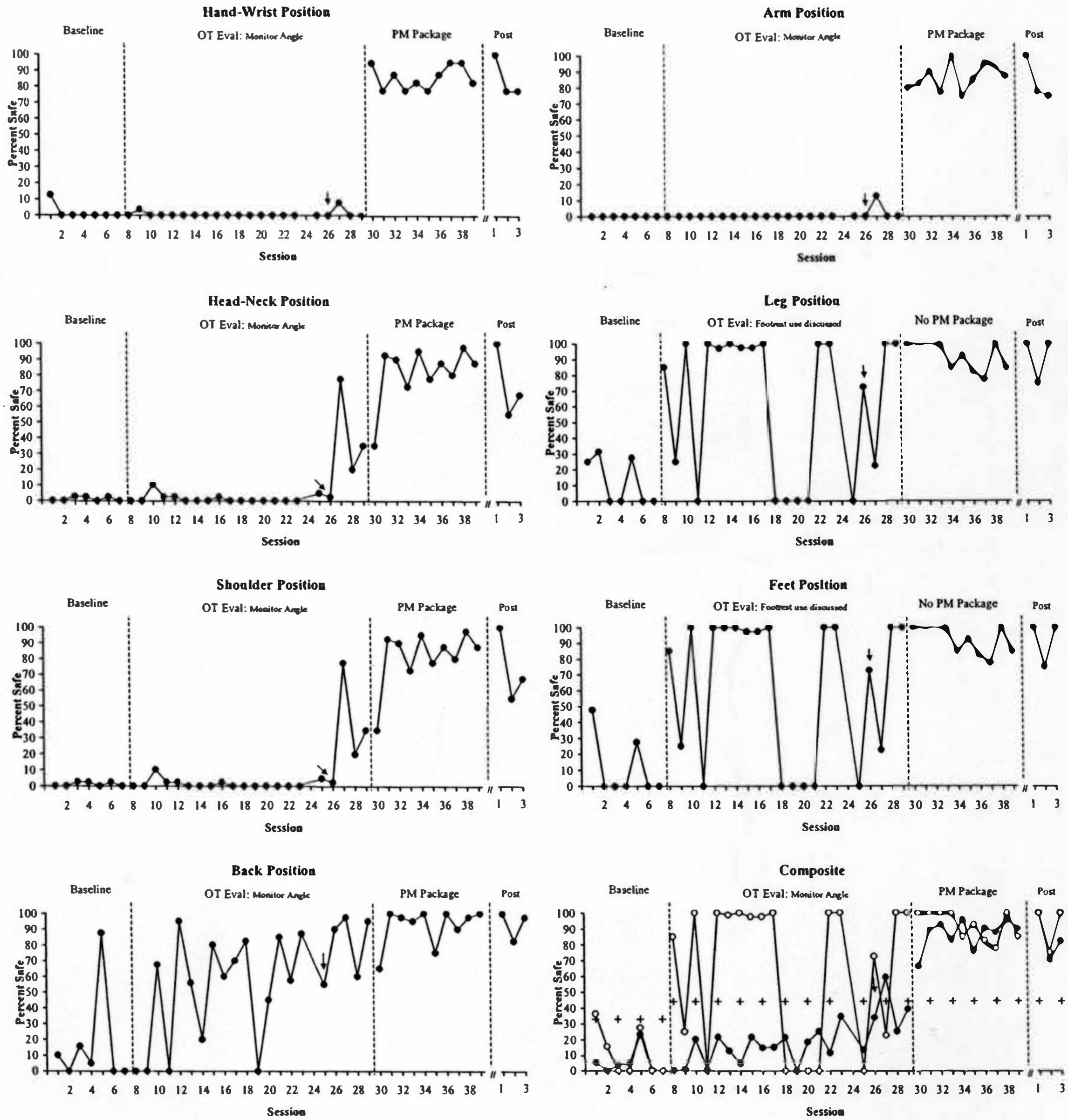
Figure 6. Percent Safe Scores for Participant 5.

evaluation phase, and then increased to 63.5% (SD: 22.4; range: 30.8% to 93.9%)

during the PM package phase. During the office ergonomic assessment OT students did not make any modifications to the participant's work area. The percent safe score of the UC interface remained constant at 22% throughout the study.

Participant 6

Safe performance for participant 6 is presented in Figure 7. Levels of safety performance of hand-wrist position fluctuated across phases. Performance averaged 1.8% (SD: 4.7; range: 0% to 1.5%) safe during baseline, decreased to 0.6% (SD: 1.9; range: 0% to 7.9%) safe during the OT evaluation phase and increased to 85.7% (SD: 7.3; range: 77.5% to 95%) safe during the PM package phase. Levels of safety performance for the remaining 6 behaviors increased across phases. Head-neck position averaged 1.1% (SD: 1.4; range: 0% to 2.6%) safe during baseline, 7.5% (SD: 18.2; range: 0% to 77.5%) safe during the OT evaluation phase and 81.5% (SD: 18.2; range: 35% to 97.5%) safe during the PM package phase. Average safety levels of shoulder position were 6.1% (SD: 10; range: 0% to 25%), 24.4% (SD: 30.9; range: 0% to 97.5%), and 87.3% (SD: 12.9; range: 57.5% to 100%) across the three phases, respectively. Average safety levels of arm position were 0%, 0.6% (SD: 2.7; range: 0% to 12.5%), and 86.5% (SD: 8; range: 75% to 100%) across the three phases. Back position averaged 16.9% (SD: 31.7; range: 0% to 87.5%) safe during baseline, 57.3% (SD: 34.1; range: 0% to 97.5%) safe during the OT evaluation phase, and 92% (SD: 12.2; range: 65% to 100%) safe during the PM package phase. Average safety levels of leg position were 12% (SD: 15.1; range: 0% to 31.4%), 62% (SD: 45.8; range: 0% to 100%) and 92.3% (SD: 8.9; range: 82.5% to 100%) across the three phases, respectively. Average safety levels of feet position were 10.7% (SD: 19.2; range: 0% to 47.5%) during baseline, 61.9% (SD: 45.9; range: 0% to 100%) during the OT



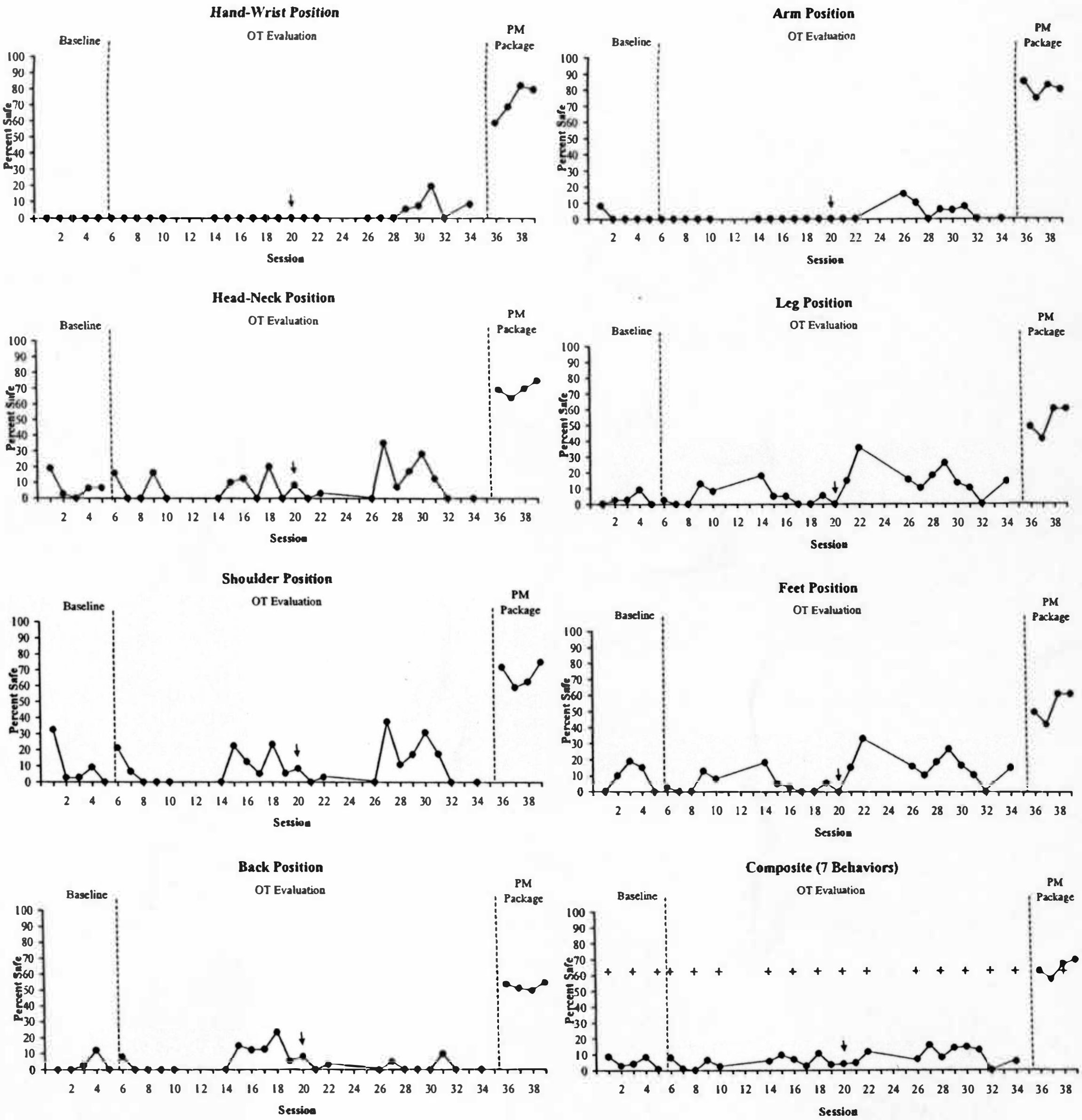
Legend. An arrow indicates the session when the participant received the OT evaluation final report. A "+" represents the percent safe score of the User-Computer Interface. On the Composite graph, a "•" indicates the 5 behaviors targeted in the PM package and a "o" indicates the 2 behaviors not targeted.

Figure 7. Percent Safe Scores for Participant 6.

evaluation phase, and 92.3% (SD: 8.9; range: 77.5% to 100%) during the final phase (no PM package). Because the average safety levels for leg position, and feet position in the OT evaluation phase increased by at least 50 percentage points above baseline they were not included in the PM package phase. This means that participant 6 did not receive ergonomics information, graphic feedback or praise on these positions during the PM package phase of the study. Two composite percent safe scores were calculated; one for the five behaviors targeted in the PM package phase, i.e., hand-wrist, head-neck, shoulder, back, and arm, and one for the two behaviors not targeted, i.e., leg and feet. Average safety performance of the five behaviors targeted in the PM package phase was 5.3% (SD: 8.2; range: 0.0% to 23.3%), 18.7% (SD: 14.7; range: 0% to 59.1%), and 86.6% (SD: 9.2; range: 66.2% to 95.5%) across the three phases. Average safety performance of the two behaviors not targeted in the PM package phase was 11.4% (SD: 15.4; range: 0% to 36.3%), 65.8% (SD: 44.2; range: 0% to 100%), and 92.3% (SD: 8.9; range: 77.5% to 100%) across the three phases. During the office ergonomic assessment OT students discussed footrest use and modified the computer monitor angle in the participant's work area. The change to the monitor angle increased the UC interface percent safe score from 33% to 44%. No other physical changes were made to the participant's computer work area during the study. Average safety levels for the seven behaviors and the UC interface during three post-study observation sessions were as follows: (1) hand-wrist position averaged 85% (SD: 13; range: 77.5% to 100%); (2) head-neck position averaged 74.2% (SD: 23.2; range: 55% to 100%); (3) shoulder position averaged 84.2% (SD: 21.3; range: 60% to 100%); (4) arm position averaged 84.2% (SD: 1.38; range: 75% to 100%); (5) back position averaged 93.3% (SD: 9.5; range: 82.5% to 100%); (6) leg position averaged 91.7% (SD: 14.4; range: 75% to 100%); (7) feet position averaged 91.7% (SD: 14.4; range: 75% to 100%); (8) the average composite percent safe score for behaviors targeted by the PM package was 84.2% (SD: 14.9; range: 70.5% to 100%); (9) the average composite percent safe score for behaviors not targeted by the PM package was 91.7% (SD: 14.4; range: 75% to 100%); and (10) the UC interface percent safe score was 44%.

Participant 7

Figure 8 illustrates the safe performance of participant 7 over the course of the study. Levels of safety performance of hand-wrist position were 0% during baseline, 1.9% (SD: 4.8; range: 0% to 20%) during the OT evaluation phase, and increased to 72.7% (SD: 10.8; range: 59% to 82.5%) during the PM package phase. Head-neck position averaged 6.8% (SD: 7.3; range: 0% to 18.9%), 11.6% (SD: 10.2; range: 0% to 35%), and 59.6% (SD: 4.5%; range: 64.1% to 75%) across the three phases. The mean for safe shoulder position was 9.4% (SD: 13.3; range: 0% to 32.4%) during baseline, 13.1% (SD: 11.3; range: 0% to 37.5%) during the OT evaluation phase, and 67.1% (SD: 7.6; range: 59% to 75%) during the PM package phase. Safe back position averaged 3% (SD: 5.3; range: 0% to 12.1%), decreased to 2% (SD: 6.5; range: 0% to 23.3%), and then increased to 52.5% (SD: 2.3; range: 50% to 55%) across the three phases, respectively. This participant's arm position averaged 1.6% (SD: 3.6; range: 0% to 8.1%) safe during baseline, 3.7% (SD: 4.2; range: 0% to 15.4%) safe during the OT evaluation phase, and increased to 80.4% (SD: 4.4; range: 74.4% to 84.6%) safe during the PM package phase. Leg position averaged 2.9% (SD: 3.7; range: 0% to 9.1%) safe during baseline, increased to 12.6% (SD: 9.3; range: 0% to 35.3%) safe during the OT evaluation phase and further increased to 52.4% (SD: 9.3; range: 41% to 60%) during the PM package phase. Average safe levels of feet position were 8.9% (SD: 8.7; range: 0% to 18.9%), 13.2% (SD: 9.1;



Legend. An arrow indicates the session when the participant received the OT evaluation final report. A "+" represents the percent safe score of the User-Computer Interface.

Figure 8. Percent Safe Scores for Participant 7.

range: 0% to 32.4%), and 52.4% (SD: 9.3; range: 41% to 60%) across the three phases, respectively. Average safety performance of all seven behaviors, represented by the composite graph increased from 4.9% (SD: 3.4; range: 0% to 8.5%) during baseline, to 9.2% (SD: 4.7; range: 0% to 15.6%) during the OT evaluation phase, and then increased to 63.9% (SD: 5.3; range: 57.1% to 69.3%) during the PM package phase. During the office ergonomic assessment OT students did not make any modifications to the participant's work area. The percent safe score of the UC interface remained constant at 62.5% throughout the study.

Workstation Changes

Table 1 shows the changes that were made to the participants' computer workstations during the OT ergonomic assessments and the resulting increases in the UC interface percent safe score. One post-study workstation change was observed, and resulted in a reduction to the UC interface percent safe score for participant 4.

Table 1

Computer Workstation Changes

Participant	Workstation Changes	UC Interface Change
01	Footrests added, monitor angle modified	+23%
03	Keyboard angle adjusted by collapsing keyboard legs	+12.5%
04	Monitor relocated and centered on user / Post-study: different chair	+12.5% / -12.5%
06	Monitor angle adjusted, footrest use discussed	+11%

Exit Interviews

Following is a list of questions asked to participants during the exit interview conducted after the last observation session of the study. Participants 2 and 7 were not available for the exit interview. Each question (Q1 through Q11) is followed by the answers given by participants. The answers given by participant 1 are identified as P1, by participant 3 as P3, and so on.

Q1 (Question 1): What did you think the study was about? Answers - P1: evaluating the effects of the OT assessment and seeing whether we implemented the suggestions by them, P3, P4: proper body mechanics, P5: figuring out whether ergonomic interventions worked, and P6: upper body position and making sure that I wasn't doing something that would damage me in the future.

Q2: What did you think was being measured or observed? Answers - P1: the behaviors on the graphs, P3, P4, P5: all behaviors on the graphs, and P6: upper body posture.

Q3: Do you think your behavior or performance changed as a result of the OT office ergonomic assessment? Answers – P1: yes, but the observations made me more aware, P3: yes, P4: no, P5: yes, and P6: yes, but only a little, most of the discussion during the assessment was about the location of my desk.

Q4: Were there any strategies that you used to help you keep the safest postures? Answers – P1: yes, the main one was that it feels better to sit with my feet on the footrest and it relieves pressure from my back, P3: yes, when I was being observed I was more aware of trying to be safe, and when I wasn't being observed I'd catch myself not being safe and try to correct my position, P4: no, it just became natural, P5: yes, renewed the box top footrest when it became unstable and self-talk, and P6: no, just more cognizant of being safe. I wanted my performance to stay safe and at a high percentage.

Q5: Do you think your behavior or performance changed as a result of seeing your graphed performance? Answers – P1: yes, it made me try harder, P3: yes, P4: no, when it comes down to it, all I'll do is what's comfortable, P5: yes, absolutely, wonderful feedback, and P6: yes, I'm a very visual person and there was instant gratification because I knew right then how I was doing. I liked seeing my performance improve and wanted to do better when it wasn't.

Q6: Do you think your behavior changed as a result of the ergonomic information package that you received at the start of phase 3? Answers: All participants answered yes to this question. In addition, P1 said "it showed me what was correct", and P5 said "it helped me visualize what I needed to do to be safe."

Q7: Your performance did not change over the course of the study. Why do you think this happened? This question was not asked because safety performance improved for all participants.

Q8: Have you ever received an ergonomic evaluation before? If yes, when and by whom? Participants 1, 3, 4, and 6 answered that they had not received an ergonomic evaluation before. Participant 5 answered that she had received an ergonomic evaluation in November of 2001 when some OT students were doing an evaluation on another employee in the department. She asked them to help fit her new chair.

Q9: Have you ever received any type of ergonomic training? Participants 1, 3, 4, and 6 answered that they had not received ergonomic training. Participant 5 answered that she received ergonomic training by watching a video when she worked at a different college and was starting physical therapy.

Q10: Was there something you said to yourself each time you were being observed? Answers – P1: I'd say to myself, "I need to behave; make sure I don't put my feet up", P3: I didn't really say anything, I was just aware that the observer was there and I tried to move my chair rather than reaching for things, P4: no, P5: at first I was very self-conscious of being observed but as the study continued I was often surprised by how quickly the observation sessions went, and P6: I don't have to type fast just because the observer is here.

Q11: Did the presence of the observer cause you to perform differently than normal? If yes, how did it affect your performance? Answers – P1: I don't think so, P3: yes, I was more careful when the observer was here but then it also caused me to perform differently after the observer left, P4: yes, I sometimes moved my legs and feet because the observer was here, P5: yes, the observer was a good, positive reminder for me, and P6: no, not ergonomically, but when the observer was here I wanted to be the fastest typist, and I didn't want to change my behavior only when the observer was here and then not use it.

Participants were asked if they had any other comments regarding their participation in the study. P1 said, "I'm safer because the observer was here." P3 said, "Until you know what's safe and what's not safe, it's hard to be safe." P6 said, "I am much better off because of this study."

Reliability

Interobserver Agreement (IOA) was calculated on a per session basis and is presented in Figure 9. In total, 81 reliability sessions were conducted (33% of observations) and agreement averaged 98.2% by session, averaged across behaviors (SD: 2.4; range: 89% to 100%).

Table 2 shows the range of Interobserver Agreement scores for each dependent variable over the course of the study.

Independent Variable Integrity

Four measures of independent variable integrity were calculated. One measure was percent compliance with the ergonomic information and demonstration

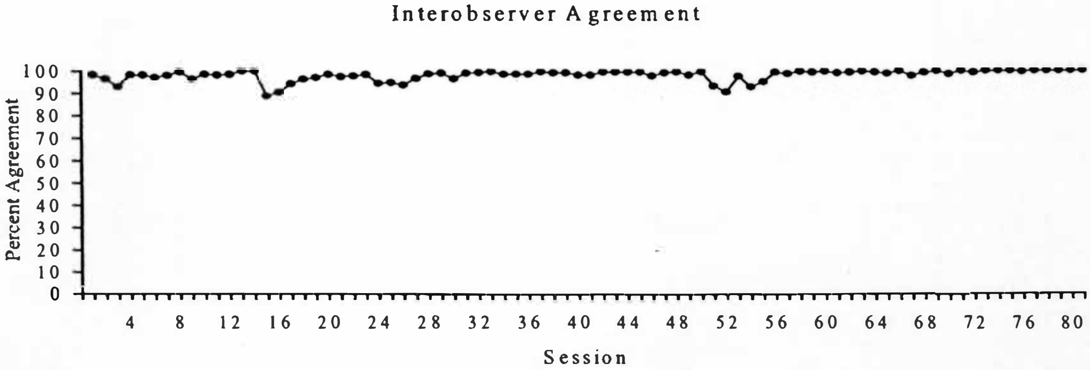


Figure 9. Percent Agreement Between Observers.

Table 2

Interobserver Agreement Percentages for Each Dependent Variable

Dependent Variable	Average IOA	Range IOA
Hand-Wrist position	97%	85 – 100
Head/Neck position	98%	85 – 100
Shoulder position	98%	70 – 100
Back supported	98%	82.5 – 100
Arm position	98.5%	82.5 – 100
Leg position	99%	70 – 100
Feet position	98%	75 – 100
Workstation variables – safety checklist	100%	N/A

procedures. All participants were able to demonstrate the safe ergonomic behaviors after reviewing the ergonomic information. The second measure was compliance with the OT ergonomic assessment protocol. In all instances, an OT student completed all sections of the checklist during the assessment. The third and fourth measures of independent variable integrity related to compliance with feedback procedures by individual and by session. Compliance on both feedback measures was 100%.

DISCUSSION

The purpose of this study was twofold: (a) to examine the effects of OT student office ergonomic assessments and the resulting computer workstation changes on the participants' safe behavior, and (b) to examine the effects of a PM package that included ergonomic training, graphic feedback and praise on the participants' safe behavior. Physical changes were made to four workstations during the OT ergonomic assessments. These changes resulted in substantial improvements in the safety performance of two participants on five behaviors. Overall, there were substantial improvements in safe behavior during the PM package phase, although individual trends in safety performance varied. Post-study observations were conducted 3.5 months after the end of the study and indicated that safety performance tended to be maintained at high levels for three of four participants observed. Under the specific conditions of the study, the results suggest that simply adjusting the computer workstation to fit the worker is not sufficient to bring about dramatic behavior change. An in-depth analysis of the results is necessary to begin to understand the underlying environmental and behavioral factors that influenced the participants' safety behavior.

OT Ergonomic Assessment Effects

Physical workstation adjustments were made to three of the seven workstations during the OT ergonomic assessments. Physical adjustments were made to participant 4's workstation during the week after the assessment. The adjustments were as follows: (a) participant 1: footrests added and monitor angle adjusted; (b) participant 3: keyboard angle adjusted by collapsing keyboard legs; (c) participant 4: monitor relocated and centered on user; and (d) participant 6: monitor angle adjusted and footrest use discussed. The workstation adjustments improved the User-Computer (UC) interface percent safe score for each of these participants as presented and described in the Results section of this paper. All participants received a written report of their assessment that included a variety of recommendations to improve their workstation arrangement. These recommendations ranged from equipment improvements, to workflow redesign, to procedural changes. None of the written recommendations were implemented during the course of the study.

The workstation adjustments had varied effects on safe behaviors across participants: no effect, a moderate effect or a strong effect. No improvements in the head-neck position of participant 1 or participant 6 resulted from the computer monitor angle adjustments. Changing the angle of the computer monitor was expected to improve the user's head-neck position (Green et al., 1991; Psihogios et al., 2001). No increases in safety performance were observed in participant 3 after the keyboard angle was adjusted so that it was parallel to the floor. This adjustment was expected to affect the hand-wrist and arm positions of the participant (Green et al., 1991; Hedge, 2002b; Hedge et al., 1999).

Moderate increases were observed in participant 4 on the three behaviors: (a) head-neck position, (b) shoulder position, and (c) back position. It is postulated that the improvement in these behaviors was a result of relocating the computer monitor so that it was centered on the user (Green et al., 1991; Psihogios et al., 2001). The improvements are described as moderate because they did not meet the author's definition of an appreciable change in behavior; that is, they were not greater than 50 percentage points above baseline.

Substantial improvements in safe behaviors, defined as greater than 50 percentage points above baseline, were observed in participant 1 on three behaviors: (a) back position, (b) leg position, and (c) feet position, and in participant 6 on two behaviors: (d) leg position, and (e) feet position. It is proposed that the improvements in participant 1's safe behaviors be attributed to the addition of footrests in her work area. Prior to having footrests, she would tuck her feet behind her and rest them on the base of her chair. She would also lean forward in her chair. The improvements to the safety performance of participant 6 are attributed to a discussion regarding footrest use during the ergonomic assessment. Participant 6 mentioned this discussion to the author at the start of the observation session following the assessment. It was also noted in the OT ergonomic assessment report. It is likely that this discussion led to the participant using her footrest correctly because prior to the assessment, she was observed using it incorrectly. After the assessment, although her use of the footrest fluctuated (see Figure 7), when she did use it, she used it correctly. That is, both feet were flat on the footrest with heels and toes touching. The improvement in back, leg and feet position is likely a result of footrest use and evidence for this is found in the literature (Hedge, 2002a; Sauter & Schleifer, 1991).

Performance Management Effects

Overall, substantial and dramatic improvements in safety performance were observed in all targeted behaviors after the implementation of the PM package phase. In all, forty-four behaviors across seven participants were targeted and each increased substantially as a result of the PM package.

The most dramatic jumps in safe performance were seen in hand-wrist position and arm position. All participants performed both behaviors unsafely during baseline and the OT evaluation phase. After the introduction of ergonomic information, feedback and praise, both behaviors improved significantly and continued throughout the PM package phase. This finding is consistent with the results from a study by Blake-McCann and Sulzer-Azaroff (1996), in which they stated, "...the intensive feedback package did appear necessary in producing optimal change in hand-wrist position" (p. 288). Another example of a dramatic improvement in performance can be seen in leg position and feet position of participant 4. Both behaviors averaged 0% safe during baseline and 0.6% safe during the OT evaluation phase. During the PM package phase, average safe performance on both behaviors increased to 73.7%.

There were five behaviors not targeted by the PM package: participant 1: (a) back position, (b) leg position, (c) feet position, and participant 6: (d) leg position, and (e) feet position. As previously discussed, because these behaviors improved by more than 50 percentage points above baseline, they were not targeted as behaviors in need of improvement and were not included in the PM package. This means that participants 1 and 6 did not receive specific ergonomic information, graphic feedback, and praise on these behaviors. Even though these participants did not receive feedback or praise about their performance on these behaviors, the behaviors continued to be performed safely during the PM package phase. One possible reason for this may be found in participant 1's answer to the question: were there any strategies that you used to help you keep the safest posture? She stated, "...the main one was that it feels better to sit with my feet on the footrest...it relieves pressure from my back." From a behavioral perspective, this participant's response can be interpreted using the concept of the establishing operation (EO). An EO is an environmental event, operation or stimulus condition that has two simultaneous functions. First, it alters the effectiveness of certain other events as reinforcers or punishers. Second, it alters the immediate frequency of behaviors associated with these reinforcing or punishing events (Michael, 1993). In the present analysis, pain (described as "pressure in my back") would be the EO that increases the reinforcing effectiveness of pain termination and increases the likelihood of any behavior that has resulted in pain reduction, i.e., "...it feels better to sit with my feet on the footrest." Building upon the concept of the EO, and as proposed by Blake-McCann and Sulzer-Azaroff (1996), several external factors, including the footrest, may have served as cues for correct posture. Stated another way, the footrest may have functioned as a discriminative stimulus (SD). An SD is defined as a stimulus that alters the current frequency of behavior because of a historical relation between the presence of that stimulus and the differential availability of an effective reinforcer for that behavior (Michael, 2002). In the current example, when the SD (footrest) is present, the reinforcer (pain termination) is available. It is important to note that it is the combined effect of the EO and the SD that may be controlling the participant's behavior; referred to as the SD evocative effect (Michael, 1993). In the present case, when the participant felt pressure in her back (EO) it was more likely that seeing the footrest (SD) would evoke placing her feet on the footrest (behavior) which resulted in pain reduction (reinforcer). An additional explanation for the dramatic increase in safe back, leg and feet position is that these posture components consist primarily of static gross motor behaviors. McFall (1977) indicated that gross motor behaviors are more salient than other behaviors and easier to discriminate than other behaviors.

Information and Demonstration

At the start of the PM package phase, all participants received written and pictorial information regarding correct ergonomic behaviors (see Appendix D: Ergonomic Information Package). Note that the information did not include the safe behavior definitions used by observers. Ergonomic information was presented only once by the author, at the start of the first session in the PM package phase. Participants received a copy of the material for reference, but it is not known if they reviewed the ergonomic information at any other time during the course of the study.

Immediately after reviewing the ergonomic information, each participant was able to demonstrate the correct behavior while seated at her computer workstation. It is important to note that participants could demonstrate the correct behaviors, in spite of workstation limitations. Even after the ergonomic assessments and resulting adjustments, none of the workstations met all of the nine criteria to be 100% safe according to the UC interface checklist. The UC interface percent safe scores ranged from 22% safe for participant 5 to 75% for participant 3.

Feedback and Praise

Feedback and praise were provided at the beginning of each session based on data scored from the previous sessions. Feedback consisted of informing and presenting the participant with graphed data about the percentage of time per session that she engaged in correct typing and posture positions. Participants were shown and given copies of their behavior graphs daily. Praise, in the form of enthusiastic approval for improvement, was delivered when the performance graphs were being reviewed. Feedback was presented with 100% compliance for all sessions in the PM package phase.

The experimental design did not allow for the effects of any single intervention (information, demonstration, feedback, or praise) to be examined in isolation. However, I assert that feedback and praise were the controlling factors in the present study rather than information and demonstration. Ergonomic information was only provided on the first session of the PM package phase, whereas feedback and praise were provided at the start of each session. As most studies of training have shown (e.g., Alavosius & Sulzer-Azaroff, 1986; Komaki, Collins, & Penn, 1982; Komaki, Heinzmann, & Lawson, 1980), behavior change does not tend to endure in the absence of support systems such as feedback. Komaki et al. (1980) reported that feedback, as a consequence, improved safety more than the antecedent of training. The results of the current study are consistent with previous research (e.g., Alavosius & Sulzer-Azaroff, 1986, 1990; Blake-McCann & Sulzer-Azaroff, 1996), which found written feedback and praise effective in enhancing and reinforcing safety performance.

In the present study, feedback and praise may have served several behavioral functions, including a rule generating function, and a conditioned establishing operation function.

Rule Generating Function

Operant conditioning involves temporal relations between behavior and its consequences that are on the order of seconds. It is convenient to refer to such effects as direct, and contrast them with the indirect effects of more remote relations between environmental events and behavior (Malott, Malott, & Trojan, 2000). In the present study, feedback and praise effectively increased the safety performance of all seven participants. I propose that the effects of feedback were indirect (i.e., delayed) for two reasons. One reason is that the delay between the response and the consequence was greater than 30 seconds (Michael, 1993). In this study, the delay between the participant's performance during the observation session, i.e., the response, and the delivery of feedback and praise (the consequence) was on average, 24 hours. A second reason is that a single occurrence of a consequence (i.e., feedback and praise) produced large change in behavior (Michael, 1993). A substantial increase in behavior was exhibited by all participants at the start of the PM package phase after the first delivery of feedback.

In the present study, the use of descriptive praise, providing a general sign of social approval (e.g., "That's great!"), was consistently paired with graphic feedback, which included a brief description of the behavior that was responsible for the approval (e.g., "Your performance on feet position has improved…"). According to Michael (1993), "when such praise is provided to a normally verbal person over 5 or 6 years of age, it probably functions as a form of instruction or as a rule" (p. 90). I am suggesting that because feedback and praise were indirect consequences to completed behaviors but relatively immediate antecedents to upcoming behaviors, they may have functioned as instructions or rules for the participants. This interpretation is supported by responses to the following question during the exit interview: when asked, do you think your behavior or performance changed as a result of seeing your graphed performance, participant 6 responded that, "I liked seeing my performance improve and wanted to do better when it wasn't. I wanted my performance to stay safe and at a high percentage." When asked the same question, participant 1 said, "Yes, it made me try harder."

Conditioned Establishing Operation Function

Recall that an EO is an environmental event, operation or stimulus condition that has two simultaneous functions. First, it alters the effectiveness of certain other events as reinforcers or punishers. Second, it alters the immediate frequency of behaviors associated with these reinforcing or punishing events (Michael, 1993). A conditioned establishing operation (CEO) is an environmental event, operation or stimulus condition that involves secondary or conditioned reinforcers instead of primary reinforcers such as food, water and pain (Michael, 1993). Feedback could function as a CEO by increasing the reinforcing effectiveness of performing safely and momentarily increasing the frequency of safe behaviors that have in the past resulted in praise.

Follow-Up

Follow-up observations were conducted approximately 3.5 months after the end of the study to examine the long-term effects of participating in the study. Four of seven participants agreed to participate in the follow-up observation sessions including participants 1, 3, 4, and 6. The three remaining participants did not respond to repeated requests to participate in the post-study sessions. Follow-up observation sessions followed the same procedures as those utilized in the baseline phase of the study.

Follow-up measures indicated that performances tended to be maintained at relatively high levels for participants 1, 3, and 6 across all behaviors. All workstation variables remained unchanged from the end of the study. The extended maintenance of target behaviors under conditions of discontinued feedback was consistent with findings in other feedback studies (e.g., Alavosius & Sulzer-Azaroff, 1990) and behavioral safety research (Grindle, Dickinson, & Boettcher, 2000). Many factors possibly contributed to this durability. For example, performance may have been maintained by natural reinforcers (e.g., more comfortable) intrinsic to engaging in the safe behaviors. With on-the-job training, common stimuli (e.g., office setting and workstation layout) were present during the study and follow-up conditions. Finally, participants may have learned rules describing correct performance.

Average safety performance of participant 4 decreased from 83.9% during the PM package phase to 36.7% during the follow-up observations. However, this was still above average safety performance during baseline (12.7%) and the OT evaluation phase (29.6%). The participant was using a different chair during the follow-up observation sessions that resulted in a reduced UC interface percent safe score from 62.5% to 50%.

Strengths and Weaknesses of the Study

This study is the only one that we could locate that systematically examined the effects of ergonomic assessments and workstation adjustments on safe behavior. It fills a gap in traditional ergonomic research by providing pre-assessment and post-assessment performance data. The practice of ergonomics in organizations usually does not include ongoing evaluation and assessment of interventions but stops once the ergonomic fix is in place. As previously mentioned, traditional approaches to office ergonomic programs do not include mechanisms to encourage or support employees to continue to use ergonomically sound work practices (Perdue, 1999). The results of the present study suggest that simply adjusting the computer workstation to fit the worker is not sufficient to bring about dramatic behavior change. The real-world setting was a strength of the study. The author was able to observe participants as they worked and as they were influenced by environmental variables at their individual workstations. Thus, there was no question as to whether the results of the interventions would generalize to the participants' work environment.

Having OT students conduct the office ergonomic assessments was both a strength and weakness of the study. The OT students who completed the evaluations were at varying levels of competency in conducting ergonomic assessments. Control over consistent administration of the ergonomic assessment was sacrificed, but comparative value to real-world ergonomic programs was strengthened. In many organizations, ergonomic assessments are conducted by personnel who do not have prior knowledge of an employee's work arrangement. Furthermore, these personnel usually have limited control over scarce resources (i.e., money) and cannot implement elaborate recommendations readily. Thus, they must overcome organizational constraints and develop creative, low-cost, or no-cost ergonomic solutions. This was also true of the OT students in the present study. An additional weakness of the study was the lack of any ergonomically correct, i.e., 100% safe according to UC interface criteria, workstations. Thus, we could not examine whether someone working at a 100% safe workstation would assume 100% safe posture. However, results from other studies in which completely safe workstations were arranged suggest that participants remain unsafe even under these conditions (Alvero & Austin, in press; Rohn & Austin, 2002).

The performance data for each participant provide important strengths of the current study. The dramatic effects demonstrated in the PM package phase indicate that participants were able to perform safely, in spite of having less than adequate computer workstations. The provision of exit interviews is a strength, as these provided critical information concerning the possible reasons for behavior change. The answers helped me develop plausible explanations regarding the behavioral functions responsible for increased safety performance. Another strength of the study was the inclusion of follow-up observations. Thus, I was able to examine the extent to which safe behaviors were maintained under conditions of discontinued feedback.

Future Research and Implications

Although the current research suggests that workstation adjustments alone are not sufficient to bring about dramatic behavior change, future research should build on this study to provide stronger conclusions related to the lasting effects of the interventions. A study should be conducted whereby personnel are able to make substantial equipment changes to the computer workstations. For example, it is not known what the effects would have been if negative tilt keyboard trays were installed on the workstation. In the present study, the workstation changes were limited to minor adjustments. Additionally, research should investigate the effects of working at a 100% safe workstation according to the UC interface measures.

In the present study, we treated all workstation adjustments equally but in terms of behavior change they each produce, they are not all equal. Thus, research is suggested that examines the relative behavior change produced by specific equipment changes. For example, research could examine the relative behavior change produced by changing the monitor angle or adding a footrest versus changing the keyboard or desk height.

The implications of written ergonomic assessments could be more thoroughly explored. We found that none of the written suggestions were implemented by the participants. This suggests that organizations need to do more than provide recommendations and rely on employees to implement ergonomic changes in their work areas.

Future research should also investigate the effects of other environmental factors, e.g., clothing, on safe behavior. As a case in point, participant 6 would engage in unsafe leg and feet positions only when wearing pants and casual clothing; when wearing skirts or dresses, her leg and feet positions were safe. When casually dressed, she would sit upon her foot as she worked at her computer. Engaging in this unsafe lower body position also affected other postural components, namely back position and to a lesser degree shoulder position and head-neck position.

The practical implications of this and future research could significantly aide practitioners in their application of the most effective office ergonomic programs and behavior-based safety processes. Organizations should be interested in applying the comparatively low-cost and highly effective behavioral technology to enhance and support their ergonomic programs. It is important to note that I am not suggesting that ergonomic interventions be replaced by behavioral interventions. Rather, we should utilize behavioral observations and feedback to ensure that tools and equipment are used correctly.

Appendix A

Office Ergonomic Assessment Form
(OT 481)

OT 481 – Occupational Therapy Work Course
Office Ergonomic Assessment

-Participant's Name-

A. Demographic Information

Company:	Western Michigan University	**Telephone Number:**	
Department:		**Contact Person:**	
Job Title:		**Analyst(s):**	
Position:		**Date:**	
Age Category (circle):	18-29 / 30-39 / 40-49 / 50-59 / 60-69 / 70-79 / Remove Keep	**Years in Position:**	

Please note: Your age category is being included for descriptive purposes only and can be removed from the final report if you prefer.

B. Job Functions

Hours worked per day (circle): 4 5 6 7 8 9 10 11 12
(Reported as a percentage of number of hours worked per day)

Function	**% of Job**	**Reported Problems**
Keyboarding		
Use of Mouse		
Filing		
Talking on phone		
Photocopying		
Composing work on computer		
Entering data from copy		
Greeting people		
Individual/s Complaints		

C. Job Description / Characteristics
Employee Report

Job Description:	
Essential Job Functions:	
Unique Aspects of Job / Work Flow:	
Individual's Complaints:	

C. Job Description / Characteristics (continued)
Written Documents

Job Description:	**Available? Y / N** **Copy Attached? Y / N or to be picked up later? Y / N** **Comments:**

D. Work Station Organization and Environment
1. Computer Work Station – Physical Dimensions

	Feature(s)	Description / Measures	Adjustments Made
Chair	Type / Model		
	Adjustable? Y / N If Yes, (circle)	Up & Down / Back angle / Back height / Seat tilt / Arms Other:	
	Seat pan length		
	Lumbar support location		
	Seat material		
	Complaints or concerns		
CPU	Location		
	# of times accessed/day		
	Complaints or concerns		
Monitor	Type / Model		
	Size		
	Space to reposition		
	Quality of viewing area		
	Complaints or concerns		
Keyboard	Location	on desk / on tray / other:	
	Adjustability	Height / Tilt	
	Dimensions	Height = in. / Depth = in.	
	Angle, Tilt & degrees	Up = / Down =	
	Legs		
	Palm rest		
	Complaints or concerns		
Mouse	Type		
	Location		
	Complaints or concerns		
Desk	Height		
	Adjustability		
	Complaints or concerns		
Other	Phone location		
	Location of documents	On desk / Document holder	

D. Work Station Organization and Environment
2. Participant - Computer Work Station Interface

Percent of time working in seated position =__% / Maximum sustained seating = _hours
Ask Participant to be seated and record following.

	Look for:	Y	N	Possible Quick-Fix	Adjustments
Chair	Both feet flat on floor & upper body high enough to work comfortably			Lower chair / Lower work surface / Footrest	
	Hip flexion more than 90			Adjust chair angle	
	Lumbar support			Add lumbar cushion	
	Complaints or concerns				
CPU	Location doesn't interfere with movement			Relocate	
	Controls accessible			Relocate	
	Complaints or concerns				
Monitor	Directly in front of user			Reposition	
	Distance to user's eyes, at least 18 inches			Reposition	
	Eyes in line with first line of text			Reposition	
	If bifocal wearer, monitor tilted backward slightly			Tilt monitor so user can assume neutral neck	
	Documents near monitor & raised off desk			Document Holder	
	Complaints or concerns				
Keyboard	Directly in front of user			Reposition	
	Height below user's seated elbow height			Lower keyboard / Raise chair	
	Sloped away from user – tilted downward			Collapse keyboard legs / Adjust keyboard tray	
	User can access keyboard & arms in neutral position			Lower chair arms / Rearrange work station	
	Complaints or concerns:				
Mouse	Mouse can be used without reaching up or out			Reposition	
	Neutral hand-wrist position on mouse			Reposition	
	On side of dominant hand			Reposition	
	Complaints or concerns				
Other	Phone + computer used at same time			If Yes: speakerphone / headset	

D. Work Station Organization and Environment
3. Office Arrangement

	Feature(s)	Description / Measures	Adjustments
Storage Areas	Files		
	Drawers		
	Bookshelves		
	Complaints or concerns		
Copy Machine	Location		
	Ease of Use		
	Complaints or concerns		
Fax Machine	Location		
	Ease of Use		
	Complaints or concerns		
Physical Environment	Air		
	Light		
	Sound		
	Complaints or concerns		
Other			

E. User Characteristics & Comments

Notable Physical Characteristics:	
Related Medical Conditions / Treatment:	
Previous Ergonomic Training:	
Suggestions for Improvement:	

F. Photos / Diagram of Work Station

The following sections are to be completed after the on-site assessment and should be included in the final report.

G. Recommendations for Worker Technique

Recommendation	Rationale with Evidence

H. Recommendations for Work Flow

Recommendation	Rationale with Evidence

I. Recommendations for Work Site

Recommendation	Rationale with Evidence	Vendor/Cost

______________________________________, OT Student ____________________
(type name here) Date

______________________________________, OT Student ____________________
(type name here) Date

Appendix B

Office Ergonomic Assessment Protocol
(OT 481)

Office Ergonomic Assessment Protocol

The following steps are to be completed the by OT students during the Office Ergonomic Assessment. The order of steps can be changed to fit the assessment, but each step must be completed.

OT students conduct the assessments in groups of 2 or 3. Roles and responsibilities should be agreed to before beginning the assessment. For example, they should decide who will conduct the interview, who will record information on the assessment and checklist, and who will take measurements.

1. Greet Participant and make introductions.
2. Explain purpose, overview and duration of assessment.
3. Explain that all information will be kept confidential and will not be discussed except as needed to develop recommendations.

Ask Participant if they have any concerns or suggestions throughout assessment

4. Interview Participant and collect following information:
   Note: Identifier in ( ) corresponds to Office Ergonomic Assessment Form
   a. Demographic Information (A)
      i. Explain that age category information is optional and can be removed from final report if they prefer.
   b. Job Functions (B)
   c. Job Description as reported by Participant (C)
   d. User Characteristics (E)
   e. Complaints or concerns
5. Measure physical dimensions of computer workstation (D1)
   a. Workstation adjustments suggested and made when appropriate
   b. Adjustments documented on assessment
6. Ask Participant to be seated and measure User-Workstation interface (D2)
   a. Workstation adjustments suggested and made when appropriate
   b. Adjustments documented on assessment
7. Review office arrangement components with participant (D3)
8. Ensure that photos are taken or diagram of office arrangement is drawn
9. Explain that a final report will be completed and sent to them in a few weeks. Tell them who they can contact for more information.
10. Thank Participant for cooperation and assistance.

Appendix C

Office Ergonomic Assessment Checklist
(OT 481)

Office Ergonomic Assessment Checklist

The following checklist will be completed the SI or OT student during the Office Ergonomic Assessment. The order of steps can be changed to fit the assessment, but each step must be completed.

Date of Assessment: ______________________Analysts: ______________

Checklist Completed by: ___________________Participant #: __________

Note: Identifier in ( ) corresponds to Office Ergonomic Assessment Form

Step	Description	Complete	
1	Greet Participant and make introductions.	**Y**	**N**
2	Explain purpose, overview and duration of assessment.	**Y**	**N**
	Comments:		
3	Explain that all information will be kept confidential and will not be discussed except as needed to develop recommendations.	**Y**	**N**
	Comments:		
4	Interview Participant and collect following information:	**n/a**	**n/a**
4a	Demographic Information (A)	**Y**	**N**
4ai	Explain that age category information is optional and can be removed from final report if they prefer.	**Y**	**N**
	Comments:		
4b	Job Functions (B)	**Y**	**N**
	Comments:		
4c	Job Description as reported by Participant (C)	**Y**	**N**
	Comments:		
4d	User Characteristics (E)	**Y**	**N**
	Comments:		
4e	Complaints or concerns	**Y**	**N**
	Comments:		
5	Measure physical dimensions of computer workstation (D1)	**Y**	**N**
	Comments:		
5a	Workstation adjustments **suggested** when appropriate	**Y**	**N**
	Comments:		

Step	Description	Complete	
5a	Workstation adjustments **made** when appropriate	**Y**	**N**
	Comments:		
5b	Adjustments documented on assessment	**Y**	**N**
	Comments:		
6	Ask Participant to be seated and measure User-Workstation interface (D2)	**Y**	**N**
	Comments:		
6a	Workstation adjustments **suggested** when appropriate	**Y**	**N**
	Comments:		
6a	Workstation adjustments **made** when appropriate	**Y**	**N**
	Comments:		
6b	Adjustments documented on assessment	**Y**	**N**
	Comments:		
7	Review office arrangement components with participant (D3)	**Y**	**N**
	Comments:		
8	Request to take photo or to draw office layout	**Y**	**N**
	Comments:		
9	Explain that a final report will be completed and sent to them in a few weeks. Verify address for final report. Tell them who to call for more information.	**Y**	**N**
10	Thank Participant for cooperation and assistance.	**Y**	**N**

Appendix D

Ergonomic Information Package

Seated Neutral Posture

A safe posture is one that places the least amount of stress on your joints and muscles. This is referred to as neutral posture. It takes the strain out of your muscles and joints and allows them to work more efficiently.

This is what seated neutral posture looks like:

Look straight ahead with your head level, not twisted or bent.
Relax your shoulders; don't hunch them or rotate them forward. Let your upper arms and elbows hand comfortably at your sides.
Keep your wrists straight.
Support your low back using the chair's backrest.
Support your feet by placing them flat on the floor or on a footrest.

Reclining Posture

Lean back 10 – 20 degrees into the chair's backrest and put your feet out in front of you to open up the angle at your hips and knees. This helps relax your back muscles and promotes blood circulation.

Seated Neutral Posture (continued)

90-degree Posture

Sit upright with your elbows, hips and knees bent at right angles and your feet flat on the floor or on a footrest. This position is biomechanically correct, but it can fatigue your back muscles over time. Fatigue can lead to slouching, even on a chair with lumbar support.

Forward Tilt Posture

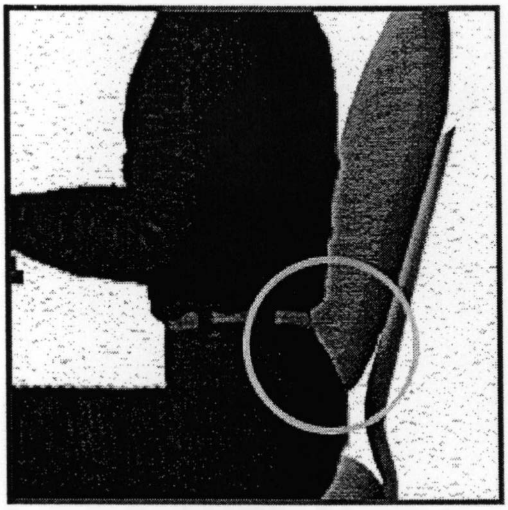
Raise the height of your chair's seat a few inches and tilt the front downward slightly. This will open up your hip angle and allow you to support some of your weight using your legs rather than having it all rest on your hips and the backs of your thighs. You may not find this posture comfortable if you have knee or foot problems, or if you feel like you are sliding off the front of the seat. A contoured chair seat can help to hold you in place.

Participant # _______ Date presented ___________ Presented by ____________
Demonstrated correctly by Participant? Y / N

Back Position

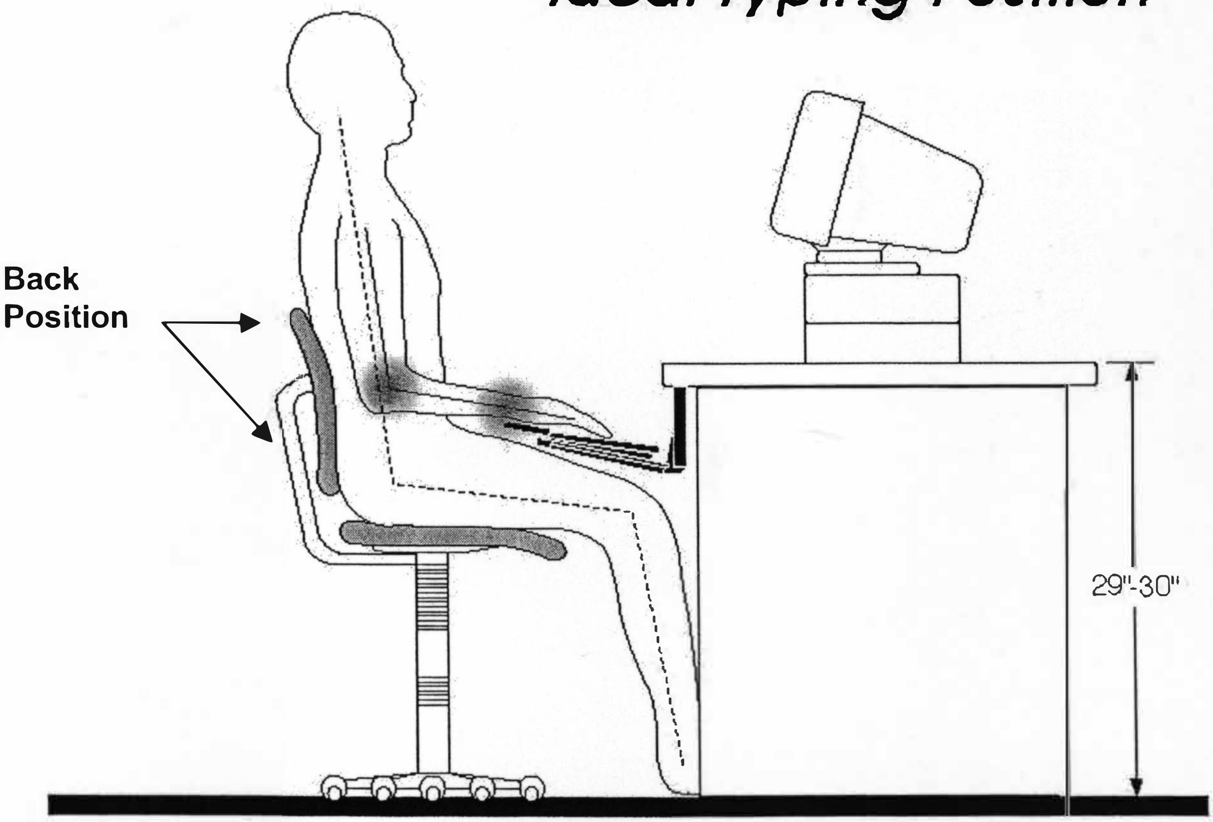
The following pictures illustrate safe back position when working at your computer workstation. After looking at the pictures, you will be asked to demonstrate safe back position at your workstation.

Low Back Support



This picture shows the correct back position when seated.

Ideal Typing Position



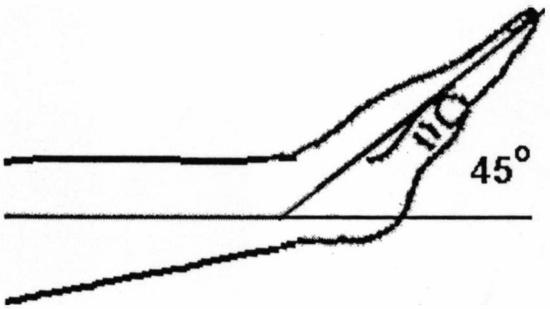
Participant # ________ Date presented ____________ Presented by ______________
Demonstrated correctly by Participant? Y / N

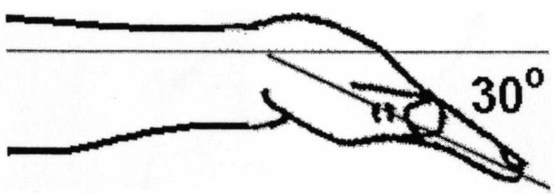
Wrist Position

The following pictures illustrate unsafe and safe wrist position when working at your computer workstation. After looking at the pictures, you will be asked to demonstrate safe wrist position while using your mouse and keyboarding.

Awkward Positions to be Avoided

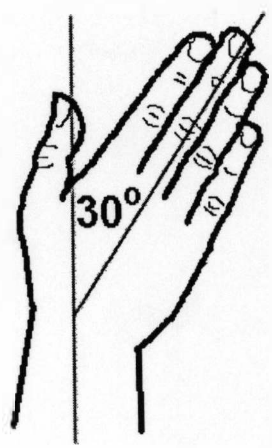
Extension (bent up)





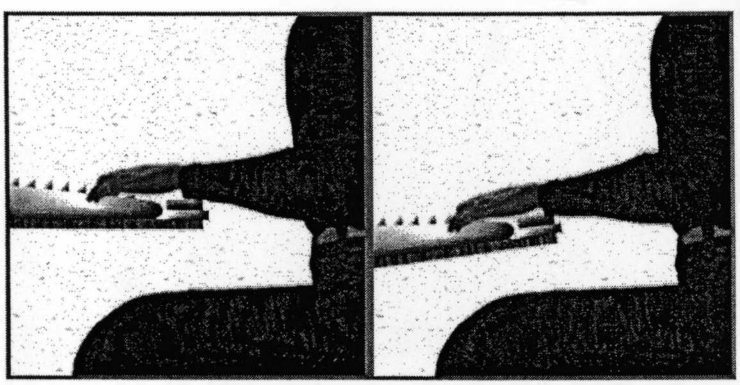
Flexion (bent down)

Ulnar Deviation (bent right or left)



Neutral Wrist Position when Keyboarding

The following two pictures are examples of neutral (safe) wrist position when keyboarding.

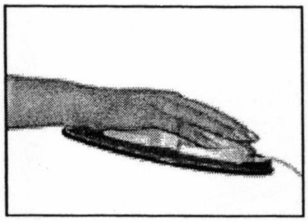


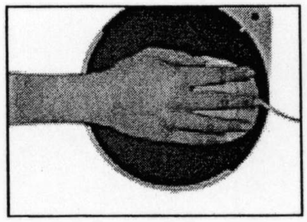
Horizontal **Slight Decline**

Wrist Position (continued)

Neutral Wrist Position when using Mouse

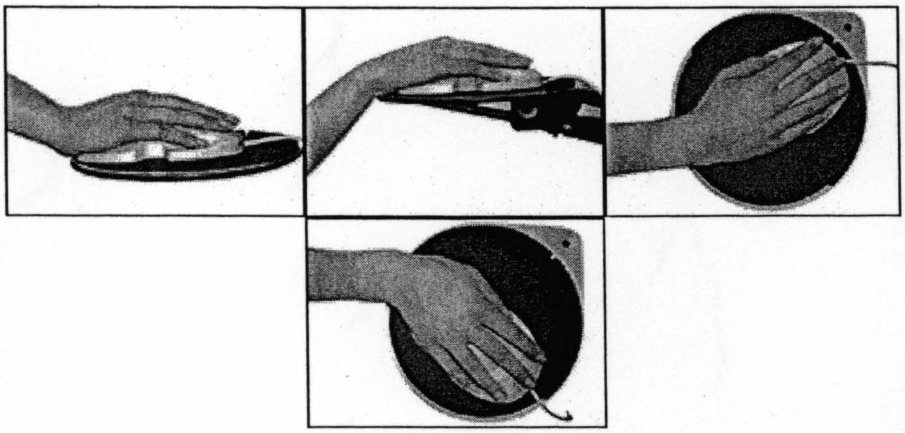
The following two pictures are examples of neutral (safe) wrist positions when using the mouse.





Awkward Wrist Position when using Mouse

The following four pictures are examples of awkward (unsafe) wrist positions when using the mouse. These positions should be avoided.



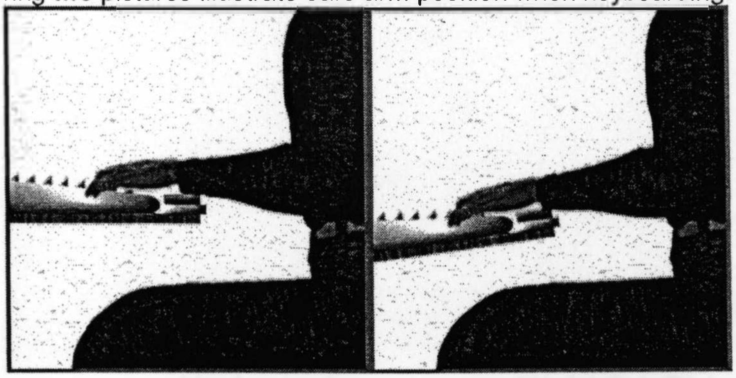
Participant # ________ Date presented ____________ Presented by ______________
Demonstrated correctly by Participant (when using mouse)? Y / N
Demonstrated correctly by Participant (when keyboarding)? Y / N

Arm Position

The following pictures illustrate safe arm position when working at your computer workstation. After looking at the pictures, you will be asked to demonstrate safe arm position at your workstation.

Neutral Arm Position when Keyboarding

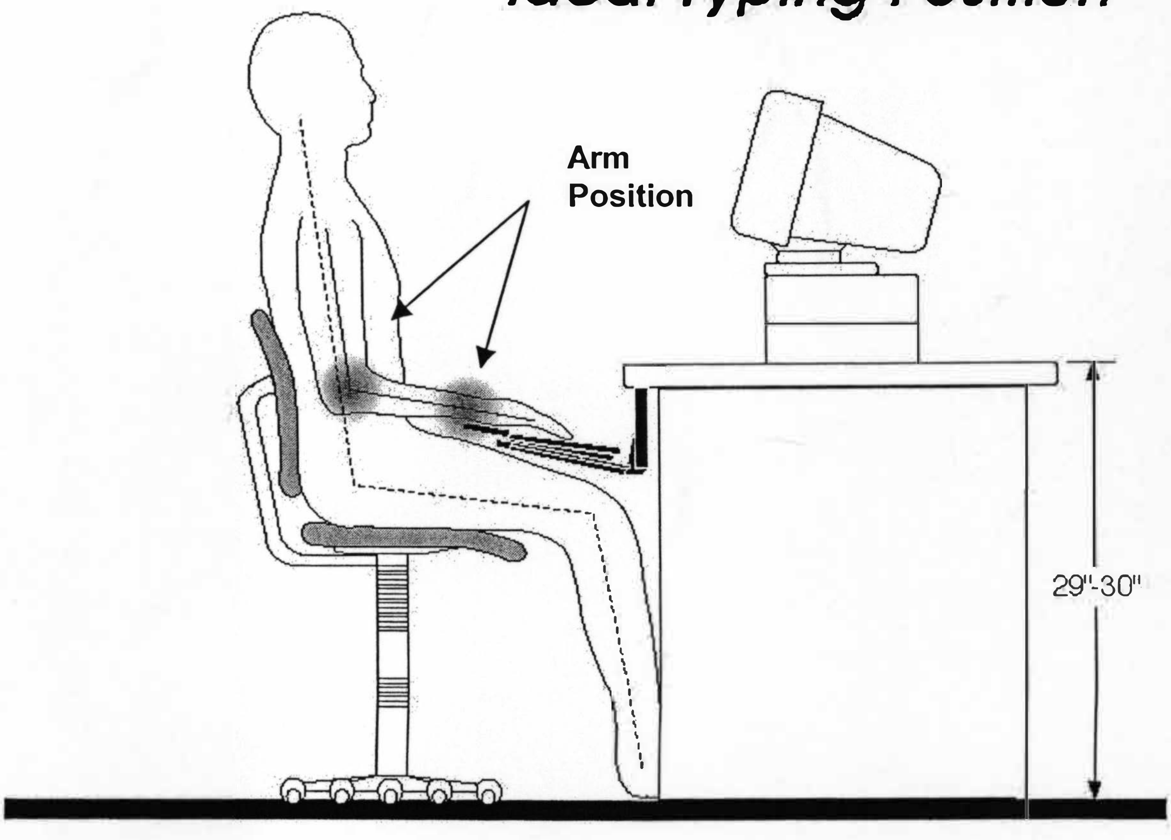
The following two pictures illustrate safe arm position when keyboarding.



Horizontal **Slight Decline**

The following picture shows neutral arm position in relation to the rest of the body.

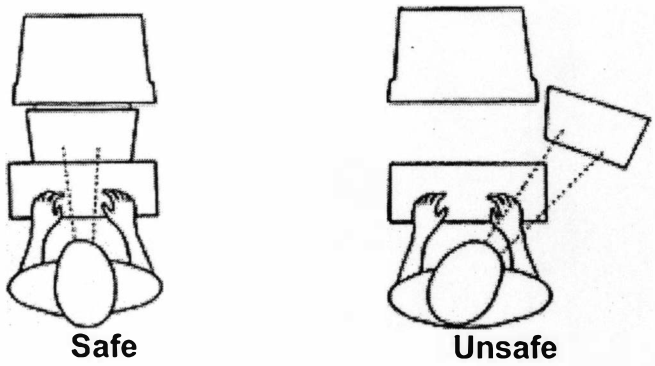
Ideal Typing Position



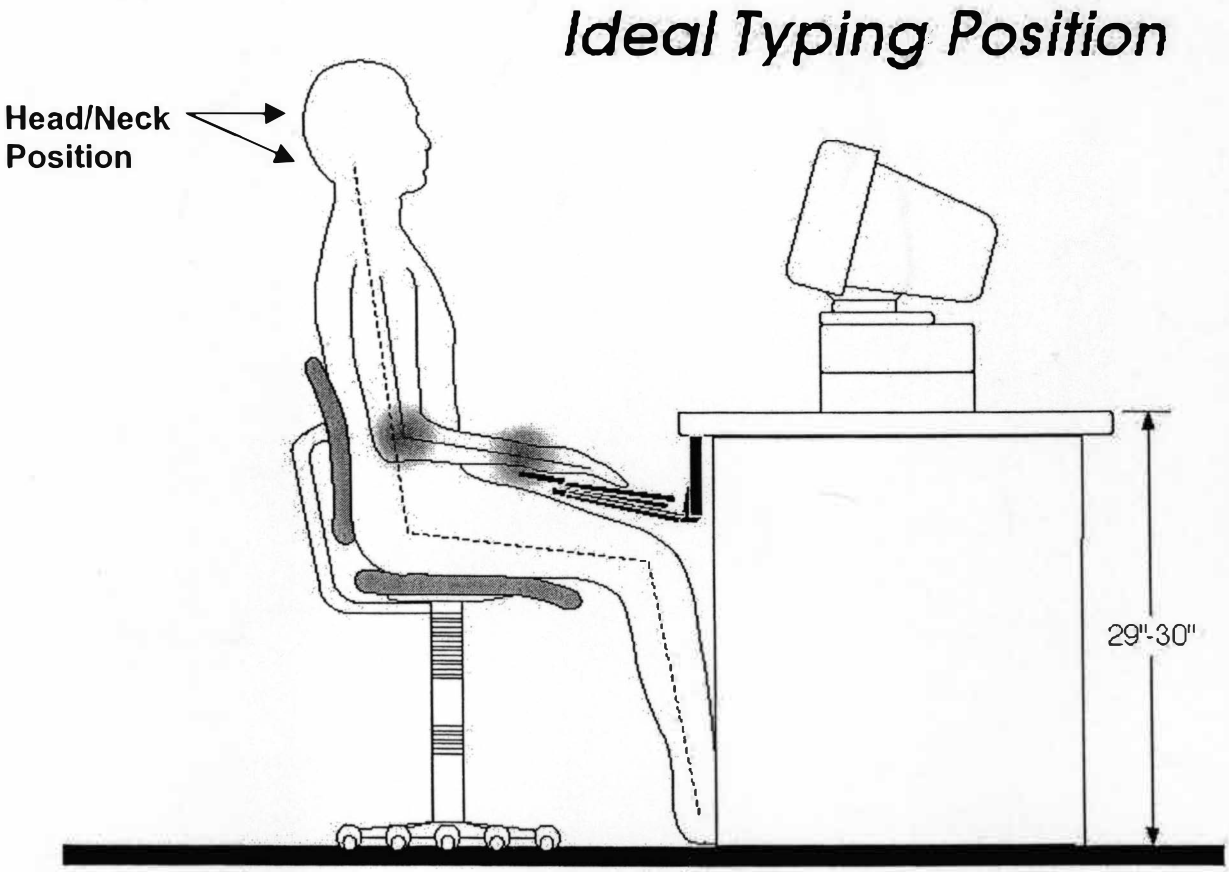
Participant # ________ Date presented ____________ Presented by ____________
Demonstrated correctly by Participant? Y / N

Neck/Head Position

The following pictures illustrate safe and unsafe neck/head position when working at your computer workstation. After looking at the pictures, you will be asked to demonstrate safe neck/head position at your workstation.



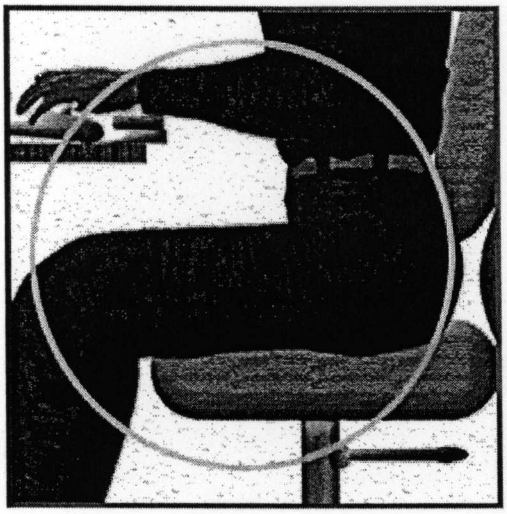
The following picture shows the head / neck in the safe position in relation to the rest of the body.

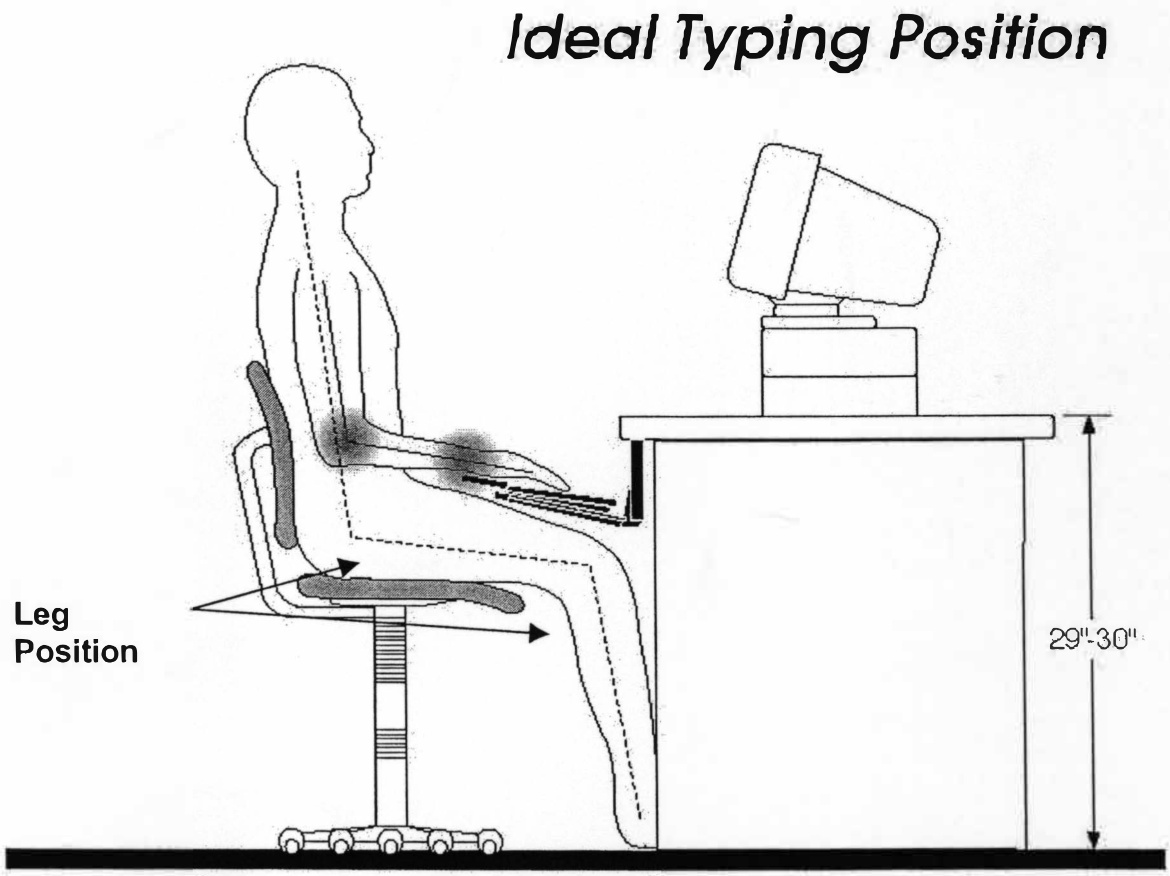


Participant # _______ Date presented ____________ Presented by ______________
Demonstrated correctly by Participant? Y / N

Leg Position

The following pictures illustrate safe leg position when working at your computer workstation. After looking at the pictures, you will be asked to demonstrate safe leg position at your workstation.

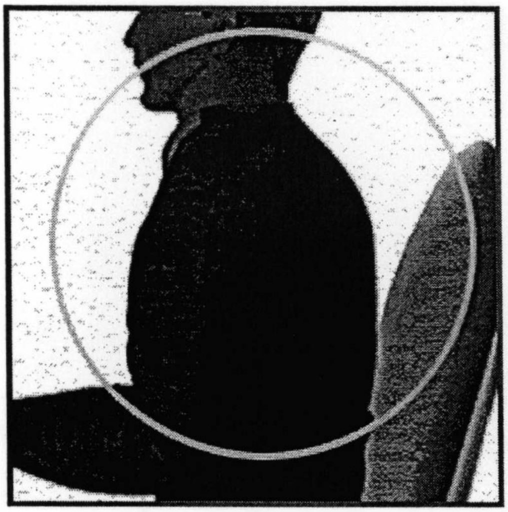


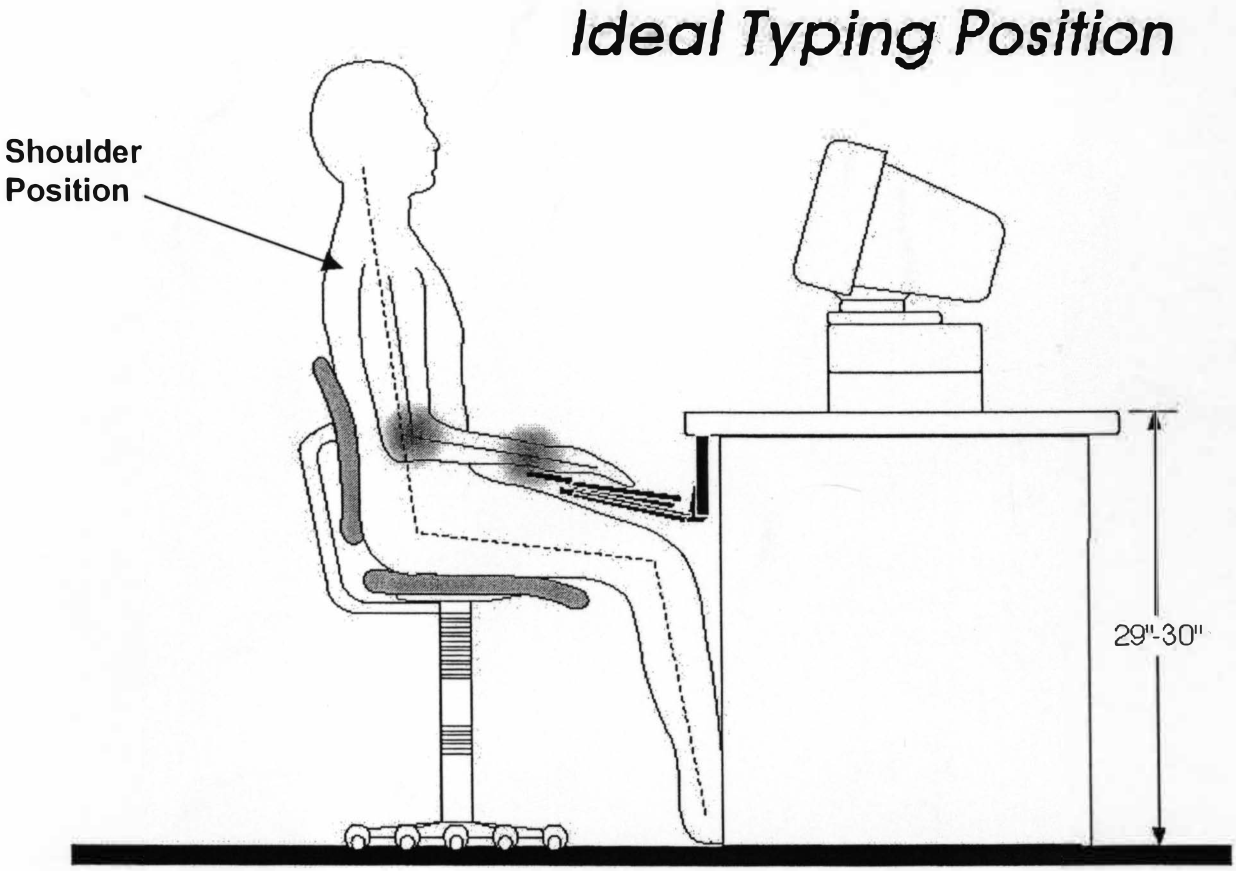


Participant # ________ Date presented ____________ Presented by ______________
Demonstrated correctly by Participant? Y / N

Shoulder Position

The following pictures illustrate safe shoulder position when working at your computer workstation. After looking at the pictures, you will be asked to demonstrate safe shoulder position at your workstation.





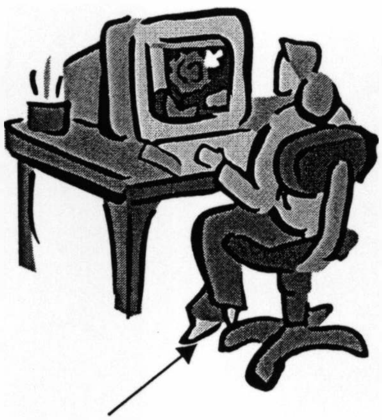
Participant # ________ Date presented ____________ Presented by ______________
Demonstrated correctly by Participant? Y / N

Feet Position

The following pictures illustrate safe and unsafe feet position when working at your computer workstation. After looking at the pictures, you will be asked to demonstrate safe feet position at your workstation.

Both feet should be flat on the floor or on a footrest - heels and toes of both foot touching floor or footrest.

The following pictures show incorrect foot position when seated at a computer workstation.



Ankles crossed

Feet on desk

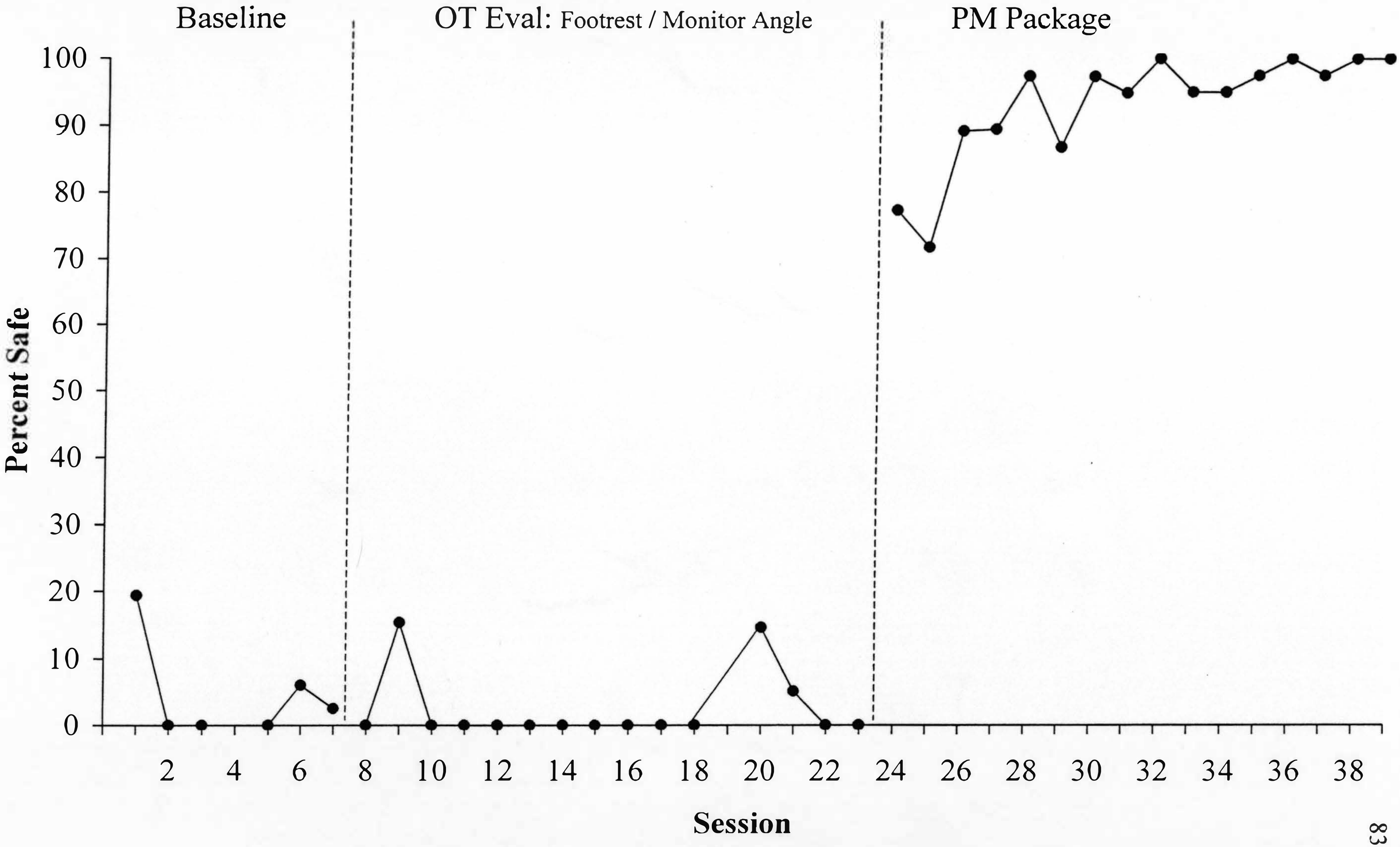
Participant # ________ Date presented ____________ Presented by ______________
Demonstrated correctly by Participant? Y / N

Appendix E

Sample Graphic Feedback Form

Participant 1

Hand-Wrist Position



Appendix F

Feedback and Praise Script

Feedback and Reinforcement Script

To be read by SI or RA at the start of each session in Phase III: TR/FB/R+. (Feedback and reinforcement delivery should take no longer than 1-2 minutes to complete.)

"Is it okay if I provide you with your performance information now?"

If No – Ask, "Can I come back at a later time that's more convenient?" Make arrangements to come back later, say thank you and leave.

If Yes: hand them the graph(s) and read the following

"Each graph represents a single posture component (see Title on top of graph) and is made up of your observational data (Participant #) that has been collected to date. (Some or all of the following will be reviewed)

- The section titled 'Baseline' was the part of the study prior to the OT office ergonomic assessment.
- The section titled 'OT Eval' included the observation sessions following the assessment.
- And the section titled 'PM Package' included the observation sessions after you received ergonomic training, written and verbal feedback
- The x-axis shows the number of observation sessions.
- The y-axis represents the percentage of observations in which you performed the posture safely."

Depending on how the data look, reinforcement will be delivered in the form of enthusiastic approval and social praise. For example:

"Your performance of (insert appropriate behavior) has shown considerable improvement over the course of the study. That's great!"

"You have made great improvement in the way you perform this (insert appropriate behavior)!"

Leave the graphs with the participant and ask, "Is it okay if I conduct an observation at this time?"

If Yes – complete observation
If No – make arrangements for different time

Appendix G

Data Collection Sheet

PARTICIPANT # ________ SESSION # _____ DATE: ________ OBSERVER: ___________ (RELIABILITY OBSERVER ________)

WORKSTATION VARIABLES – PHYSICAL DIMENSIONS											
HEIGHT	Keyboard		Mouse		Monitor*		Chair		Desk		
ANGLE	Keyboard		Mouse		Monitor						

* - distance from user's eye to monitor

WORKSTATION VARIABLES – USER-COMPUTER INTERFACE	(+ = SAFE / - = UNSAFE)		
COMPONENT	**DESCRIPTION**	**SAFE**	
CHAIR	User's feet rest on floor or footrest and upper body is high enough to work comfortably	+	-
MONITOR	Positioned directly in front of and centered on user	+	-
	User's eyes should be in line with a point 2-3 inches below top of monitor	+	-
	Distance from user's eye to monitor at least 18 inches	+	-
	Angle relevant for bifocal user's: tilted backwards slightly so user can see screen w/out tilting head	+	-
KEYBOARD	Positioned in front of and centered on user	+	-
	Height is below user's seated elbow height	+	-
	Sloped away from user – tilted downward	+	-
MOUSE	On a flat surface that 1-2 inches above keyboard and moveable, OR	+	-
	On same level as keyboard: sloped away from user – tilted downward	+	-

BEHAVIOR + = PERFORMED SAFELY / - = PERFORMED UNSAFELY / X = NOT PERFORMED

TYPING

INTERVALS		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	% S
Hand-Wrist Position Wrists flat (not bent up or down) and straight (not bent right or left)	0	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
	2	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	

POSTURE

INTERVALS		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	% S
Head/Neck Position Head in vertical position such that the neck aligned with back; head facing forward	0	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
	2	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
Shoulder Position Upper arms close to body & relaxed, not extended; shoulders not hunched or raised	0	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
	2	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
Back Supported Lower back supported reclined posture; angle of the back & thigh approx. 100 – 110 degrees	0	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
	2	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
Arm Position Arms & elbows close to body; inside elbow angle 90-120 degree	0	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
	2	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
Leg Position Knees bent forming an angle between 90 – 120 degrees	0	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
	2	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
Both Feet Flat on Floor Both feet are flat on the floor or footrest (ball of foot and heel should be touching)	0	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	
	2	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	+ - X	

Interval duration = 10

Appendix H

Initial Consent Documentation

WESTERN MICHIGAN UNIVERSITY
DEPARTMENT OF PSYCHOLOGY

Evaluating the Effects of Workstation Changes on Performance in an Office Setting

Kathryn Culig, John Austin and Debra Lindstrom-Hazel
WESTERN MICHIGAN UNIVERSITY

My name is Kathryn Culig and I am graduate student in the Department of Psychology at Western Michigan University. This study will fulfill my thesis requirement. My faculty advisor is Dr. John Austin and my collaborating advisor is Dr. Debra Lindstrom-Hazel of the Department of Occupational Therapy.

Purpose. You are invited to participate in a research study entitled "The Effects of Workstation Changes on Safe Behavior". The purpose of the study is twofold: a) to evaluate the effectiveness of the office ergonomic assessments conducted by WMU Occupational Therapy students, and b) to examine the effects of workstation changes on certain aspects of office performance.

If you choose to participate in the study you would help us evaluate how helpful the evaluations are for employees. We will be able to determine if the evaluations resulted in behavior changes that will reduce the likelihood of the development of musculoskeletal disorders. If you choose not to participate in the study you will still receive your OT student evaluation.

Duration. You are asked to allow me to quietly observe you while you are working for 10 minutes at a time over the next 6 to 10 weeks. The observation sessions will be scheduled at your convenience. The number of sessions will range from 20 to 30. The length of your participation in the study will vary depending on your availability.

Explanation of Study Procedures. Your behavior will be observed daily by an investigator from Western Michigan University as you work as you normally would at your office workstation. You behavior will be observed for a number of days prior to the office ergonomic assessment conducted by Occupational Therapy students. The assessment will take between 45 and 90 minutes to complete. You will continue to be observed daily after the office ergonomic assessment. Depending upon the effectiveness of the workstation adjustments, you may also have the opportunity to receive ergonomic training and one-on-one feedback to improve your safe ergonomic behaviors. Prior to the training and feedback condition, you will be asked to provide consent given the option to continue.

Benefits. As a result of the office ergonomic assessment conducted by Occupational Therapy students you will receive workstation adjustments that are designed to improve the arrangement of your office. These adjustments will attempt to reduce or eliminate barriers to performing safely, thus creating an environment that will allow you to assume correct ergonomic behaviors. Engaging in correct ergonomic behaviors will reduce the likelihood of the development of musculoskeletal disorders later in life. You will be provided with information regarding correct workstation design and work process improvements to prevent the onset of repetitive strain injuries. By observing your behavior before and after the assessment, the investigators will be able to evaluate the effectiveness of the assessment to allow you to assume correct ergonomic behaviors.

Risks and Protections. You may experience mild uneasiness associated with being observed. This risk will be minimized by the fact that the each observation session will only begin after you have given your verbal approval to begin.

To protect your safety, any and all workstation adjustments will comply with government accepted ergonomic standards. As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency procedures will be taken; however, no compensation or additional treatment will be made available to you except otherwise stated in this consent form.

Confidentiality. All information obtained in this study will remain strictly confidential. Your work supervisor will not have any access to your data or results. A number will be assigned to you and will be used to identify your data; no names or identifiers will be used. If results are presented publicly, you will not be identified by name or identifier. By signing the consent form you will be giving permission for data obtained in this study to be presented in professional presentations and publications. Any incidental information collected (e.g. during observations or via phone calls) will be held in confidence.

Voluntary participation. Your participation in this study is completely voluntary. You are free to refuse to participate or withdraw at any time without penalty. You will receive the OT ergonomic evaluation whether or not you choose to participate in the study. You can cut short an observation if circumstances require and I will reschedule another time that is more convenient. You will help me determine where to position myself while I observe you so that I will not disrupt your work. At the end of the study, the experimenter will answer any questions you have and explain how your data helped us learn more about performance in an office.

Who to contact with questions. If you have any questions about this study you may call Kathryn Culig at 383-1171. In addition, Dr. John Austin, my faculty advisor can be reached at 387-4495. And, Dr. Debra Lindstrom-Hazel, my collaborating advisor of the Occupational Therapy department can be reached at 387-7239. You may also contact the Chair, Human Subjects Institutional Review Board at 387-8293 or the vice President for Research, 387-8298 if questions or problems arise during the course of the study.

Your signature below indicates that you read the above information and agree to participate in the study.

Participant Signature　　　　　　　　Date

Please keep the attached copy of this form for your records

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date 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

Secondary Consent Documentation

WESTERN MICHIGAN UNIVERSITY
DEPARTMENT OF PSYCHOLOGY

Evaluating the Effects of Workstation Changes on Performance in an Office Setting

Kathryn Culig, John Austin and Debra Lindstrom-Hazel
WESTERN MICHIGAN UNIVERSITY

Purpose. You are currently participating in a research study entitled "The Effects of Workstation Changes on Safe Behavior" and you have completed the initial follow-up phase of the study. When you initially provided your consent to participate in the study, you were informed that you might have the opportunity to receive ergonomic training and feedback. You are now invited to participate in the last phase of the study that will examine the effects of ergonomic training, feedback and praise on certain aspects of office performance. If you choose not to receive training and feedback, the investigators would like to continue observing you as they have been up to this point in time. You also have the right to withdraw from the study if you choose.

Duration. You are asked to allow me to observe you for approximately 10 10-minute observation and feedback sessions over 2 to 3 weeks. The observation and feedback sessions will be scheduled at your convenience. The length of your participation in the study will vary depending on your availability.

Explanation of Study Procedures. Your behavior will be observed daily by an investigator from Western Michigan University as you work as you normally would at your office workstation. You will receive one-on-one ergonomic training and feedback and reinforcement to improve your safe ergonomic behaviors. The ergonomic training session will take no longer than 15 minutes to complete.

Benefits. You will be provided with information regarding correct ergonomic behaviors to prevent the onset of repetitive strain injuries. You will also be provided with graphic feedback on only those behaviors that have not been significantly improved by the workstation adjustments. Previous studies have shown that interventions that include training, feedback and reinforcement have been effective in improving ergonomic behaviors.

Risks and Protections. You may experience mild uneasiness associated with receiving feedback. This risk will be minimized by the fact that each feedback session will only commence after you have given your verbal approval to begin. You may experience mild uneasiness associated with being observed. This risk will be minimized by the fact that the each observation session will only begin after you have given your verbal approval to begin.

To protect your safety, any and all workstation adjustments will comply with government accepted ergonomic standards. As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency procedures will be taken; however, no compensation or additional treatment will be made available to you except otherwise stated in this consent form.

Confidentiality. All information obtained in this study will remain strictly confidential. Your work supervisor will not have any access to your data or results. A number will be assigned to you and will be used to identify your data; no names or identifiers will be used. If results are presented publicly, you will not be identified by name or identifier. By signing the consent form you will be giving permission for data obtained in this study to be presented in professional presentations and publications. Any incidental information collected (e.g. during observations or via phone calls) will be held in confidence.

Voluntary participation. Your participation in this study is completely voluntary. You are free to refuse to participate or withdraw at any time without penalty. You can cut short an observation if circumstances require and I will reschedule another time that is more convenient. You will help me determine where to position myself while I observe you so that I will not disrupt your work. At the end of the study, the experimenter will answer any questions you have and explain how your data helped us learn more about performance in an office.

Who to contact with questions. If you have any questions about this study you may call Kathryn Culig at 383-1171. In addition, Dr. John Austin, my faculty advisor can be reached at 387-4495. And, Dr. Debra Lindstrom-Hazel, my collaborating advisor of the Occupational Therapy department can be reached at 387-7239. You may also contact the Chair, Human Subjects Institutional Review Board at 387-8293 or the vice President for Research, 387-8298 if questions or problems arise during the course of the study.

Your signature below indicates that you read the above information and agree to participate in the study.

Participant Signature — Date

Please keep the attached copy of this form for your records

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date 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 J

Post-Study Consent Documentation

WESTERN MICHIGAN UNIVERSITY
DEPARTMENT OF PSYCHOLOGY

Evaluating the Effects of Workstation Changes on Performance in an Office Setting

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WESTERN MICHIGAN UNIVERSITY

Purpose. You previously participated in a research study entitled "The Effects of Workstation Changes on Safe Behavior". You are now invited to participate in a follow-up phase to the study that will examine the long-term effects of ergonomic training, feedback and praise on certain aspects of office performance. You also have the right to withdraw from the follow-up phase to the study at any time.

Duration. You are asked to allow me to observe you for three 10-minute observation sessions over 1 to 2 weeks, for up to 7 months. This means that you will be observed three times each month from September 2002 to March 22, 2003. The observation sessions will be scheduled at your convenience. The length of your participation in the study will vary depending on your availability.

Explanation of Study Procedures. Your behavior will be observed daily by an investigator from Western Michigan University as you work as you normally would at your office workstation.

Benefits. As a result of the office ergonomic assessment conducted by Occupational Therapy students you received workstation adjustments that were designed to improve the arrangement of your office. These adjustments were designed to reduce or eliminate barriers to performing safely, thus creating an environment that would allow you to assume correct ergonomic behaviors. Engaging in correct ergonomic behaviors will reduce the likelihood of the development of musculoskeletal disorders later in life. By observing your behavior approximately 4 months after the completion of the study, investigators will be able to evaluate the effectiveness of the assessment and performance management package to produce long-term behavior change. Engaging in correct ergonomic behaviors will reduce the likelihood of the development of musculoskeletal disorders later in life. Previous studies have shown that interventions that include training, feedback and reinforcement have been effective in improving ergonomic behaviors.

Risks and Protections. You may experience mild uneasiness associated with receiving feedback. This risk will be minimized by the fact that each feedback session will only commence after you have given your verbal approval to begin. You may experience mild uneasiness associated with being observed. This risk will be minimized by the fact that the each observation session will only begin after you have given your verbal approval to begin.

To protect your safety, any and all workstation adjustments will comply with government accepted ergonomic standards. As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency procedures will be taken; however, no compensation or additional treatment will be made available to you except otherwise stated in this consent form.

Confidentiality. All information obtained in this study will remain strictly confidential. Your work supervisor will not have any access to your data or results. A number will be assigned to you and will be used to identify your data; no names or identifiers will be used. If results are presented publicly, you will not be identified by name or identifier. By signing the consent form you will be giving permission for data obtained in this study to be presented in professional presentations and publications. Any incidental information collected (e.g. during observations or via phone calls) will be held in confidence.

Voluntary participation. Your participation in this study is completely voluntary. You are free to refuse to participate or withdraw at any time without penalty. You can cut short an observation if circumstances require and I will reschedule another time that is more convenient. You will help me determine where to position myself while I observe you so that I will not disrupt your work. At the end of the study, the experimenter will answer any questions you have and explain how your data helped us learn more about performance in an office.

Who to contact with questions. If you have any questions about this study you may call Kathryn Culig at 383-1171. In addition, Dr. John Austin, my faculty advisor can be reached at 387-4495. And, Dr. Debra Lindstrom-Hazel, my collaborating advisor of the Occupational Therapy department can be reached at 387-7239. You may also contact the Chair, Human Subjects Institutional Review Board at 387-8293 or the vice President for Research, 387-8298 if questions or problems arise during the course of the study.

Your signature below indicates that you read the above information and agree to participate in the study.

________________________________ ________________
Participant Signature Date

Please keep the attached copy of this form for your records

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date 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 K

Exit Interview: List of Questions

Exit Interview

Questions to be read by the student investigator during the Debriefing Session.

1. What did you think this study was about?

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

3. Do you think your behavior or performance changed as a result of the office ergonomic assessment?

4. Were there any strategies that you used to help you keep the safest postures?
   Y / N   If yes, can you describe them for me?

5. (Phase III Participants only) Do you think your behavior or performance changed as a result of seeing your graphed performance?

6. (Phase III Participants only) Do you think your behavior or performance changed as a result of the ergonomic information you received?

7. (If performance did not change) Your performance did not change over the course of the study. Why do you think this happened?

8. Have you ever received an office ergonomic evaluation before?

9. Have you ever received any type of ergonomic training before?

10. Was there something you said to yourself each time you were being observed?

11. Did the presence of the observer cause you to perform differently than normal?
    Y / N   If yes, how did it affect your performance?

Appendix L

Debriefing: Explanation of Study

Debriefing Script

Following the last session of participation the student investigator will review the following information with each participant individually.

"This is a brief explanation of the purpose of the study. If you have any questions, as I read through the following, please ask.

The purpose of the study was twofold. The first purpose was to examine the effects of individualized computer workstation adjustments on safe behavior. We were interested in determining if the workstation adjustments caused you to perform more safely when working at your computer workstation. The purpose of the workstation adjustments was to create an environment that would encourage and support safe postures. If we determined that the workstation adjustments did not sufficiently change safe posture, we entered the next phase of the study.

The second purpose of the study was to examine the effects ergonomic training, feedback and reinforcement on postures that did not improve as a result of the workstation adjustments. Feedback was provided only for those postures that did not improve. Previous studies have shown that interventions that include training, feedback and reinforcement have been effective in improving ergonomic behaviors.

Do you have any questions regarding the purpose of the study?

Would you like to see graphs of your performance? (Hand graphs to participant) Each graph represents a different posture component (see Title of graph) and is made up of your observational data (Participant #) that was collected over the course of the study. The section titled 'Baseline' was the part of the study prior to the OT office ergonomic assessment. The section titled 'Workstation Changes' included the observation sessions following the assessment. And the section titled 'TR/FB/R+' included the observation sessions during ergonomic training, feedback and reinforcement. The x-axis shows the number of observation sessions. The y-axis represents the percentage of observations in which you performed the posture safely. Do you have any questions about your performance?

Do you have any questions regarding your participation in this study?

Thank you for participating in the study. Your help is greatly appreciated."

Appendix M

Research Protocol Approval

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Centennial 1903-2003 Celebration

Date: March 22, 2202

To: John Austin, Principal Investigator
Debra Lindstrom-Hazel, Co-Principal Investigator
Kathryn Culig, Student Investigator for thesis

From: Mary Lagerwey, Chair Mary Lagerwey

Re: HSIRB Project Number: 02-03-01

This letter will serve as confirmation that your research project entitled "Program Evaluation – Occupational Therapy 481 and Masters Thesis – Examining the Effects of Individualized Computer Workstation Adjustments of Safe Behavior" 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: March 22, 2003

Walwood Hall, Kalamazoo MI 49008-5456
PHONE: (616) 387-8293 FAX: (616) 387-8276

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Centennial
1903-2003 Celebration

Date: September 17, 2002

To: John Austin, Principal Investigator
Debra Lindstrom-Hazel, Co-Principal Investigator
Kathryn Culig, Student Investigator for thesis

From: Mary Lagerwey, Chair

Re: HSIRB Project Number: 02-03-01

This letter will serve as confirmation that the changes to your research project "Program Evaluation – Occupational Therapy 481 and Masters Thesis – Examining the Effects of Individualized Computer Workstation Adjustments on Safe Behavior" requested in your memo dated September 16, 2002, have been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

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: March 22, 2003

Walwood Hall, Kalamazoo MI 49008-5456

BIBLIOGRAPHY

Alavosius, M.P., & Sulzer-Azaroff, B. (1986). The effects of performance feedback on the safety of client lifting and transfer. Journal of Applied Behavior Analysis, 19(3), 261-267.

Alavosius, M.P., & Sulzer-Azaroff, B. (1990). Acquisition and maintenance of health-care routines as a function of feedback density. Journal of Applied Behavior Analysis, 23(2), 151-162.

Alvero, A.M., & Austin, J. (in press). The observer effect: The effects of conducting behavioral observations on the behavior of the observer. Journal of Applied Behavior Analysis.

Austin, J., Kessler, M.L., Riccobono, J.E., & Bailey, J.S. (1996). Using feedback and reinforcement to improve performance and safety of a roofing crew. Journal of Organizational Behavior Management, 16(2), 49-75.

Bergqvist, U., Wogast, E., Nilsson, B., & Voss, M. (1995). The influence of VDT work on musculoskeletal disorders. Ergonomics, 38(4), 754-762.

Bhatnager, V., Drury, C.G., & Schiro, S.G. (1985). Posture, postural discomfort, and performance. Human Factors, 27(2), 189-199.

Blake-McCann, K., & Sulzer-Azaroff, B. (1996). Cumulative trauma disorders: Behavioral injury prevention at work. Journal of Applied Behavioral Science, 32(3), 277-291.

CTD News (2000). Workplace solutions for repetitive stress injuries. CTD News website. Available: http://www.ctdnews.com.

Fellner, D.J., & Sulzer-Azaroff, B. (1986). Occupational safety: Assessing the impact of adding assigned or participative goal-setting. Journal of Organizational Behavior Management, 7 (1/2), 3-24.

Grandjean, E. (1988). Fitting the task to the man (4th ed.). Bristol, PA: Taylor & Francis.

Green, R.A., Briggs, C.A., & Wrigley, T.V. (1991). Factors related to working posture and its assessment among keyboard operators. Applied Ergonomics, 22(1), 29-35.

Grimaldi, J.V., & Simonds, R.H. (1989). Psychological aspects and ergonomics. In J.V. Grimaldi & R.H. Simonds (Eds.), Safety management (pp. 494-517). Homewood, IL: American Society of Safety Engineers.

Grindle, A.C., Dickinson, A.M., & Boettcher, W. (2000). Behavioral safety research in manufacturing settings: A review of the literature. Journal of Organizational Behavioral Management, 20(1), 29-68.

Hedge, A. (2001). Four-step ergonomics program for computer users. Proformix website. Available: http://www.proformix.com.

Hedge, A. (2002a). Ergonomic guidelines for arranging a computer workstation – 10 steps for users. Cornell University Ergonomics website. Available: http://www.ergo.human.cornell.edu/ergoguide.html.

Hedge, A. (2002b). Ideal typing posture: Negative slope keyboard support. Cornell University Ergonomics website. Available: http://www.ergo.human.cornell.edu/AHTutorials/typingposture.html.

Hedge, A., Morimoto, S., & McCrobie, D. (1999). Effects of keyboard tray geometry on upper body posture and comfort. Ergonomics, 42(10), 1333-1349.

Hochanadel, C.D. (1995). Computer workstation adjustment: a novel process and large sample study. Applied Ergonomics, 26(5), 315-326.

Kiesler, S. & Finholt, T. (1988). The mystery of RSI. American Psychologist, 43(12), 1004-1013.

Komaki, J., Barwick, K.D., & Scott, L.R. (1978). A behavioral approach to occupational safety: Pinpointing and reinforcing safe performance in a food manufacturing plant. Journal of Applied Psychology, 63(4), 434-445.

Komaki, J., Collins, R., & Penn, P. (1982). The role of performance antecedents and consequences in work motivation. Journal of Applied Psychology, 67(3), 334-340.

Komaki, J., Heinzmann, A.T., & Lawson, L. (1980). Effect of training and feedback: Component analysis of a behavioral safety program. Journal of Applied Psychology, 65(2), 261-270.

Kroemer, K.H.E. (1989). Cumulative trauma disorders: Their recognition and ergonomics measures to avoid them. Applied Ergonomics, 20(4), 274-280.

Ludwig, T.D., & Geller, E.S. (1997). Assigned versus participative goal setting and response generalization: Managing injury control among professional pizza deliverers. Journal of Applied Psychology, 82(2), 253-261.

Malott, R.W., Malott, M.E., & Trojan, E.A. (2000). Elementary principles of behavior (4th ed.). Upper Saddle River, NJ: Prentice Hall.

Marcus, M. (1996). Upper extremity musculoskeletal symptoms among office workers: Associations with video display terminal use and office psychosocial stressors. American Journal of Industrial Medicine, 29(2), 161-170.

Martin, C., & Andrew-Tuthill, D.M. (1999). Office ergonomics: Measurements of success. AAOHN Journal, 47(10), 479-491.

McFall, R.M. (1977). Parameters of self-monitoring. In R.B. Stuart (Ed.), Behavioral self-management: Strategies, techniques, and outcomes. NY, NY: Brunner/Mazel.

McLean, L., Tingley, M., Scott, R.N., & Rickards, J. (2001). Computer terminal work and the benefit of microbreaks. Applied Ergonomics, 32(3), 225-237.

Michael, J. (1993). Concepts and principles of behavior analysis. Kalamazoo, MI: Society for the Advancement of Behavior Analysis.

Michael, J. (2002). Basic principles of behavior. Unpublished manuscript, Kalamazoo: Western Michigan University.

National Academy of Sciences. (2001). Musculoskeletal disorders and the workplace: Low back and upper extremities. National Academy Press website. Available: http://www.nap.edu/openbook/0309072840/html/R2.html.

National Institute for Occupational Safety and Health. (2000). A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. National Institute for Occupational Safety and Health website. Available: http://www.cdc.gov/niosh/ergtxt2.html.

Nelson, N.A., & Silverstein, B.A. (1998). Workplace changes associated with a reduction in musculoskeletal symptoms in office workers. Human Factors, 40(2), 337-350.

Occupational Safety and Health Administration (1999). Preventing work-related musculoskeletal disorders. OSHA website. Available: http://www.osha-slc.gov/SLTC/ergonomics/ergofactnew.html.

Perdue, S. (1999). Addressing ergonomic hazards through behavioral observation and feedback. Safety Performance Solutions website. Available: http://www.safetyperformancesolutions.com.

Plog, B.A., Niland, J., & Quinlan, P.J. (Eds.). (1996). Fundamentals of industrial hygiene (4th ed.). Itasca, IL: National Safety Council.

Psihogios, J.P., Sommerich, C.M., Mirka, G.A., & Moon, S.D. (2001). A field evaluation of monitor placement effects in VDT users. Applied Ergonomics, 32(2), 313-325.

Reber, R.A., & Wallin, J. (1984). The effects of training, goal setting, and knowledge of results on safe behavior: A component analysis. Academy of Management Journal, 27(3), 544-560.

Revelle, T. (2000). Ergonomics 101: Working painlessly. Humanscale website. Available: http://www.humanscale.com/ergo_info/ergo_101_main.htm.

Rohn, D.H., & Austin, J. (2002). The momentary effects of observation: Examining the immediate effects of a behavior-based safety observation. Unpublished master's thesis, Western Michigan University, Kalamazoo, Michigan.

Robertson, M.M., & Courtney, T.K. (2001). Office ergonomics: Analyzing the problem and creating solutions. Professional Safety, 46(4), 25-29.

Sauter, S.L., & Schleifer, L.M. (1991). Work posture, workstation design, and musculoskeletal discomfort in a VDT data entry task. Human Factors, 33(2), 151-167.

Schneider, F. (2001). Four steps to an effective office ergonomics program. Occupational Health & Safety, 70(9), 140-144.

Shute, S.J., & Starr, S.J. (1984). Effects of adjustable furniture on VDT users. Human Factors, 26(2), 157-170.

Smith, M.J., Karsh, B.T., & Moro, F.B.P. (1999). A review of research on interventions to control musculoskeletal disorders. National Academy Press website. Available: http://www.nap.edu/openbook/03093973/html/R1.html.

Sulzer-Azaroff, B. (1978). Behavioral ecology and accident prevention. Journal of Organizational Behavior Management, 2(1), 11-44.

Sulzer-Azaroff, B. & Austin, J. (2000). Does BBS work? Behavior-based safety & injury reduction: A survey of the evidence. Professional Safety, 45(7), 19-24.

Swanson, N.G., Galinsky, T.L., Cole, L.L., Pan, C.S., & Sauter, S.L. (1997). The impact of keyboard design on comfort and productivity in a text-entry task. Applied Ergonomics, 28(1), 9-16.

United States Department of Labor. (1998). OSHA press release: Statements by Secretary of Labor Alexis M. Herman. Department of Labor website. Available: http://www2.dol.gov/dol/opa/public/media/press/osha/osh9848.htm.

United States Department of Labor. (2001). Lost-worktime injuries and illnesses: Characteristics resulting in time away from work, 1999. BLS website. Available: http://stats.bls.gov/oshhome.htm.

Washington Industrial Safety and Health Administration. (2000). Ergonomic tips: Neutral posture at your workstation helps prevent injury. WISHA website. Available: http://www.lni.wa.gov/wisha/ergo/officerg/offergee.htm.

3M Corporation. (1998). 3M office ergonomics self-help site: Workspace evaluation. 3M website. Available: http://www.3m.com/cws/selfhelp.